(3) Selection of alternative water resources

In comparison of potential for water supply, development cost and water quality, the development of the IKC-Ishim pipeline is selected as the preferred alternative plan.

There is a potential for development of irrigation using treated sewage in the project area although in-depth study needs to be done. Treated sewage is also recommended for forestation, which is less sensitive for water quality.

The Study Team considers groundwater as a future water resource option. Details need to be clarified as to the available production capacity of groundwater, together with monitoring of water quality. (Refer to Sub-section 6.2.3)

With regard to the water quality issue, it is recommended to take stage wise countermeasures. First when the amount of transferred water is not sizable, the dilution by mixing with the available water from the Ishim shall take effects to maintain the water quality. In later stage, dilution effects dissipates and more substantial measure need to be enacted. This issue shall be discussed later in Sub-section 4.2.4 (5).

4.2.4 Proposed Development Plan for Alternative Water Resources up to 2030

(1) Stage-wise Development of IKC-Ishim Pipeline Project

The water deficit in Astana City and its vicinity expands over a time span of 30 years as calculated in the previous section. In view of the necessity for a large scale facility to transfer the IKC water to the Ishim basin due to need of additional water resources, it is recommended to implement the IKC pipeline project in two stages, namely, to develop one half (90 MCM/year) of the water transfer capacity of the project in the first stage, and to develop the remaining one half (90 MCM/year) in the second stage.

(2) Development Plan of IKC-Ishim Pipeline Project for Target Years

1) Development Plan Up to 2010

Taking into consideration the water demand of Astana City and its vicinity, it is necessary to complete the first stage construction by 2003.

The pipeline is designed to transfer an annual amount of 90 MCM to the upstream of the Ishim River. It is assumed that 30% of the transferred amount will be lost due to evaporation at small ponds/lakes and human consumption while the haulage over a distance of 100 km of the Ishim River and a net volume of 63 MCM is designed to be available at Vyacheslavsky reservoir After the first stage development, an annual volume of 152.2 MCM including the design yield of 89.2 MCM/year of the Vyacheslavsky reservoir will be available at 95% dependability in Astana City and its vicinity.

The pipeline is 19.6 km in total length with the intake provided at about 6 km upstream of the pumping station No.19 of the IKC and the discharging outlet in the upstream of the Ishim River near Priishimsky village. Two-step elevation of water is designed on the total height of 122 m by two pumping stations.

The water pipeline consists of three sections; (i) a 9.6 km long pressure section of 1.4 m dia. steel pipe, (ii) a 3.2 km box culvert section, and (iii) a 6.8 km long non-pressure section of 1.2 m dia. RC pipe. The whole length of the pipeline is designed to be embedded under ground with a soil cover of minimum 1.6 m in order to enable water transfer even in winter season (see Figure 4.2.2).

In addition, one unit of water pump with a discharge capacity of 7 m^3/sec is designed to be provided each at pump stations No.17, 18 and 19 of the existing IKC in order to facilitate synchronized pump operation at these pumping stations for water transfer to the Ishim River. The following table shows major structures to be constructed/installed in the first stage development.

Major Facilities of First Stage Development

Structure	Nos.	Discharge capcity/Dimension
1) Steel pipe	1 lane	3.5 m^3/sec, 1.4 m dia. x 9.6 km long
2) RC pipe with box culvert	1 lane	3.5 m^3/sec, 1.2 m dia. x 10.0 km long
3) Pump stations with substations	2 stations	
4) Water pump at P/S of pipeline.	2 sets	3.5 m^3/sec, 61.0 m in static head
5) Water pumps at IKC P/S Nos.17, 18, 19	3 units	7.0 m^3/sec

2) Development Plan Up to 2020

The total water supply capacity of 152.2 MCM from the Ishim basin and the first stage development of IKC will meet the water demand up to 2020, as calculated in Subsection 4.2.3 (1). No additional development of the IKC-Ishim pipeline project is required in this period.

3) Development Plan up to 2030

Taking into consideration the projected water demand in this period, it is considered necessary to complete the second stage development of the IKC-Ishim pipeline project by 2025. After the second stage development, an annual volume of 215.2 MCM will be available at 95% dependability in Astana City and its vicinity.

The structural facilities that are required for the second stage development are (i) additional lane of water pipeline including steel pipe of the pressure section and RC pipe of the non-pressure section, and (ii) water pump units with the capacity of 3.5 m^3/sec. The relevant RC structures of two pump stations and box culver for water pipeline are included in the first stage construction. The following table shows list of major structures to be constructed/installed in the second stage development:

Major Facilities of Second Stage Development

Structure	Nos.	Discharge capcity/Dimension
1) Steel pipe	1 lane	3.5 m^3/sec, 1.4 m dia. x 9.6 km long
2) RC pipe with box culvert	1 lane	3.5 m^3/sec, 1.2 m dia. x 10.0 km long
3) Water pumps at P/S of pipeline	2 sets	3.5 m^3/sec, 61.0 m in static head

(3) Dependability of Water Supply at Target Years

A simulation analysis on reservoir operation of Vyacheslavsky reservoir is conducted to evaluate dependability of water supply in the years of 2010, 2020 and 2030 taking into consideration the development of additional water resources of IKC with the amount of 63 MCM/year by 2010 and 126 MCM/year by 2030. In the analysis, a tentative reservoir operation rule is presumed that maintains minimum storage capacity equivalent to one-year reserve at the end of each year by replenishment from IKC. The following table shows the results of analysis.

Dependability of Water Supply in Target Years

	2010	2020	2030
No. of years of water deficit	0	1	0
Dependability (%)	100	96.8	100

The above results show that the proposed development plan of water resources gives a dependability of water supply exceeding the minimum requirement of 95 % and thus can be justified.

(4) Water Resources Allocation

The simulation analysis mentioned above also depicted the operational aspect of the pipeline project in conjunction with the Ishim river basin. As the water from IKC requires to be lifted for the static head more than 100 m and subject to water loss detailed in (1) above, operation of the pipelines should be minimal.

The results of the simulation revealed water resources allocation under such principle to meet the water demand in 2010, 2020 and 2030, as summarized below. Replenishment by IKC is calculated to be 3.7% in 2010 of the total, 12.2 % in 2020 and 27.7 % in 2030, respectively.

Water Resources Allocation

	2010	2020	2030
Yield at Vacheslavsky Reservoir	101.0	118.5	115.9
Replenishment from IKC	3.9	16.5	44.3
Total	104.9	135.0	160.2
Note: IKC (%)	3.7	12.2	27.7

(5) Water Quality Control

It is proposed to adopt stage wise countermeasures for practical solution of water quality of IKC which indicates high content of copper in the water. During course of development of water resources of IKC, the following actions will be required:

1) First Phase

In the period up to 2020, replenishment from IKC will remain relatively low in average as calculated in Subsection (4). The IKC water will be substantially diluted to the level of Vyacheslavsky reservoir. In this phase, it is essential to establish a monitoring scheme for water quality of the Vyacheslavsky reservoir and in IKC. Since replenishment from

IKC tends to increase at the end of dry year period, particular care should be taken on these occasions.

2) Second Phase

In the period after 2020, replenishment from the IKC will increase up to 27.7 % in average in 2030. Monitoring needs to be intensified, as the water quality is expected to worsen in due course. Dilution effect will substantially dissipate with the increase of replenished volume, and more substantial countermeasures will need to be enacted.

For this purpose, it is essential to control water quality at the source of contamination. The watershed of the Irtysh river which is the source of IKC involves several industrial sites. In cases water contamination of copper of IKC is connected to a large number of industries, an extensive watershed management will have to be considered.

4.2.5 Implementation Schedule

Taking into consideration the future increase in water demand, it is estimated that the additional water supply from IKC will become necessary in 2004, so that the first stage construction of the IKC-Ishim pipeline will be required to be completed by 2003. However, in view of the decreasing water storage in Vyacheslavsky reservoir, the first stage construction is scheduled to be completed by July 2001.

The additional water supply from IKC will be required to be increased in 2026, so that it will be necessary to complete the second stage construction of the IKC-Ishim pipeline by the end of 2025. Assuming that the construction will take two years, it is necessary to start construction in the beginning of 2024.

The implementation schedule of the pipeline project is shown below.

Implementation Schedule of IKC-Ishim Pipeline Project

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
IKC-Ishim pipeline																															
1) 1 st stage construction	—	—																													
2) 2 nd stage construction																									—	—					

4.3 Planning of Water Supply System[3]

4.3.1 Present Conditions

Water supply in Astana City was started in 1937, and *Gorvodokanal*, a municipal enterprise for operation and maintenance of water supply and sewerage system in Astana City, was established in 1959. The enterprise was renamed in 2000 as ASA (*Astana Su Aransy*). During the 63 years of operation, the service area has been expanded to some 55 km^2, covering the population of 321,600 in 2000. The water supply system consists of drinking water supply for domestic and commercial users and technical water supply, with non-treated river water, mainly for factories.

(1) Water Treatment Plant

The existing water treatment plant is located 4 km east of the city center. This plant was constructed in two stages; the first stage in 1969 and the second in 1982. The plant has an original production capacity of 200,000 m^3/day and it mainly treats the raw water extracted and transmitted from Vyacheslavsky Reservoir.

The water treatment plant for drinking water utilizes a treatment process consisting of coagulation, sedimentation and filtration. Drinking water produced in recent years at this plant was approximately 146,000 m^3/day on average, while technical water produced was approximately 32,000 m^3/day[4]. Operation of water supply facilities in 2000 is summarized in Figure 4.3.1.

A major problem of this plant is that the original production capacity cannot fully be utilized now nor in future due to severe deterioration of the mechanical and electrical equipment. There are also some problems pertaining to the system design, such as turbulence in the sedimentation tanks.

Distribution pump stations for both drinking and technical water are located in the same building as the water treatment plant.

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[3] Full text of Water Resources Planning appears in Appendix F of Volume III; Supporting Report.

[4] Discrepancy exists in extracted and provided drinking and technical water amounts, reflecting the limited availability of flow measurement results.

(2) Distribution Network

For residents in Astana City, water supplied by ASA is the only water source. Drinking water is distributed through a network consisting of pipes with varying diameters from 1,000 mm to 50 mm with the total length of 489.3 km. These pipes are mainly cast iron or steel, though in some parts asbestos pipes are used. The distribution system is a pressured system without elevated reservoirs nor tanks. The network supplies to about 90,000 connections and 340 public faucets of domestic users and 1,800 commercial users or public utilities.

The technical water distribution network extends to the industrial area north of the city. At present, twelve factories use technical water, of which TETs-1 and 2 are the major consumers.

The leakage from the drinking water distribution network was estimated to be 26.2 % of the supplied volume from the water treatment plant, while the leakage and wastage by consumer's facility was estimated to be 20.1 %.

(3) Water Use

According to ASA's reports, drinking water is grouped into three categories; domestic use, public use and others. The domestic use consists of water consumption at living places, such ass apartments, houses and public faucets. The public use refers to the water consumption at governmental offices, schools, hospitals etc, and others include water consumption at working places such as enterprises, hotels, restaurants, shops etc. Others denote the remainder. Water consumption by these three categories in 1998, 1999 and 2000 (plan) are as follows.

Water Consumption by Category

	Annual (MCM)			Daily (m3/day) equivalent to annual			Per capita (lpcd)		
Year	1998	1999	2000	1998	1999	2000	1998	1999	2000
Domestic use	13.670	17.080	21,304	37,500	46800	58,400	135	155	181
Public use	2.271	1.762	2,076	6,200	4,800	5,700	22	16	18
Others uses	9.701	8.070	8,124	26,600	22,100	22,300	96	73	69
Total	25.642	26.912	31,504	70,300	73,700	86,300	253	244	286

Availability of watermeters at connection differentiate the consumption. There are about 9,400 flats with individual watermeters while some part of the remainder are equipped with bulk watermeters, total number of which is approximately one hundred, wherein a watermeter measures the total water consumption for the community in an entire apartment building. Actual water consumption was analyzed to collate the effects of individual watermetering on consumption, using the data on water measurements for 102 flats and 41 communities with bulk meters. While people living in flats with individual watermeters consumed only 133 Lpcd, those in apartments with bulk watermeters consumed as much as 295 Lpcd. This signifies that a significant gap exists between the two groups of consumers with substantial latent wastage of water in apartments with bulk watermeters. A large part of this gap is presumably caused by lack of bulk watermeter consumers' attentiveness on water use. To raise the consumers' attentiveness on water use shall be a key step in rationalizing the water use in the future in Astana City.

4.3.2 Demand Forecast

(1) Dinking Water

As discussed in Section 3.4, Astana will be a government, business city with industrial functions appropriate to the capital. As the capital of the republic, Astana will generally require highly reliable infrastructure systems, including water supply, for the republic's central cultural, medical and educational facilities, as discussed in Section 4.1.

Summarizing the following detailed calculations, the drinking water demand both at homes (domestic) and at working places, supplied with the treated water will be as follows.

Drinking water demand both at homes (domestic) and at working places - Summary

Housing Type	2010			2020			2030		
	Population	Lpcd	Demand (m^3/day)	Population	Lpcd	Demand (m^3/day)	Population	Lpcd	Demand (m^3/day)
Domestic	490,000	130	63,900	690,000	150	103,500	800,000	170	136,000
Working Place	-	-	20,130	-	-	29,100	-	-	31,700
Leakage	-	-	28,800	-	-	41,200	-	-	50,300
Total	490,000	230	112,840	690,000	252	173,800	800,000	273	218,000

Note; The drinking water consumed at working place does not include the water consumed for industrial use.

In comparison to the standard established in RK in SNiP the above estimation reasonably falls within the minimum and maximum bounds.

This water demand has been discussed thoroughly between the Study Team and the relevant authorities including Construction Committee, and was accepted duly by the Construction Committee and ASA. The following table summarizes the overall comparison between the estimation herein and those stipulated in SNiP.

Comparison of Water Consumption Projection and SNiP

Year		2010		2020		2030	
Unit		Lpcd	m^3/day	Lpcd	m^3/day	Lpcd	m^3/day
JICA M/P		230	112,840	252	173,820	272	217,970
SNiP	Min	200	98,135	225	155,574	237	189,624
	Max	301	147,495	342	235,858	357	285,712

For domestic use, installation of watermeters at each household connection shall be assumed for future water demand projection. By launching this individual metering scheme throughout the water supply service area, the per capita drinking water consumption for domestic use shall be decreased to 130 Lpcd in 2010. Therefore, an average increase of 20 Lpcd for every decade is applied in accordance with the projected income increase depicted in Section 2.2. The drinking water consumption at homes is thereby projected at 150 Lpcd in 2020 and 170 Lpcd in 2030 as shown below.

Type of Housing and Population/Water Consumption

Housing Type	2010			2020			2030		
	Population	Lpcd	Demand (m^3/day)	Population	Lpcd	Demand (m^3/day)	Population	Lpcd	Demand (m^3/day)
High	322,500	159	51,278	575,700	165	94,990	691,700	180	124,510
Middle - 1	42,100	137	5,768	49,700	130	6,460	49,700	160	7,960
Middle - 2	47,800	103	4,923						
Low	77,600	25	1,940	64,600	40	2,050	58,600	60	3,530
Domestic	490,000	130	63,900	690,000	150	103,500	800,000	170	136,000

Public and commercial water consumption of drinking water at working places is estimated in consideration of the number of employment discussed in Section 3.4. Providing that watermeters are installed at all connections, water consumption for each category is estimated as 70 percent of the present water consumption and water will be saved further, owing to stronger motivation for water conservation.

Public/Commercial Consumption (Working Place) up to 2030

Year	1999	2010	2020	2030
No. of Employee (persons)				
Public workers	36,100	61,900	94,300	108,600
Commercial workers	95,300	164,900	247,800	287,500
Total	131,400	226,800	342,100	396,100
Per Employee (lpcd)	133	90	85	80
Total Demand (m^3/day)	17,476	20400	29,100	31,700

Note; This is the drinking water consumed at working place, in addition to the water consumed at homes.

Industrial water consumption of drinking water is estimated in consideration of the number of employment and the development plans of *TETs* 1 and 2.

Industrial Consumption up to 2030

Year	1999	2010	2020	2030
No. of Industry workers	15,900	28,000	37,000	44,000
Per Employee (lpcd)	133	90	85	80
Demand by Employee(m^3/day)	2,115	2,520	3,150	3,520
TETs-1&2 (m^3/day)	22,260	28,590	29,250	29,880
Total (m^3/day)	24,375	31,110	32,400	33,400

(2) Technical Water

With respect to the technical water demand supplied with non-treated water, Astana will expand its light industry including food processing and agricultural machine fabrication, as discussed in Section 3.4. These industries do not require large quantity of non-treated technical water. Therefore the same water consumption rate per employee as present will be applied up to 2030, as shown in the table below. Technical water for *TETs*-1 and 2 is estimated in the same method as for the drinking water demand.

Technical Water Consumption up to 2030

Year	1999	2010	2020	2030
No. of Employee				
Industry	15,900	28,000	37,000	44,000
Per Employee (l)	27	27	27	27
Demand (m^3/day)	440	760	1,000	1,200
TETs – 1&2 (m^3/day)	15,560	21,440	24,300	28,000
Total (m^3/day)	16,000	22,200	25,300	29,200

(3) Raw Water Demand

In general all water supply systems have leakage and losses. Leakage occurs in (1) raw water transmission pipeline, (2) distribution network, and at (3) building/ houses. Losses also occur in the water treatment plant by de-sludging from sedimentation tanks and backwashing of filters.

Reduction of leakage and losses can be thought of as equivalent to exploitation of a new and additional water source. In view of the wide range of leakage detection practices, a combined loss rate of about 30% is considered as a proper target for the improvement of water loss reduction for dinking water supply in Astana. For technical water supply, a flat rate of 5% is applied.

In conclusion, the daily average water demands for the drinking water and technical water, as well as the daily average raw water demand for Astana are summarized in the following table.

Daily Average Water Demand

Year	2010	2020	2030
Drinking Water (m^3/day)			
- Water Demand	115,200	165,000	201,100
- Loss and Leakage	36,500	52,100	63,500
- Raw Water Demand	151,700	217,100	264,600
Technical Water (m^3/day)			
- Water Demand	22,200	25,300	29,200
- Leakage	1,200	1,300	1,500
- Raw Water Demand	23,400	26,600	30,700
Raw Water Demand - Total	175,100	243,700	295,300

4.3.3 On-Going and Planned Improvement

Some major works have already been commenced or are in preparation for improving and expanding the existing water supply system, as discussed below.

(1) Third Pipeline from Vyacheslavsky Reservoir to Water Treatment Plant

The third pipeline project shall consist of pipeline of 1,400 mm diameter between the Vyacheslavsky Reservoir and the treatment plan, and appurtenant intake pump facilities. Attempts have been made to finance this project basically on a Build-Operate-and-Transfer (BOT) scheme but were not successful. The Kazakhstan Government finally decided to turn down the BOT scheme and implement this pipeline installation by local funding.

(2) Water Treatment Plant

Improvement works such as replacement of filter sand and repair of electrical equipment at the water treatment plant have been planned, and a budget has been allocated from *Akimat*.

(3) Flowmeters and Watermeters

Installation of flowmeters at major water supply facilities for monitoring, as well as the installation of watermeters at major consumer connections is in progress.

(4) Urgent Rehabilitation by EBRD

As part of the TACIS interstate project "Widening the Environmental Action Program to the NIS and Mongolia", European Bank for Reconstruction and Development (EBRD) conducted a pre-investment feasibility assessment of funding in water supply and environmental infrastructure in Astana. The overall objective of the project is the introduction of sustainable, safe and efficient water and wastewater services in Astana.

This project is dormant now, for a clear and explicit commitment for managerial improvement of ASA, which is a prerequisite of financing by EBRD, has not been approved by *Akimat*.

4.3.4 Medium Term Development Needs

As depicted in Sub-section 4.3.2, the water demand will rapidly increase with population growth and economic development in Astana, which necessitates capacity expansion. At the same time, the existing water system is aged and deteriorated, and has come to curtail proper performance to provide sufficient service to the consumers. On these accounts, as the abovementioned projects are not entirely satisfactory, the following additional measures need to be fulfilled.

The description in this subsection is essentially in accordance with the proposals in the Feasibility Study of Water Supply and Sewerage.

(1) Water Sources

Vyacheslavsky Reservoir will remain as the staple water source for drinking water of Astana. The inflow of water from the spring floods in 1998 to 2000, however, was unexpectedly insufficient, and the current storage of the reservoir is endangering stable supply of water, necessitating additional water source urgently to meet with demand for water consumption.

(2) Water Supply Facility

Although the existing civil structure of Vyacheslavsky Reservoir Pumping Station is still operational, rehabilitation work will be extremely difficult since most of the equipment is located underground. When a new transmission pipeline is constructed, the existing pumps will not be suitable for operation because the existing pumps operating with a large pump head will not be economical. Therefore, new pumping station shall need to be constructed and pumps with an adequate performance shall be installed.

Water treatment plant, despite its original design capacity of 200,000 m^3/day, has impaired the full capability in terms of quantity and quality due mainly to superannuation of the facility in the 33 years of operation. Therefore, reconstruction of the whole treatment plant will be required.

The distribution pump station at the water treatment plant has enough supply capacity for both drinking water and technical water, but the existing pump facility is aged, and renovation of mechanical and electrical facilities is required for proper and reliable operation.

In addition to some reinforcement to the existing distribution system, water distribution system will be expanded to the eastern and western directions on the right bank of the Ishim River as well as to the southern direction crossing the river to the left bank. The main distribution pipelines shall be installed into the three directions with branch pipelines installed to cover new service areas.

(3) Non-Revenue Water Reduction Program

Without launching a non-revenue water reduction program, water demand would increase uncontrollably with the progress of new development. Under such circumstance, the existing water source would be short and development of a new water source would be necessary which would require a large amount of investment.

This is the reason why non-revenue water reduction program will be one of the major activities to be conducted, besides the new construction of water supply facility. This program will consist of two components; one is a reduction of physical losses, which requires monitoring of leakage; while the other is minimizing wastage of water use by consumers' attentiveness and an introduction of an improved tariff system.

4.3.5 Long Term and Ultimate Term Development Needs

Water demand in 2030 is projected to be 2.1 times of 1999 level. To cope with this increase, the following requirement shall have to be fulfilled.

(1) Water Source

The total raw water demand is projected to be 243,700 m^3/day in 2020 and 295,300 m^3/day in 2030. Irtysh-Karaganda Canal water will be utilized to meet this increase of water demand, as discussed in Section 4.2. Groundwater will be an emergency water source.

(2) Raw Water Intake Facility

The pumping station at Vyacheslavsky Reservoir shall be enlarged to meet with the required capacity in the future. Raw water transmission pipe shall additionally be constructed.

(3) Water Treatment Plant

The required production capacity for water treatment shall be more than 304,400 m^3/day by 2030. A new treatment plant shall be needed to cope with the water demand in several stages.

(4) Water Distribution Facility

The water supply service area will be extended to new development areas, and distribution pipes shall need to be installed at the time of development. The distribution pumping station at the water treatment plant has to be enlarged to meet with the demand.

(5) Non-Revenue Water Reduction Program

Non-revenue water reduction program shall be continued to maintain a sufficient water supply system.

4.3.6 Formulation of Water Supply Development Plan

Water supply facility shall be designed to provide the proper capacity shown in the following tables.

Design Parameters of Facility

Facility	Drinking Water	Technical Water
Intake Pump	Daily Maximum with Leakage and Treatment Loss	Daily Maximum with Leakage
Raw Water Transmission Pipe	Daily Maximum with Leakage and Treatment Loss	Daily Maximum with Leakage
Water Treatment Plant	Daily Maximum with Leakage and Treatment Loss	Daily Maximum
Distribution Pump	Hourly Maximum with Leakage	Hourly Maximum with Leakage
Distribution Network	Hourly Maximum with Leakage	Hourly Maximum with Leakage

Daily and Hourly Maximum Water Demand

Year	Ratio	2010	2020	2030
Drinking Water (m^3/day)				
- Daily Average without Leakage and Loss	-	115,200	165,000	201,100
- Daily Average with Leakage and Loss (Raw Water)	-	151,700	217,100	264,600
- Daily Average with Leakage	1.00	144,000	206,200	251,400
- Daily Maximum with Leakage (Treatment Plant)	1.20	172,800	247,200	301,700
- Hourly Maximum with Leakage (Distribution System)	1.40	241,900	364,100	422,400
Technical Water (m^3/day)				
- Daily Average without Leakage	-	22,200	25,300	29,200
- Daily Average with Leakage	1.00	23,400	26,600	30,700
- Daily Maximum	1.90	44,500	50,500	58,300
- Hourly Maximum	1.10	49,000	55,600	64,100

Water demand projection and proposed production capacity are shown in Figure 4.3.2.

Water intake sites will remain at Vyacheslavsky Reservoir for drinking water and Ishim River for technical water. Pumping station at the reservoir will be newly constructed in the first stage (by 2010) and expanded in the subsequent two stages.

A new raw water transmission pipe from the reservoir will be additionally installed to meet the demand in 2030 at the second stage by 2020.

Utilizing the existing water treatment plant, new plant with a capacity of 100,000 m^3/day will be constructed in the first stage. In the second stage, a new plant with a capacity of 120,000 m^3/day will be constructed near the existing intake pumping station along the Ishim River. The existing plant, which will be aged and superannuated by then, will be dismantled and an additional 100,000 m^3/day plant will be constructed in the third stage.

Distribution pumping stations will be located at water treatment plants, and they will be constructed and expanded to cope with the developments of treatment plants.

Only major distribution pipes are planned in this development plan, and branches shall be studied and designed in detail at the stage when the actual development will be implemented.

The following descriptions and Figure 4.3.3 summarizes major water supply facilities for future water supply development plan.

Priority Project (Phase 1 Project : Scope of JICA Feasibility Study)

In order to reinforce water production capacity and its reliability, construction of a new pumping station at Vyacheslavsky Reservoir, rehabilitation of electrical facilities in pumping station at Ishim River and construction of a new treatment plant (No. 1 – 100,000 m^3/day) and a new distribution pumping station shall be implemented by 2010.

As for distribution network, some existing pipelines shall be given priority for replacement to minimize leakage. Residential Districts 4B, 9, 10, 12, 13, 17 and 14(part), Industrial District Station 40 and Planning District I and VII are planned to develop by 2010, distribution pipelines for these new service area shall be installed with the development.

Water Supply Development Project for 2020 (Phase 2 Project)

To cope with increase of water demand, construction of an additional pumping station at Vyacheslavsky Reservoir, a raw water transmission pipeline from the reservoir, construction of a new treatment plant (No. 2 – 120,000 m^3/day) and a new distribution pumping station shall be implemented by 2020.

As for distribution network, Resident District 14 (part), 15 (part), 16 (part), 18 and 19, and Planning District III and IV are planned to develop by 2020, and new distribution pipelines for these new service area shall be installed with the development.

Water Supply Development Project for 2030 (Phase 3 Project)

In order to reinforce water production capacity and its reliability, construction of a new pumping station at Vyacheslavsky Reservoir, rehabilitation of electrical facilities in the pumping station at Ishim River and construction of a new treatment plant (No. 3 – 100,000 m^3/day) and additional distribution pumping station shall be implemented by 2020.

As for distribution network, some existing pipelines shall be given priority for replacement to minimize leakage. Resident District 11, 15 (part), and 16 (part), and Planning District II are planned to develop by 2030, distribution pipelines for these new service area shall be installed with the development.

4.3.7 Infrastructure Plan for New City Center

New City Center consists of Government Area, Diplomatic Area and Business Area, and it is located at Resident District 13 and a part of District 14 in Southern Planning Region. The center will have a population of 18,600 and working population of 94,300 in 2030. Daily maximum water consumption of 18,900 m^3/day is projected for domestic and public/commercial use in this center.

Drinking water will be supplied from the existing water treatment plant before the second stage of expansion, and it will be supplied from new plant at the left bank of the Ishim River after expansion.

This center will be serviced by major water distribution pipes of 400 to 700 mm diameter, which will also transmit water to other surrounding districts. Water supply pipelines on Street No. 1 and 2, which are planned to be installed using *Akimat*'s budget can be considered as the branches to supply water to each facility in this center.

Refer to Figure 4.3.4 for the infrastructure planning of the New City Center.

4.3.8 Implementation Schedule

Water supply development plan is proposed to implement by the following three stages to cope with water demand increase.

Priority Project (Phase 1 Project : Scope of JICA Feasibility Study)

This priority project shall be implemented by 2008. The actual construction shall be about four years, from 2004 to 2007.

Water Supply Development Project for 2020 (Phase 2 Project)

Phase 2 Project shall be implemented by 2014. The actual construction shall be about three years, from 2011 to 2013.

Water Supply Development Project for 2030 (Phase 3 Project)

Phase 3 Project shall be implemented by 2020. The actual construction shall be about three years, from 2017 to 2019.

4.4 Planning of Sewerage System[5]

4.4.1 Present Condition

The existing sewerage system covers an area of about 3,500 ha of mostly urbanized part of Astana City, in relation to the entire city's administrative area of 71,000 ha. According to the implementing agency of sewerage services, *Astana Su Aransy* (ASA), while the service population of water supply counts 300,900, 220,200 residents have access to sewerage service as of 1999. The sewerage system consists of sewer pipes, sewage pumping stations and the sewage treatment plant, all operated and managed by ASA.

(1) Sewage Collection System

The sewage collection system includes sewer pipelines and 37 pumping stations. All the sewage collected by the system is transmitted to a sewage treatment plant (STP) located on the left bank of the Ishim River at about 7 km southwest of the city center. Existing sewer mains have capacity enough to collect and transmit all the sewage generated in Astana. A large proportion of the sewage collection system, however, is very old and is thereby in a poor condition. Especially, about 20 km mainly unprotected steel pipelines and mechanical and electrical equipment in seventeen (17) sewage pumping stations are in a severely superannuated condition.

About 30 % of households are not at all connected to the sewerage system, as sewer pipes are installed only in limited areas. These households have on-site treatment facilities (septic tanks and night soil storage tanks). Fifty (50) septage collection vehicles are in operation by a municipal enterprise, "Gorcommunkhoz".

(2) Sewage Treatment Plant

The sewage treatment plant (STP) uses the conventional activated sludge process with a design treatment capacity of 136,000 m^3/day, while the actual amount of influent to the STP is estimated about 100,000 m^3/day on a daily average. Present operational condition of the plant is satisfactory, although requiring rehabilitation and/or replacement in some parts of sections, mainly the electric and mechanical equipment.

The effluent from STP is discharged to Taldy Kol Impounding Reservoir by pumping facilities. As Taldy Kol Reservoir does not have any outlet, the

[5] Full text of Water Resources Planning appears in Appendix G of Volume III; Supporting Report

water in excess of the reservoir capacity is sometimes discharged through an emergency pipe to a low-lying wetland northwest of the reservoir.

4.4.2 Demand Forecast

Proper management of wastewater is essential in preserving the natural environment and mitigating the impacts of human activities on the environment. Thus in this Master Plan, the sewerage system is planned to cover all the existing and planned residential districts (14,060 ha in 2030) as well as industrial districts. As shown in the following table, residential sewerage service area will increase from 3,284 ha at present to 14,060 ha in 2030, and the sewerage service population will increase from 220,100 at present to 760,000 in 2030. About 90 % of the sewage will be generated in the residential sewerage service area. Sewerage service population rate is planned to increase from the present 73 % to 95 % in 2030.

Sewerage Service Area and Population

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

*) Sewage service area excluding Industrial Area

The results of sewage generation forecast in Astana City up to 2030 are shown below.

Sewage Generation Forecast **(unit: m^3/day)**

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

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

4.4.3 Taldy Kol Reservoir

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

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

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

In order that the capacity of the Taldy Kol Reservoir would not be surpassed in future, the volume of effluent water to be discharged to the reservoir needs to be reduced in one of the following ways;

1) To discharge the effluent to the Ishim River and/or Nura River

2) To use the effluent for irrigation

At present, discharge of effluent to the Ishim River and Nura River is not allowed due to the environmental regulation in Kazakhstan whilst agricultural land has not been ready yet to receive the treated wastewater.

<u>Irrigation Development Plan</u>

Irrigation use of treated sewage had been considered in the Soviet Union era, and irrigation land operated by using the water from Taldy Kol Reservoir was not more than 1,700 ha in area, although the scheme collapsed at the disintegration of Soviet Union. It is recorded that the productivity of crops in the agricultural land are

20,000 kg/ha of potato, 37,900 kg/ha of corn for silage of and 21,000 kg/ha of Forage Crop

As the unit water demand for the irrigation area is estimated at 4,000 m^3/ha /year by Ministry of Agriculture, water demand for 1,700 ha of irrigation area is roughly estimated 6.8 million m^3/year.

There is a large potential of agricultural development south of Taldy Kol Reservoir. The F/S of Water Supply and Sewerage for Astana indicated that 8,500 ha of land has the potential for irrigation using the treated wastewater. As the Medium Term project by 2010, it is recommendable that about 1,700 ha of agriculture land, equal to the Soviet era extent, will be developed for re-use of the treated wastewater. As the Long Term by 2020, 8,500 ha of agriculture land is assumed for development. The proposed development plan of agriculture land and required minimum water demand is shown in the table below.

Tentative Development Plan for Agriculture Land for Re-use of Treated Wastewater

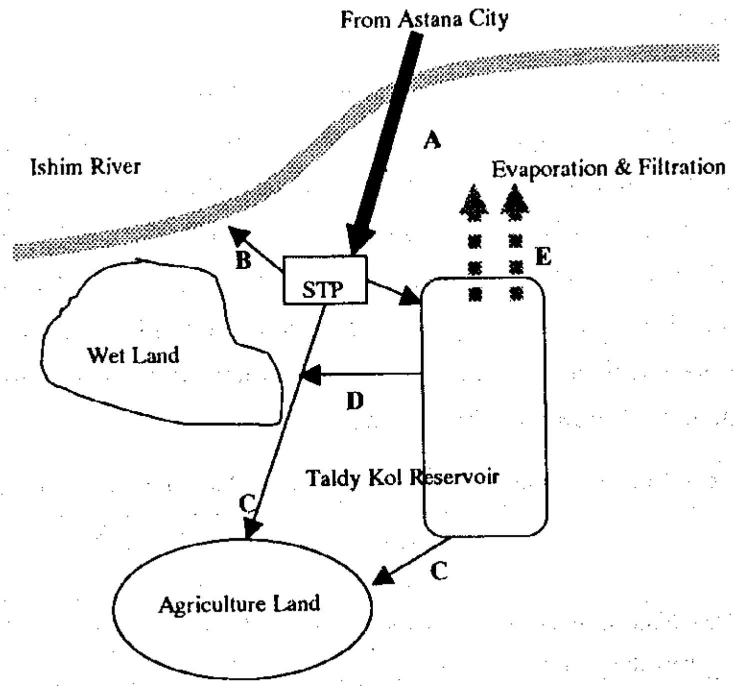
	Before 1995	2000	2010	2020	2030
Development Area for Irrigation (ha)	1,700	0	1,700	8,500	8,500
Irrigation Water Use (million m^3/year)	6.8	0	6.8	34.0	34.0

Even with agricultural development, lands would not be irrigated during the winter season. A large volume of seasonal storage would therefore be required to keep effluent in the winter. It is recommendable to keep Taldy Kol Reservoir as a seasonal storage pond to allow for an effective operation of the irrigation system.

<u>Discharge to the Ishim River</u>

Even if 8,500 ha of agriculture land is developed for the reuse of the treated wastewater, all the effluent could not be used up. For using up all of effluent of STP in 2030, 16,500 ha of agriculture land would be necessary. At present it is difficult to propose a development plan of this extent of agriculture land without a detail study for the development.

It would be a realistic option to discharge part of the treated wastewater to the Ishim River in winter season on the Long Term. Advanced treatment process would be required at STP to achieve suitable water quality in order to discharge to the Ishim River. In order to introduce proper changes in the environmnetal regulation and to select the suitable advanced treatment process, further study will be required. This option is also recommendable from viewpoint of water balance of the Ishim River.



Tentative Water Balance Diagram of Treated Sewage (Alternative 1)

(million m^3/year)

		1999	2010	2020	2030
A	Sewage Generation Amount	36.5	40.9	62.5	79.1
B	Direct Discharge to Ishim River After Advanced Treatment	0	0	14.6	45.1
C	Irrigation Water Use	0	6.8	34.0	34.0
D	Discharge from Taldy Kol Reservoir to Wetland in Flood Season	6.9	6.9	6.9	0.0
E	Evaporation and Filtration (when Taldy Kol Reservoir is full)	29.6	27.2	7.0	0.0
F	Surface Area of Taldy Kol Reservoir (km2)	21.3	19.6	5.1	0.0

There is an opinion that Taldy Kol Reservoir should be reclaimed completely before 2010. If this opinion is to be realized, about 8,500 ha of agriculture land for the reuse of treated wastewater and irrigation system with storage ponds shall have to be developed in due time as shown below.

Tentative Water Balance Diagram of Treated Sewage (Alternative 2)

		1999	2010	2020	2030
A	Sewage Generation Amount	36.5	40.9	62.5	79.1
B	Direct Discharge to Ishim River After Advanced Treatment	0	0	14.6	45.1
C	Irrigation Water Use	0	34.0	34.0	34.0
D	Discharge from Taldy Kol Reservoir to Wetland in Flood Season	6.9	6.9	6.9	0.0
E	Evaporation and Filtration (when Taldy Kol Reservoir is full)	29.6	0.0	7.0	0.0
F	Surface Area of Taldy Kol Reservoir (km2)	21.3	0.0	5.1	0.0

4.4.4 Medium Term Development Needs

(1) Sewage Treatment Plant

The existing sewage treatment plant is considered to be operating properly at present, and has large enough a capacity to treat the volume of sewage to be generated in 2010. In order to assure proper operation in the future, however, large-scale rehabilitation works of STP are required. The rehabilitation works includes sludge treatment process.

(2) Sewage Collection System

Although the design capacity of the existing sewage collection system is considered to have enough capacity for the present demand, some rehabilitation and/or expansion works need to be carried out for the present and future operation, as discussed below.

Rehabilitation

Old and decrepit sewer pipes and sewage pumping stations sometimes cause blockage of sewage flow. For proper operation of the sewage collection system, rehabilitation of old sewer pipes and sewage pumping station is required.

Expansion

About 4,300 ha of new residential area will be developed by 2010 both on the left bank of the Ishim River and eastern part of the right bank. Installation of sewage collection system shall be necessitated in the new development area in time for the commencement of construction of housing units in the area.

4.4.5 Long Term and Ultimate Term Development Needs

(1) Sewage Treatment Plant

The sewage generation amount in 2013 is expected to exceed 136,000 m^3/day (capacity of existing STP). The capacity of STP therefore should be expanded before 2013. The sewage generation in 2030 is projected at 216,842 m^3/day, which means that more than 80,000 m^3/day of the capacity shall be expanded before 2030. In order to reduce pollution load on water bodies, the rapid sand filter process is to be introduced in the expanded facilities. Rapid sand filter process, which is most popular advanced treatment process, is expected to reduce about 50 % of BOD load of effluent of the STP.

After 2020, residential area will expand within 2 km of the STP site. The sludge drying beds will be demolished and mechanical de-watering facilities are to be introduced in order to reduce offensive odor impact.

Even if the existing sewage treatment plant would be rehabilitated properly, the STP will require rehabilitation again in 20 years, because of the superannuation of the equipment.

(2) Sewage Collection System

The sewage collection system shall be developed to meet the residential area development year by year. Residential sewerage service area is planned to expand to 12,320 ha in 2020, and 14,060 ha in 2030. After 2010, not only sewer pipes in new development area, but also trunk main should be installed to increase sewage transmission capacity to STP. The pumping stations also shall be reinforced to meet future demand.

4.4.6 Formulation of Sewerage Development Plan

(1) Basic Strategy of Development

As the conclusion of the study, the basic strategy of sewage system development is shown below.

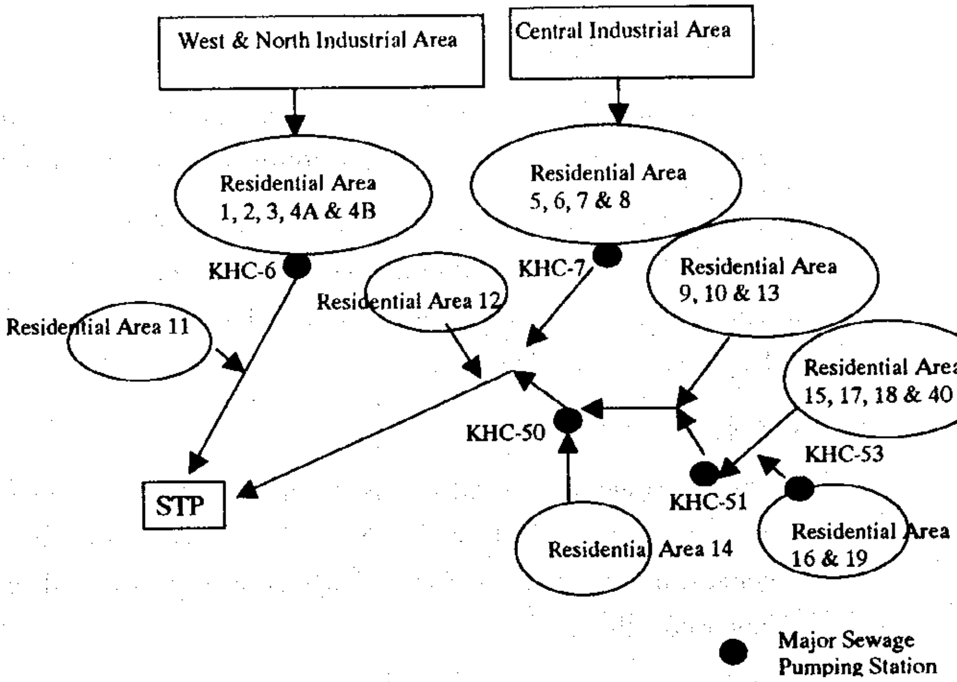
Sewage Treatment Plant

- The existing STP will be rehabilitated and expanded to meet future demand. Advanced treatment process will be introduced to new expanded facilities.
- The treated sewage will be discharged to Taldy Kol Reservoir, and surplus water will be discharged to the wetland northwest of the reservoir in the same manner as in the present operation. The re-use of treated sewage shall be promoted for irrigational use.

Sewage Collection System

- The sewerage service area consists of two separate service areas, West Service Area and East Service Area. Each service area has a trunk main connecting directly to STP. Two service areas will be developed independently.
- The sewerage service area will cover both the residential districts and industrial districts. The sewage collection system in the residential districts shall be expanded to service the planned new residential development. The existing sewage collection system in the industrial districts is considered to have enough capacity for the sewage generated in the industrial districts up to 2030. The sewage collection system in the industrial districts will not therefore be mentioned in this Master Plan.
- The number of new pumping stations shall be minimized, in view of efficient operation of the system,

The proposed system diagram of the sewerage system in Astana City up to 2030 is shown below.



Proposed System Diagram of Sewerage System In Astana

(2) Development Plan of Sewage Treatment Plant

To meet the increasing sewage generation up to 2030, the capacity of the STP shall be increased as shown below.

Development Plan of Sewage Treatment Plant

Item	2010	2020	2030
Incremental Capacity (m^3/day)	0	40,000	42,000
Secondary Treatment Capacity (m^3/day)	136,000	176,000	218,000
Advanced Treatment Capacity (m^3/day)	0	40,000	218,000

In order to operate at the design treatment capacity, the existing STP shall be rehabilitated, and before 2030, 20 years after the rehabilitation, the STP will again require full-scale rehabilitation and advanced treatment process.

(3) Development Plan of Sewage Collection System

<u>Sewer Pipe</u>

Sewer pipes shall be installed mainly in newly developed residential districts as shown in Figure 4.4.1 and summarized in the following table.

New Installation of Sewer Pipes

Pipe Diameter (mm)	2010	2020	2030
1200 - 1500	3.4 km	7.0 km	0
800 - 1000	9.1 km	13.0 km	0
350 - 600	23.6 km	30.5 km	15.0 km
Total	36.1 km	50.5 km	15.0 km

Pumping Station

From the view point of minimizing the number of pumping stations, location of the new pumping stations are selected. Three new pumping stations will cover 8,700 ha of sewerage service area in the new development area, which is on the left bank of Ishim River and the east side of right bank of Ishim River in the City. Required capacity of the pumping station is shown below.

Required Capacity of Major Pump Station Capacity

(hourly peak: m^3/h)

Pump Station	2010	2020	2030
KHC-50	2,300	4,700	6,100
KHC-51	1,200	2,900	3,800
KHC-53	-	700	1,200

(4) Outline of Proposed Project

1) Priority Project

Rehabilitation Project for the Existing Sewage Treatment Plant

The project consists of the rehabilitation of pumping facilities in STP; re-construction of grit removal and disposal facilities; rehabilitation of primary and final sedimentation tanks; rehabilitation of aeration tanks; and construction and rehabilitation of sludge treatment facilities. The project shall be completed as early as possible. Considering the implementation schedule, the project could be completed in 2007.

Sewage Collection System Rehabilitation Project.

In all 20 km of sewer pipes, mainly unprotected steel pipes are to be replaced and seventeen sewage pumping stations shall be rehabilitated.

The project shall be completed as early as possible. Considering the implementation schedule, the project could be completed in 2007.

Sewage Collection System Expansion Project (1)

Sewage collection system shall be constructed in the area of 4,200 ha to be developed up to 2010. Three pumping stations and approximately 36.1 km of sewer pipes shall be constructed.

2) Sewerage Development Project for 2020

STP Expansion Project (1)

The treatment capacity of 40,000 m^3/day with advanced treatment process shall be expanded to treat the sewage generation volume in 2020. The project should be completed by 2013, when the sewage generation amount exceeds the capacity.

Sewage Collection System Expansion Project (2)

Sewage collection system shall be constructed in the area of 4,300 ha to be developed between 2010 and 2020. New pumps shall be installed in three pumping stations, and one new pumping station shall be constructed, and approximately 50.5 km of sewer pipes shall be constructed. 6 km of trunk main (transmission pipe to the STP) shall be installed before 2015 to supplement the shortage of capacity of the existing trunk main. All works for the project shall be completed before 2020.

3) Sewerage Development Project for 2030

STP Expansion Project (2)

The treatment capacity of 42,000 m^3/day with advanced treatment process shall be expanded to process the sewage generation in 2030. The project shall be completed by 2023, when the sewage generation amount exceeds the capacity.

STP Rehabilitation Project

By 2030, rehabilitation of the STP and introduction of advanced treatment process will be required. The project may be carried out in parallel with

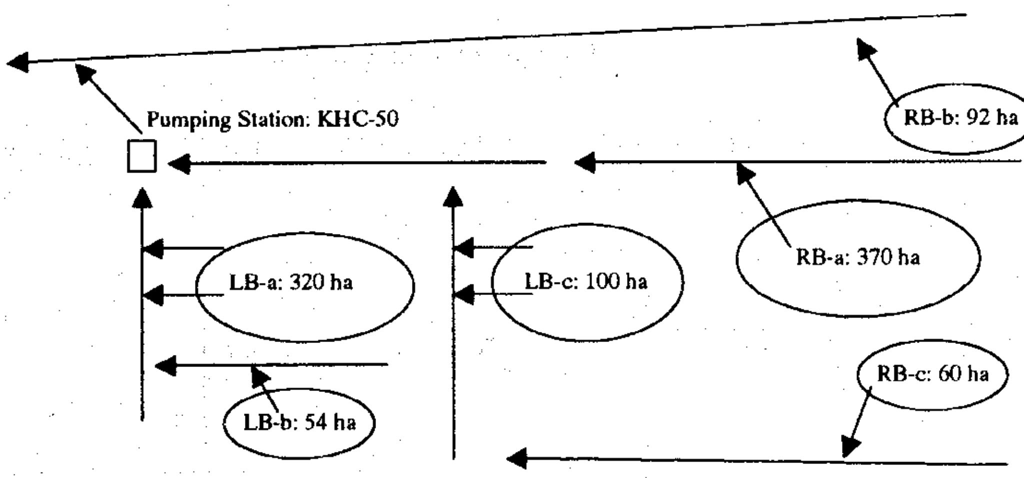
STP Expansion Project (2). The sludge drying beds will be demolished and mechanical de-watering facilities are to be introduced.

Sewage Collection System Expansion Project (3)

Sewage collection system shall be constructed in the area of 1,700 ha to be developed between 2020 and 2030. New pumps shall be installed in three pumping stations, and approximately 15.0 km of sewer pipes shall be constructed.

4.4.7 Sewerage Development Plan of New City Center

Major sewer pipeline routes are shown in Figure 4.4.2. The figure indicates that all the sewage generated in the New City Center area is discharged to the pumping station KHC-50. For the planning of collection in the area, the New City Center area is divided into 6 sub-areas. The proposed system diagram is shown in the figure below.



System Diagram of Sewerage System in New City Center

Sewage generation forecast for each area is shown below.

Sewage Generation Amount

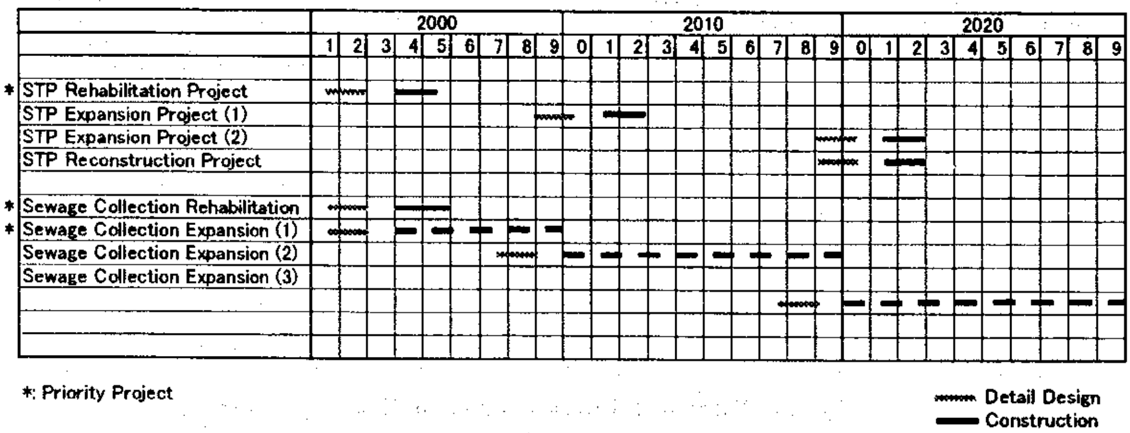
	Area	2010	2020	2030
Left Bank (a)	320 ha	3,260	4,021	4,365
Left Bank (b)	100 ha	1,019	1,256	1,364
Left Bank (c)	54 ha	550	678	736
Right Bank (a)	370 ha	813	938	1,063
Right Bank (b)	92 ha	202	233	264
Right Bank (c)	60 ha	132	152	172
Total	996 ha	5,976	7,278	7,964

Akimat has already started to install sewer pipes in the Left Bank (a) area. Sewer pipe installation in the area shall be completed before 2010.

4.4.8 Implementation Schedule

As described in Sub-Section 4.4.5 (4), eight projects are proposed for the development of sewerage system in Astana City up to 2030. The proposed implementation schedule is shown in the figure below.

Implementation Schedule



4.5 Planning of Power and Heat Supply System[6]

4.5.1 Present Conditions

(1) Electric Power and Heat Energy Sector

Astanaenergyservice (AES) registered as an opened joint-stock company produces heat and electric energy and sells them to users of Astana City. Also, it controls the following four affiliate companies in performing their activities:

- Electric power and heat energy generating station for *TETs*-1 (OJSC *TETs*-1)
- Electric power and heat energy generating station for *TETs*-2 (OJSC *TETs*-2)
- Heat supply company (LLC *Teplotranzit*)
- Electricity distribution and supply company (LLC *Gorodskie elktroseti*)

(2) Historical Trend and Present State of Electric Power Supply

1) Historical Trend of Electric Power Supply

Most of the electric power required for Astana City is generated by the coal-fired thermal plant, *TETs*-2 while approximately 5% of the whole electricity requirement is supplied from Ekibastuz through the Ekibastuz – Astana 500 kV single transmission line.

Although *TETs*-1, another coal-fired thermal plant, generates a small amount of electricity, the power is only used for the operation of facilities within *TETs*-1 itself.

Peak electric power demand was 1,198,096 MWh in 1995 but gradually decreased to 935,776 MWh in 1997 mainly because of decline of industrial activities and decreasing population. The declining trend was reversed in 1998 with the annual growth rate of 8.5%, and the electric power demand in 1999 reached 1,156,829 MWh with the annual growth rate of 13.9%. This sharp change was presumable due to the rapid expansion of Astana City that had become the new capital of Kazakhstan in late 1997.

6 Full text of Water Resources Planning appears in Appendix H of Volume III; Supporting Report.

2) Present State of Electric Power Supply

Average electricity tariff is Tenge 3.84/kwh, while the electric power generation cost at *TETs*-2 sending end is approximately Tenge 0.8/kwh. Fuel cost of coal is approximately Tenge 700 /t (with VAT), whereas fuel cost of heavy oil is approximately Tenge 15,400 /t (with VAT).

At present, electric power consumed by *TETs*-2 for electric power and heat energy production is approximately 17.5% of the generated electric power at the generator end. Moreover, there are considerable transmission losses consisting of technical loss and non-technical loss and unknown factor and the sum exceeds 36% of the generated power at *TETs*-2.

As a result, applicable effective electric power is approximately 46% of the generated power at the generator ends of *TETs*-2.

3) Power Supply Network

The electric power for Astana City is supplied by 110 kV transmission lines from two power sources; one is *TETs*-2 and the other is 500 kV central substation of KEGOC (Kazakhstan Electricity Grid Operation Company). AES buys electric power from KEGOC when the electric power supply is insufficient due to periodical inspection or trouble of some electric power generation unit of *TETs*-2.

Although the total installed capacity of electric power generating facilities of *TETs*-2 is 240 MW, available electric power generation at present is 219 MW, mainly because of the aging and functional decline of the generating facilities.

(3) Historical Trend and Present State of Heat Energy Supply

1) Historical Trend of Heat Energy Supply

The heat energy is supplied by means of hot water and steam from the electric power and heat energy generating stations *TETs*-1 and *TETs*-2. While *TETs*-2 supplies heat energy throughout the year, *TETs*-1 normally supplies heat energy only in winter.

The average annual heat energy supply amount was 2,539 x 1000 Gcal (*TETs*-1; 612 x 1000 Gcal, *TETs*-2; 1,927 x 1000 Gcal) during the past five years. In 1999, the total generated heat amount was 2,721 x 1000 Gcal (*TETs*-1; 600 x 1000 Gcal, *TETs*-2; 2,121 x 1000 Gcal) which was 14% higher than that of 1998.

2) Present State of Heat Energy Supply

Approximately 70% of heat energy consumed in Astana City is supplied by *TETs*-1 and *TETs*-2 through the central district heating system.

The design heat capacity of *TETs*-1 is 732 Gcal/h and usual heat supply amount is in the range of 300 to 330 Gcal/h. Optimal heat supply amount of *TETs*-2 is 540 Gcal/h, though recent data show that the amount was 465 Gcal/h as peak load in winter season.

Generation cost of heat energy by *s* is approximately Tenge 465/Gcal, while the sale price of heat energy is Tenge 1,468 /Gcal

3) Heat Supply Network

The existing central district heating system covers the central area on the right bank of Ishim River. The heat for space heating and hot water for domestic use in the city is supplied by means of high temperature hot water. In order to distribute hot water evenly to each user, five pressurizing pump stations are in service. In addition, No.6 pump station is now under construction.

(4) Electric Power and Heat Energy Generating Stations *TETs*-1 and *TETs*-2

<u>TETs-1</u>

The major facilities of *TETs*-1 consist of four (4) sets of steam generating boilers, six (6) sets of hot water boilers and three (3) sets of steam turbine-generator sets. In general, main activity of *TETs*-1 is in winter season because no production of heat energy from May to the end of August.

As the most of the facilities except No.1 and No.2 boilers have been operated for 30 years or more since their first commissioning, their retirement will be required within 10 to 15 years, when the aging No.1 boiler replacement will need to be considered.

<u>TETs-2</u>

TETs-2 supplies both electric power and heat energy to Astana City throughout the year.

Major facilities of *TETs*-2 consists of five (5) sets of 420 t/h steam generating boiler, and three (3) sets of 80MW turbine generator for electric power generation as well for steam supply to the hot water heating system.

As the fuel for generating electric power and heat energy, domestic coal is transported by railways from Ekibastuz located approximately 300 km east of Astana City. Although unit price of the coal is relatively low, the coal quality is not high due to extremely high ash content (approximate 40%). As most of the major facilities except No.5 boiler have been in operation for more than 15 years since their first commissioning, some of them for even 21 years, costs for maintenance and improvement of de-rated steam turbines are becoming high, with occasional steam generator trouble owing to high ash content of coal.

4.5.2 Demand Forecast

(1) Forecast Methodology

Methodologies of electric power and heat energy demand forecasts may be classified into two; one is the macroscopic forecasting method in which the electric power and heat energy demand for Astana City are forecasted as a whole and on a long term, while the other is the microscopic forecasting method which the distribution of high and low electric power and heat energy demand areas in Astana City is individually scrutinized. The latter method is appropriate for short term forecasting, as this enables the planning of district-wise distribution of electric power and heat energy demand, which is essential to the power and heat energy system planning.

(2) Peak Load Electric Power and Heat Energy Demand Forecast

The microscopic forecast results for electric power and heat energy demands are shown below. The projected district-wise demand data were widely adopted for selecting capacities of local facilities for electric power and heat energy.

Projected Electric Power Demand Forecast (Peak)

Unit: MW

	2000	2005	2010	2015	2020	2025	2030
Electric Power Demand Forecast (Peak)	226	295	362	425	485	530	570

Projected Heat Energy Demand Forecast (Peak)

Unit: Gcal/h

	2000	2005	2010	2015	2020	2025	2030
Heat Energy Demand Forecast (Peak)	764	1,045	1,306	1,465	1,619	1,797	1,974

4.5.3 Medium Term Development Needs

(1) Planned and Scheduled Improvements

Based on the above peak load electric power demand forecast, the peak load in 2001 is estimated approximately 240 MW which is equal to the total installed capacity of steam turbine generators of *TETs*-2.

In the mean time, the peak heat energy demand forecast shows that the demand of 1,045 Gcal/h in 2005 exceeds the latest maximum applicable heat generation of 1,014 Gcal/h. It is essential and urgent to newly construct additional electric power and heat energy generating facilities in order to supply power and heat for the rapidly developing areas in Astana City including the New City Center.

AES has prepared a report showing the development of heat and power supply system of Astana City for the period up to 2005. Major items in the report are;

- To supply electricity to new substation in New City Center from Airport switching substation with new 110 kV transmission lines,
- To supply heat energy to New City Center from *TETs*-1 and *TETs*-2 through the new extension pipelines,
- To construct a 115 MW electric power and heat energy generating plant at *TETs*-2 as an extension project, including reconstruction and modernization of the existing facilities and energy saving measures.

In addition, the list of facilities instructed for construction in the Astana City in 2001 includes the above transmission lines (the Minutes of meeting with the President of the RK).

The followings are the planned and scheduled improvements.

1) Electric Power Supply

i) New construction of 110kV transmission lines from Airport switching substation to new substation in New City Center and new construction of 110kV/10kV substation

Period of completion; 2001

ii) New construction of 110kV transmission lines from the existing switching substation Eastern to new substation in District No.17 and new construction of 110 kV/10 kV substation

Period of completion; 2010

iii) New construction of 110kV transmission line from *TETs*-2 to Airport switching substation along with the planned outer ring road

Period of completion; at the end of 2005

2) Heat Energy Supply

Extension of heat distribution pipelines from the existing district heating system (supplied from *TETs*-1 and *TETs*-2) to New City Center and District No. 17

Period of commissioning; by 2003, 2010 (Dist. 17)

3) Electric Power and Heat Generating Plant

New construction of 115 MW conventional coal fired electric power and heat energy generation plant at *s* –2 as extension project

Period of commissioning; at the beginning of 2006

(2) Medium Term Development Needs

Major developing areas up to 2010 are New City Center, District No.17, District No.9 and District Station 40. The following is an outline of development needs to supply electricity and heat energy in accordance with the projected demand of each developing area on a 10 year term.

1) Electric Power Supply

i) 110kV transmission lines to the developing areas including new transmission lines from *TETs*-2 to Airport switching substation as replacement of the existing old transmission lines

ii) New construction of 110kV/10kV substations to distribute electricity to each developing areas such as New City Center, District No. 17 and High-Tech Park in District I

iii) Supply of electricity required for extension of the existing water treatment plant, sewage treatment plant and new provision of south-north line of light railway transit (LRT) through the existing 110kV/10kV substations, Airport switching substation and Koktem substation

2) Heat Energy Supply

Extension of heat distribution pipes from the existing central district heating network to the developing areas including New City Center

3) Electric Power and Heat Energy Generating Plant

Installation of a new electric power and heat energy generating plant at *TETs*-2 to supply electricity and heat energy to the developing areas will be necessary.

4.5.4 Long and Ultimate Term Development Needs

The followings show long term and ultimate term development needs in the year range from 2010 to 2030.

In order to supply electric power and heat energy to the development areas in the entire Astana City, the following provisions are required.

<u>Up to 2020</u>

1) Electric Power Supply

110 kV transmission lines and substations will be newly provided in accordance with the demand requirements

i) 110 kV transmission lines;

From Airport switching substation to new substation in District No. 14

From 500 kV Central Substation to Western switching substation

From Western switching substation to Airport switching substation

From *TETs*-2 to High-Tech Park in District III

ii) 110 kV/ 10 kV substations;

New substation in District No. 14

New substation at High-Tech Park in District III

iii) Supply of electricity required for extension and new facility of water treatment plant and extension of sewage treatment plant and new provision of LRT East-West Line

2) Heat Energy Supply

As the district heating systems, heat centers consisting of natural gas firing boilers, ancillary equipment and piping will be provided at the district areas of the left bank of Ishim River.

Heat centers; three (3) at the beginning of 2011

six (6) in total by 2020.

From 2011 heat distribution to the left bank of Ishim River will be made by those heat centers with tie lines from *TETs*-1 and *TETs*-2 closed. Therefore, heat supply from *TETs*-1 and *TETs*-2 will be basically limited to the heat demand areas of the right bank of Ishim River.

3) Electric Power and Heat Energy Generating Plant

To respond to electricity and heat energy demand, natural gas firing gas turbine combined cycle plants of 150 MW output will be constructed at *TETs*-1 in 2011.

Up to 2030

1) Electric Power Supply

i) 110 kV transmission lines and substations will be newly provided in accordance with the demand requirement.

110 kV transmission lines;
Tie lines between 500 kV central substation and *TETs*-2

Branch of the above tie lines to High-Tech Park in District II

110 kV / 10 kV new substation;

High-Tech Park in District II

ii) Supply of electricity required for extension of water treatment facilities and sewage treatment facilities as well as new provision of LRT Circle Line

2) Heat Energy Supply

New construction of one heat center and extension of the constructed district heating system of both areas on the right and left bank of Ishim River.

3) Electric Power and Heat Energy Generating Plant

200 MW natural gas firing combined cycle plant will be constructed in 2021 at *TETs*-2 to supply electricity to the entire Astana City and to supply heat energy to the area on the right bank of Ishim River.

4.5.5 Infrastructure Master Plan

The following is an outline of the basic strategy for electric power supply, heat energy supply and electric power and heat energy generating plants to respond to new electric power and heat energy demand in the developing areas in Astana City to create opportunities for replacement or modification of old facilities or systems taking into consideration that Astana City is the capital of the Republic of Kazakhstan.

<u>Electric power supply</u>

New transmission lines required for new developing areas as well as increasing electric power demand on the existing areas will be constructed together with the construction or extension of 110 kV /10 kV substations as well as reinforcement of electric power supply sources.

As the existing 110 kV transmission lines have been in service more than 30 years, the main lines will be replaced with new transmission lines arranged along with the planned outer ring road.

As an urgent matter, electric power supply to New City Center with 110 kV transmission lines from Airport switching substation to New City Center will be constructed including construction of 110 kV/ 10 kV substation.

<u>Heat Energy Supply</u>

Heat energy required for the developing areas on the right bank of Ishim River will be supplied by *TETs*-1 and *TETs*-2 up to 2030 with the extension of the heat supply pipelines and reinforcement of heat energy supply sources.

Heat energy required for the developing areas on the left bank of Ishim River will be supplied by *TETs*-1 and *TETs*-2 with the existing central district heating system extended up to the end of 2010. From 2011, heat centers consisting natural gas firing hot water boilers, ancillary equipment and hot water pipelines will be in service to cover the heat demand of the areas with isolation of the heat supply tie lines connecting the right and left banks of Ishim River.

Therefore, *TETs*-1 and *TETs*-2 supply heat energy to the areas on the right bank of Ishim River only from the year of 2011 and heat energy to the areas on the left bank of Ishim River will be supplied by the heat centers, which will be distributed close to high heat demand areas.

Electric Power and Heat Energy Generating Plant

In order to secure reliable supply of electric power and heat energy to Astana City, to create opportunities to replace or modify the existing old electric power and heat energy generating facilities and to respond to the required electric power and heat energy demand in future, new electric power and heat energy generating plants will be constructed in *TETs*-1 and *TETs*-2 as the extension works.

(1) Electric Power and Heat Energy Generation Facilities and Supply

Refer to Figure 4.5.1 Plan of 110kV Transmission Lines, Switchyards and Substations.

In order to meet the electric power and heat energy demand of Astana City, the following facility expansions are required.

Up to 2010

1) Electric Power Supply

i) 110 kV Transmission Lines and 110 kV/10 kV substations

New construction of 110 kV transmission lines from Airport switching substation to new substation of New City Center

Length approx. 11 km

Period of completion; by the end of 2001

New construction of 110 kV/ 10 kV substation in New City Center
110 kV/ 10 kV Transformers 2 x 63 MVA
Period of completion; by the end of 2001

New construction of 110 kV transmission lines from the existing switching substation Eastern to new substation in District No.17
Length approx. 3.5 km
Period of completion; by 2010

New construction of 110 kV/ 10 kV substation in District No. 17
110 kV/ 10 kV Transformers 2 x 25 MVA
Period of completion; by 2010

New construction of 110 kV transmission lines from *TETs*-2 to Airport switching substation along with the planned outer ring road and new construction of 110 kV transmission lines from the branch to Eastern switching substation including removal of the existing transmission lines after the completion of new transmission lines
Length of new transmission lines
From *TETs*-2 to Airport S. Substation approx. 35 km
Period of completion; by 2005
From the branch to Eastern S. Substation approx 7.7 km
Period of completion; by 2010

New construction of 110 kV transmission lines from 500 kV Central Substation to High-Tech Park in District I
Length approx. 4.2 km
Period of completion; 2010

New construction of 110 kV/ 10 kV substation at High-Tech Park in District I
110 kV/ 10 kV Transformers 2 x 6.3 MVA

Period of completion; 2010

2) Heat Energy Supply

Refer to Figure 4.5.2 Layout of Major District Heating Pipelines and Heat Centers.

Heat (Hot Water) Distribution Pipelines

Extension of heat distribution pipelines from the existing central district heating system (supplied from *TETs*-1 and *TETs*-2) to New City Center and District No. 12

Period of completion; by 2003

Extension of heat distribution pipelines from the existing central district heating system to District No.17

Period of completion; by 2010

New installation of heat distribution pipelines in New City Center

Period of completion; by 2003 (Main)

3) Electric Power and Heat Energy Generating Plant

New construction of conventional electric power and heat energy generating plant

Output; Electric Power 115 MW
Heat Energy approx. 175 Gcal/h

Fuel ; Coal

Location *TETs*-2 as extension

Period of commissioning; at the beginning of 2006

Up to 2020

1) Electric Power Supply

110 kV Transmission Lines and 110 kV/10 kV substations

New construction of 110 kV transmission lines;

From Airport switching substation to new substation in District No.14

From the existing switching substation Western to Airport switching substation

From 500 kV Central Substation to the existing switching substation of Western

From the branch (the transmission lines from *TETs*-2 to Airport) to High-Tech Park in District III

New construction of 110 kV/ 10 kV substations;

At District No.14

At High-Tech Park in District III

2) Heat Energy Supply

Extension of heat distribution pipelines from the existing district heating system to District Nos. 4B, 18 and a part of Central Industrial District

New constructions of heat distribution piping networks on the left bank of Ishim River such as District Nos.15, 16 and 19

New constructions of natural gas firing six (6) heat centers (HC) as shown below:

HC-1 (District No.13), HC-2 (District No.14), HC-3 (District No.12), HC-4 (District No.15), HC-5 (District No.16) and HC-6 (District No.19)

3) Electric Power and Heat Energy Generating Plant

New construction of 150 MW natural gas firing gas turbine combined cycle electric power and heat energy generating plant at *TET*s-1

Up to 2030

1) Electric Power Supply

110 kV Transmission Lines and 110 kV/10 kV substations

New construction of 110 kV transmission lines;

From 500 kV Central Substation to *TET*s-2

From a branch on the above lines to High-Tech Park in District II

New construction of 110 kV/ 10 kV substation at High-Tech Park in District II

2) Heat Energy Supply

Extension of heat distribution pipelines from the existing district heating system to Northern Industrial District

New constructions of heat distribution piping networks on the left bank of Ishim River such as District Numbers 11, 14 and 16

New construction of HC-11 (District 11) and extension of heat generating facilities at six (6) heat centers (HC) such as HC-1, HC-2, HC-3, HC-4, HC-5 and HC-6

3) Electric Power and Heat Energy Generating Plant

New construction of 200 MW natural gas firing gas turbine combined cycle electric power and heat energy generating plant at *TET*s-2

(2) Environmental Management

1) Air Pollution Management

In order to fulfill air pollution management, design consideration needs to be made that the new electric power and heat energy generating plant will be equipped with the following facilities:

i) Boiler design should include combustion control technologies to minimize NOx emission.

ii) An electrostatic precipitator will be installed to collect dust particles in the flue gas.

iii) A flue gas desulfurization plant will be installed to remove sulfur oxide in the flue gas.

The required emission standards for coal fired boilers are shown in the table below.

Required Emission Standards for Coal Fired Boilers

Boiler capacity	Emission Standard		
	Emission Level at Excess O_2 = 1.4 ; mg / Nm^3		
	Total Suspended Particles	Oxides	
	Ash contents more than 4%	SOx	NOx
Steam generator 420t/h and below	150	600	340

NOx Control

NOx control technologies are currently and widely available in the world.

The combination of the following three technologies is applied in the utility field to reduce NOx emission levels.

i) Low NOx Burner Method

ii) Two Stage Combustion Method

iii) Flue Gas recirculation Method

Combination of the above can reduce NOx emission level to 100 ppm, which is equivalent to 135 mg / Nm^3.

SOx Control

In order to remove sulfur dioxide in flue gas, flue gas desulfurization plant (FGD) of wet limestone – gypsum process is highly recommendable.

The estimated SO_2 in flue gas emission is will be approximately 225 mg/ Nm^3.

Total Suspended Particles Control

In coal fired thermal power plants, it is a common practice to use electrostatic precipitator (ESP) to remove fly ash in flue gas, although dust collection rate of EP depends on a range of fly ash particle sizes and electric resistance of the fly ash.

As the coal used in *TET*s-1 and *TET*s-2 contains very high content of ash amount (approx. 40%), compared with the normal range of 10 to 25 %, it is very hard to attain the standard of total suspended particles of 150 mg/Nm^3 even though high dust collection rate of ESP such as 99.0 % is achieved.

It will be approximately 475 mg/Nm^3 with the ESP dust collection rate of 99.0%.

Since flue gas discharged from *TET*s-1 and *TET*s-2 is the main factor of air pollution, a boiler manufacturer or an ESP manufacturer needs to conduct detail investigation to remove the dust more effectively by ESP at the time of the extension of *TET*s-2.

Fly ash collected at ESP or other flue gas duct hoppers and clinker ash collected from the boiler furnace bottom will be mixed with water and then discharged to an ash disposal pond located near *TET*s-2. The used water for the ash disposal will be reused in a closed cycle for the same purpose without being discharged into a river or water course. The whole system is almost the same as those of the existing *TETs*-1 and *TET*s-2.

2) Waste Water Discharge Management

General waste water from electric power and heat energy generating plant will be treated by new waste water treatment facility which will be constructed in the *TET*s-2. The treated waste water will be discharged outside to the allowable quality range for waste water.

Waste water containing oil will be sent to the new oily water treatment facility and then the treated waste water will then be mixed with other waste water and sent to the waste water treatment facility.

3) Noise Management

As a general rule, noise generated from outside the shell of every equipment and facilities of electric power and heat energy generating plant in operation should be lower than 90 dB (A) and noise in the central control room should be lower than 60 dB (A).

4.5.6 Infrastructure Plan for New City Center

New City Center consists of the whole area of District No.13 and a part of District No.14.

As the development of New City Center bears the top priority among the development plans of Astana City, so are the plans related to electricity and heat energy supply, the main points of which are shown below:

(1) Electric Power Supply Plan

Refer to Figure 4.5.3 for the power cable network in New City Center.

1) 110kV transmission lines

110kV transmission lines will be newly constructed from Airport switching substation to new 110kV/10kV substation in New City Center.

Period of completion; by the end of 2001

2) 110 kV/10 kV substation

110kV/10kV substation will be newly constructed to supply electricity to each 10kV/400V substations including the users located in the District No. 14.

Number of the transformers and selected installed capacity of 110 kV/10 kV New City Center substation are as follows:

2 x 63 MVA

The drawing also shows a part of District No. 14 that doesn't belong to New City Center, because electricity supply to the entire area of District No.14 will be made by new 110 kV/10 kV substation in District No. 14 which will be constructed by 2012.

(2) Heat Energy Supply Plan

Refer to Figure 4.5.4 for the heat supply network in New City Center.

1) Heat Source

As urgent heat supply provision is required in this area, heat sources will be led from *TET*s-1 and *TET*s-2 up to the end of 2003 through extension pipelines of the existing central district heating network.

HC-1 (Heat Center No.1) with natural gas firing boilers and related ancillary equipment will be in service at the beginning of 2010 and supply heat energy to New City Center. Required capacity of HC-1 in 2010 is 94 Gcal/h.

2) Tie Lines

The tie lines connecting right bank and the left bank of Ishim River will be isolated with two valves (Supply and Return) after HC-1 in service.

Although a part of the business area is located on District No. 14, heat supply to the area will be made from *TET*s-1 and *TET*s-2 until the new construction of HC-2 for supplying heat energy to the entire area of District No.14. The scheduled commissioning time period of HC-2 is at the beginning of 2011.

4.5.7 Implementation Schedule

Implementation schedule related to electric power and heat energy generation and supply is shown in Table 4.5.1.

The table shows three major items, electric power and heat energy generating plants, heat energy generation and supply facilities and 110 kV transmission lines and 110 kV/ 10 kV substation and shows time period of construction of each item with a straight line.

4.6 Planning of Gas Supply System[7]

As part of the Master Plan of Astana City, the study on the introduction of natural gas plays an important role in both environmental and economic aspects.

When natural gas becomes available to Astana City, it will be utilized for 1) city gas and 2) fuel for electric power and heat generation in *TETs*, and 3) fuel for heat generation in heat centers.

For utilization of natural gas for the purposes of city gas and as a source for electric power and heat generation, economic and environmental evaluation must be conducted in order to assess whether the introduction of natural gas is feasible or not. This Section focuses mainly on the use of natural gas for city gas, while the utilization for electric power and heat generation is discussed in Section 4.5 Power and Heat Supply.

4.6.1 Present Condition of Natural Gas in Kazakhstan

In the general energy perspectives in Kazakhstan, the abundant coal and oil are subject to export, while natural gas is imported from adjacent countries on a net basis. There is a plan to introduce substantial amount of natural gas to Astana and its surrounding areas by means of an international pipeline from Russian Federation, which will be discussed later in this sub-section.

The conditions and trend of natural gas in Kazakhstan is summarized below.

(1) Natural gas supply areas and situation in Kazakhstan

Out of the 14 *oblasts* in Kazakhstan, natural gas is supplied in 8 *oblasts* as well as in Almaty City. The three southern *oblasts* receive natural gas from Uzbekistan via an international gas pipeline "Gazli-Shimkent-Zhambyl (Taraz)-Almaty". Since other forms of energy such as coal, heavy oil and cheap electricity are not common in these areas, natural gas has became widely utilized. For example, in 1991, natural gas consumption in these areas was 6.0 billion m^3, which accounts for nearly half of the total consumption of the whole of Kazakhstan.

The remaining regions (Manghystau, Atyrau, Western-Kazakhstan, Aktobe, and Kostanai) consume natural gas supplied by the Manghystau pipelines.

Natural gas consumption in Kazakhstan decreased in recent years from 13

[7] Full text of Water Resources Planning appears in Appendix I of Volume III; Supporting Report.

billion m^3/year in 1990 and 1991 to 4.5 billion m^3/year in 1999. The main reason behind this sharp fall is the unstable gas tariff policy. For example, tariff in Almaty fluctuated between US$ 25 and US$ 100 per $1000m^3$ over several years causing difficulty on the consumers' side to pay the tariff. Also, after *Traktebel* C.A. acquired concession on the transport of gas from Russia, the price of gas settled at US$ 42-45 per $1000m^3$, which was 1.5 times as much as it was when *Kazakhgas* had ownership.

In the last few years, price for gas showed gradual tendency for stability. Namely, in the southern regions, the price decreased from US$ 50 to US$ 35, and in the western regions from US$ 42 to US$ 32 per $1000m^3$, respectively. With these price levels, natural gas is preferable compared to other types of fuels. Case in point is that natural gas for cooking purpose in Almaty costs Tenge 95 per person per month, while in Astana the LPG utilized costs Tenge 180.

(2) Natural gas pipeline to Astana

The competitiveness in price of natural gas gives ground for the realization of the natural gas transporting project "Ishim-Petropavlovsk-Kokshetau-Astana", which the Government of Kazakhstan is presently considering with *Kaztransgas*. Natural gas pipeline plan, natural gas supply to Astana City and accompanying consumers has been confirmed between the Government of Kazakhstan and the Government of Russian Federation in Item 8 of the Minutes of Meeting dated 16 July 1999. On 1st November, 2000, a meeting was held to discuss the various aspects pertinent to the realization of this project, and a general agreement was obtained among the participated parties to strive towards implementation of the project, although much is left to be studied whether the feasibility of the introduction of natural gas to Astana is finally verified.

The implementation of natural gas supply to Astana commenced according to Memorandum between the Government of Kazakhstan and the Government of Russian Federation on the collaboration in the sphere of energy systems of the two countries, dated 8 October 2000, where the following issues were agreed upon.

1. Confirm the Astana City natural gas project
2. Approve the project implementation schedule set forward jointly by *CSC Kaztransgas, OSC Gaspromrazvitie,* and *OSC Stroytransgas.*

3. To *Akims* of the cities of Astana, Petropavlovs, Kokshetau, Karaganda and *Akims* of the *oblasts* of North-Kazakhstan, Akmola, Karaganda:
   - Recommend to each create a structure in the Akimat for the development of gas projects in their cities and oblasts.
   - Recommend to allocate city and oblast budgets for 2001 as special article of expenditure for receiving gas, designing of gas supply network for towns, cities and oblasts.
   - Identify the consumer group of long term vast consumption.
   - Recommend to utilize the experience of OSC Stroytransgas for the consideration of regional gasification.
4. To resolve the problems regarding gas supply of Astana City, the Government of Kazakhstan shall cooperate on the following issues.
   - Contract conclusion between Government of Kazakhstan and *OSC Gasprom* of Russia on gas supply.
   - Agreement conclusion between the Ministry of Energy, Industry and Trade of Kazakhstan and Ministry of Fuel and Energy of Russia regarding gas supply on the ground of mutual exchange.
   - To entrust Ministry of Energy, Industry and Trade of Kazakhstan to design a program utilizing gas by regions and cities located along the gas transmission line.
   - Together with the local self-governing body the allocation of national budget in 2001 for the gas project.

The implementation schedule of this project is as shown in the figure on the following page.

(3) Regulations and Norms for Gas Supply

In Kazakhstan there exists several regulations and norms that specify and restrict the use of natural gas such as SNiP 2.08.01-89 NO. 3.10 and 3.13, and SNiP 2.08.02-89 No. 3.55. The major provisions are as follows.

- Fuels of water heater for individual apartments
- Cookers in kitchen rooms
- Gas equipment in public buildings and other buildings
- Pressure of gas supply system

Schedule of Gas Pipeline

No.	Item	Responsibility	2000					2001												2002			
			8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	Declaration of intentions	GPR	■	■	■	■																	
2	Cartographic material preparation base of aerospace photography and computer imitation "Route Flyby"	STG	■	■																			
3	Coordination of agreement for implementation terms and cost of feasibility study	GPR, STG, KTG			■																		
4	Coordination of the sub-contracting organizations and funding sources of the FS	GPR, STG, KTG				■																	
5	Adoption of the declaration of intentions	KTG					■																
6	Choosing the basic variant of the gas pipeline and its coordination with the interested authorities	KTG	■	■	■	■	■	■															
7	Recommendations of the choice of the general direction of the gas pipeline, survey initial data collection	GPR, STG			■	■	■																
8	Coordination of the general direction of the main route of th gas-pipeline, getting technical specifications, initial data implementation of the engineering survey of the soils	KTG, GPR, STG, KDO							■	■	■	■	■										
9	The feasibility study of the project	KTG, GPR							■	■	■	■	■	■	■								
10	Carrying out the FS expertise and getting its approval from the interested authorities	KTG, GPR, STG														■	■						
11	Taking decision of the construction of the trunk gas pipeline	KTG																■					
12	Choosing the contractor for implementation of building and assembly jobs on the construction of the trunk gas pipeline, including development of the project documentation	KTG																	■	■	■		
13	Construction of the trunk gas-pipeline	Contractor																				▼ ■	■

<Legend> GPR: Open Public Organization "Gaspromrazvitiye"
KDO: Kazakhstan Design Organizations
KTG: Closed JSC "KazTransGas"
STG: Open JSC "Stroytransgas"

4.6.2 Demand Forecast

As for the demand for natural gas as city gas, the following are the potential consumers where the use of natural gas is viable both from environmental and economic viewpoints.

- Domestic use
- Public use
- Mini boilers

(1) Domestic Use

At present, LPG is widely used in residential areas in Astana, due to its favorable energy cost compared to electric power. The cost of natural gas for domestic use is competitive compared even with LPG, making the introduction of natural gas economically viable.

There are reportedly more than 300 units of underground LPG tanks (solely the possession of *Alautransgas*) in the existing city on the right bank, most of which are obsolete and potentially hazardous. The replacement of LPG to natural gas is therefore advantageous from a safety point of view as well.

(2) Public Use

As fuel to be used in the urban areas, natural gas is most suitable. Although coal is superior in the pure comparison of costs, environmental protection measures are required for the use within the urbanized area of the city. All measures considered, natural gas could be competent economically for small facilities, not to mention its environmental superiority.

Brick industry, for example, may become one of the most promising consumers, because locally available materials in Astana could be used as raw material, while quality bricks are imported at present. Natural gas will make this industry more feasible.

(3) Mini Boilers

There are several existing mini boilers in the city, which burn heavy oil or diesel oil for fuel. Replacing the heavy oil and diesel oil to natural gas is economically viable and environmentally preferable.

(4) Demand Forecast

Demand forecast for natural gas was conducted according to the SNiP by *ASTANA 2,* as shown below. Data on residential area and population used for the calculation are based on the figures in Section 2.2 Population and Economic Planning Framework.

Demand Forecast of Natural Gas

Item / Year	2000	2010	2020	2030
Population (x 1000)	**330**	**490**	**690**	**800**
Natural Gas Consumption (Million Nm^3/y)				
< Domestic Use >	**34.4**	**51.0**	**71.5**	**82.8**
< Public Use >	**13.9**	**20.2**	**29.0**	**33.5**
Laundries	0.7	1.0	1.5	1.7
Bath-house	2.0	3.0	4.2	4.8
Catering Enterprise	2.4	3.5	4.9	5.7
Public Health Institute	0.2	0.3	0.4	0.5
Bread-Baking plants	7.0	10.3	14.5	16.7
Services Enterprises (dressmaking, workshops, hairdressers', shops etc.)	1.7	2.1	3.6	4.1
<Independent Mini-boiler>	**-**	**5.0**	**10.3**	**16.7**
Subtotal Consumption (Million Nm^3/y)	**48.3**	**76.2**	**110.8**	**133.0**

In addition to the above, there is a plan to introduce new individual heat centers using natural gas for fuel apart from the centralized heat supply, as described in Section 4.5 Power and Heat Supply. The forecast demand is as follows.

Item / Year	2000	2010	2020	2030
New HC (Nm^3/h)	-	27,300	56,100	90,500
New HC (Million Nm^3/y)	-	100.7	206.8	333.7
Total Consumption (Million Nm^3/y)	**48.3**	**176.9**	**317.6**	**466.7**

4.6.3 Medium Term Development Needs

For introduction of city gas, high-pressure network of natural gas shall be established in the planned development area. Since considerable number of new buildings will be erected before the completion of the international main gas pipeline, design of new buildings shall comply with the possibility of future introducing natural gas. The key factor herein is to realize city gas to be readily available to draw into the buildings, and for this purpose the installation of high-pressure network in time is crucial.

Close monitoring of the progress of the international gas pipeline, therefore, is important for this development.

In order to accelerate the establishment of the gas network, utilizing the existing facility of LPG gas suppliers is relevant. This facility will be useful not only for the support of natural gas network by LPG, but also for peak saving of demand and storage.

Furthermore, a large quantity of natural gas is planned to be used for the generation of electric power and heat as described in Section 4.5 Power and Heat Supply. Natural gas supply at high pressure is preferable for these consumers (*TETs*-1 and 2), and to save procurement cost, natural gas should be directly connected from a natural gas transporter, and not via the city gas network. Accordingly, the boundary of this pipeline between transporter and consumer should be adjusted close to the international gas pipeline.

This pipeline route shall be as short as possible, positioned along main streets, and connecting between the transporter and consumers.

4.6.4 Long Term and Ultimate Term Development Needs

After the completion of medium term development, introduced natural gas will become a popular source of energy, and probably be accepted as useful energy in Astana, as is the case in Almaty. Gas network will be expanded according to the subsequent urban development.

Development plan itself shall be adjusted according to the economic availability of natural gas.

4.6.5 Infrastructure Master Plan

As each decennial development plan, city gas network will be expanded according to the growth of the city as shown in Figure 4.6.1.

The basic concept of the planned network is as follows.

- The network will be connected with the planned Trans National Gas Pipeline.
- The pressure of natural gas supplied from Trans National Gas Pipeline will properly be adjusted for high-pressure distribution (1.2 MPa). High pressure networks (hereinafter called as HP-network) are aligned along the main road.
- HP-network will cover the area of each development district of the city.

- HP-network shall be installed underground including the crossing of the Ishim River. To reduce construction cost, lines crossing the Ishim River and railways shall be minimized.
- Since the required quantity for Heat Centers is enormous, HP-network is planned close to the Heat Centers.
- For the Heat Centers and some industries, the high pressure (1.2MPa) will be utilized without pressure down.
- For other consumers such as domestic and general industry etc. pressure will be adjusted in the Gas Distribution Station (GDS), according to SNiP.
- City gas adjusted to low pressure (below 0.6MPa) will be supplied to each general consumer by low-pressure network (hereinafter called as LP-network).
- Loop type network is considered for stabling pressure at each point, but this policy should be further studied at the design stage considering cost saving.
- The network system will be connected to storage tanks installed in the existing LPG area. This LPG area is close to the railway network and already has required facility for supplying LPG. In case of delay of natural gas development, LPG could be supplied by using this new network. Considering that in the existing supply system LPG is supplied using underground tank or LPG container the new network is also superior in the sense of safety.

4.6.6 Infrastructure Plan for New City Center

For the New City Center, the infrastructure planned for 2010 is as follows.

Refer to Figure 4.6.2 for the infrastructure plan for the New City Center.

(1) Domestic use

From the HP-network, pressure is adjusted to 300dPa in Gas Distribution Station for use in apartments. LP-network do not cross Ishim River.

(2) Industrial use

There will be no special industries in this area. Therefore, the consumer is not considered.

(3) Mini boiler

Since required heat for this area can be covered Heat Center –1 (HC-1), the introduction of mini boiler is not considered.

4.6.7 Implementation Schedule

Implementation of city gas based on natural gas shall be in accordance with the international pipeline schedule. Refer to Schedule of international pipeline in Sub-section 4.6.1.

<u>Short Term Implementation Schedule: 2006 – 2009</u>

Schedule shall be adjusted according to the schedule of international pipeline.

<u>Long Term Implementation Schedule</u>

After the completion of short-term development, long term implementation shall be harmonized with other development schedule.

4.7 Planning of Telecommunications System[8]

4.7.1 Present Conditions

In Astana the telecommunications services are offered by Astanatelecom, a regional affiliate of the Open Joint Stock Company Kazakhtelecom (hereinafter referred to as Kazakhtelecom). Under the supervision of the Ministry of Transportation and Communications, Kazakhtelecom provides the following kinds of services by expanding and reinforcing the telecommunications network:

- Local telephone communication
- Inter-city telephone communication
- International telephone communication
- Telegraph and telex communication
- Data transmission
- Satellite communication

(1) Network Configuration

Kazakhstan is divided into fourteen(14) Provinces(*Oblasts*), and each province is farther divided into multiple districts. The national telephone network in Kazakhstan is composed of the inter-regional network (primary network) and the intra-regional network (secondary network), having a hierarchical structure.

(2) Telephone Services and Facilities

1) Telephone Services

There are approximately 1,820,000 telephone lines in Kazakhstan. Average telephone density as of October 1998 was 11.5 lines per 100 inhabitants (comparing with 17.7 in Russia; 16.9 in Ukraine; 6.9 in Uzbekistan).

In Astana there are 64,544 telephone lines and average telephone density as of March 2000 was 20.1 lines per 100 inhabitants. Figure 4.7.1 shows the location of present telephone exchanges in Astana.

[8] Full text of Water Resources Planning appears in Appendix J of Volume III; Supporting Report.

2) Switching Facilities

Digitalization of the switching system in Astana has been strongly promoted in the last few years. The total amount of switching capacity has reached about 102,000 circuits, and the old analogue type switches remain 37% of the total capacity of the existing switches.

3) Transmission Facilities

The digitalization of transmission lines is in progress to cope with the digitalization of telephone exchanges in the existing city area. In the urban area of Astana, the main part of local junction network is SDH optical cable transmission ring with STM-4 Add-drop multiplexers, with STM-1 level SDH optical transmission lines also employed as branch lines. Additionally, 140Mb/s and 34Mb/s radio transmission systems are also in operation.

4) Outside Plant Facilities

<u>Subscriber Cable Network</u>

The subscriber cable distribution methods adopted in Kazakhstan are of two kinds, namely a cabinet method (Flexible Network) and a direct distribution method (Rigid Network). The subscriber cable is categorized into a primary cable (main cable) connecting a section between the MDF (main distribution frame) and the cabinet, and a secondary cable (distribution cable) connecting a section between the cabinet and distribution box at a subscriber end. The primary and secondary cables used are air-core type (pressurized with dry air) installed in a duct system. The existing cables in Astana are conduit cables and aerial cables. Most of these underground cables are paper insulated, lead sheathed cables installed more than 20 to 25 years ago, and these aged cables mainly cause communication failures.

<u>Civil Work</u>

Manholes are generally made of reinforced concrete. The manholes made in recent years have been fitted with hardware and the space is sufficient. Manholes are built at a typical maximum interval of 150m. Duct is basically used in the primary cable and secondary cable section. The inside diameter of duct is classified into two types; 100mm and 50mm. The asbestos cement is used for the material of the duct.

(3) Present Service Quality

Generally, telephone service quality is measured with the following indicators; telephone call completion rate, telephone line fault rate, and fault clearance rate. In the telephone network in Astana, the old type exchanges still remain in operation, and most of underground cables are obsolete paper insulated and lead sheathed cables as mentioned above. Under such circumstances, the service quality of Astanatelecom in 1999 is depicted in the table below.

Telephone Service quality of Astanatelecom in 1999

Indicators	Results of Astanatelecom	Reference
Call Completion Rate	45 % at inter-city & international call connection	The percentage of call attempts which receive answer. A rate above 60% can be achieved in a good network.
Line Fault Rate	5	The rate indicates as the number of faults a month per 100 main lines. Users will not always satisfy with a rate near 8 that occurs nearly one fault a year.
Fault Clearance Rate	96 %	The percentage of cleared faults within next one day. Astanatelecom has regulated an original rule by the kind of faults.
Waiting Applicants (Telephone Density)	About 14,600 (20.1%)	It is expected that the figure of waiting applicants will be nearly zero as a service in the capital.

(4) Present Demand

Present demand in Astana is about 83,500 as indicated in the following table.

(As of January 1st, 2000)

Name	DEL's	Waiting Applicants	Suppressed Demand (30%)	Demand Total
Astana	64,544	14,564	4370	83,478

DEL: Direct Exchange Line

(5) Project Finance

According to the document of "Program on Modernization and Development of Kazakhtelecom from 1999 to 2003", issued by Kazakhtelecom in 1999, the total amount of the project cost for 1999 to 2003 is estimated as about US$ 300 million. The financing of the project will mainly depend on the supplier's credit by almost 80% of the total, comparing with 20% by own assets. The selection of suppliers will be made in kind of a tender. The suppliers credit might oppress the accounts balance of the company in future.

Another issue concerning the management is how to introduce a time duration charging system to the local call service. Kzakhtelecom says that the time duration charging system is now under experimental introduction at two places including Karaganda City. For the improvement of service and financial situation, the system should be introduced widely as early as possible

4.7.2 Demand Forecast

Astana is the new capital of Kazakhstan, having already more than 20% DEL (Direct Exchange Line) density. The telephone demand forecast in Astana has been made, based on the population framework of the new area development plan of the present Master Plan over the next 30 years. The following table shows the DEL forecast of the entire city of Astana.

DEL Forecast of the Entire City of ASTANA (up to 2030)

ATC	Population	2010		2020		2030	
		Pop.	DEL	Pop.	DEL	Pop.	DEL
NDA Total	Residents	127,386	38,216	278,642	97,525	368,034	147,215
	Working Pop.	107,548	32,264	168,600	50,582	208,201	62,461
	Sub-total	–	70,480	–	148,107	–	209,675
ETA Total	Residents	362,650	108,795	408,790	143,077	427,990	171,196
	Working Pop.	146,558	36,640	205,142	51,287	228,015	57,004
	Sub-total	–	145,435	–	194,364	–	228,200
Astana Total		490,036	490,036	215,915	687,432	342,471	796,024
Telephone Density(%)		42.6		44.1		49.8	

ATC: Automatic Telecommunication Center, DEL: Direct Exchange Line
NDA: New Developing Area, ETA: Existing Town Area
Pop: Population

4.7.3 Medium Term Development Needs

According to the Kazakhtelecom, the priority program on telecommunication network development in Astana for the years 1999 - 2002 was approved by the Government of the RK, and the immediate construction works related to the development of telecommunication network on the left bank of Ishim river is underway since 1999 with the necessary financing. According to the capital development plan of present Master Plan, there will be a new commercial, presidential, governmental and diplomatic area besides several new residential districts (No.9, No.13, No.14, No.15, No.17 etc.) up to 2010. The new telephone demand in the new development area will reach approximately 67,600 in total. The government of Kazakhstan has been emphasizing the needs of adequate, efficient and reliable infrastructures in the national development policy, to realize a higher economic growth of the country and an improvement of the people's standard of living.

The telecommunication development is given one of the highest priorities. The efficiency of the whole society, namely the economic development, welfare of individual life, education and healthcare support all depend on the new telecommunication means. In order to cope effectively with relatively long and severe winter, effective telecommunication system is vital and essential in performing the functions necessary as the new capital, which represents Kazakhstan internationally and domestically. For the daily activities in newly designed commercial, presidential, governmental and diplomatic buildings, the telecommunication system will be essentials and one of the basic social infrastructures. The introduction of a new telecommunication system planned in the present Master Plan to Astana is especially important.

4.7.4 Long Term and Ultimate Term Development Needs

According to the capital development plan up to 2030 of present Master Plan, there will appear new residential districts (No.4B, No.11, No.16, No.18, No.19 etc.) besides the expansion of new development area at the period of phase-1. The telecommunication demand by residents and working population in the new development area at 2020 will reach 141,900, and that at 2030 will reach around 201,000 in total.

4.7.5 Infrastructure of Master Plan

(1) Telecommunication Policy for Astana

The basic plan for the development of the telecommunications network in Astana aims to fulfill the telephone demand in the new development area of Astana as soon as possible, in accordance with the present Master Plan. The new telecommunication network will be constructed to upgrade the network structure to be more reliable and efficient one and also prepare for the introduction of new type of telecommunication means in future, considering the increasing roll of the capital and its status. For this purpose, the latest digital technologies such as optical fiber access network, digital switching system, optical fiber transmission systems, SDH, IP network and so on, will be adopted.

(2) Telecommunication Policy for the Existing Town Area of Astana

Various improvement measures are in progress in the existing town area of Astana under the control of *Kazakhtelecom*. In the long term development plan for the existing town area, the following policies will be recommended to Kazakhtelecom, in harmony with the telecommunication development of the new development area of Astana.

A systematical local network expansion plan is necessary in order to satisfy all the new telephone demands occurring in the area.

A planned replacement from the old analogue type facilities to the latest digital type facilities is necessary to be promoted with optical fiber access network, digital switching systems, etc.

To promote a perspective arrangement of telephone office area.

The key stations like ITC and AMTC should be dispersed by unit/location in order to upgrade the reliability of the capital telecommunication network.

Preparation for the diversification of telecommunication measures; cellular telephone service, IP network for data communication service, etc.

(3) Telecommunication Facility Plan

The facility plan to construct a telecommunication network in new development areas of Astana will be made with the latest equipment. Figure 4.7.2 shows the Location Plan of Telecommunication Centers and Telecommunication Center Area.

1) Switching Facilities

The facilities to be introduced shall satisfy the demand planned for 2010, 2020 and 2030, respectively in the new development areas of Astana.

Digital switching systems shall be adopted exclusively for new installation. The following table shows the work quantity of switching facilities.

Work Quantity of Switching Facilities

ATS	Switching Facilities (2010)			Switching Facilities (2020)		
	Type	Capacity	Contents	Type	Capacity	Contents
ATC-A	Digital	29,400	New	Digital	53,800	Expansion
ATC-B	Digital	22,100	New	Digital	29,400	Expansion
ATC-C	Digital	12,300	New	Digital	14,100	Expansion
ATC-D	–	–	–	Digital	15,200	New
ATC-E	–	–	–	Digital	17,600	New
ATC-F	–	–	–	Digital	18,200	New
Total		63,800	-	-	148,300	-

ATS	Switching Facilities (2030)			Remarks
	Type	Capacity	Contents	
ATC-A	Digital	72,800	Expansion	
ATC-B	Digital	33,200	Expansion	
ATC-C	Digital	15,900	Expansion	RSU (HOST: ATC-B)
ATC-D	Digital	26,500	Expansion	
ATC-E	Digital	19,800	Expansion	RSU (HOST: ATC-B)
ATC-F	Digital	41,700	Expansion	
Total		209,900	-	

2) Transmission Facilities

Considering the network reliability, the ring configuration as the SDH transmission network topology will be adopted at Phase-1 (up to2010), connecting three (3) new telecommunication center; ATC-A, ATC-B and ATC-C. Other three new telecommunication center; ATC-D, ATC-E and ATC-F will be added to the ring configuration at Phase-2 (up to 2020).

The new ring will have the independent structure with the existing ring network. The connection points of these two ring networks shall be at ATC-21 and ATC-36 offices.

To be economical, some joint facilities will be installed between new ring and the existing ring as long as no interference to the network independence will occur. Main facilities of these rings are cable ducts between telecommunication centers and DF (Distribution Frame) in the centers. Figure 4.7.3 shows Future Configuration of Astana Local SDH Ring Transmission System (Phase-1) and Figure 4.7.4 shows that of Phase-2.

Work Quantity of Local Junction Network Facilities

Items	Year	Quantity	Notes
STM-16 ADM	Phase-1	1	Ring configuration by SDH (ATC-A－ATC-B－ATC-C－ATC-36－ATC-21－ATC-A)
STM-16 ADM	Phase-2	Expansion	Ring configuration by SDH (ATC-21－ATC-F－ATC-A－ATC-D－ATC-E－ATC-B－ATC-C－ATC-36－ATC-21)

3) DLC (Digital Loop Carrier) Facilities

Considering the possibility of introducing various new services, optical cable transmission systems would be introduced in subscriber lines to near-by subscribers as close as possible. Specifically, the introduction of FTTC (Fiber to the Curb) system will be planned in the residential district. Introduction of FTTB (Fiber to the Building) system will be planned mainly in the New City Center; Business Area, Presidential Area and Governmental Area which will be in ATC-A center service area. The following table shows the work quantity of DLC Facilities.

Work Quantity of DLC Facilities

Telephone Office	2010		2020		2030		Notes
	Cap.	Quant.	Cap.	Quant.	Cap.	Quant.	
ATC-A:							
DLC Controller		4		6		8	
Indoor DLC	720	44	720	80	720	108	
Outdoor DLC	480	2		4		5	
ATC-B:							
DLC Controller		6		7		8	
Outdoor DLC	480	51	480	68	480	77	
ATC-C:							
DLC Controller		3		4		4	
Outdoor DLC	480	29	480	33	480	37	
ATC-D							
DLC Controller		-		4		7	
Outdoor DLC	-	-	480	35	480	61	
ATC-E							
DLC Controller		-		5		5	
Outdoor DLC	-	-	480	41	480	46	
ATC-F							
DLC Controller		-		5		10	
Outdoor DLC	-	-	480	42	480	96	

4) Outside Plant Facilities

Telecommunication outside plant consists of cable facilities and civil facilities. Figure 4.7.5 shows the outside plant facilities to be considered in the present Master Plan.

Efficient construction of reliable subscriber cable network will be realized with DLC (Digital Loop Carrier). In this system, the cable from the telephone exchange to DLC (Outdoor or Indoor Type) is called optic feeder cable, while the metallic cable from the DLC to DP (Distribution Point) is called the secondary cable. The application of DLC (Outdoor Type/Indoor Type) in the new development area is as follows.

Application of DLC

DLC	Area to be applied
Indoor Type (Capacity:720 lines)	Business area, Governmental area and Presidential area of the New City Center
Outdoor Type (capacity:480 lines)	All the residential district, Diplomatic area of the New City Center

Distribution of Optic Feeder Cable

In consideration of the security of the facilities, the duct system will be used for optic feeder cable which has to accommodate a large number of subscribers. This system facilitates easy cable expansion to meet increased demand and easy replacement of fault cables. This system can also protect cables from damages due to construction work for other underground facilities. Cable connection will be done in manholes.

Distribution of Secondary Cable

For secondary cables, the direct buried cable method (steel tape armored cables) in which cables are directly buried under the ground will be used in principle.

Catchment Area

A distribution area is an area used to achieve effective management of outside plant facilities which permits efficient utilization and proper expansion of facilities and once established, the area boundary may not be changed easily. The area size will be so designed that approximate 500 subscribers will be accommodated in each area. The area is usually bounded by highways, rivers, railways, etc.

5) Power Supply Facilities

Basic policy for the power supply facilities is as follows.

Receiving the general power supply at each center, the power supply system shall allow automatic changeover to a generator at the time of service interruption.

The power supply capacity shall be planned in consideration of the future facilities expansion in addition to the exchange and transmission facilities planned to be constructed in the project.

The battery discharge time shall be about 2 hours in an office with a generator.

Work Quantity of Power Supply Facilities

Telephone Office	Power Receive	Rectifier	Battery	Generator	Air Conditioner
ATC-A	New	New	New	New	New
ATC-B	New	New	New	New	New
ATC-C	New	New	New	New	New
ATC-D	New	New	New	New	New
ATC-E	New	New	New	New	New
ATC-F	New	New	New	New	New

6) Buildings

As for the new telephone office, buildings that comply with the standard of Kazakhtelecom will be built.

Work Quantity of Buildings

Telecom Center	State	Notes
ATC-A	New	Standard type for 73,000 lines station
ATC-B	New	Standard type for 34,000 lines station
ATC-C	New	Standard RSU type for 16,000 lines station
ATC-D	New	Standard type for 27,000 lines station
ATC-E	New	Standard RSU type for 20,000 lines station
ATC-F	New	Standard type for 42,000 lines station

(4) Administration Data Communication Network

It will be urgently necessary to install an Administration Data Communication Network which will connect all categories of state and government communications among Government, Ministries, General Administration Offices and Astana local government. This will facilitate more efficient government administrative performance, improving greatly the information exchange speed and reliability. The new network will consist of Internet Protocol (IP) network. Refer to Figure 4.7.6 Administration Data Communication System by IP Network in Astana.

4.7.6 Infrastructure Plan for New City Center

The infrastructure plan for the New City Center up to 2010 will be made according to the present Master Plan, giving careful consideration to the plans ordered and the construction works in progress.

(1) Demand Forecast up to 2010 for New City Center

DEL forecast of the New City Center is shown in the following table.

DEL Forecast of the New City Center up to 2010

AREA (District No.)	Article	Population	DEL	ATC
Government Area Presidential Area Business Area Diplomatic Area (13*1, 14)	Residents	1,188	357	ATC-A
	Working Population	82,093	24,628	
	Sub-total	–	24,985	
Diplomatic Area (13*2)	Residents	4,294	1,289	ATC-B
	Working Population	3,090	927	
	Sub-total	–	2,216	
Diplomatic Area (13*3)	Residents	3,343	1,003	ATC-C
	Working Population	2,427	728	
	Sub-total	–	1,731	
New City Center Total		8,825	28,932	
Telephone Density(%)		327.8		

13*1: Diplomatic area on the left Bank of Ishim river
13*2: Northern part of diplomatic area on the right bank of Ishim river
13*3: Eastern & southern part of diplomatic area on the right bank of Ishim river

(2) Infrastructure Plan for New City Center

Considering the character of the area as the core district of the new capital, the telecommunication network will be constructed to make the network structure more reliable and efficient while preparing for the introduction of new type of telecommunication means should be commenced. For this purpose, the latest digital technologies such as optical fiber access network, digital switching system, optical fiber transmission system, SDH, IP network, and so on, will be adopted.

The following table shows the telecommunication facility plan for New City Center, and Figure 4.7.7 shows Telecommunication Facility Plan for New City Center.