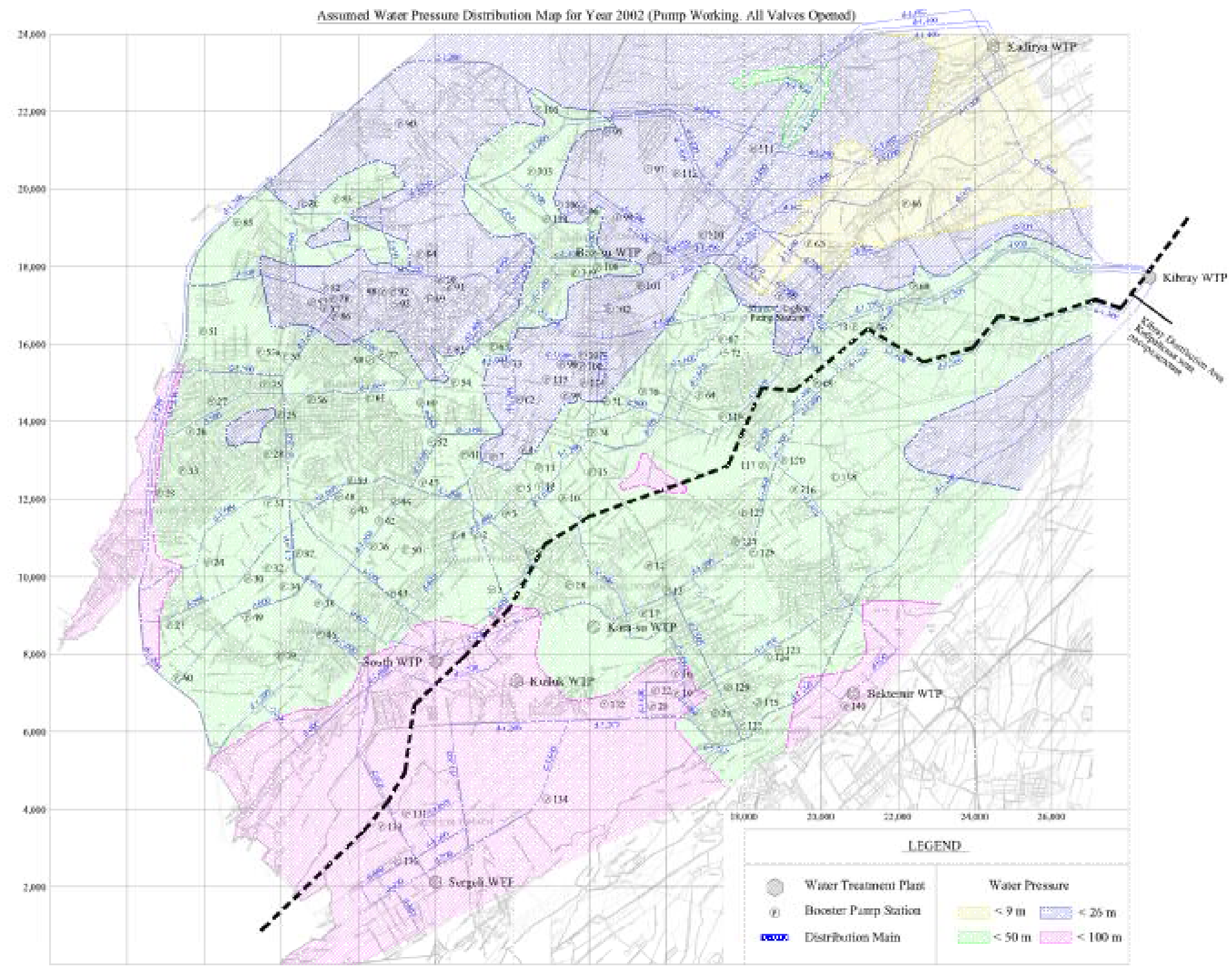

Figure S 3.1.4.3 Water Pressure in the Sample Calculation without Pressure Control

iv) Calculation Results

Based on the above conditions, a series of hydraulic analysis was carried out. As previously mentioned, it is noted that the hydraulic conditions of the pipe network were simulated in order to considerably represent actual inlet/outlet water pressure of booster pump stations. As a result, flow balance in the City was simulated as shown in Figure S 3.1.4.4. From Kadirya WTP, water is delivered in three (3) different directions, which reach to western and central part of the City and Kibray WTP, with a supply volume of 687,000 m^3/d, 1,034,000 m^3/d and 410,000 m^3/d, respectively. Kibray WTP supplies water to eastern - southern part of the City with a total volume of approximate 750,000 m^3/d including 400,000 m^3/d transmitted from Kadirya WTP.

Distribution mains from Kadirya WTP, of which diameter are 1,400-1,800 mm, are considered maximally used, since velocity of the pipes are calculated as 1.2 - 2.6 m/sec at peak time. Likewise, those from Kibray WTP, two (2) trunk pipelines (1,200 and 1,400 mm), out of total three (3), show 2.2 - 2.3 m/sec., however, the velocity of remaining trunk line installed in the southern area is assumed to be 0.4 m/sec., between Kibray and Khamza because of pressure reducing applied for this pipe in Khamza area.

As for water pressure, the calculated result is summarized as shown in Figure S3.1.4.5. Water pressure of 26 m (or 2.6 kg/cm^2) or lower prevails in most of the supply zones. Therefore, it is considered that the calculation result roughly represents the current flow condition of the City, compared with current operation status of WTPs as well as inlet/outlet water pressure of booster PSs previously described.

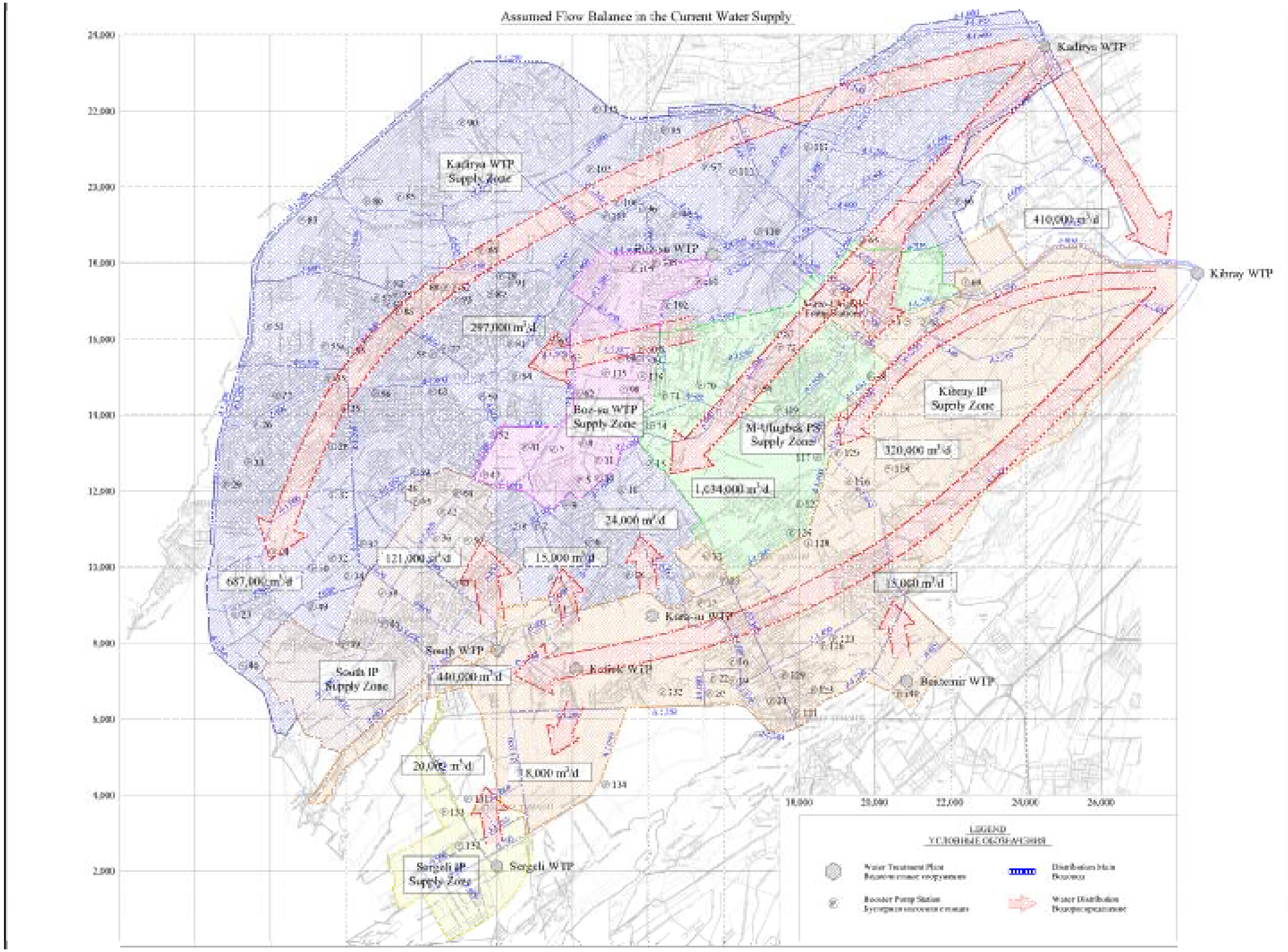

Figure S 3.1.4.4 Assumed Flow Balance in the Current Water Supply

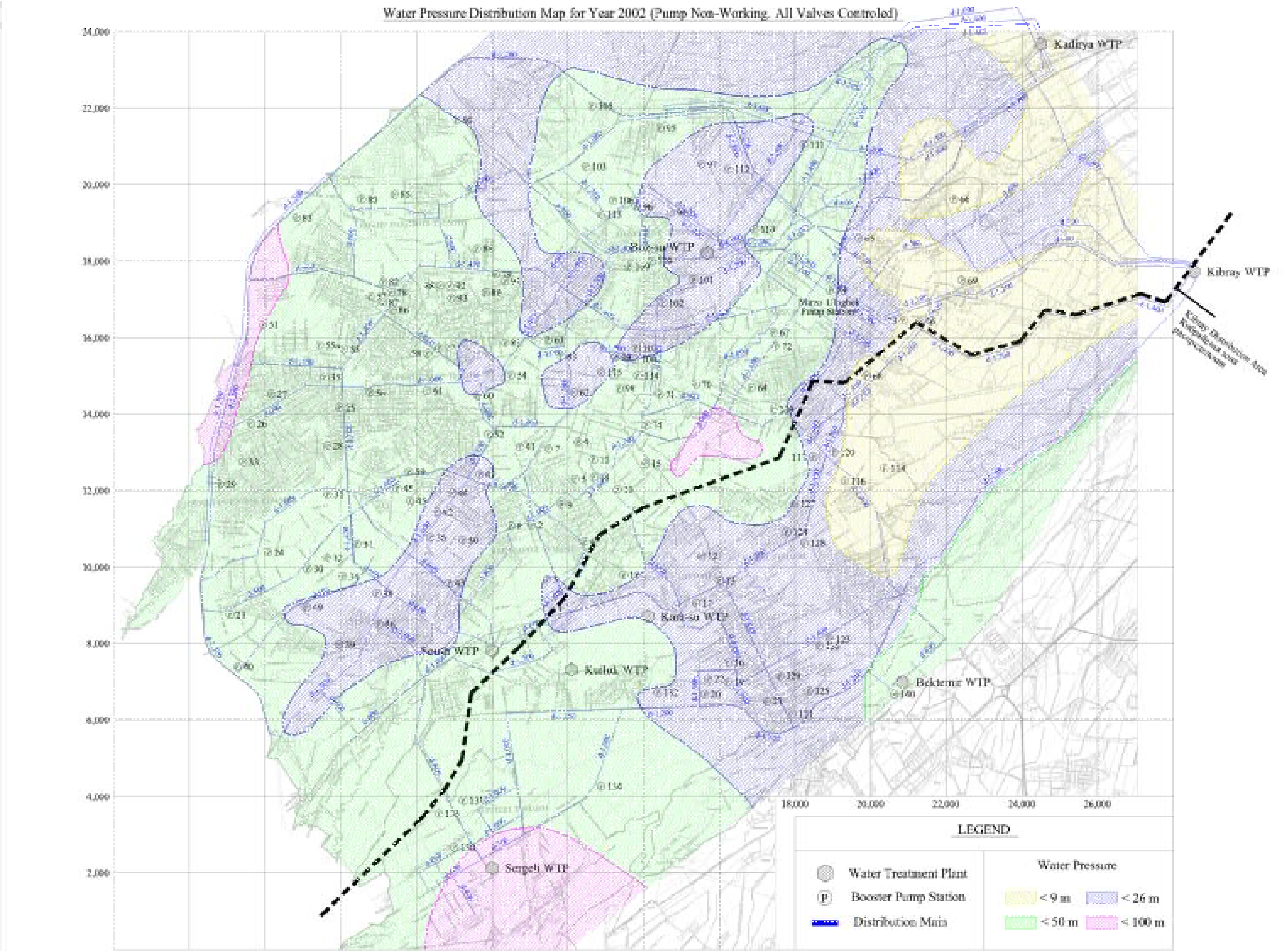

Figure S 3.1.4.5 Calculated Water Pressure in the Existing Network

Chapter 4 Planning Fundamentals for Development Plan

S 4.2 Water Demand Projection

S 4.2.1 Method of Water Demand Projection

In water demand projection, customers were divided into two categories - domestic customers and large consumers. The domestic customers' category was further broken down into (a) apartment residents, and (b) those living in detached houses. Likewise, the large consumers' category was classified into (a) budgetary organizations, (b) hot water plants and (c) small industries. It was observed that there is huge amount of water wasted by those in the domestic customers' category, either through leakages or wasteful use.

Since there is a huge water loss in the distribution network, reduction of this water loss according to the progress of NRW reduction program will also be considered in water demand projection. Accordingly, the future water demand was projected on precondition that the NRW reduction program will be implemented.

Per capita consumption for domestic customers living in apartment, who account for 66% of the total population in the city, is estimated at 150Lpcd if the water meter is installed. This consumption is relatively small; however, these users seem to use additional 84 Lpcd of hot water supply, which was calculated based on the volumes supplied and billed by Vodokanal to hot water plants as calculated in Chapter 3.2. Therefore the combined per capita consumption of cold water and hot water is estimated to be 234 Lpcd.

Water demand is projected for three cases, as follows: Case 1: maximum effect of NRW reduction program will be expected, Case2: medium effect and Case 3: minimum effect. For designing water supply facilities, the projected water demand in Case 2 will be employed, therefore estimated value of Case 2 is presented in this report.
Other cases of projection are presented in S 4.2.1.

S 4.2.2 Water Demand Projection for Domestic Customers

Water demand projection for domestic customers was made considering the extent of the progress of meter installation for reducing water consumption as shown in Table 4.2.1. Water demand projection for domestic consumers was made for three cases considering the extent of the progress of meter installation for reducing water consumption; Case-1 (maximum effect of water saving), Case-2 (medium) and Case-3 (minimum). The followings are the assumptions for these cases:

- For Case-1, the latest meter installation plan prepared by Vodokanal's is adopted, and per capita consumption of apartment customers is assumed to be reduced by 10% based on the PR program for water saving, which will be carried out in the future;
- For Case-2, the implementation of the plan had been behind schedule due to lack of budget, and per capita consumption of apartment customers is assumed to be flat.;
- For Case-3, a minimal progress of meter installation ratio and an introduction of tariff system employing bulk meters for apartment were considered. Per capita consumption of apartment customers is assumed to be increased by 10%; and
- In the case of detached houses, per capita consumption is assumed not to be reduced, because wastage at detached houses is relatively small.

Based on the above scenarios, water demand for domestic consumers was projected as shown in Table 4.2.1 and Figure 4.2.1.

Table S 4.2.1 Water Demand Projection for Domestic Customers

Division			Meter installation ratio (%)					Consumption (lpcd)				
			2002	2005	2009	2010	2015	2002	2005	2009	2010	2015
Total population in the city ($x10^3$)			2,139.1	2,136.2	2,138.6	2,139.2	2,142.2					
Service population	Surrounding area ($1x10^3$)		63.8	71.6	87.0	87.6	107.9					
	Total ($x10^3$)		2,170.8	2,177.8	2,193.6	2,195.7	2,218.0					
Apartment	Population ($x10^3$)		1,390.8	1,389.5	1,391.0	1,391.4	1,392.6					
	With flat Meter (%)	Case1	9.2	36	100	100	100	150	150	144	143	135
		Case2	9.2	30	85	100	100	150	150	150	150	150
		Case3	9.2	20	30	33	50	150	150	156	158	165
	With bulk Meter (%)	Case1	0	0	0	0	0	280	280	258	252	224
		Case2	0	0	0	0	0	280	280	269	266	252
		Case3	0	40	70	67	50	280	280	280	280	280
	Without Meter (%)	Case1	90.8	64	0	0	0	500	500	500	500	500
		Case2	90.8	70	15	0	0	500	500	500	500	500
		Case3	90.8	40	0	0	0	500	500	500	500	500
	Consumption ($10^3m^3/d$)	Case1	650.6	519.7	200.3	198.3	188.0					
		Case2	650.6	548.9	281.7	208.7	208.9					
		Case3	650.6	475.2	337.7	333.3	309.9					
Detached house	Population (x103)		780.0	788.3	802.5	804.3	825.4					
	With meter (%)	Case1	33.2	70	100	100	100	200	200	200	200	200
		Case2	33.2	60	100	100	100	200	200	200	200	200
		Case3	33.2	50	90	100	100	200	200	208	210	220
	Without (%)	Case1	66.8	30	0	0	0	270	270	270	270	270
		Case2	66.8	40	0	0	0	270	270	270	270	270
		Case3	66.8	50	10	0	0	270	270	270	270	270
	Consumption ($103m^3/d$)	Case1	192.5	174.2	160.5	160.9	165.1					
		Case2	192.5	179.7	160.5	160.9	165.1					
		Case3	192.5	185.3	171.9	168.9	181.6					
Total consumption ($10^3m^3/d$)		Case1	843.1	693.9	360.8	359.1	353.1					
		Case2	843.1	728.6	442.2	369.6	374.0					
		Case3	843.1	660.5	509.6	502.2	491.4					

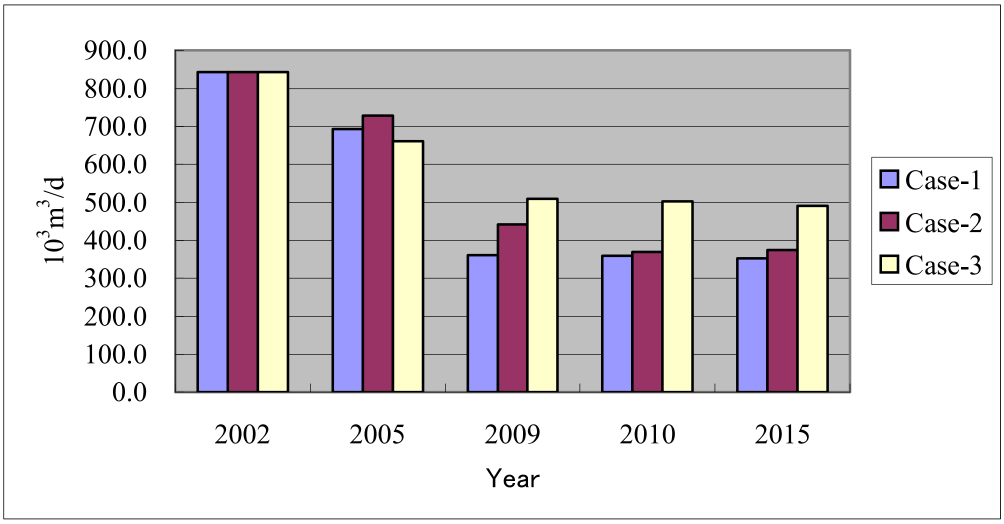

Figure S 4.2.1 Water Demand Projection for Domestic customers

S 4.2.3 Water Demand Projection for Large Consumers

Because the countermeasures to reduce water wastage and to save water will be introduced in Tashkent City in the future (which are discussed in Section 5.2), some categories of consumers are seen to save water, especially hot water plants. Table S 4.2.2 and Figure S 4.2.2 show the calculated results of water demand projection for large consumers.
The reduction range is divided into three; Case-1, 2 and 3.

The reasons for the differences in the reduction ratio for each category are as follows:

- Eighty percent of water meters for large consumers have already been installed, meaning, over 95% of water has been consumed under metered charge system. Therefore, the effect of progress of meter installation is seen not to be significant;
- Consumption by budgetary organizations (Public/government offices including water supply organizations supplying to the surrounding area of the City and public facilities) shall be reduced because much of leaking water service equipment of these offices has not been repaired. The unit consumption of 110L/capita/day to the total service population is considered to be too large (refer to Table 4.2.3, water demand of budgetary organization (234,000 m^3/d) x 1,000 / Total service population (2,170,800));
- Consumption of industries is very small due in part to the recession of Uzbekistan economy, however it may recover in future;
- Consumption of hot water is quite high in the city, wasting water and energy, thus TKEO has decided to improve the system and the improvement project will include meter installation for hot water and heating water. Therefore the demand by domestic customers for hot water will be reduced sharply same as cold water, while that by large consumers will not be reduced because of the economy recovering; and
- Consumption of small commercial establishments as well as industries may be picked up as the economy improves.

Table S 4.2.2 Water Demand Projection for Large Consumers

Division			Consumption ($10^3m^3/d$)					Reduction ratio (%)				
			2002	2005	2009	2010	2015	2002	2005	2009	2010	2015
Total service population (x103)			2170.8	2177.8	2193.6	2195.7	2218.0					
Budgetary		Case1	234.0	217.8	196.2	190.8	163.8	100	93	84	82	70
		Case2	234.0	223.2	208.8	205.2	187.2	100	95	89	88	80
		Case3	234.0	228.6	221.4	219.6	210.6	100	98	95	94	90
Industries		Case1	56.0	56.0	56.0	56.0	56.0	100	100	100	100	100
		Case2	56.0	57.3	59.0	59.4	61.6	100	102	105	106	110
		Case3	56.0	58.6	62.0	62.9	67.2	100	107	116	118	130
Hot water Plant	Domestic Customers	Case1	347.0	319.0	281.6	272.3	225.6	100	92	81	78	65
		Case2	347.0	327.0	300.3	293.6	260.3	100	94	87	85	75
		Case3	347.0	339.0	328.3	325.6	312.3	100	98	95	94	90
	Large Consumers	Case1	148.0	144.6	140.0	138.9	133.2	100	98	95	94	90
		Case2	148.0	148.0	148.0	148.0	148.0	100	100	100	100	100
		Case3	148.0	154.8	163.9	166.2	177.6	100	105	111	112	120
Small Commercial		Case1	111.0	111.0	111.0	111.0	111.0	100	100	100	100	100
		Case2	111.0	113.6	117.0	117.8	122.1	100	102	105	106	110
		Case3	111.0	118.7	128.9	131.5	144.3	100	107	116	118	130
Total		Case1	896.0	848.4	784.8	769.0	689.6	100	95	88	86	77
		Case2	896.0	869.0	833.1	824.1	779.2	100	97	93	92	87
		Case3	896.0	899.7	904.6	905.8	912.0	100	100	101	101	102

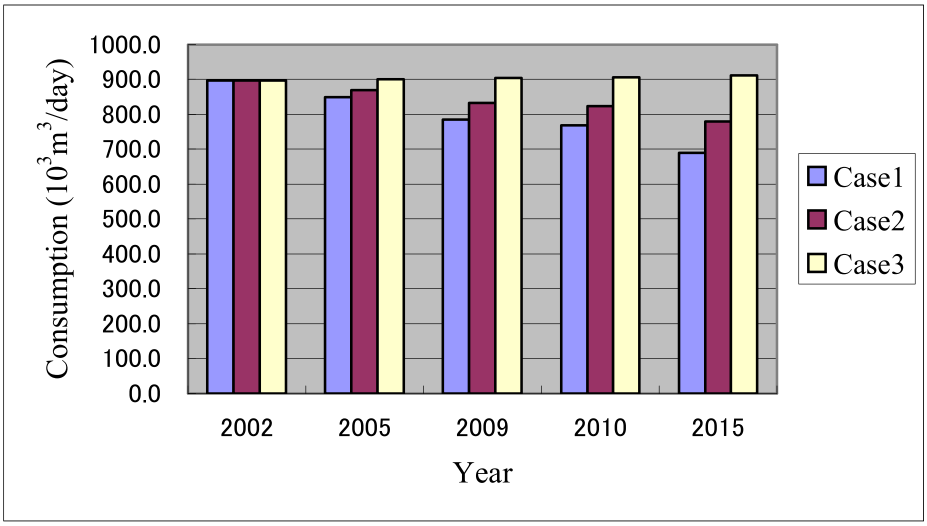

Figure S 4.2.2 Water Demand Projection of Large Consumers

S. 4.2.4 Projection of Water Loss from Distribution Network

The estimated water balance in 2002 is shown in Table S 4.2.3, while the leakage from distribution pipelines is assumed to be 80% of the total water losses from distribution pipeline.

Table S 4.2.3 Estimated Water Balance in the City in 2002

Consumers		Volume ($10^3m^3/d$)
Water distribution (m^3/d)		2,900
Water Consumption	Domestic customers	843
	Large consumers	896
	Total	1,739(60%)
Water Loss	Leakage	725(25%)
	Improper usage	436(15%)
	Total	1,161(40%)

The leakage ratio from the distribution pipelines is assumed by the survey results of water leakage in Sergeli District referred to S 2.3.6.

Recently since many illegal connections to sprinkle surrounding gardens and green belts in apartment buildings and those of housings along the water transmission pipes have been found, the ratio of improper usage are supposed to be significantly large.

Assumption for reduction projection of water losses are shown as follows:

- When NRW Reduction Program including the pipe replacement is implemented, leakage from pipes will decrease as the progress of the replacement. However the reduction ratio will not be so high because other old pipes will begin to leak; and
- Improper usage should be exterminated, however a certain rate of the usage cannot be reduced because some illegal usage is necessary for the City.

Projection of water loss is shown in Table S 4.2.4.

Table S 4.2.4 Projection of Water Loss

Category		Consumption ($10^3m^3/d$)							Reduction ratio (%)						
		2002	2005	2007	2009	2010	2011	2015	2002	2005	2007	2009	2010	2011	2015
Leakage	Case1	725.0	725.0	580.0	507.5	471.3	435.0	290.0	100	100	80	70	65	60	40
	Case2	725.0	725.0	616.3	543.8	507.5	471.3	362.5	100	100	85	75	70	65	50
	Case3	725.0	725.0	652.5	580.0	543.8	507.5	435.0	100	100	90	80	75	70	60
Improper usage	Case1	436.0	436.0	348.8	218.0	174.4	152.6	87.2	100	100	80	50	40	35	20
	Case2	436.0	436.0	370.6	261.6	218.0	174.4	109.0	100	100	85	60	50	40	25
	Case3	436.0	436.0	392.4	305.2	261.6	218.0	174.4	100	100	90	70	60	50	40
Total	Case1	1,161	1,161	929	726	646	588	377	100	100	80	62	56	51	32
	Case2	1,161	1,161	987	805	726	646	472	100	100	85	69	62	56	41
	Case3	1,161	1,161	1,045	885	805	726	609	100	100	90	76	69	62	52

S 4.2.5 Projection of Total Water Demand

Table S 4.2.5 shows the projected water demand for domestic customers and large consumers, water losses from distribution network and total water demand.

Figure S .2.3 shows projection of the total water demand. As shown in Table S 4.2.5, although quantity of water loss decreases sharply, loss ratio will not be reduced so much because total water demand decreases.

Table S 4.2.5 Total Water Demand Projection ($10^3m^3/d$)

Category		2002	2005	2007	2009	2010	2011	2015
Individuals	Case1	843.1	693.9	527	360.8	359.1	358	353.1
	Case2	843.1	728.6	585	442.2	369.6	370	374.0
	Case3	843.1	660.5	585	509.6	502.2	500	491.4
Large Consumers	Case1	896.0	848.4	817	784.8	769.0	753	689.6
	Case2	896.0	869.0	851	833.1	824.1	815	779.2
	Case3	896.0	899.7	902	904.6	905.8	907	912.0
Water Loss	Case1	1,161	1,161	929	726	646	588	377
	Case2	1,161	1,161	987	805	726	646	472
	Case3	1,161	1,161	1,045	885	805	726	609
Total	Case1	2,900	2,703	2,273	1,871	1,774	1,699	1,420
	Case2	2,900	2,759	2,423	2,081	1,919	1,831	1,625
	Case3	2,900	2,721	2,532	2,299	2,213	2,133	2,013
Water Loss Ratio (%)	Case1	40	43	41	39	36	35	27
	Case2	40	42	41	39	38	35	29
	Case3	40	43	41	38	36	34	30

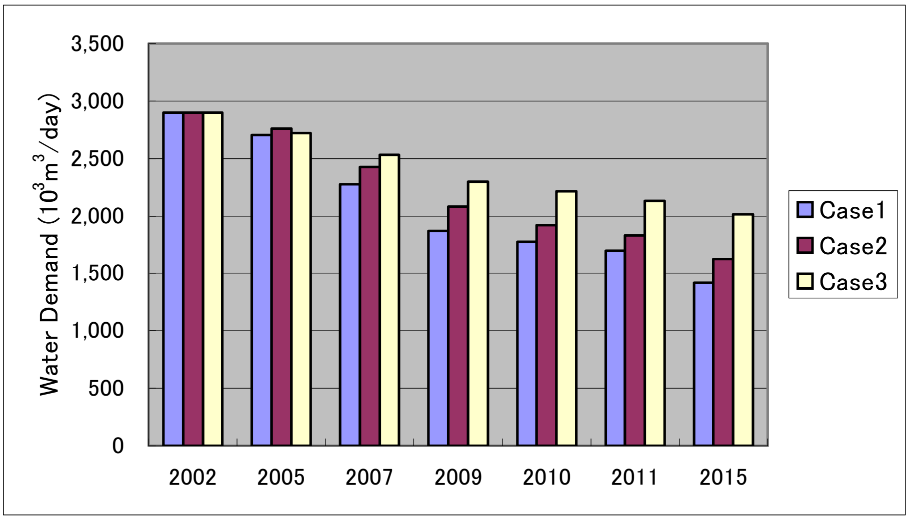

Figure S 4.2.3 Projection of Total Demand

S 4.2.6 Estimation of Daily and Hourly Maximum Flow

The maximum daily water demand is adopted as a design flow for WTPs. For distribution system the maximum hourly flow is adopted as a design flow.

The current daily and hourly factors are very low at 1.07 and 1.03 respectively. They are assumed to be relatively low also in the future because water loss ratio has been assumed to improve gradually. Table S 4.2.6 shows that the daily factor (daily maximum water demand/daily average water demand) will gradually increase as water losses and wastage are reduced. Therefore the factor in the target year for Case1 is set at approximate two times as much as the current fluctuation level, that for Case 3 is set at 1.10, and for Case2 is modified.

Table S 4.2.6 Calculation of Daily and Hourly Maximum Flow

Division		2002	2005	2007	2009	2010	2011	2015
Total daily Average demand	Case-1	2,900	2,703	2,273	1,871	1,774	1,699	1,420
	Case-2	2,900	2,759	2,423	2,081	1,919	1,831	1,625
	Case-3	2,900	2,721	2,532	2,299	2,213	2,133	2,013
Water loss ratio (%)	Case-1	40	43	41	39	36	35	27
	Case-2	40	42	41	39	38	35	29
	Case-3	40	43	41	38	36	34	30
Total daily max demand	Case-1	3,100	2,974	2,500	2,058	1,987	1,953	1,633
	Case-2	3,100	3,034	2,666	2,289	2,130	2,051	1,820
	Case-3	3,100	2,993	2,785	2,529	2,435	2,346	2,214
Daily factor	Case-1	1.07	1.10	1.10	1.10	1.12	1.15	1.15
	Case-2	1.07	1.10	1.10	1.10	1.11	1.12	1.12
	Case-3	1.07	1.10	1.10	1.10	1.10	1.10	1.10
Total hourly max demand	Case-1	3,200	3,122	2,750	2,264	2,225	2,246	1,878
	Case-2	3,200	3,186	2,932	2,518	2,365	2,359	2,038
	Case-3	3,200	3,143	2,925	2,782	2,678	2,581	2,436
Hourly factor	Case-1	1.03	1.05	1.10	1.10	1.12	1.15	1.15
	Case-2	1.03	1.05	1.10	1.10	1.11	1.15	1.12
	Case-3	1.03	1.05	1.05	1.10	1.10	1.10	1.10

The hourly factor is considered also gradually increasing, in accordance with the progress of NRW Reduction Program. The other JICA Study in Astana city, the capital of Kazakhstan, shows 1.07 of hourly factor in its water supply (150,000m^3/day: 300,000 of the served population and 500 Lpcd of per capita consumption). On the other hand, “Japanese Guidelines for Waterworks Technical Management” shows around 1.35 of hourly factor to 1.5 million m^3/day of water supply.

Considering above, hourly factor of Tashkent City is assumed to increase in the future as shown in Table S 4.2.6. Therefore the factors in the target year are set at 1.15 in Case1, 1.12 in Case2 and 1.10 in Case 3.

Chapter 5 Long Term Development Plan

S 5.3.4 Comparison between Existing and Proposed Distribution Systems

(1) Condition for the Comparison

The comparison is carried out in order to evaluate the costs between the existing distribution system with a lot of booster PSs and the proposed gravity distribution system.

In this comparison, electricity consumption, the number of operation staff, and investment for improvement/replacement are the items to be compared. The contents for each item are shown in Table S 5.3.4.1.

Table S 5.3.4.1 Contents for each Comparison Item

Items	Existing System	Proposed System
Electricity consumption	Annual consumption for distribution system	
Number of operation staff	For booster pump stations	
Investment	Replacement of existing PSs for machines and electrical facilities	-Change from “by pump” to “by gravity” in Kibray WTP, -Improvement for PSs, -Pipe reinforcement, -Installation of automatic pressure/flow regulation facilities, -Installation of monitoring station.

(2) Scheduled Costs

The electricity consumption and the number of operation staff in 2002 and 2015 as the target year of M/P are calculated in Chapter 5.4. Referring to the calculation results, the electricity consumption and the number of operation staff from 2005 to 2014 are presented in Table S 5.3.4.2

The construction costs for proposed system is calculated in Chapter 5.12.

Table 3.1.3 in Chapter 3.1 shows diagnosis results for booster PSs, and the results of C1 and C2 need to be replaced in near future. The replacement costs for existing PSs, which are divided into two categories; one is diagnosis results with C1 and C2, and another is that with A and B, are calculated in Table S 5.3.4.2.

The scheduled investment for proposed system as shown in Table S 5.3.4.2 is referred from Chapter 5.13. In addition, the replacement costs for facilities are added up 15 years later because a proper replacement for proposed facilities should be planned in the case of M/P.

Table S 5.3.4.2 Transition of Electricity Consumption, Number of Staff and necessary Investment for Distribution System

Item/Year		2002	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016-2020	2021-2025	2026-2030	2031-2035
Daily Average Water Demand (103m3/d)		2,900	2,741	2,589	2,438	2,286	2,134	1,919	1,831	1,780	1,728	1,677	1,625	1,625	1,625	1,625	1,625
Proposed System	Electricity Consumption (mil.kwh/y)	100	94	89	84	79	59	40	26	24	23	21	20	20	20	20	20
	Number of Operation Staff	794	794	794	794	794	794	575	356	356	356	356	356	356	356	356	356
	Investment (1000USD)						5,000	15,144	17,291	0	0	0	0	0	1,400	6,000	0
Existing System	Electricity Consumption (mil.kwh)	275	265	252	239	226	213	200	187	184	181	179	172	172	172	172	172
	Number of Operation Staff	794	794	794	794	794	794	794	794	794	794	794	794	794	794	794	794
	Investment (1000USD)								5,000	5,000	5,000				6,000	6,000	9,000

Table S 5.3.4.3 Replacement Costs for Existing Booster PSs

Capacity (m3/hr)	Replacement Cost (1000USD)	Diagnosis results C1 and C2		Diagnosis results A and B	
		Number	Cost (1000USD)	Number	Cost (1000USD)
30,000	8,000	1	8,000	---	---
7,200	3,000	---	---	1	3,000
3,000	1,500	1	1,500	4	6,000
1,000	300	17	5,100	26	7,800
800-600	150	2	300	12	1,800
500-300	80	2	160	7	560
100-200	50	0	0	10	500
>100	30	0	0	51	1,530
Total			15,060		21,190
Modified			15,000		21,000

For existing system, since replacement is planned to delay as much as possible in order to save PVs (present values), the PSs with diagnosis results of C1 and C2 will be replaced from 2011 to 2013 and other PSs will be replaced after 2023 as shown in Table S 5.3.4.2

(3) Cost Comparison between Existing and Proposed Distribution Systems

Resulted in investigation as shown in Table S 5.3.4.2, a cost comparison between existing and proposed distribution systems are shown in Table S 5.3.4.4. This table is same with Table 5.3.7 in Chapter 5.3.4.

Table S 5.3.4.4 Cost Comparison between Existing and Proposed Distribution Systems

Item	Contents	Unit	Existing Pump System	Proposed Gravity System	Note
Construction Cost	-2015	1000USD	15,000	37,435	
	2015-2035	1000USD	21,000	7,400	
	Total	1000USD	36,000	44,835	
Unit Cost	Electricity	mil.kwh/y	100	20	30 USD/1000kwh
	Staff	Number	794	356	600 USD/y.p
Annual Cost	Electricity	1000USD/y	3,000	600	
	Personnel	1000USD/y	476	213	
	Total	1000USD/y	3,476	813	

S 5.4.5 Examination of Future Distribution Network

(1) Rearrangement of Supply Zone and Distribution System

In this Study, only Kadirya and Kibray WTP are proposed to supply water for the whole city and vicinity areas of Tashkent in the future. Production capacity of Kibray WTP is assumed to be 450,000 m^3/day and Kadirya WTP will cover the remaining water demand. Consequently, rearrangement of existing supply zones and distribution system are required. Table S 5.4.5.1 presents future water supply zones by water source and distribution system to be recommended in the Study. These are:

- Supply zones supplied from Kadirya WTP by gravity flow will be broken down into Kadirya Northern Area, Kadirya Central Area and Kadirya Southern Area;
- Pumped water from the proposed Boz-su and Mirzo-Ulugbek PSs of which water source is Kadirya WTP will supply water with a scale-down compared with current condition to limited areas. Likewise, booster-pumping system will supply vicinity area of Kadirya WTP;
- Supply zones supplied from Kibray WTP will comprise of Kibray Gravity Zone; and
- Booster-pumping system will supply vicinity area of Kibray WTP.

(2) Water Demand Used for Hydraulic Analysis

For hydraulic analysis on the future water supply, the projected water demand prepared for medium scenario, was used because of moderate consideration in the plan. Table S.5.4.5.2 (1) shows the projected water demand of medium scenario for target year of 2015. Water demand by district was assumed in the same manner as described in Section S 3.1.4.

Table S 5.4.5.1 Rearrangement of Supply Zone and Distribution System

Water Source (Production Volume)	Supply Zone	Service Area	Elevation (m)	Max. Daily Water Demand (m^3/day)	Distribution Method
Kadirya WTP (1,375,000 m^3/day)	Kadirya Northern Area	S. Rahimov Yunusbad (part) Shayhantahur (part) Mirzo-Ulugbek (part)	410-495	460,000	Gravity
	Kadirya Central Area	Shayhantahur (part) Mirzo-Ulugubek (part) Mirabad (part) A. Ikramov (part)	400-510	610,000	Gravity (Pressure reducing)
	Kadirya Southern Area	Chilanzar Yakkasaray (part) Mirabad (part)	400-470	214,000	Gravity
Kibray WTP (350,000 m^3/day)	Kibray Gravity Zone	Khamza Sergeli Bectemir Mirabad (Part)	395-480	*) 420,000	Gravity (Pressure reducing)
	Kibray Booster Zone	Vicinity area of Kibray WTP	>490	21,000	Booster Pump
Boz-su WTP (100,000 m^3/day)	Boz-su Booster Zone	Shayhantahur (part) Yunusbad (part) Mirzo-Ulugbek (part)	450-480	100,000	Booster Pump
Total				1,825,000	

*): 420,000 m^3/day includes water from Kadirya WTP

Table S 5.4.5.2 (1) Assumed Water Demand by District (Target Year 2015)

(Unit: m3/day)

		Domestic (1)	Large Consumer (2)	Water Loss (3)	Subtotal (Except HP) (4) (1)+(2)+(3)	Hot Water Plant (5)	Budgetary (6)	Total (4)+(5)+(6)
<Tashkent>								
1	A. Ikramov	38,865	14,160	48,501	**101,525**	**25,651**	-	127,177
2	Bektemir	4,354	4,266	6,036	**14,655**	-	-	14,655
3	Mirabad	19,995	36,640	26,134	**82,770**	**15,896**	-	98,665
4	M. Ulgbek	39,033	47,026	52,631	**138,690**	**55,149**	-	193,839
5	S. Rahimov	24,102	39,200	32,683	**95,985**	**32,430**	-	128,415
6	Sergeli	48,014	22,303	60,337	**130,654**	**32,637**	-	163,291
7	Khamza	34,378	30,916	44,305	**109,599**	**25,811**	-	135,410
8	Chilanzar	34,747	27,421	46,103	**108,272**	**49,841**	-	158,112
9	Shayhantahur	44,878	28,367	55,949	**129,194**	**31,765**	-	160,959
10	Yunusabad	46,368	37,933	61,493	**145,794**	**78,682**	-	224,475
11	Yakkasaray	18,348	16,305	23,672	**58,326**	**60,390**	-	118,715
<Other Vicinity Area>								
12	Kibray	6,435	7,964	3,767	**18,166**	-		18,166
13	Ata	9,725	-	7,213	**16,938**	-	**523**	16,938
14	Other vicinity towns (Kadirya)	4,720	58,400	2,675	**65,795**	-	**2,927**	65,795
Total		373,962	370,901	471,500	**1,216,363**	**408,250**	**3,450**	1,624,614

(3) Assumed Conditions

1) Layout of the model

Basically, Figure S 3.1.4.2 in S 3.1.4 was used with some modifications based on the proposed future plan as follows:

- Water level of the proposed Kibray service reservoir is assumed at 500.5 masl;
- Operation status of South, Sergeli, Kara-su, Kuiluk and Bectemir WTPs are changed to off-duty; and
- Additional distribution pipes and pressure reducing valves are placed as required.

2) Water demand for respective nodes

The manner of allocation of water demand for respective nodes is same with S 3.1.4, Supporting Report. Table S 5.4.5.2 (2) shows water demand allotted to respective nodes as a peak flow basis with a factor of 1.12 to maximum daily water demand for target year 2015.

Table S 5.4.5.2 (2) Water Demand Allotted to Nodes by District

District	Water Demand for Respective Nodes		Water Demand for Hot Water Plant		Water Demand for Budgetary	
	Number	Water Demand/Node (m^3/h)	Number	Water Demand (m^3/h)	Number	Water Demand (m^3/h)
<Tashkent City>						
A. Ikramov	68	78	1	1,341	-	-
Bektemir	6	96	-	-	-	-
Mirabad	39	111	1	831	-	-
M. Ulgbek	80	91	2	2,882	-	-
S. Rahimov	64	78	1	1,695	-	-
Sergeli	54	126	1	1,706	-	-
Khamza	51	112	1	1,349	-	-
Chilanzar	64	88	1	2,605	-	-
Shayhantahur	40	169	1	1,660	-	-
Yunusabad	111	69	1	4,112	-	-
Yakkasaray	37	82	1	3,156	-	-
<Vicinity area>						
Kibray	5	190	-	-	-	-
Ata	3	121	-	-	1	523
Other vicinity towns (Kadirya)	15	34	-	-	2	2,927
Total	639	1,443,000 (m^3/d)	11	512,000 (m^3/d)		83,000 (m^3/d)

3) Flow/pressure control applied for specific areas

The criteria for the calculation result in terms of water pressure was set as 26-50 m (2.5-5.0 kg/cm^2) at majority of nodes in order to secure direct water supply to 5- story apartment houses.

In order to obtain such results, additional distribution pipes were introduced for the specific area. Likewise, constant pressure valves were inserted in the distribution pipes placed in the areas of A. Ikramov, Chilanzar, Khamza, Mirzo-Ulgbek, S. Rahimov, Shayhantahur, Sergeli and Yunusabad. Table S 5.4.5.3 and Table S 5.4.5.4 are examples of such arrangements made in the analysis.

Table S 5.4.5.3 Additional Distribution Pipes Incorporated in the Model

Label		From Node	To Node	Material	Diameter (mm)	Length (m)	Location
1	P-1150a	J-178	J-35	Steel	1,400	20	M.Ulugbek
2	P-1530a	J-379	J-57	Steel	1,200	2,000	M.Ulugbek
3	P-1531a	J-57	J-264	Steel	1,200	700	M.Ulugbek
4	P-1532a	J-27	J-23	Steel	1,400	2,000	M.Ulugbek
5	P-1533a	J-114	J-582	Steel	1,000	500	Yunusabad
6	P-1536a	J-98	J-158	Steel	1,200	1,000	Sergeli
7	P-1537a	J-45	J-208	Steel	1,200	3,000	S.Rahimov
8	P-1548a	J-30	J-671	Steel	1,000	7	Boz-su
9	P-1555a	J-449	J-577	Steel	1,000	300	Sergeli
10	P-1557a	J-522	J-27	Steel	1,000	3,000	M.Ulugbek
11	P-1567a	J-240	J-239	DI	500	1,000	Chilanzar
12	P-1568a	J-279	J-93	Steel	1,200	2,500	Yakkasaray-Chilanzar
13	P-1569a	J-23	J-154	Steel	1,400	800	M.Ulugbek
	Total					16,827	

Table S 5.4.5.4 Constant Pressure Valves Incorporated in the Model

Label		Diameter (mm)	Type	Tentative Status	Location	Elevation (m)
1	FCV-8	1,600	Flow Control Valves	Throttling	Mirzo-Ulugbek	487
2	FCV-9	1,200	Flow Control Valves	Throttling	Mirzo-Ulugbek	492
3	FCV-2001	1,100	Flow Control Valves	Throttling	Khamza	474
4	PRV-1	1,200	Pressure Regulation Valves	Closed	Sergeli	425
5	PRV-6	1,000	Pressure Regulation Valves	Throttling	S. Rahimov	442
6	PRV-7	1,000	Pressure Regulation Valves	Throttling	S. Rahimov	442
7	PRV-8	1,000	Pressure Regulation Valves	Throttling	Shayhantahur	412
8	PRV-16	1,000	Pressure Regulation Valves	Throttling	Mirzo-Ulugbek	434
9	PRV-18	900	Pressure Regulation Valves	Throttling	Khamza	435
10	PRV-19	1,000	Pressure Regulation Valves	Inactive	S. Rahimov	441
11	PRV-20	900	Pressure Regulation Valves	Throttling	Sergeli	405
12	PRV-21	600	Pressure Regulation Valves	Closed	Sergeli	410
13	PRV-24	1,200	Pressure Regulation Valves	Throttling	Shayhantahur	424
14	PRV-25	600	Pressure Regulation Valves	Closed	A. Ikramov	430
15	PRV-26	900	Pressure Regulation Valves	Throttling	A. Ikramov	409
16	PRV-27	1,000	Pressure Regulation Valves	Throttling	Sergeli	420
17	PRV-28	1,000	Pressure Regulation Valves	Closed	Sergeli	415
18	PRV-29	600	Pressure Regulation Valves	Throttling	Chilanzar	427
19	PRV-30	600	Pressure Regulation Valves	Throttling	Sergeli	412
20	PRV-32	1,200	Pressure Regulation Valves	Throttling	Mirzo-Ulugbek	465
21	PRV-101	1,200	Pressure Regulation Valves	Throttling	Mirabad	435
22	PRV-102	600	Pressure Regulation Valves	Throttling	Bektemir	440

(4) Calculation Results

Figure S 5.4.5.1 shows future flow balance based on the above conditions.

From Kadirya WTP, basically water is delivered in three (3) different directions which head for Northern, Central and Southern Aarea of the City with a supply volume of 460,000 m^3/d, 610,000 m^3/d and 214,000 m^3/d, respectively. Some water distribution for Central Area is lifted up by Mirzo-Ulugbek booster pump station. Water distribution for Southern Area is via Kibray WTP with, three (3) distribution mains with a diameter of 700, 900 and 1,200 mm

Kibray WTP will supply water to eastern - southern part of the City with a total volume of approximate 420,000 m^3/d using 1,200mm and 1,400 mm distribution trunk lines.

Boz-su WTP will supply water to a part of central area of the City with a total volume of approximate 100,000 m^3/d.

Since the total water supply volume in target year is planned to decrease to almost half of the current water consumption, it is considered that the distribution mains from Kadirya and Kibray WTP will be used under more favorable condition compared with the current status. Velocity of the distribution mains from both Kadirya and Kibray are assumed as ranging 1.0-1.7 m/sec., except for the previously mentioned 900 mm trunk line (2.3 m/sec.) to be used for Kadirya water.

Calculated water pressure for the year 2011 and target year of 2015 are summarized as shown in Figure S 5.4.5.2. and Figure S 5.4.5.3 respectively. Water demand (daily average flow) for each year is shown below;

Water Demand (Daily Average Flow)	Year 2011:	1,830,000 m^3/day
	Target year of 2015:	1,620,000 m^3/day

26-50 m (or 2.6-5.0 kg/cm^2) of water pressure will be improved in year 2011 and in target year of 2015 by adopting pressure reducing valves and additional distribution pipes in the specific areas.

However, due to water demand of 1,830,000 m^3/day, a part of Mirabad and Khamza district will not keep 26-50 m (or 2.6-5.0 kg/cm^2) water pressure in year 2011. But decreasing water demand will make better for water pressure in the target year of 2015.

Water pressure in most of the supply zones will be 26-50 m (or 2.6-5.0 kg/cm^2) in the target year of 2015.

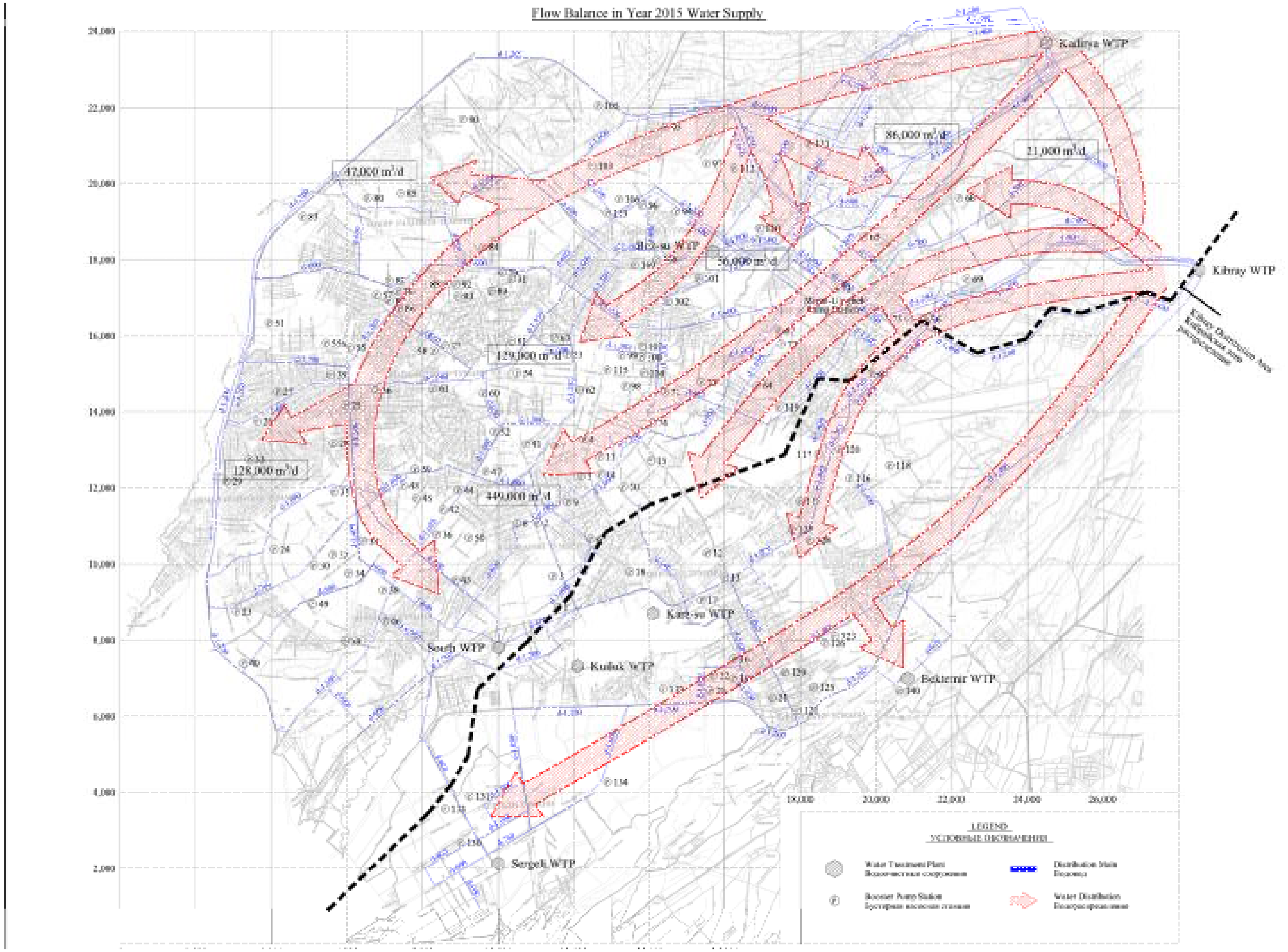

Figure S 5.4.5.1 Flow Balance in the Future Water Supply

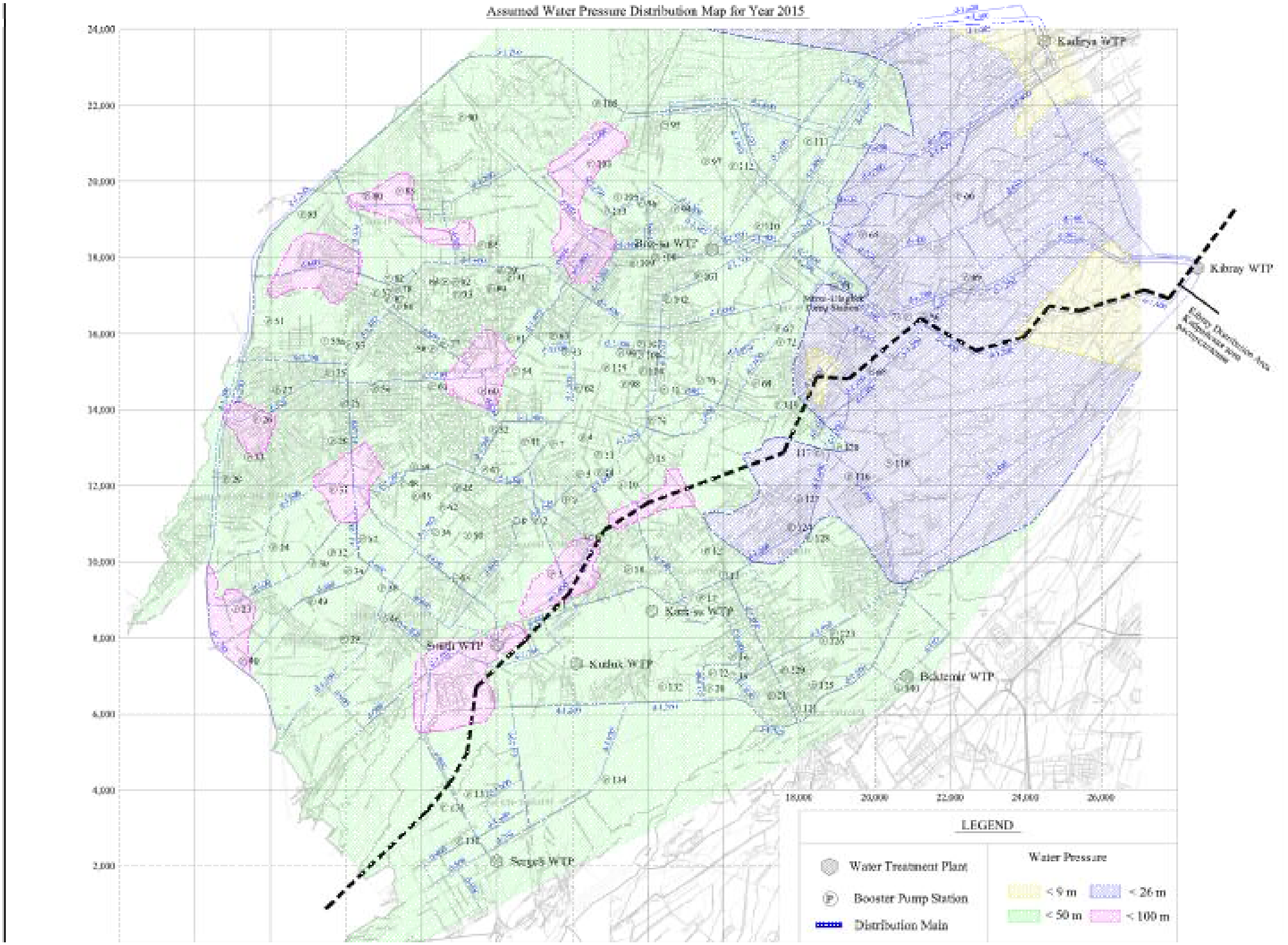

Figure S 5.4.5.2 Distribution Map of Assumed Water Pressure in the Year 2015

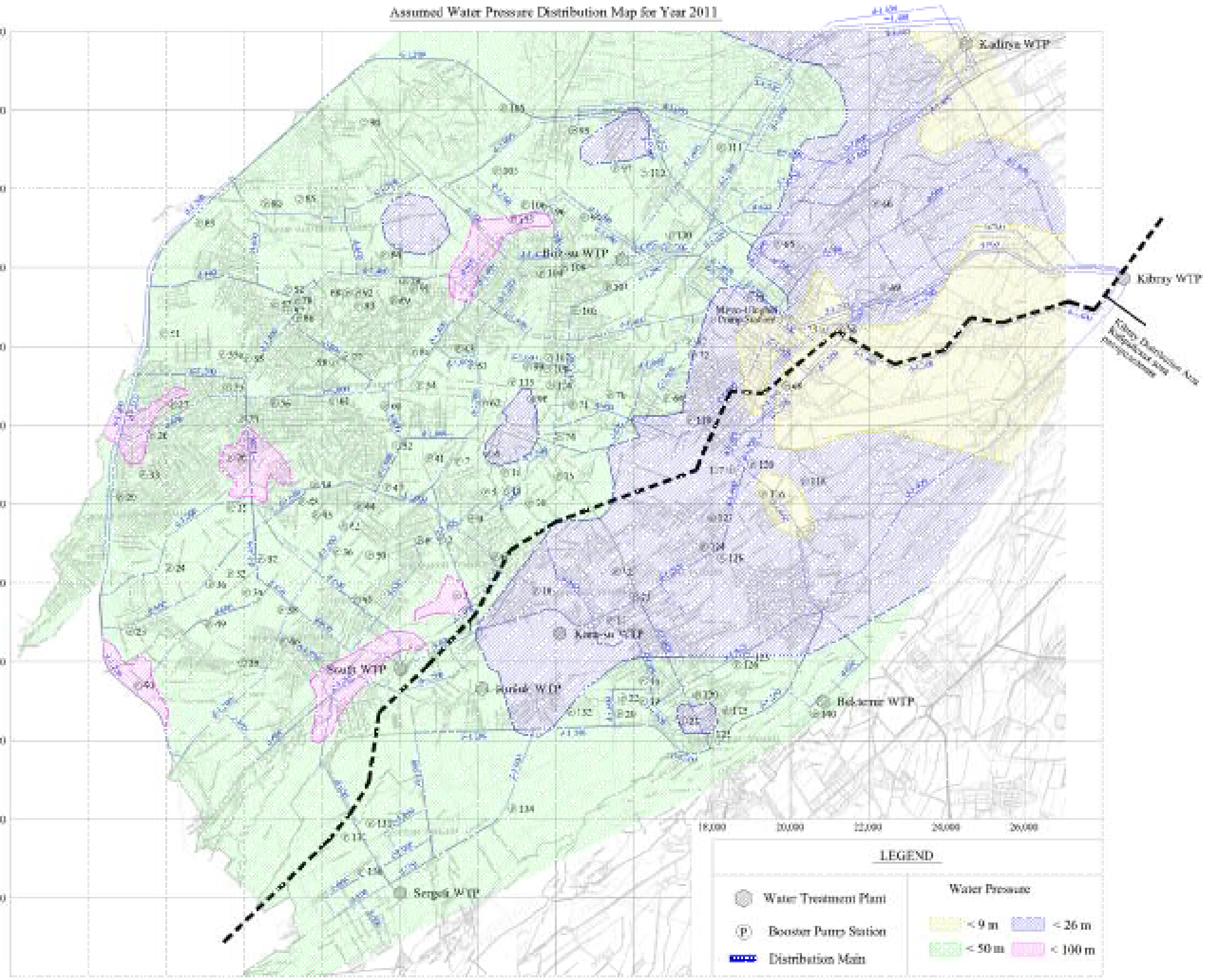

Figure S 5.4.5.3 Distribution Map of Assumed Water Pressure in the Year 2011

(5) Conclusion and Recommendation

As described in S 3.1.4, taking account of configuration of the network system and topographic condition of the City, the existing distribution network of Tashekent City is considered to be relatively fair. However, its operation/flow control in specific areas is unreasonable and needs improvement. Although it is a fact that there is limitation in data availability as described previously, the water pressure obtained in initial calculation implies that the current network affords ample scope of direct water supply without booster pumping system in specific areas.

In line with this, in examining future distribution network, the Study Team focused on utilizing gravity system as much as possible in Tashkent water supply with minimal investment as described in above (1).

To realize such a water supply in the future, the following will be recommended for Vodokanal to carry out. With regard to this, it is noted that these measures shall be further examined in the detailed design stage.

- Respective supply zones shall be properly isolated by provision of isolation valves and/ or disconnection of unnecessary pipes;
- Additional distribution pipes with a diameter of 500-1,400 mm shall be installed to augment water supply in M. Ulugbek-Mirabad-Cilanzar and Yakkasaray-Chilanzar areas;
- Realignment of pipes in Yunusabada and Mirzo-Ulugbek shall be made for the proposed Boz-su and Mirzo-Ulugbek PS in accordance with rearrangement of supply zones; and
- Pressure regulation valves and flow control valves shall be provided for appropriate sites in the proposed pressure reducing zones.

Furthermore, pipe replacement/rehabilitation will be an urgent issue to cope with the improved water pressure of 26 m (2.6 kg/cm^2) or larger, considering the magnitude of current water leakage. Vodokanal has already prepared pipe replacement plan which targeted a total of 420 km length of the existing distribution pipes as shown in Table D

5.4.5.1 and Figure D 5.4.5.1 in Data Report. Therefore, the said replacement plan shall be incorporated into the proposed Master Plan of this Study. In the implementation of the project, due consideration shall be made for following from technical aspects:

- Selection of appropriate pipe material;
- Adopting proper pipe joints/fittings and due execution of works; and
- Preparation of the realistic action plan to minimize the affected area due to suspension of water supply during execution of works.

Aside from the above, the following shall be recommended for operation and maintenance of the future distribution network:

- Monitoring water flow and pressure as a routine work;
- Preparation of drawings and maps of distribution network and updating system;
- Preparation of inventory of pipes, valves and others, and updating system; and
- Establishment of record keeping system for operation status of concerned facilities, water leakage, repair works and others.

S 5.4.7 Future Plan including Expansion Area

(1) Expansion of Service Area surrounding Tashkent City

Tashkent City Government is planning to expand the water supply service area to the outside areas of Tashkent City. The area is divided into six; Tashkent Region North, Keles City, Northern encircling highway, Zangiota Region, Urta-aul Village and Kibray Region.

The areas are shown in Figure S 5.4.7.1 Target year of expansion is stipulated at 2010.

(2) Population and Water Demand for the Expansion Areas

According to Vodokanal, the population and water demand for the expansion area are presented as shown in Table S 5.4.7.1. In the table, water demand for the existing area is derived from Chapter 4.2, and daily per capita demand for expansion areas is 600 lpcd as the Standard value of SNIP. That value includes water demand for public office, school, hospital, market and losses as well as domestic costumers except for industrial demand.

Table S.5.4.7.1 Population and Water Demand

Area Name	Population (10^3)		Daily Average Water Demand ($10^3m^3/d$)				
	In 2000	In 2010	In 2000	In 2010			Increased Value
				Norm*1	Industries	Total	
Tashkent District North	225.6	193.2	---	115.92	---	115.92	---
Keles City	22	29.7	---	17.82	5.28	23.10	---
Northern encircling highway	49	83.4	---	50.04	0.01	50.05	---
Zangiota District	12	17.7	---	10.62	0.10	10.72	---
Urta-aul Village	14.3	245	---	147.00	---	147.00	---
Kibray District	25	30	---	18.00	0.18	18.18	---
Total	347.9	599	70.34	359.40	5.56	364.96	294.62

Source : Vodokanal

*1: Norm is 600lpcd, and it includes domestic and large consumption including losses except for industries.

*2: The water demand in 2000 included large consumers consumption in the areas

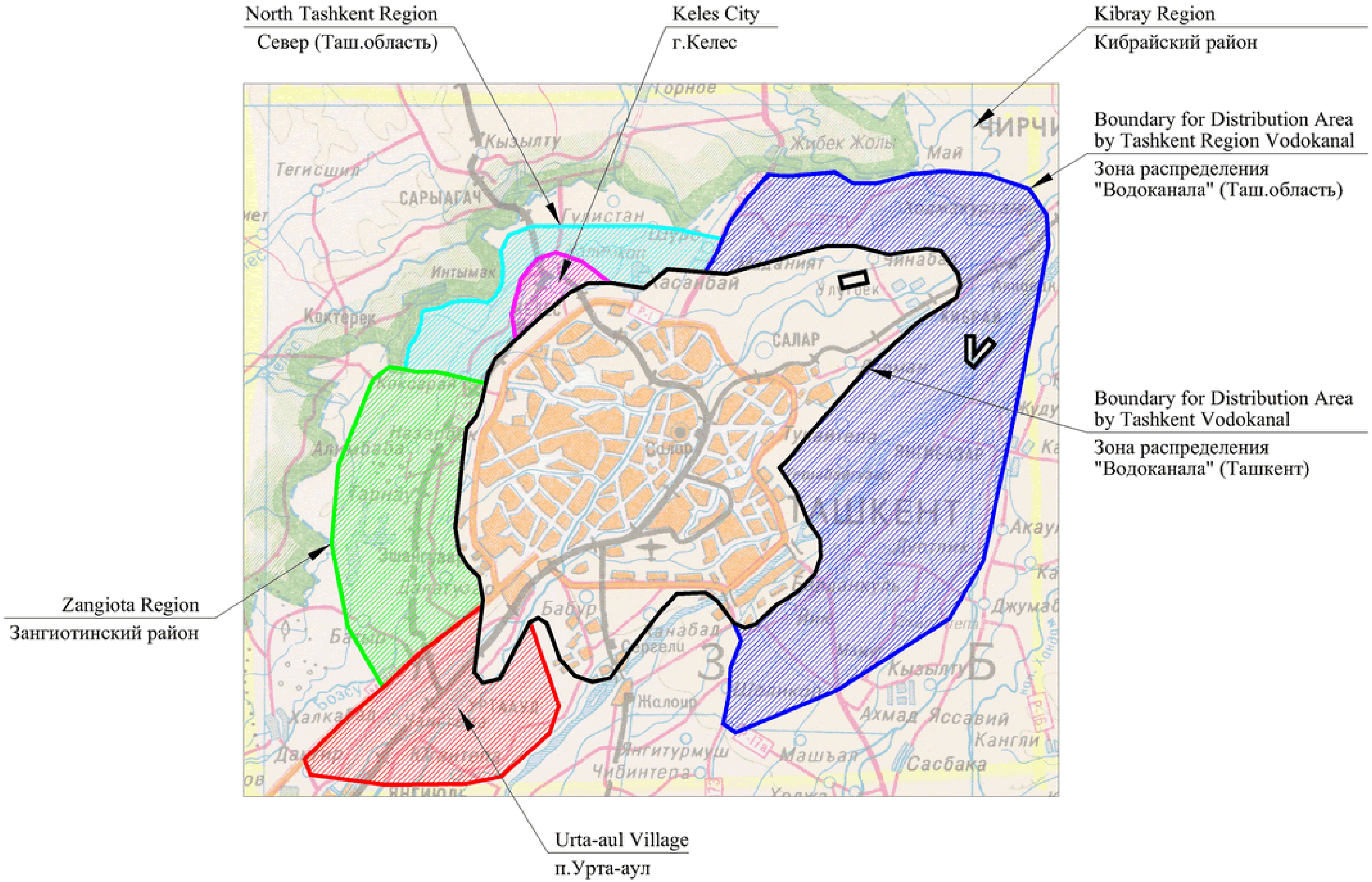

Figure 5.4.7.1 Target Expansion Area

(3) Water Demand Projection Including Expansion Area

1) Projection of daily average demand

Water demand projection including expansion areas is shown in Table S 5.4.7.2 and Figure S 5.4.7.2. As shown in Table S 5.4.7.2, additional demand for expansion area in 2007 is assumed at 40% of the planned value in 2010 and that in 2009 is assumed at 80% of the planned value.

Table S 5.4.7.2 Water Demand Projection including Expansion Area（$10^3m^3/d$）

Division	Division	2002	2005	2007	2009	2010	2011	2015
Existing Area	Population (10^3)	2,171	2,178	2,171	2,195	2,196	2,200	2,218
	Domestic customers	843	729	585	442	370	370	374
	Large consumers	896	851	842	833	824	815	779
	Water Losses	1,161	1,161	987	805	726	646	472
	Total	2,900	2,741	2,414	2,081	1,919	1,831	1,625
Expansion area	Population (10^3)	348	348	400	470	599	599	599
	Additional demand	0	0	106	212	265	265	265
	Water loss (10%)[*1]	0	0	12	24	29	29	29
	Total	0	0	118	236	295	295	295
Total		**2,900**	**2,741**	**2,532**	**2,316**	**2,214**	**2,126**	**1,919**
Water Loss Ratio (%)		40.0	42.4	39.4	35.8	34.1	31.8	26.1

*1: Water loss ratio for expansion areas is assumed at 10%, because most of distribution system in this area will be newly constructed

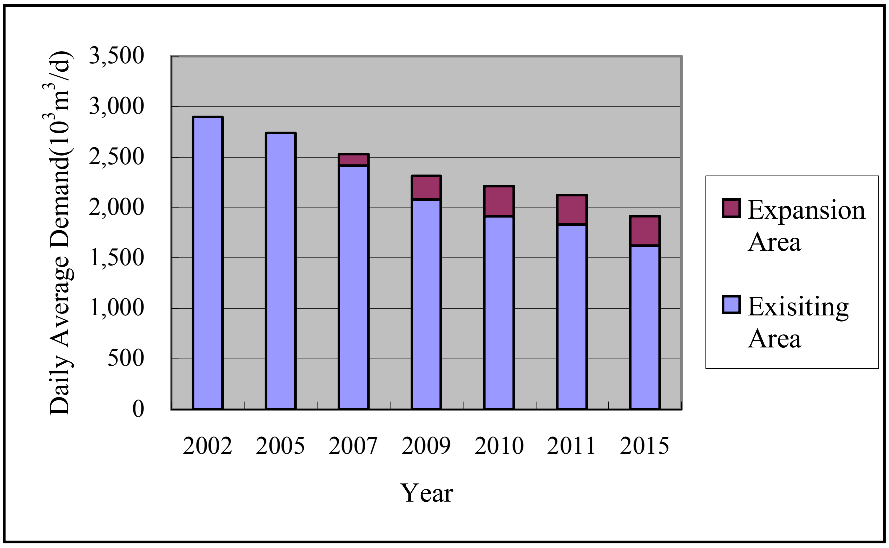

Figure S 5.4.7.2 Water Demand Projection including Expansion Area

2) Daily maximum demand

Daily maximum demand (design value for water treatment plant) and hourly maximum demand (design value for distribution network) are calculated in Table S 5.4.7.3.

Table S 5.4.7.3 Calculation of Daily and Hourly maximum Demand

Item	2002	2005	2007	2009	2010	2011	2015
Total daily average demand ($10^3m^3/d$)	2,900	2,741	2,532	2,316	2,214	2,126	1,919
Water loss ratio (%)	40	42	39	36	34	32	26
Total daily max demand ($10^3m^3/d$)	**3,100**	**3,015**	**2,785**	**2,548**	**2,457**	**2,381**	**2,150**
Daily factor	1.07	1.1	1.1	1.1	1.11	1.12	1.12
Total hourly max demand *($10^3m^3/d$)	3,200	3,165	3,064	2,803	2,728	2,738	2,408
Hourly factor	1.03	1.05	1.1	1.1	1.11	1.15	1.12

Hourly max demand x 24hr

(4) Required Capacity of Water Treatment Plant

The aforementioned projection shows that the water treatment capacity 2,150,000m^3/d is required in 2015, which means additional capacity of 330,000.m^3/d in needed for the total service area, comparing to the requirement of M/P for the existing areas (1,820,000 m^3/d). It is recommended that the additional capacity be allocated to Kadirya, Boz-su and South WTP as follows:

- Kadirya WTP should be operated at the production capacity of 1,450,000m^3/d, which is within the allowance of SNIP Standards;
- Expanding of Boz-su WTP should be made by construction a further rapid filter system with capacity of 100,000m^3/d, which is enacted by The Cabinet Resolution;
- South WTP should be rehabilitated and secure the water production capacity of 150,000 m^3/d.

Thus, the balance of required capacity of WTPs is summarized as shown in Table S5.4.7.4.

Table S 5.4.7.4 Required Capacity of WTP

WTP Name	Total Capacity of WTP ($10^3m^3/d$)	
	Existing Area	Including Expansion area
Kadirya	1,375	1,450 (1,700*1)
Boz-su	100	200
Kibray	350	350
South		150
Total	1,825	2,150 (2,400)
Required Capacity	1,820	2,150

*1; The capacity of Kadirya WTP can be increased according to SNIP standard
- The intake and distribution capacity of Kadirya WTP is over 2 million m^3/d.
- The total area of rapid filters is 6,600m^2 including 10 % of stand-by filters
- The maximum filtration speed filter is 12m/hr (=288m/d) as enacted in SMIP.
- Therefore the maximum capacity of Kadirya WTP should be;

$$6,600m^2 \times (1-0.1) \times 288 = 1.700 \times 10^3\ m^3/d$$

(5) Distribution Pipelines for Expansion Area

Currently, for expansion area, pipelines are partly installed, however per capita water consumption of those areas is quite small. Therefore, the pipelines for expansion areas need to be newly designed. Because distribution of the population have not yet decided exactly, this pipeline cannot be designed now.

Since the target areas surround the City, those pipelines should be expanded from existing distribution network. However because the flow abilities of existing network will be short to the required ability, some reinforcement pipes will be required.