Table 1.13 Planned Water Demand for the rescheduled Project

(Unit : thousand m^3/day)

Description		1995	2000	2005	2010
Daily average water demand					
T-Nukus	Urban	184.1	257.0	279.3	302.9
	Rural	49.2	34.2	43.7	55.2
	Total	233.3	291.2	323.0	358.1
T-Urgench	Urban	191.0	229.9	236.6	241.1
	Rural	88.2	80.8	104.4	130.8
	Total	279.2	310.7	341.0	371.9
Daily maximum water demand					
T-Nukus	Urban	211.7	295.5	321.3	348.3
	Rural	56.6	39.3	50.2	63.5
	Total	268.3	334.8	371.5	411.8
T-Urgench	Urban	219.7	264.4	271.9	277.2
	Rural	101.4	92.9	119.9	150.4
	Total	321.1	357.3	391.8	427.6

Water demand for the rescheduled project is shown in Table 1.15-(a) and (b), Table 1.16 and Figure 1.1-(a) and (b).

1.6 Improvement in Drinking Water Quality

Presently, the raw water for drinking purpose is taken from water sources polluted to different degrees - the Amudarya river, canals or wells. Consequently, water treated by ordinary treatment process or by sedimentation process only, is not suitable for drinking because of the high concentration of contaminants. Moreover total hardness and mineralization cannot be removed by the ordinary treatment process.

According to the Basic Plan, Kaparas reservoir, where good quality water is to be stored during the flood season of Amudarya river, will be used as the water source instead of the existing polluted sources. The quality of drinking water will improve significantly. The preliminary forecast for anticipated water quality improvement in 2010 is shown in Table 1.14. According to this table, the improvement in quality (total hardness and mineralization) are estimated as 6.7 and 6.3 meq/l, and 733 mg/l and 690 mg/l on an average for each system respectively. These figures are less than the maximum allowable levels in the Uzbeki standard. {Total hardness (7 meq/l) and mineralization (1000 mg/l)} In practice, the degree of improvement in water quality by district depends on the mixing ratio of the water in the Kaparas reservoir and the local source. However, it is possible to predict the tendency of improvement in water quality on the average in future by using the Kaparas reservoir.

Table 1.14 Calculation of Water Quality Improvement in 2010

Water supply system	Daily average water demand (thousand m^3/day)			Water Quality		
	Total (a)	from Kaparas reservoir (b)	from Local sources (c)	Kaparas reservoir (d)	Local sources (e)	Calculated quality (f)
				Total hardness(meq/l)		
T-N system	358.1	315	43.1	6.1	10.8	6.9
T-U system	371.9	360	11.9	6.1	10.8	6.2
				Mineralization (mg/l)		
T-N system	358.1	315	43.1	675	1,156	754
T-U system	371.9	360	11.9	675	1,156	682
Remarks		90 % of the design capacity of Tuyamuyun WTP	c = a - b	average quality in July at Tuyamuyun for about 20 years	average quality in March at Shumanai for about 20 years	f =(b x d + c x e) / a

Note: Water quality of each water source is estimated as shown in Remarks. These values of the water quality are derived from Chapter 5 of the Basic Plan report (Part I).

Table 1.15-(a) Future Water Demand in Karakalpakstan

		1995					2000					2005					2010				
		Population	Coverage Rate	Served Population	Ave. Water Demand	Max Water Demand	Population	Coverage Rate	Served Population	Ave. Water Demand	Max Water Demand	Population	Coverage Rate	Served Population	Ave. Water Demand	Max Water Demand	Population	Coverage Rate	Served Population	Ave. Water Demand	Max Water Demand
		ths.	%	ths.	ths.m3/day		ths.	%	ths.	ths.m3/day		ths.	%	ths.	ths.m3/day		ths.	%	ths.	ths.m3/day	
KKP	(Urban)																				
	Nukus	230.3	77	176.6	66.0	75.9	247.3	90	222.6	86.5	99.5	260.2	95	247.2	91.0	104.7	272.0	100	272.0	94.8	109.0
	Takhiatash(G.P)	49.3	92	45.4	19.2	22.1	52.9	95	50.3	20.4	23.4	55.6	95	52.8	23.1	26.6	58.2	100	58.2	24.5	28.1
	Turtkul	45.0	75	33.7	12.7	14.6	48.3	90	43.5	18.1	20.8	51.8	95	49.2	19.5	22.4	53.1	100	53.1	20.6	23.7
	Muynak	13.7	92	12.6	5.3	6.1	14.6	95	13.9	6.1	7.0	15.4	95	14.6	6.3	7.2	16.1	100	16.1	6.6	7.6
	Khodjeily(G.P)	65.0	76	49.5	17.4	20.0	70.0	90	63.0	26.7	30.7	73.6	95	69.9	29.0	33.3	77.0	100	77.0	30.2	34.7
	Beruny	44.6	72	31.9	12.3	14.1	47.5	90	42.8	18.3	21.1	50.0	95	47.5	21.5	24.7	52.3	100	52.3	24.1	27.7
	Chimbay	31.9	79	25.1	9.0	10.3	34.2	90	30.8	15.4	17.7	36.0	95	34.2	16.3	18.8	37.7	100	37.7	16.9	19.5
	Shumanay	12.5	70	8.8	3.8	4.3	13.5	90	12.2	4.1	4.7	14.2	95	13.5	4.5	5.2	14.9	100	14.9	4.9	5.7
	Kungrad(G.P)	56.1	81	45.3	18.8	21.7	60.3	90	54.3	20.9	24.0	63.5	95	60.3	21.8	25.1	66.4	100	66.4	22.8	26.2
	Khalkabad	10.9	60	6.5	2.5	2.9	11.7	90	10.5	4.8	5.5	12.4	95	11.8	4.9	5.7	13.0	100	13.0	5.1	5.8
	Kegeily	12.9	73	9.4	3.2	3.7	13.9	90	12.5	5.4	6.2	14.6	95	13.9	5.6	6.4	15.3	100	15.3	5.8	6.6
	Akmangit	7.5	75	5.6	2.0	2.3	8.1	90	7.3	2.7	3.1	8.6	95	8.2	2.9	3.3	9.0	100	9.0	3.0	3.5
	Karauzyak	12.6	75	9.5	3.6	4.1	13.6	90	12.2	4.4	5.1	14.3	95	13.6	4.8	5.5	15.1	100	15.1	5.1	5.8
	Takhtakupyr	16.8	64	10.7	3.9	4.5	18.0	90	16.2	5.9	6.8	19.0	95	18.1	6.4	7.3	20.0	100	20.0	6.7	7.7
	Kanlykul	9.0	83	7.5	2.6	2.9	9.7	90	8.7	3.1	3.6	10.2	95	9.7	3.4	3.9	10.7	100	10.7	3.6	4.2
	Bozatau	3.7	89	3.3	1.1	1.3	4.1	90	3.7	1.3	1.5	4.3	95	4.1	1.5	1.7	4.5	100	4.5	1.5	1.8
	Ellikaly	10.9	21	2.3	0.9	1.0	11.7	90	10.5	7.3	8.4	12.3	95	11.7	8.6	9.9	12.9	100	12.9	9.5	10.9
	Karatau						2.7	90	2.4	1.4	1.6	5.0	95	4.8	3.7	4.3	25.0	100	25.0	12.3	14.2
	Djumurtau						3.5	90	3.2	1.8	2.0	3.7	95	3.5	1.8	2.1	3.9	100	3.9	2.1	2.4
	Komsomol						0.6	90	0.5	0.2	0.2	0.6	95	0.6	0.2	0.2	0.7	100	0.7	0.2	0.2
	Karakalpakia						4.0	90	3.6	1.2	1.4	4.2	95	4.0	1.3	1.5	4.4	100	4.4	1.4	1.6
	Zhaslyk						4.0	90	3.6	1.2	1.4	4.2	95	4.0	1.3	1.5	4.4	100	4.4	1.4	1.6
	Vodnik						6.2	90	5.6	1.8	2.1	6.5	95	6.2	1.9	2.2	6.8	100	6.8	2.0	2.4
	Sadovy plant						5.0	90	4.5	1.4	1.7	16.0	95	15.2	4.7	5.4	25.0	100	25.0	7.5	8.6
	Mangit	27.3	67	18.4	8.1	9.3	29.3	90	26.4	15.0	17.2	30.8	95	29.3	15.6	17.9	32.2	100	32.2	15.7	18.1
	Urban Area	660.0	76	502.1	192.2	221.0	734.7	90	664.8	275.2	316.5	787.0	95	747.9	301.4	346.6	850.6	100	850.6	328.2	377.4
	(Rural)																				
	Amudaria	95.9	15	14.1	4.5	5.1	107.5	16	17.2	4.5	5.2	118.7	18	21.4	6.6	7.6	131.0	20	26.0	8.4	9.7
	Takhtakupyr	25.4	57	14.6	1.3	1.5	28.5	63	17.9	1.6	1.8	31.5	70	21.9	1.9	2.2	34.7	77	26.6	2.2	2.6
	Kungrad	36.8	70	25.6	1.5	1.8	41.3	76	31.3	2.6	3.0	45.6	84	38.4	2.7	3.1	50.3	93	46.6	3.3	3.7
	Karauzyak	28.3	37	10.6	1.2	1.3	31.6	41	12.9	1.4	1.6	35.0	45	15.8	2.0	2.2	38.7	50	19.3	2.5	2.9
	Kegeily	31.9	32	10.3	2.9	3.3	36.0	35	12.7	1.6	1.8	39.6	39	15.5	2.2	2.5	43.7	43	18.8	2.8	3.2
	Kanlykul	25.9	69	18.0	1.1	1.2	29.0	76	22.0	1.6	1.8	32.1	84	27.0	1.9	2.2	35.4	92	32.7	2.3	2.6
	Chimbay	52.7	54	28.5	9.5	10.9	59.1	59	34.8	3.0	3.5	65.2	65	42.7	3.6	4.2	72.0	72	51.8	4.7	5.4
	Ellikaly	89.4	65	58.0	12.0	13.8	100.2	71	70.9	6.3	7.2	110.6	79	87.0	6.6	7.6	122.2	86	105.6	7.9	9.1
	Khodjeily	62.6	25	15.8	3.1	3.5	70.2	27	19.3	2.2	2.5	77.5	30	23.6	3.7	4.2	85.6	34	28.7	5.5	6.3
	Turtkul	93.9	55	51.7	7.1	8.1	105.2	60	63.1	5.5	6.3	116.2	67	77.4	6.9	7.9	128.3	73	94.0	8.2	9.5
	Nukus	36.7	62	22.6	2.2	2.5	41.1	67	27.6	2.4	2.8	45.4	75	33.9	2.7	3.1	50.1	82	41.1	3.2	3.7
	Shumanay	28.0	11	3.1	1.0	1.1	31.4	12	3.8	1.0	1.1	34.7	14	4.7	1.7	1.9	38.3	15	5.6	2.4	2.8
	Beruny	85.3	15	12.6	3.5	4.1	95.6	16	15.4	3.5	4.0	105.5	18	18.9	5.9	6.7	116.5	20	22.9	7.6	8.8
	Muynak	14.2	47	6.7	0.8	0.9	15.8	51	8.1	0.8	0.9	17.5	57	10.0	1.0	1.1	19.3	63	12.2	1.2	1.4
	Bozatau	15.0	39	5.9	2.2	2.5	16.8	43	7.2	0.8	0.9	18.6	48	8.9	1.0	1.2	19.7	52	10.3	1.3	1.5
	Rural Area	722.0	41	298.1	53.7	61.7	809.3	45	364.2	38.7	44.6	893.7	50	447.1	50.3	57.9	985.8	55	542.2	63.6	73.2
	Grand Total	1382.0	58	800.2	245.9	282.7	1544.0	67	1029.0	313.9	361.1	1680.7	71	1195.0	351.7	404.5	1836.4	76	1392.8	391.7	450.5

Sodavy Plant in Karakalpakstan is supplied by water from the Water Supply System of Urgench Trans Gas

Table 1.15-(b) Future Water Demand in Khorezm

		1995					2000					2005					2010				
		Population	Coverage Rate	Served Population	Ave. Water Demand	Max Water Demand	Population	Coverage Rate	Served Population	Ave. Water Demand	Max Water Demand	Population	Coverage Rate	Served Population	Ave. Water Demand	Max Water Demand	Population	Coverage Rate	Served Population	Ave. Water Demand	Max Water Demand
		ths.	%	ths.	ths.m3/day		ths.	%	ths.	ths.m3/day		ths.	%	ths.	ths.m3/day		ths.	%	ths.	ths.m3/day	
Khorezm	(Urban)																				
	Urgench	138.6	98	136.0	88.1	101.4	150.0	100	150.0	90.3	103.9	156.0	100	156.0	89.0	102.4	164.0	100	164.0	85.8	98.7
	Khiva	46.3	95	44.1	22.6	26.0	50.0	100	50.0	23.7	27.2	52.0	100	52.0	24.7	28.4	55.0	100	55.0	29.5	33.9
	Khanka	29.2	87	25.5	14.3	16.4	31.5	90	28.4	14.8	17.0	33.0	95	31.4	15.4	17.7	34.5	100	34.5	15.4	17.7
	Khazarasp	14.7	87	12.8	7.5	8.7	15.6	90	14.0	8.5	9.7	16.5	95	15.7	9.2	10.5	17.3	100	17.3	9.4	10.8
	Shavat	13.8	77	10.6	5.7	6.5	14.7	90	13.2	9.3	10.7	15.5	95	14.7	10.6	12.2	16.3	100	16.3	10.9	12.5
	Gurlen	19.9	70	13.9	7.4	8.5	21.2	90	19.1	14.3	16.5	22.4	95	21.3	14.8	17.1	23.5	100	23.5	14.9	17.1
	Karaul	14.0	96	13.5	10.5	12.0	15.0	100	15.0	10.8	12.4	15.7	100	15.7	10.9	12.5	16.5	100	16.5	10.9	12.6
	Koshkupyr	15.2	76	11.6	6.6	7.6	16.2	90	14.6	7.3	8.4	17.1	95	16.2	7.6	8.7	17.9	100	17.9	8.0	9.2
	Bagat	8.6	50	4.3	4.8	5.5	9.2	90	8.3	7.2	8.2	9.7	95	9.2	8.2	9.5	10.2	100	10.2	8.6	9.9
	Yangiaryk	9.9	34	3.4	3.2	3.7	10.6	90	9.5	8.2	9.4	11.2	95	10.6	8.1	9.3	11.8	100	11.8	7.9	9.1
	Druzhba	15.0	95	14.2	9.4	10.8	16.0	95	15.2	11.2	12.9	17.0	100	17.0	11.9	13.7	17.7	100	17.7	12.8	14.8
	Yangibazar	5.4	54	2.9	2.0	2.4	5.8	90	5.2	5.0	5.8	6.1	95	5.8	6.3	7.3	6.4	100	6.4	6.7	7.8
	Chalysh	5.4	19	1.0	0.7	0.9	5.7	90	5.1	2.6	3.0	6.0	95	5.7	2.6	2.9	6.3	100	6.3	2.5	2.9
	Urban Area	336.0	87	293.8	183.0	210.4	361.5	96	347.6	213.1	245.1	378.2	98	371.3	219.2	252.1	397.4	100	397.4	223.3	256.8
	(Rural)																				
	Gurlen	76.5	58	44.6	1.5	1.8	88.5	58	51.3	6.7	7.7	100.5	59	58.8	8.1	9.3	114.0	65	73.7	10.3	11.9
	Koshkupyr	94.0	25	23.8	1.4	1.6	109.1	38	42.0	6.3	7.3	123.0	55	67.1	9.2	10.6	139.6	65	90.2	12.7	14.6
	Khanka	87.5	83	73.0	5.1	5.9	101.2	74	74.9	9.0	10.3	114.9	70	80.6	11.9	13.7	130.5	68	89.0	12.5	14.4
	Khazarasp	130.6	47	61.6	4.4	5.0	151.1	52	78.9	10.6	12.2	171.5	58	100.2	13.0	14.9	194.6	65	125.8	17.6	20.3
	Shavat	94.0	43	40.7	2.5	2.9	109.4	52	57.2	7.7	8.8	124.2	58	72.6	10.0	11.5	140.9	65	91.1	12.8	14.7
	Urgench	112.7	37	41.2	10.7	12.3	130.5	48	62.5	8.4	9.6	148.2	58	86.6	11.9	13.7	168.2	65	108.7	15.3	17.5
	Khiva	102.5	70	72.2	9.0	10.4	118.6	70	82.6	11.0	12.6	134.4	66	89.1	12.3	14.1	152.5	65	98.6	13.8	15.9
	Yangibazar	49.2	38	18.9	2.7	3.1	56.9	44	24.8	3.3	3.8	64.7	55	35.3	4.9	5.6	73.4	65	47.5	6.7	7.7
	Yangiaryk	61.8	30	18.7	7.1	8.2	71.5	43	31.1	4.1	4.8	81.2	55	44.3	6.1	7.0	92.2	65	59.6	8.4	9.6
	Bagat	91.0	69	62.5	39.3	45.1	105.0	65	68.6	9.2	10.6	120.0	62	74.9	10.3	11.9	136.2	65	88.1	12.4	14.2
	Rural Area	899.8	51	457.2	83.7	96.3	1041.8	55	573.9	76.3	87.7	1182.6	60	709.5	97.7	112.4	1342.1	65	872.3	122.4	140.7
	Grand Total	1235.8	61	751.0	266.7	306.7	1403.3	66	921.5	289.4	332.9	1560.8	69	1080.8	316.9	364.4	1739.5	73	1269.7	345.6	397.5

Table 1.16 Population and Water Demand

	1996				1997				1998				1999				2000			
	Total population	Served population	Ave.water demand	Max water demand	Total population	Served population	Ave.water demand	Max water demand	Total population	Served population	Ave.water demand	Max water demand	Total population	Served population	Ave.water demand	Max water demand	Total population	Served population	Ave.water demand	Max water demand
	ths.		ths.m3/day		ths.		ths.m3/day		ths.		ths.m3/day		ths.		ths.m3/day		ths.		ths.m3/day	
T-N																				
urban	645.5	513.1	198.7	228.5	658.4	542.5	213.3	245.2	671.2	571.9	227.8	262.0	684.1	601.3	242.4	278.7	696.9	630.7	257.0	295.5
rural	641.2	296.6	46.2	53.1	656.4	309.2	43.2	49.7	671.5	321.8	40.2	46.2	686.7	334.4	37.2	42.8	701.8	347.0	34.2	39.3
total	1,286.7	809.7	244.9	281.6	1,314.8	851.7	256.5	294.9	1,342.7	893.7	268.0	308.2	1,370.8	935.7	279.6	321.5	1,398.7	977.7	291.2	334.8
T-U																				
urban	369.5	325.2	198.8	228.6	375.7	338.2	206.6	237.6	381.9	351.2	214.3	246.5	388.1	364.2	222.1	255.5	394.3	377.2	229.9	264.4
rural	1,026.4	495.3	86.7	99.7	1,057.1	519.2	85.2	98.0	1,087.9	543.2	83.8	96.3	1,118.6	567.1	82.3	94.6	1,149.3	591.1	80.8	92.9
total	1,395.9	820.5	285.5	328.3	1,432.8	857.4	291.8	335.6	1,469.8	894.4	298.1	342.8	1,506.7	931.3	304.4	350.1	1,543.6	968.3	310.7	357.3

	2001				2002				2003				2004				2005			
	Total population	Served population	Ave.water demand	Max water demand	Total population	Served population	Ave.water demand	Max water demand	Total population	Served population	Ave.water demand	Max water demand	Total population	Served population	Ave.water demand	Max water demand	Total population	Served population	Ave.water demand	Max water demand
	ths.		ths.m3/day		ths.		ths.m3/day		ths.		ths.m3/day		ths.		ths.m3/day		ths.		ths.m3/day	
T-N																				
urban	704.8	644.5	261.5	300.7	712.7	658.4	265.9	305.8	720.7	672.2	270.4	311.0	728.6	686.1	274.8	316.1	736.5	699.9	279.3	321.3
rural	716.4	362.7	36.1	41.5	731.1	378.5	38.0	43.7	745.7	394.2	39.9	45.8	760.4	410.0	41.8	48.0	775.0	425.7	43.7	50.2
total	1,421.2	1,007.2	297.6	342.2	1,443.8	1,036.9	303.9	349.5	1,466.4	1,066.4	310.3	356.8	1,489.0	1,096.1	316.6	364.1	1,511.5	1,125.6	323.0	371.5
T-U																				
urban	398.0	382.6	231.2	265.9	401.7	388.0	232.6	267.4	405.3	393.3	233.9	268.9	409.0	398.7	235.3	270.4	412.7	404.1	236.6	271.9
rural	1,179.7	619.1	85.5	98.3	1,210.1	647.0	90.2	103.7	1,240.5	675.0	95.0	109.1	1,270.9	702.9	99.7	114.5	1,301.3	730.9	104.4	119.9
total	1,577.7	1,001.7	316.7	364.2	1,611.8	1,035.0	322.8	371.1	1,645.8	1,068.3	328.9	378.0	1,679.9	1,101.6	335.0	384.9	1,714.0	1,135.0	341.0	391.8

	2006				2007				2008				2009				2010			
	Total population	Served population	Ave.water demand	Max water demand	Total population	Served population	Ave.water demand	Max water demand	Total population	Served population	Ave.water demand	Max water demand	Total population	Served population	Ave.water demand	Max water demand	Total population	Served population	Ave.water demand	Max water demand
	ths.		ths.m3/day		ths.		ths.m3/day		ths.		ths.m3/day		ths.		ths.m3/day		ths.		ths.m3/day	
T-N																				
urban	747.1	717.8	284.0	326.7	757.7	735.7	288.7	332.1	768.3	753.7	293.5	337.5	778.9	771.6	298.2	342.9	789.5	789.5	302.9	348.3
rural	791.0	443.8	46.0	52.9	806.9	461.9	48.3	55.5	822.9	480.0	50.6	58.2	838.8	498.1	52.9	60.8	854.8	516.2	55.2	63.5
total	1,538.1	1,161.6	330.0	379.6	1,564.6	1,197.6	337.0	387.6	1,591.2	1,233.7	344.1	395.7	1,617.7	1,269.7	351.1	403.7	1,644.3	1,305.7	358.1	411.8
T-U																				
urban	416.9	410.0	237.5	273.0	421.0	415.9	238.4	274.0	425.2	421.7	239.3	275.1	429.3	427.6	240.2	276.1	433.5	433.5	241.1	277.2
rural	1,335.7	764.4	109.7	126.0	1,370.0	797.9	115.0	132.1	1,404.4	831.3	120.2	138.2	1,438.7	864.8	125.5	144.3	1,473.1	898.3	130.8	150.4
total	1,752.6	1,174.4	347.2	399.0	1,791.0	1,213.8	353.4	406.1	1,829.6	1,253.0	359.5	413.3	1,868.0	1,292.4	365.7	420.4	1,906.6	1,331.8	371.9	427.6

Population and water demand for Amudarya region are included in Khorezm
Water demand for Sadovy plant is supplied from Uztransgas.
(Pop. and water demand for Sadovy plant is not included in KKP(urban).

Fig. 1.1-(a) Planed Water Demand for Tuyamuyun-Nukus Water Supply System of B/P and Rescheduled Plan for F/S

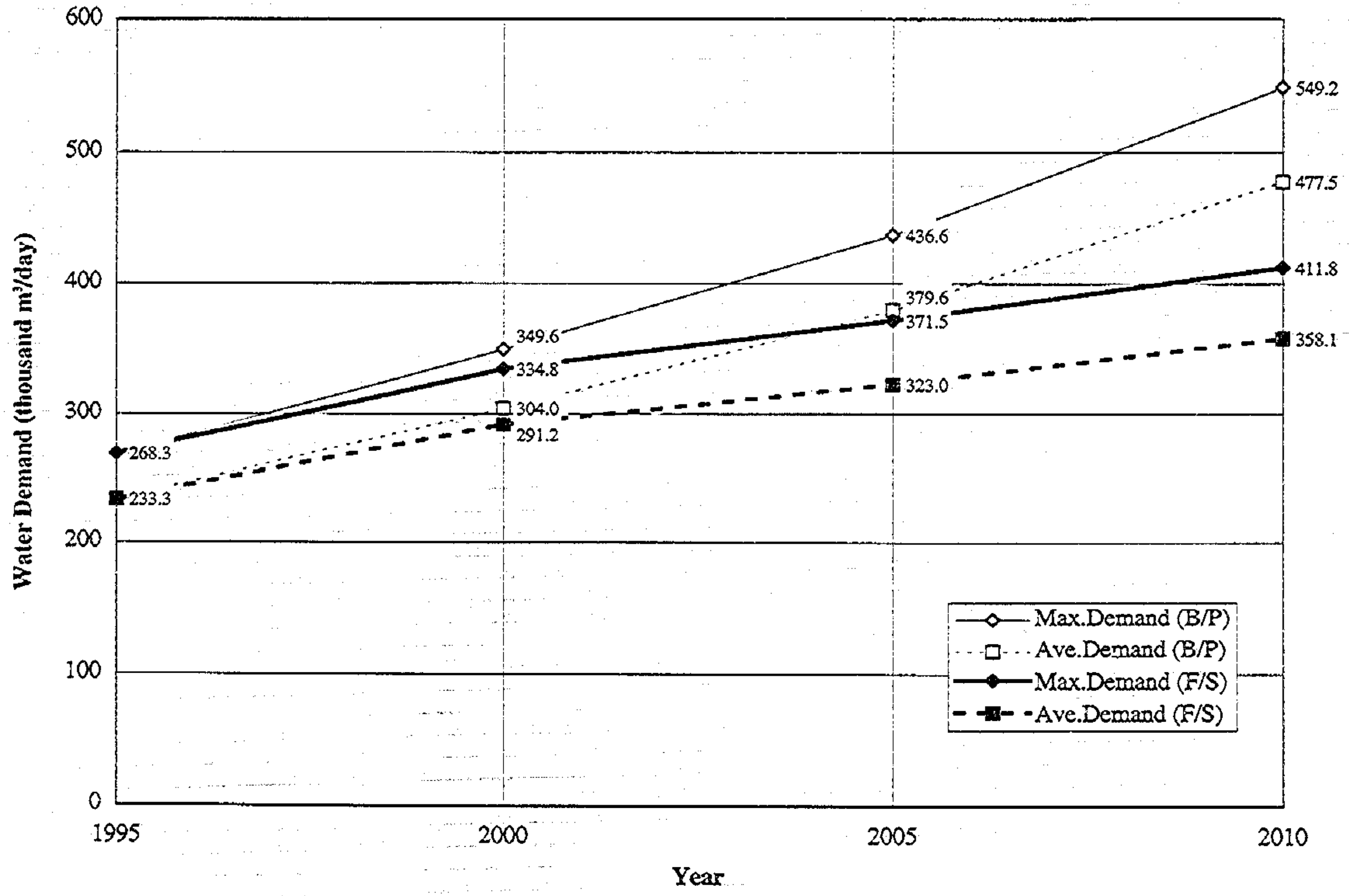
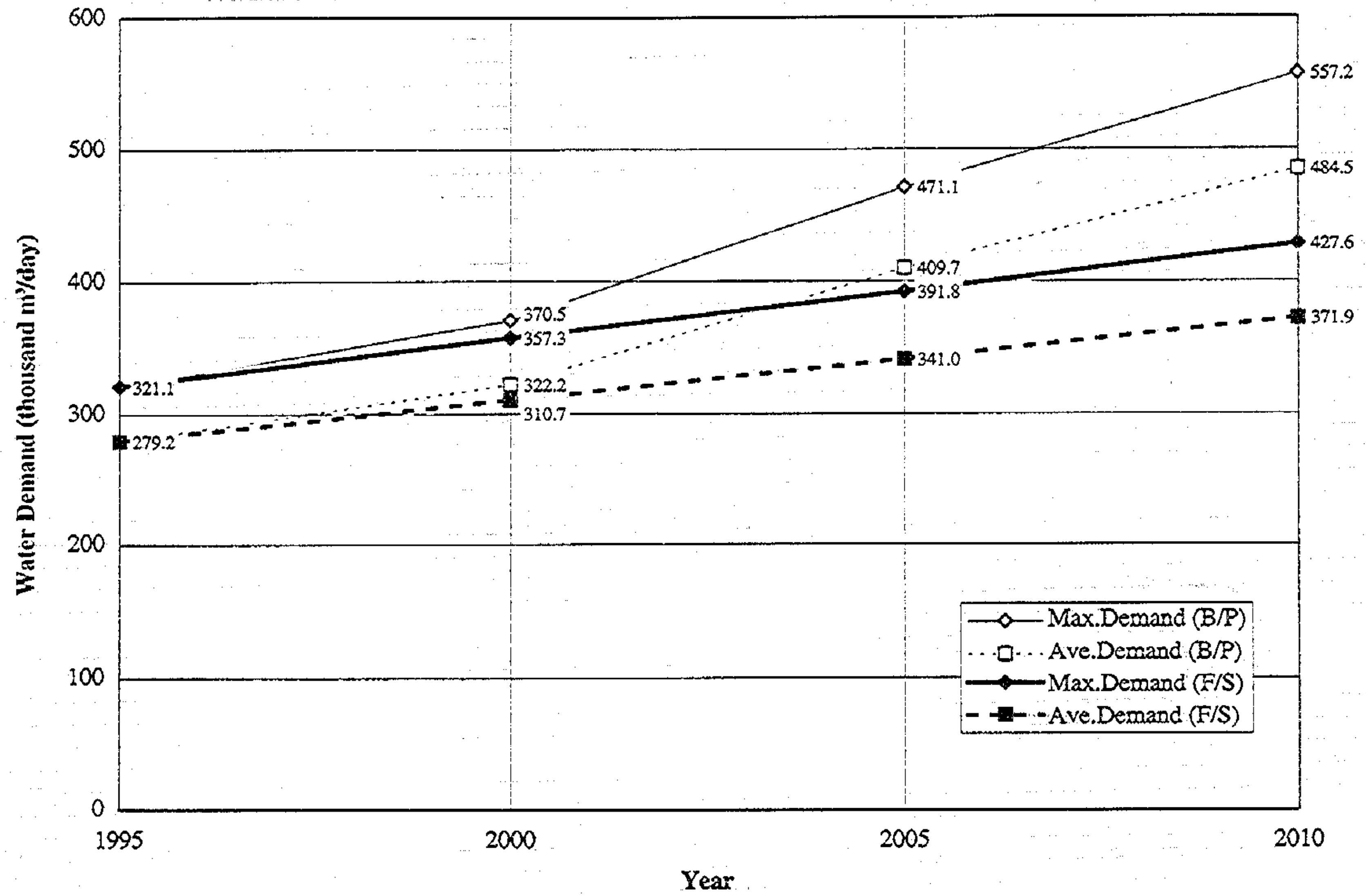


Fig. 1.1-(b) Planed Water Demand for Tuyamuyun-Urgench Water Supply System of B/P and Rescheduled Plan for F/S



CHAPTER 2

ENGINEERING DESIGN

F/S

CHAPTER 2 ENGINEERING DESIGN

2.1 Design Criteria

2.1.1 Introduction

Rehabilitation, improvement, and expansion of the existing water supply system are undertaken, based on the facilities for the feasibility study, This chapter develops the design concept and the preliminary design of the expanded facilities to obtain technical specifications of each facility.

The projects identified as the facilities for the feasibility study are given in table 1.7 in Chapter 1. However, of all listed facilities, the pipeline between Takhiatash and Kungrad was excluded as a result of preliminary evaluation.

Some of these proposed facilities have been already designed by the Uzbeki side in their own water supply master plans (the Uzbeki master plans), some are under construction, while the construction of some facilities has been suspended. Therefore, the design for this study has been conducted based on the design of existing facilities and plans.

2.1.2 Design Criteria

Criteria, formulae and conditions used for the design of the water supply system are as follows:

Design quantity of each facility

1) Storage capacity of reservoir :	1.1 x 365 x daily average water demand
2) Intake pumping capacity :	1.1.x daily maximum water demand
3) Raw water main :	1.1 x daily maximum water demand
4) Water treatment plant :	1.1 (or 10/9) x daily maximum water demand
5) Transmission pipeline :	daily maximum water demand
6) Transmission pumping station :	daily maximum water demand
7) Distribution pipeline :	hourly maximum water demand
8) Distribution pumping station :	hourly maximum water demand

Formula used to design pipelines

Formula for hydraulic analysis : Hazen-Williams

$$H = I/1{,}000 \times L$$

$I = 10.666 \times C^{-4.87} \times Q^{1.85}$

where;

H :	Head loss (m)
I :	Hydraulic gradient (no dimension)
L :	Pipe length (m)
Q :	Flow rate (m/s)
C :	110

Note; As a result of comparing hydraulic analysis by the Hazen-Williams formula with results of the analysis by the Uzbeki side, C=110 was considered to be appropriate for the analysis and the design.

2.1.3 Natural Conditions

In general, crucial natural conditions in the area used for the design are as follows:

1) The depth of seasonal soil freezing is 0.7- 1.0 m.

2) The ground waters are disclosed at the depth of 1.10 - 6.0 m, depending on the location.

2.2 Kaparas Reservoir and Control Gate

The natural depression for the reservoir for drinking water (Kaparas reservoir) has been prepared and construction of the control gate structure has been completed. All facilities for storing good quality water in the reservoir have been completed. The operation mode of the reservoirs to store the necessary water needs to be planned. Flow rate at control gate is 250 m^3/sec and the bottom level of the structure is 110 m.

Specification of the reservoir is below.

- Length : 15 km
- Width (max./ave.) : 9/4km
- Depth (max./ave.) : 36/13.7 km
- Area (HWL) : 149 km^2
- Water Level (HWL) : 130m
- Water Level (DWL) : 115m

Water volume of the reservoir according to the water level is shown in table 2.1.

Table 2.1 Water Volume and Level of Kaparas Reservoir

Water level (m)	Total Volume (million m^3)	Effective Volume (million m^3)	Remarks
130	960	700	High Water Level
125	650	390	
120	410	150	
115	260	0	Dead Water Level
110	0		Average Bottom Level

2.3 Intake Facilities

2.3.1 Design Conditions

Intake facilities are needed to deliver raw water from the Kaparas reservoir to the two Tuyamuyun water treatment plants.

Design conditions of the pumping station Kaparas Ps based on the Uzbek water supply master plans are summarized as follows:

- Total delivery capacity : 1,350 ths. m^3/day
- Capacity at first stage : 690 ths. m^3/day
- Total water head : 63 m
- Number of Pumps : total 6 sets including 2 standby sets
  4 sets including 1 standby set
- Minimum intake water level : 116 m
- Water level at receiving wells in water treatment plants:
  129 m (Tuyamuyun-Nukus WTP)
  126 m (Tuyamuyun-Urgench WTP)
- Distance from the pumping station to water treatment plants:
  10.7 km (Tuyamuyun-Nukus WTP)
  17.2 km (Tuyamuyun-Urgench WTP)

Delivery capacity of the raw water main and the pump from Kaparas reservoir to each Tuyamuyun WTP is planned based on the total water quantity required for the water treatment plants in 2002 of 721.4 thousand m^3/day, including 328.0 thousand m^3/day for Tuyamuyun-Nukus WTP and 393.4 for Tuyamuyun-Urgench WTP

2.3.2 Kaparas Intake Facilities

Kaparas intake facilities are composed of two facilities:

i) Intake box culverts and connecting pipes for flow of raw water to the intake pump station (Kaparas pumping station) by gravity

ii) Kaparas pumping station

From the above, intake box culverts and connecting pipes have been completed. The Kaparas pumping station is under construction.

(1) Intake Culvert and Pipe

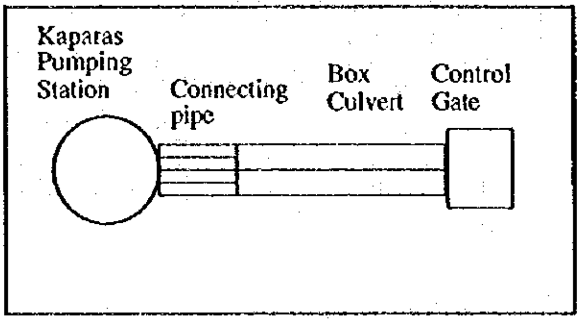
The dimensions and sketch of the constructed intake pipes are as follows:

Box culvert

diameter :	2,000 mm
Number :	2 lines
Length :	280 m

Connecting pipes

diameter :	1,600 mm
Number :	4 lines
Length :	20 m



(2) Pumping Station

Using the above design conditions, the existing facilities and the already arranged equipment, the pumping station has been designed and its specifications and dimensions are shown in table 2.2 together with the present progress of construction and the arranged equipment. Figures 2.1 and 2.2 show the plan and the design drawing of the pumping station.

Table 2.2 Specifications and Dimensions of Designed Facilities

	Item	Specifications / dimensions	Present construction progress
1	Power transmission line	35 kV and 110 kV Length : 12 km	
2	Power substation	110 kV to 10 kV	
3	Under ground structure	Diameter : 38.0 m Top level : 131.25 m Bottom level : 107.2 m Height : 24.05 m Reinforced concrete structure for column and beam Concrete block structure for wall	80 % has been completed.
4	Overland building	Diameter : 38.0 m Top level : 148.0 m Bottom level : 131.25 m Height : 16.75 m Reinforced concrete structure for column and beam Concrete block structure for wall	
5	Pump equipment	Type of pump : centrifugal vertical type Suction head : 4.1 m Delivery quantity : 14,400 m^3/hour Total water head : 63 m Speed of rotation: 500 r.p.m Pump input : 3,200 kw Voltage : 6,000 V	4 pumps with motor and electric control equipment has been procured.
6	Other buildings	Boiler house, administrative building	Construction has been completed.
7	Miscellaneous	Plumbing and valves, equipment, Ventilating, heating, water network, drainage	Some plumbing fittings and valves have been procured.

2.3.3 Raw Water Main

Design

The existing water intake facilities of the two Tuyamuyun water treatment plants are located between each plant and the Kaparas pumping station. Accordingly, the proposed water main is to be connected with the existing water main at the existing intake pumping station for effective use. Table 2.3 shows dimensions of the existing raw water main.

Table 2.3 Dimension of Existing Raw Water Main

Raw water main pipeline	Diameter (mm)	Length (m)	Number	Total Length (m)
T-N WTP to intake P.S	1,200	1,540	2	3,080
T-U WTP to intake P.S	1,200 1,400	8,250	1 1	16,500

The proposed pipeline routes are the same as the routes in the Uzbeki master plan.

As a result of hydraulic analysis of raw water main, two pipelines with diameter 1,400 mm for the Tuyamuyun-Urgench water treatment plant and one pipeline with diameter 1,400 mm for the Tuyamuyun water treatment plant are necessary to deliver the water quantity required for each water treatment plant in 2002. Table 2.4 shows the specifications of the designed raw water mains from Kaparas pumping station to each existing intake pumping station and their routes and schematic layouts are shown in Fig. 2.3 and 2.4.

Table 2.4 Planned Raw Water Mains from Kaparas Reservoir to Existing Intake Pumping Stations

Section	Delivery capacity (ths. m^3/day)	Dimension			
		Diameter (mm)	Length (m)	Number	Total Length (m)
to existing intake P.S of T-N WTP	328.0	1,400	10,700	1	10,700
to existing intake P.S of T-U WTP	393.4	1,400	9,000	2	18,000
total	721.4	-	-	3	28,700

Specifications of Pipeline

1) Pipe materials : Steel pipe with cement mortar lining and tar epoxy coating to prevent corrosion due to underground water.

2) Air-valve and wash-out valve: Installation of air-valves at high points and wash-out valves at the appropriate points for washing of pipelines

3) Depth of buried pipe : 1.0 m

At present one line of dia. 1,400 mm which will be connected to the existing water mains of Tuyamuyun-Urgench water treatment plant at the existing intake pumping station, is under construction and is scheduled for completion by the end of 1996.

River Crossing

There are four river crossings over Amudarya river, Left bank canal and water way to Sultansandjar along the route of the proposed pipelines. Their designs specifications are given below.

1) Amudarya river on the route to Tuyamuyun Nukus water treatment plant

- Location : 8,800 m - 9,200 m distance from Kaparas pumping station
- River width : 400 m
- Type of crossing : Aqueduct bridge
- Type of bridge : Truss bridge
- Length of bridge : 500 m
- Bridge width : 5 m (for installation of two pipes including one line reserved for the future)
- Foundation : Caisson type pile with steel and reinforced concrete (RC)

2) Left Bank canal on the route to Tuyamuyun Nukus water treatment plant

- Location : 7,910 m - 8,055 m distance from Kaparas pumping station
- River width : 145 m
- Type of crossing : Aqueduct bridge
- Type of bridge : Continuous girder
- Length of bridge : 200 m
- Bridge width : 5 m(for installation of two pipes including one line reserved for the future)
- Foundation : RC

3) Left Bank canal on the route to Tuyamuyun Urgench water treatment plant

- Location : 7,730 m - 7,850 m distance from Kaparas pumping station
- River width : 120 m
- Type of crossing : Aqueduct bridge
- Type of bridge : Continuous girder
- Length of bridge : 200 m
- Bridge width : 3 m(for installation of two pipes including one line reserved for future)
- Foundation : RC

4) water way to Sultansandjar reservoir

- Location : 1,465 m - 1,565 m distance from Kaparas pumping station
- River width : 100 m
- Type of crossing : direct laying on the river bed

2.4 Tuyamuyun Nukus Water Supply System (T-N WSS)

2.4.1 Tuyamuyun Nukus Water Treatment Plant (T-N WTP)

Design drawing of proposed expansion and rehabilitation works for T-N WTP is shown in Fig 2.5.

(1) Product Capacity

Existing :	200,000 m^3/day
Expansion :	150,000 m^3/day
Total :	350,000 m^3/day

(2) Supply Capacity

Existing :	180,000 m^3/day (170,000 m^3/day)
Expansion :	135,000 m^3/day
Total :	315,000 m^3/day

Due to the insufficient transmission capability of supply water, viz., incomplete transmission pumping stations, current supply capacity is 170,000 m^3/day. However, after the expansion works, it become 180,000 m^3/day. In the design aspects, ten percent (10%) of the produced water is planned for maintenance purposes in water treatment plant and the rest (90%) of the water is used for actual delivery.

(3) Rehabilitation

1) Receiving Basin
   No Rehabilitation
2) Clarifier
   No Rehabilitation
3) Horizontal sedimentation Basin
   No Rehabilitation
4) Filter
   Q=11,100 m^3/day/unit W= 4.5m L=11.5 m A=51.8 m^2 N=18 units
   Replacement of Under Collection Pipe, Gravel and Sand
5) Chemical Dosing System
   Improved by USAID (Under Installation)
6) Chlorination Dosing System
   Improved by USAID (Completed)

7) Clear Water Reservoir

No Rehabilitation

8) Transmission Pump Equipment

No Rehabilitation

9) Electrical Equipment

Replacement of Panel and Cable for the Water Treatment Facilities without Filter, Chemical Dosing System, Chlorination Dosing System

10) Laboratory

Supplement of Device for Water Quality Analysis

(4) Expansion

1) Receiving Basin

Q=200,000 m^3/day/unit W=3.15 m L=5.4 m Z=1.9 m N=1 unit

Under Construction

2) Clarifier

Q=50,000 m^3/day/unit D=50.0 m Z=2.0 to 5.0 m N=3 units

Under Construction

3) Horizontal Sedimentation Basin

Q=9,450 m^3/day/unit W=6.0 m L=75.0 m Z=2.5 m N=18 units

Under Construction

4) Filter

Q=11,100 m^3/day/unit W= 4.5m L=11.5 m A=51.8 m^2 N=18 units

Under Construction

5) Chemical Dosing System

Q=150,000 m^3/day (Solution and Storage Tank, Dosing Pump, Dosing Pipeline)

6) Chlorination Dosing System

Q=150,000 m^3/day (Dosing Equipment, Dosing Pipeline)

7) Clear Water Reservoir

C=3,000 m^3 N=3 units T= 42 minutes (for Q=315,000 m^3/day)

Existing

8) Transmission Pump Equipment

Q=4,000 m^3/hour H= 95 m P=1,600 kw N=6 units

Q=3,600 m^3/hour H=230 m P=2,500 kw N=6 units

Existing.

The above pumps are planned at two stages pump system. Total number of operation pumps is four (4).

9) Electrical Equipment

Panel and Cable for Expanded Water Treatment Facilities

2.4.2 Tuyamuyun Nukus Transmission System

Design

Detail hydraulic analysis of the planned transmission facilities is carried out using the water demand in 2010. The water demand by region and the production capacity in 2010 by source are as given below and in table 2.5.

- Total water demand: 411.8 thousand m^3/day
- Local water source : 98.0 thousand m^3/day
- Tuyamuyun Nukus water treatment plant : 313.8 thousand m^3/day

As result of the hydraulic analysis, the planned facilities for 2010 are designed as shown in table 2.6-(a) and Fig. 2.6 (Transmission pipeline) and 2.6-(b) and Fig. 2.7 to Fig. 2.9 (Pumping Station).

Table 2.5 Water Demand in 2010 in Karakalpakstan for Design of Transmission pipeline

(unit : thousand m^3/day)

Node No. in fig.	Region Name	Daily maximum demand	Demand covered by local sources	Demand covered by T-N WTP
2	Turtkul	33.20	22.4	10.80
3	Beruni	36.50	12.6	23.90
3	Ellikali	20.00	-	20.00
3	Karatau	14.20	-	14.20
6	Nukus	112.60	60.0	52.60
6	Akmangit	3.50	-	3.50
7	Khalkabad	5.80	-	5.80
11	Kigali	9.80	1.0	8.80
17	Bozatau	3.30	-	3.30
8	Chimbai	24.90	2.0	22.90
9	Karauzyak	8.70	-	8.70
10	Takhtakupyr	10.30	-	10.30
12	Takhiatash	28.10	-	28.10
12	Vodnik	2.40	-	2.40
12	Khodjeili	40.90	-	40.90
13	Shumanai	8.50	-	8.50
14	Kanlykul	6.80	-	6.80
15	Kungrad	29.90	-	29.90
15	Karakalpakia	1.60	-	1.60
15	Komsomol	0.20	-	0.20
15	Zhaslyk	1.60	-	1.60
16	Muynak	9.00	-	9.00
Total		411.80	98.0	313.80

Note : Total includes urban and rural demand

For the number of node, refer to the Supporting Report.

Table 2.6-(a) Planned Pipelines for the Tuyamuyun-Nukus Transmission System in 2010

	Section	Diameter (mm)	Length (km)	Present Construction progress
1	T-N WTP - P.S 1	1,400	63.0	
2	Kigali - Bozatau	400	50.0	
3	Nukus - Takhiatash	1,200	11.0	10 km of total 21 km has been completed.
4	Takhiatash - Kungrad	1,200	111.0	Uztransgas, Existing
5	Kungrad - Muynak	500	96.5	
	total	-	220.5	Not including L=111 km

Specifications of Pipelines

1) Pipe materials : Steel pipe with inner cement mortar lining and tar epoxy coating with protection tape to prevent corrosion due to salinity soil or underground water.

2) Air-valve and wash-out valve:
Installation of air-valves at high points and wash-out valves at appropriate points for washing pipelines

3) Depth of buried pipe : 1.0 m

Table 2.6-(b) Planned Transmission Pumping Station of Tuyamuyun-Nukus System in 2010

	Section	Specification		Present construction progress
1.	P.S 2 (81st bridge P.S)	1.Pump 2.Reservoir 3.Chlorination facility	$3,600\ m^3/h$ x H 290 m x 6 units $3,000\ m^3$ x 3 basins	Power substation and power transmission lines have been completed. 5 % of other work has been completed.
2.	Nukus North P.S	1.Pump 2.Reservoir 3.Chlorination facility	$1,800m^3/h$ x H 190m x 6 units $10,00\ m^3$ x 1 basin	
3.	Kungrad P.S	1.Pump 2.Reservoir 3.Chlorination facility	$270\ m^3/h$ x H 160m x 4 units $10,000\ m^3$ x 3 basins	
		1.Distribution pump	($220\ m^3/h$ x H90 m 8 units) ($200\ m^3/h$ x H125 m 4 units)	

H : Head

2.5 Tuyamuyun Urgench Water Supply System (T-U WSS)

2.5.1 Tuyamuyun Urgench Water Treatment Plant (T-U WTP)

Design drawing of proposed expansion and rehabilitation works for T-U WTP is shown Fig. 2.10.

(1) Product Capacity

Existing : 200,000 m^3/day
Expansion : 200,000 m^3/day
Total : 400,000 m^3/day

(2) Supply Capacity

Existing : 180,000 m^3/day
Expansion : 180,000 m^3/day
Total : 360,000 m^3/day

Ten percent (10%) of the produced water is planned for maintenance purpose and the rest (90%) of the water is for supply water.

(3) Rehabilitation

1) Receiving Basin
No Rehabilitation

2) Clarifier
No Rehabilitation

3) Horizontal Sedimentation Basin
No Rehabilitation

4) Filter
Q=11,100 m^3/day/unit W= 4.5m L=11.5 m A=51.8 m^2 N=18 units
Replacement of Under Collection Pipe, Gravel and Sand

5) Chemical Dosing System
Improved by USAID (Under Installation)

6) Chlorination Dosing System
Improved by USAID (Completed)

7) Clear Water Reservoir
No Rehabilitation

8) Transmission Pump Equipment

No Rehabilitation

9) Electrical Equipment

Replacement of Panel and Cable for the Water Treatment Facilities without Filter, Chemical Dosing System and Chlorination Dosing System

10) Laboratory

Supplement of Device for Water Quality Analysis

(4) Expansion

1) Receiving Basin

Q=200,000 m^3/day/units W=3.15 m L=5.4 m Z=1.9 m N=1 unit

2) Clarifier

Q=50,000 m^3/day/unit D=50.0 m Z=2.0 to 5.0 m N=4 units

Under Construction

3) Horizontal Sedimentation Basin

Q=9,450 m^3/day/unit W=6.0 m L=75.0 m Z=2.5 m N=18 units

Under Construction

4) Filter

Q=11,100 m^3/day/unit W= 4.5m L=11.5 m A=51.8 m^2 N=18 units

Under Construction

5) Chemical Dosing System

Q=200,000 m^3/day (Solution and Storage Tank, Dosing Pump, Dosing Pipeline)

6) Chlorination Dosing System

Q=200,000 m^3/day (Dosing Equipment, Dosing Pipeline)

7) Clear Water Reservoir

C=2,000 m^3 N=2 units T= 27 minutes (for Q=360,000 m^3/day)

Existing

8) Transmission Pump Equipment

Q=1,250 m^3/hour	H=125 m	P= 630 kw	N=2 units
Q=4,000 m^3/hour	H= 90 m	P=1,250 kw	N=4 units
Q=3,200 m^3/hour	H= 70 m	P=1,250 kw	N=2 units

Existing

The above four pumps are in operation.

9) Electrical Equipment

Panel and Cable for Expanded Water Treatment Facilities

2.5.2 Tuyamuyun Urgench Transmission System

Design

Detail hydraulic analysis of the planned transmission facilities is carried out using the water demand in 2010. Water demand by region and production capacity in 2010 by source are as shown below and in table 2.7.

- Total water demand: 427.6 thousand m^3/day
- Local water source : 55.0 thousand m^3/day
- Tuyamuyun Nukus water treatment plant : 372.6 thousand m^3/day

As result of the hydraulic analysis, the planned facilities for 2010 are designed as shown in table 2.8 (Transmission pipeline) and Fig. 2.11.

Table 2.7 Water Demand in 2010 in Khorezm for Design of Transmission Pipeline

(unit : thousand m^3/day)

Node No. in fig.	Name	Daily maximum demand	Demand covered by local sources	Demand covered by T-N WTP
1	Druzhba	14.80	-	14.80
2	Khazarasp	31.00	-	31.00
8	Bagat	24.10	-	24.10
9	Yangiaryk	18.70	-	18.70
10	Khiva	49.70	-	49.70
3	Khanka	32.00	-	32.00
4	Urgench	116.10	45.00	71.10
4	Chalysh	2.90	10.00	-7.10
4	Karaul	12.60	-	12.60
11	Koshkupyr	23.80	-	23.80
12	Shavat	27.20	-	27.20
5	Yangibazar	15.50	-	15.50
6	Gurlen	29.00	-	29.00
7	Mangit	27.80	-	27.80
7	Djumurtau	2.40	-	2.40
	Total	427.60	55.00	372.60

Note : Total includes urban and rural demand
Minus indicates that capacity of water source exceeds the area's water demand. This capacity is used for the other area's demand through Tuyamuyun system.
For the number of node, refer to the Supporting Report.

Table 2.8 Planned Transmission Pipelines of Tuyamuyun-Urgench System in 2010

	Section	Diameter (mm)	Length (km)	Present construction progress
1	T-U WTP - Khazarasp	1200	27.0	
2	Khanka - Urgench	1200	13.2	
3	S.P 1 - Koshkupyr	600	14.0	
4	Yangiaryk - Khiva	600	20.0	
5	Gurlen - Shavat	600	19.5	3.7 km of total 23.2 km completed.
	total	-	93.7	

Specifications of pipeline

1) Pipe materials : Steel pipe with inner cement mortar lining and tar epoxy coating with protection tape to prevent corrosion due to salinity soil or underground water.

2) Air-valve and wash-out valve: Installation of air-valves at high points and wash-out valves at appropriate points for washing pipelines

3) Depth of buried pipe : 1.0 m

River Crossing

There is one major river crossing over Amudarya river and several small crossings over canals along the route of proposed pipelines. Their design specifications are given below.

1) Amudarya river on the route between Nukus North pumping station and Takhiatash.

- Location : 17,175 m - 17,585 m distance from Nukus North pumping station
- River width : 410 m
- Type of crossing : Aqueduct bridge
- Type of bridge : Truss bridge
- Length of bridge : 450 m
- Bridge width : 3 m
- Foundation : Caisson type pile with steel and reinforced concrete

2) Other small canals on the route between Nukus North pumping station and Takhiatash.

- River width : 40 - 50 m
- Type of crossing : Aqueduct bridge
- Type of bridge : Continuous girder
- Length of bridge : 40 - 50 m
- Bridge width : 3 m

- Foundation : RC

2.6 Vodokanal Water Supply System (Vodokanal WSS)

2.6.1 Nukus Water Treatment Plant (Nukus WTP)

Design drawing of proposed rehabilitation works for Nukus WTP is shown in Fig. 2.12.

(1) Product Capacity

Q=65,000 m^3/day

(2) Supply Capacity

Q=60,000 m^3/day

Eight percent (8%) of the produced water is planned for maintenance purpose and the rest (92%) of the water is planned for supply water.

(3) Rehabilitation

1) Intake Pump

Q=1,800 m^3/hour H=22 m P=160 kw N=6 units

Replacement

2) Sedimentation Basin

Q=32,500 m^3/day/unit W=60.0 m L=150 m Z=4.0 m C=38,000 m^3 N=4 units

No Rehabilitation

3) Lift Pump for Filter

Q=1,800 m^3/hour H=22 m P=160 kw N=4 units

Q=3,200 m^3/hour H=33 m P=160 kw N=1 unit

Replacement

4) Filter

Q=7,200 m^3/day/unit W=4.5 m L=11.5 m A=51.8 m^2 V=139 m/day N=9 units

Replacement of Under Collection Pipe, Gravel, Sand and Valves

5) Backwashing Pump for Filter

Q=3,200 m^3/hour H=33 m P=320 kw N=2 units

Replacement

6) Reservoir

W=48.0 m L=48.0 m Z=4.5 m C=10,000 m^3 N=2 units

No Rehabilitation

7) Distribution Pump

Q=2,500 m^3/hour H=62 m P=500 kw N=3 units

Q=2,500 m^3/hour H=62 m P=630 kw N=2 units

Replacement

8) Chemical Dosing System

Replacement of Chemical Dosing System (Dosing Pump, Dosing Pipeline)

9) Chlorination Dosing System

Replacement of Chlorination Dosing System (Chlorinator, Injector, Dosing Pipeline)

10) Electrical Equipment

Replacement of Panel and Cable for the Water Treatment Facilities

11) Laboratory

Supplement of Device for Water Quality Analysis

2.6.2 Chimbai Water Treatment Plant

Design drawing of proposed rehabilitation works for Chimbai Wells is shown in Fig. 2.13.

(1) Supply Capacity

Q=2,000 m^3/day

(2) Rehabilitation

1) Well

Z=23 m N=14 wells

Cleaning

2) Pump for Well

Q=36 m^3/hour H=10 m P=3.5 kw N=14 units

Replacement of 5 Pumps

3) Reservoir

C= 400 m^3 N=1 unit

C=1,000 m^3 N=1 unit

No Rehabilitation

4) Distribution Pump

Q=290 m^3/hour H=20 m P=55 kw N=1 unit

Q=210 m^3/hour H=20 m P=38 kw N=2 units

Q=290 m^3/hour H=20 m P=38 kw N=1 unit

Replacement

5) Chlorination Dosing System

Replacement of Chlorination Dosing System (Chlorinator, Injector, Dosing Pipeline)

6) Electrical Equipment

Replacement of Panel and Cable for the Water Treatment Facilities

2.6.3 Urgench Water Treatment Plant

Design drawing of proposed rehabilitation works for Urgench WTP is shown in Fig. 2.14.

(1) Product Capacity

Q=50,000 m^3/day

(2) Supply Capacity

Q=45,000 m^3/day

Ten percent (10%) of the produced water is planned for maintenance purpose and the rest (90%) of the water is planned for supply water.

(3) Rehabilitation

1) Intake Pump

Q=5,000 m^3/hour H=32 m P=320 kw N=2 units

Q=2,000 m^3/hour H=22 m P=160 kw N=1 unit

Q=1,360 m^3/hour H=21 m P= 55 kw N=1 unit

Replacement

2) Sedimentation Basin

N=6 units

No Rehabilitation

3) Lift Pump for Filter

Q=2,000 m^3/hour H=22 m P=160 kw N=1 unit

Q=5,000 m^3/hour H=32 m P=320 kw N=2 units

Replacement

4) Filter

Q = 8,300 m^3/day/unit W=6.3 m L=6.8 m A=42.5 m^2 V=195 m/day N=6 units
Replacement of Under Collection Pipe, Gravel, Sand and Valves

5) Backwashing Pump for Filter

Q=1,000 m^3/hour H=27 m P=110 kw N=3 units
Replacement

6) Lift Pump for Reservoir

Q=2,000 m^3/hour H=22 m P=160 kw N=2 units
Q=2,100 m^3/hour H=27 m P=160 kw N=1 unit
Replacement

7) Reservoir

C=6,000 m^3 N=1 unit
No Rehabilitation

8) Distribution Pump

Q=2,500 m^3/hour H=45 m P=400 kw N=1 unit
Q=1,250 m^3/hour H=54 m P=250 kw N=4 units
Q=2,500 m^3/hour H=62 m P=500 kw N=1 unit
Replacement

9) Chemical Dosing System

Replacement of Chemical Dosing System (Dosing Pump, Dosing Pipeline)

10) Chlorination Dosing System

Replacement of Chlorination Dosing System (Chlorinator, Injector, Dosing Pipeline)

11) Electrical Equipment

Replacement of Panel and Cable for the Water Treatment Facilities

12) Laboratory

Supplement of Device for Water Quality Analysis

2.6.4 Chalish Water Treatment Plant

Design drawing of proposed rehabilitation works for Chalish Wells is shown in Fig. 2.15.

(1) Supply Capacity

Q=11,000 m^3/day

(2) Rehabilitation

1) Well

Z=40 to 50 m N=26 wells
Cleaning

2) Pump for Well

Q= 50 m^3/hour H= 85 m P=25 kw N=4 units
Q= 40 m^3/hour H=110 m P=25 kw N=3 units
Q=100 m^3/hour H=100 m P=45 kw N=1 unit
Q= 63 m^3/hour H=100 m P=25 kw N=2 units
Replacement of 13 Pumps

3) Reservoir

C=500 m^3 W=10 m L=12 m Z=4 m N=2 units
No Rehabilitation

4) Distribution Pump

Q=900 m^3/hour H=60 m P=250 kw N=3 units
Q=400 m^3/hour H=50 m P= 90 kw N=1 unit
Replacement

5) Chlorination Dosing System

Replacement of Chlorination Dosing System (Chlorinator, Injector, Dosing Pipeline)

6) Electrical Equipment

Replacement of Panel and Cable for the Water Treatment Facilities

2.6.5 Distribution Facilities

(1) Planned Extension and Replacement of Distribution Network

The length of the planned pipes to be installed newly and to be replaced by 2010 for the feasibility study is extracted from the Basic Plan. All planned pipes to be replaced by 2010 are installed for the prevention of leakage, whose ratio is planned as 15 % in 2010. Planned pipes to be installed newly by 2000 in the Basic Plan are installed up to 2010 as shown in table 2.9. By 2010, a total length of 348.4 km of pipelines will be installed in Karakalpakstan and 241.8 km will be installed in Khorezm.

Table 2.9 Planned Length of Extension and Replacement of Distribution Network by 2010

(unit: km)

Year	Karakalpakstan			Khorezm		
	Replaced and New Pipes			Replaced and New Pipes		
	Replaced	Expansion	total	Replaced	Expansion	total
1998	17.6	9.2	26.8	13.1	5.5	18.6
1999	17.6	9.2	26.8	13.1	5.5	18.6
2000	17.6	9.2	26.8	13.1	5.5	18.6
2001	17.6	9.2	26.8	13.1	5.5	18.6
2002	17.6	9.2	26.8	13.1	5.5	18.6
2003	17.6	9.2	26.8	13.1	5.5	18.6
2004	17.6	9.2	26.8	13.1	5.5	18.6
2005	17.6	9.2	26.8	13.1	5.5	18.6
2006	17.6	9.2	26.8	13.1	5.5	18.6
2007	17.6	9.2	26.8	13.1	5.5	18.6
2008	17.6	9.2	26.8	13.1	5.5	18.6
2009	17.6	9.2	26.8	13.1	5.5	18.6
2010	17.6	9.2	26.8	13.1	5.5	18.6
total	228.8	119.6	348.4	170.3	71.5	241.8

(2) Pipe Length by Pipe Size

The existing distribution of pipe sizes in each area is as follows;

Table 2.10 Percentage of distribution pipes by diameter in 1995

(unit : %)

/Diameter	50 - 100 mm	150 - 250 mm	300 - 400 mm	< 500 mm
Karakalpakstan	34	31	32	3
Khorezm	36	37	17	10

Source : the World Bank report

Using the above figures for total length and the distribution, the pipe lengths by diameter are decided for the present project.

(3) Pipe Material

Ductile iron pipe with cement mortar lining and tar epoxy coating is used as the pipe material for preventing of corrosion due to underground water.

(4) Valve

Air-valves and wash-out valves are installed at high points and at appropriate points respectively for washing pipelines.

2.6.6 Water Meters

(1) Planned Installation of Water Meters

In the Basic Plan, water meters are to be installed for only the first group consumers using public funds. Two types of consumers - the already - served households (existing consumers) without water meters and the newcomers to the water supply system in future, have been taken into account for the installation of water meters. The number of planned water meters by type to be installed by 2010 for the Feasibility study is shown in table 2.11. From the Basic Plan, all water meters for existing customers are planned to install by 2010. Water meters for new comers by 2000 in the Basic Plan are planned to install by 2010.

Table 2.11 Number of Planned Water Meters to be Installed by 2010

Year	Karakalpakstan			Khorezm		
	Existing customers	New comers	total	Existing customers	New comers	total
1998	7,250	1,670	8,920	4,030	660	4,690
1999	7,250	1,670	8,920	4,030	660	4,690
2000	7,250	1,670	8,920	4,030	660	4,690
2001	7,250	1,670	8,920	4,030	660	4,690
2002	7,250	1,670	8,920	4,030	660	4,690
2003	7,250	1,670	8,920	4,030	660	4,690
2004	7,250	1,670	8,920	4,030	660	4,690
2005	7,250	1,670	8,920	4,030	660	4,690
2006	7,250	1,670	8,920	4,030	660	4,690
2007	7,250	1,670	8,920	4,030	660	4,690
2008	7,250	1,670	8,920	4,030	660	4,690
2009	7,250	1,670	8,920	4,030	660	4,690
2010	7,250	1,670	8,920	4,030	660	4,690
total	94,250	21,710	115,960	52,390	8,580	60,970

(2) Diameter of Water Meters

Diameter of the service pipes connecting residences is 15 mm or 20 mm. So water meters of the above diameters are to be installed.

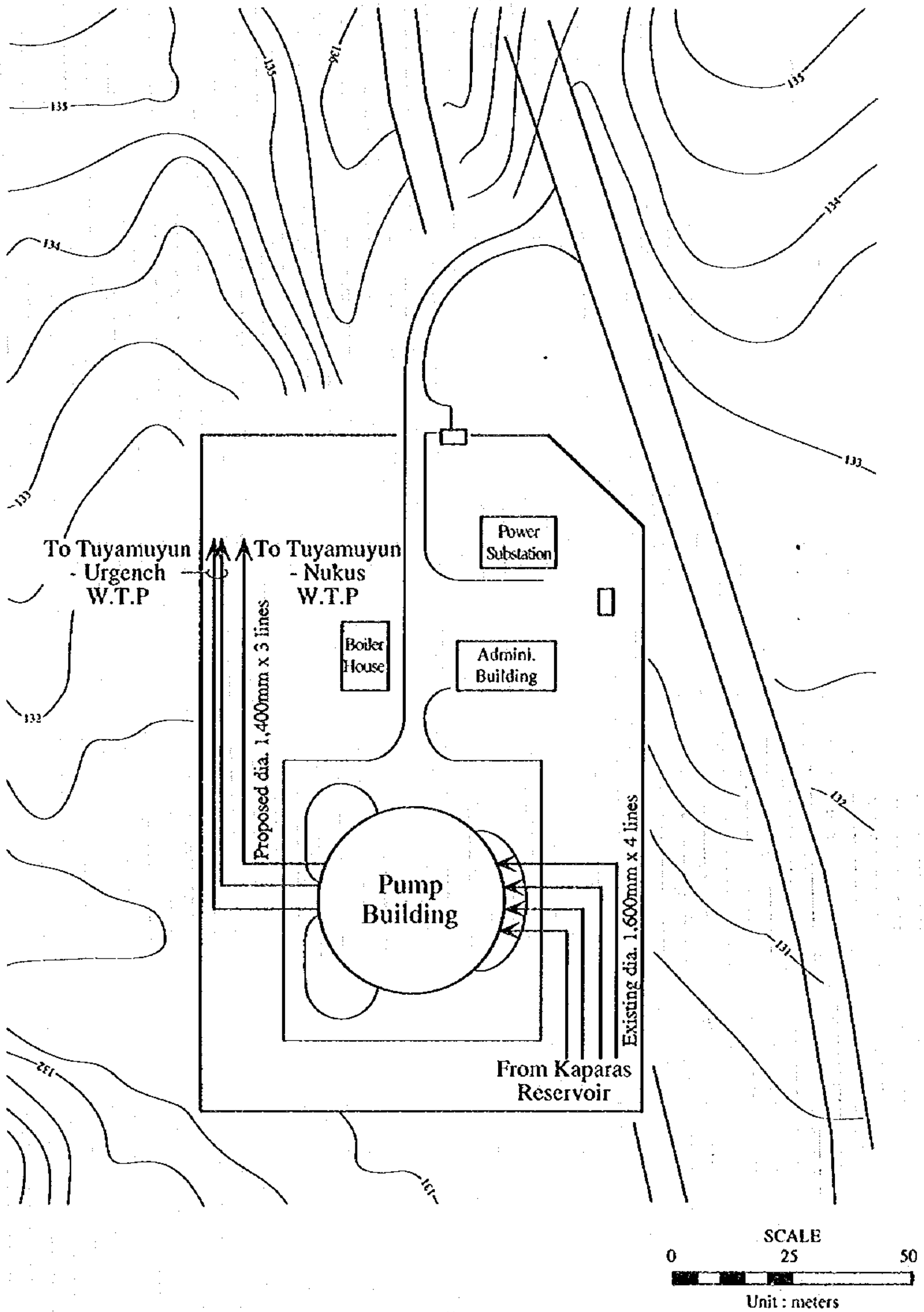
(3) Installation Method for Water Meters

A major problem in installation of water meters, is that water meters readily freeze in winter due to the very cold weather. Freeze-resistant water meter must be installed. However, the cost of preventing freezing, preliminary estimated by Vodokanal Nukus and by JICA Study Team, is so high that residents cannot afford to install it at their own expense. Especially, installation of freeze-resistant box culvert underground is costly. The cost of the installation is approximately 10 times the annual water tariff of the consumer. The best solution for this problem is to install water meter inside individual houses.

Approximately 75 % of the consumers, however, are supplied water by stand pipes and yard taps outside in Karakalpakstan presently. In contrast, similar consumers in Khorezm amount to 15 % only. Therefore the JICA Study Team has proposes that installation of water meter and replacement of standpipe and yard taps to inside taps be implemented at the same time, especially in Karakalpakstan. This will reduce costs for preventing freezing and also enable consumes to use water conveniently.

2.7 Summary of Proposed Water Supply System

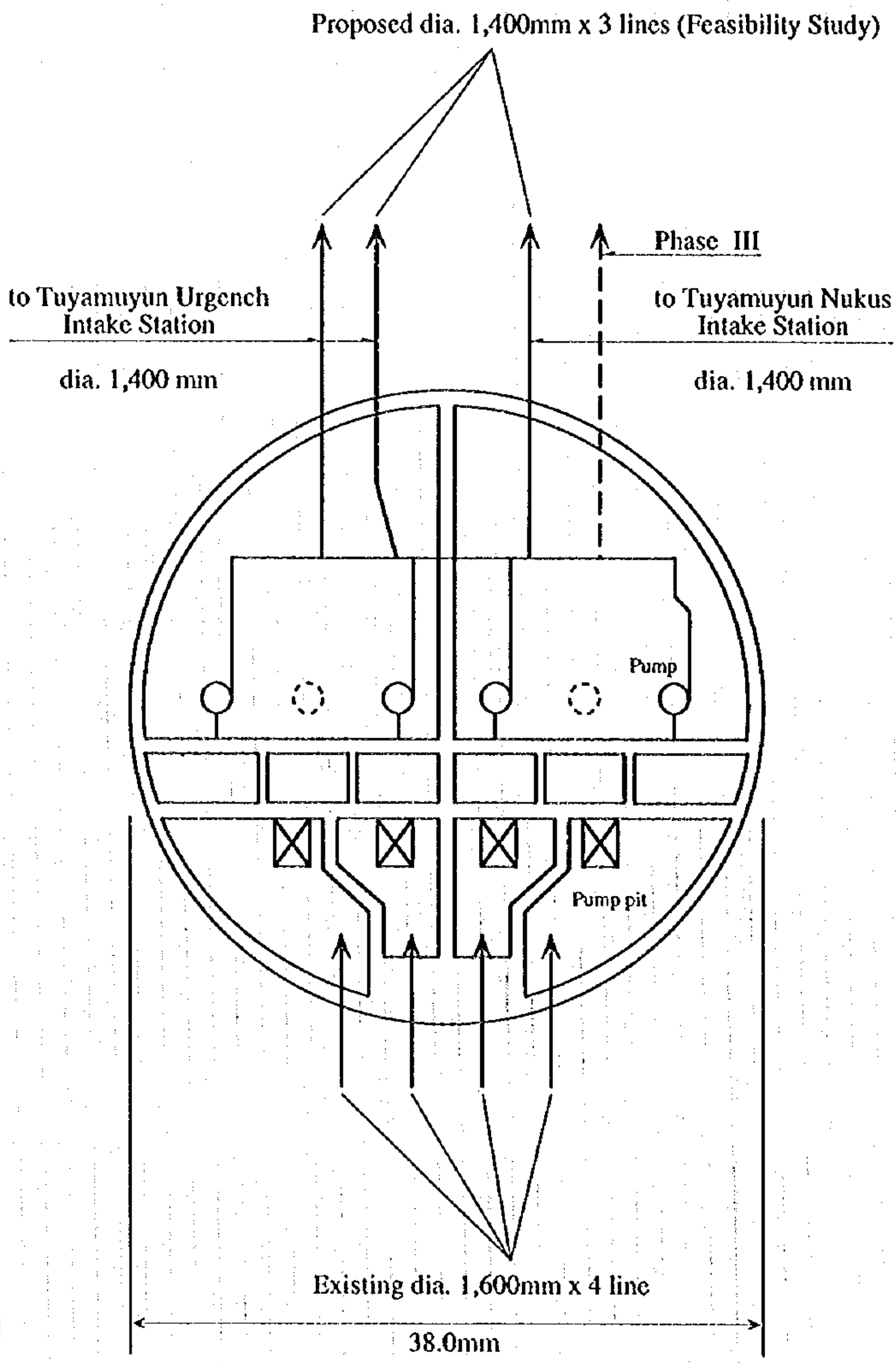
Outline of the proposed water supply system and the major proposed facilities are summarized in Fig. 2.16.



THE STUDY ON
WATER SUPPLY SYSTEM IN SIX CITIES OF
THE ARAL SEA REGION IN UZBEKISTAN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 2.1
Kaparas Intake Pumping Station



THE STUDY ON WATER SUPPLY SYSTEM IN SIX CITIES OF THE ARAL SEA REGION IN UZBEKISTAN

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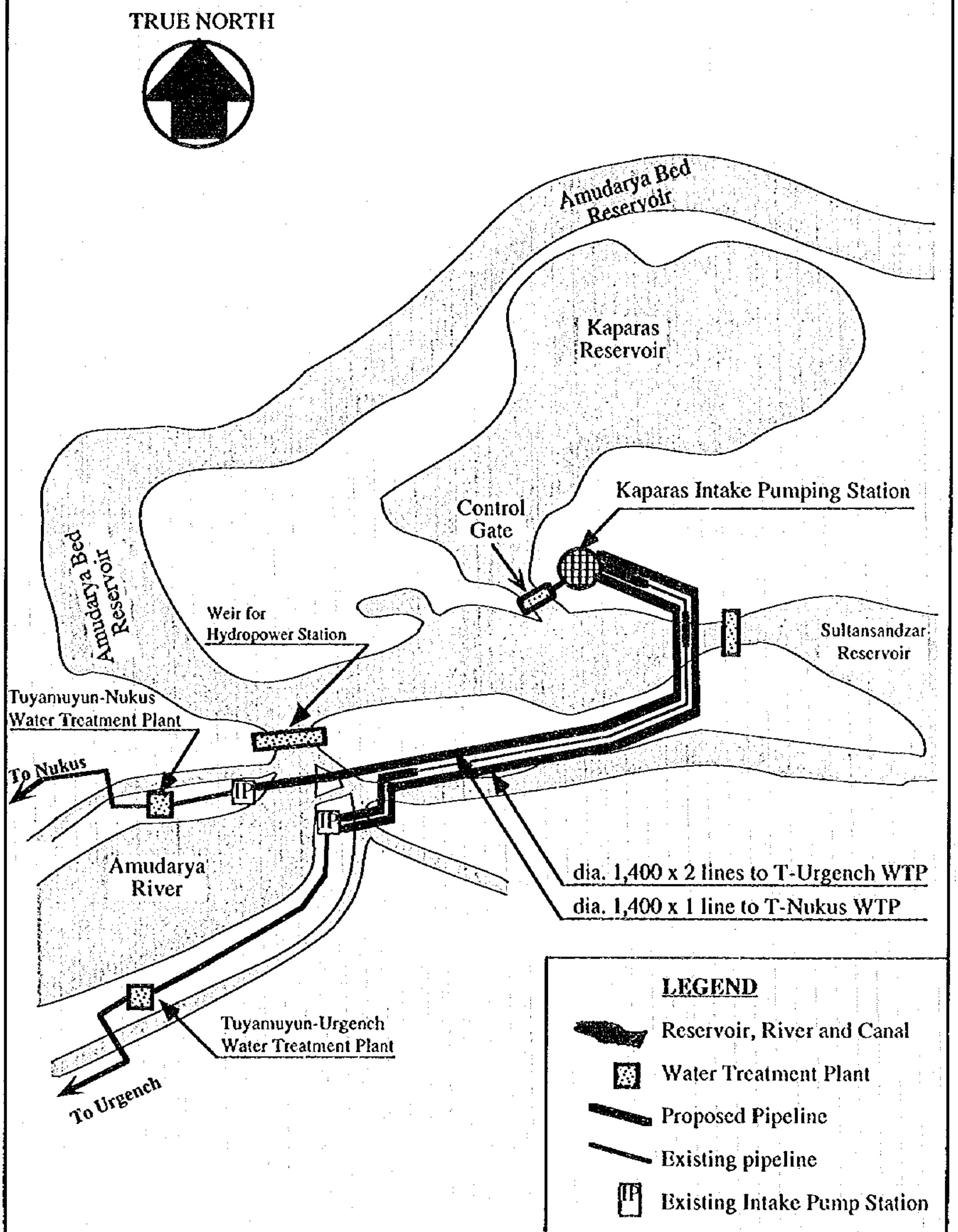
Fig. 2.2 Kaparas Intake Pumping Station (Detail)



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THE ARAL SEA REGION IN UZBEKISTAN

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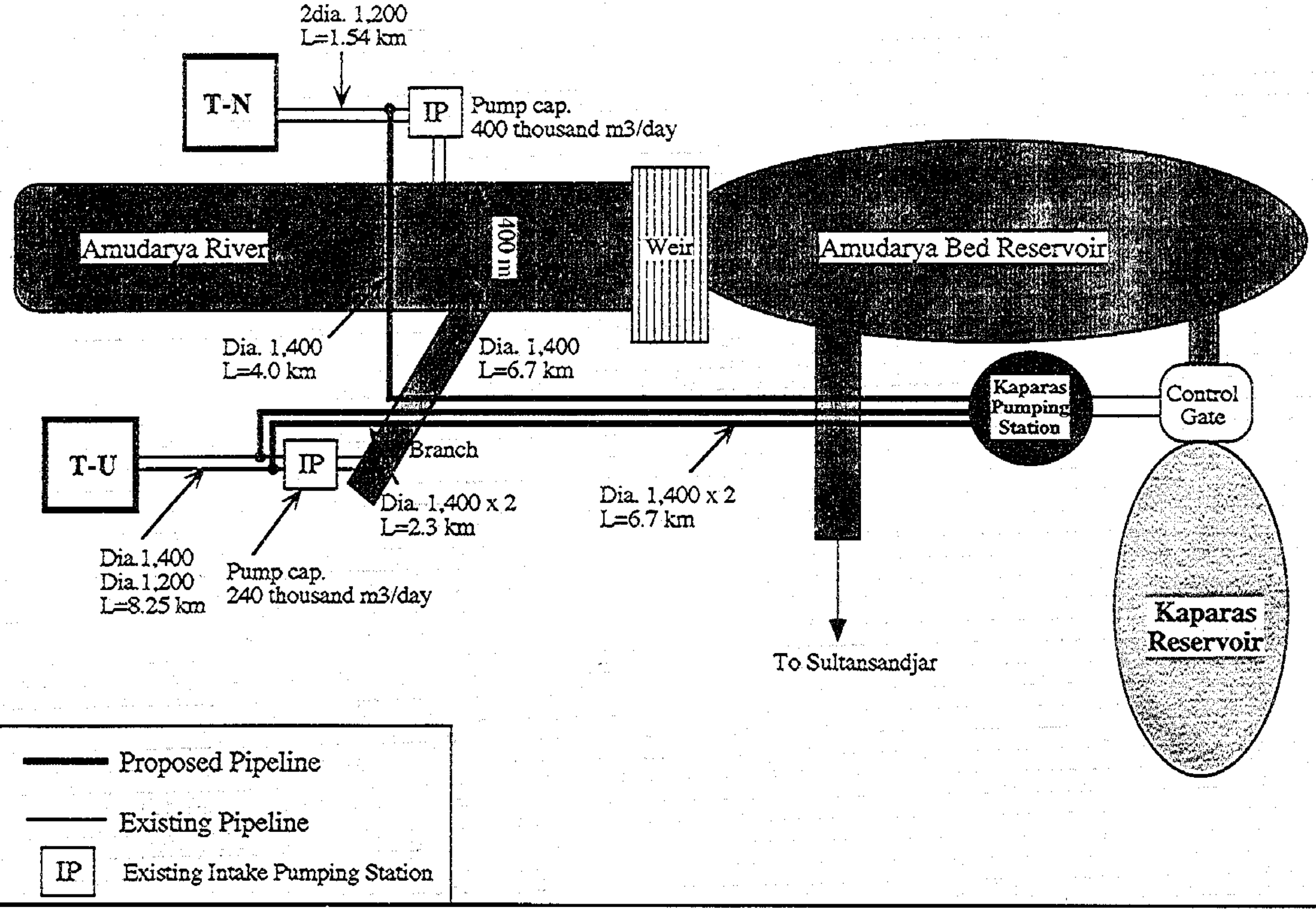
Fig. 2.3

Proposed Kaparas Intake Facility



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THE ARAL SEA REGION IN UZBEKISTAN

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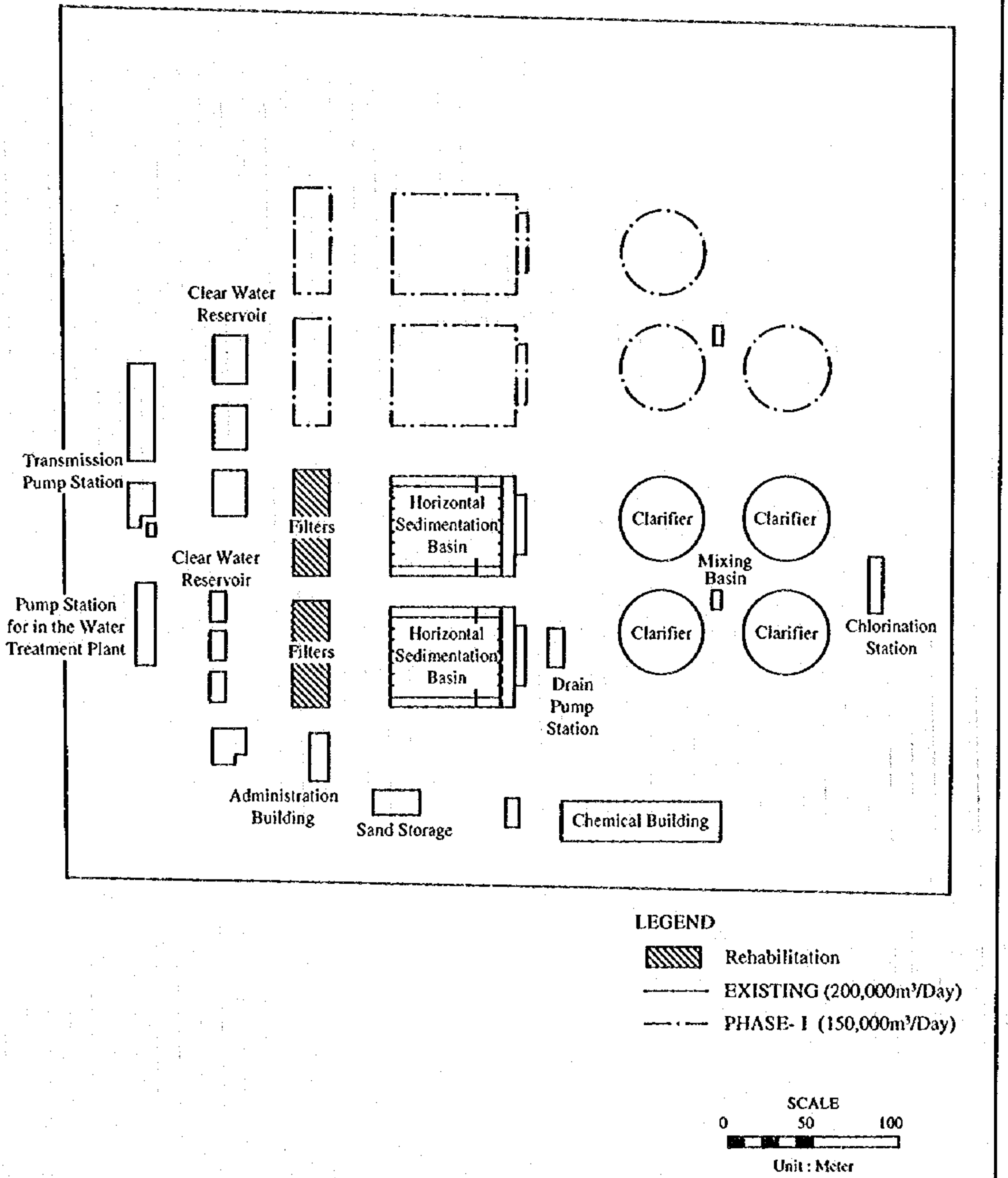
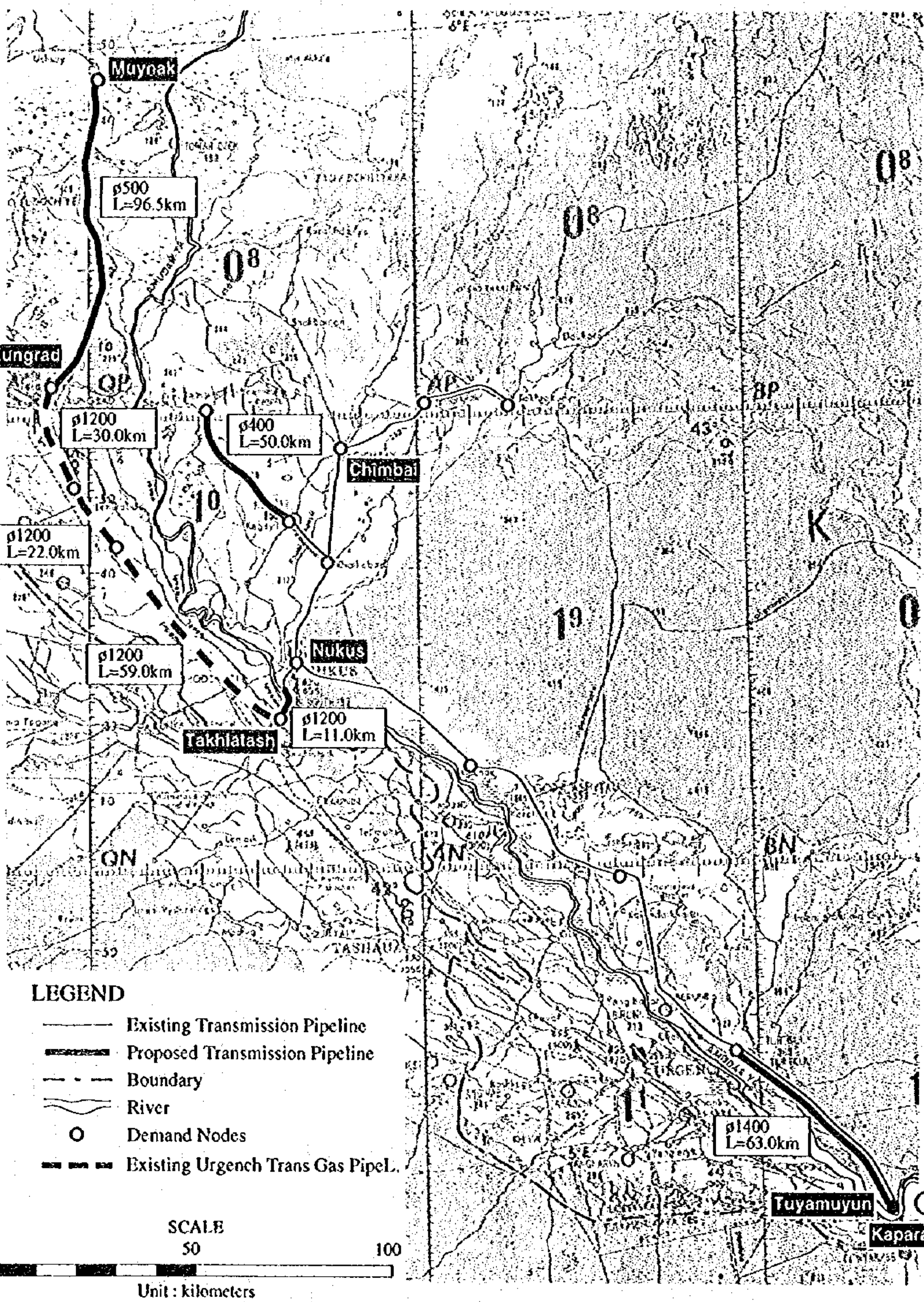
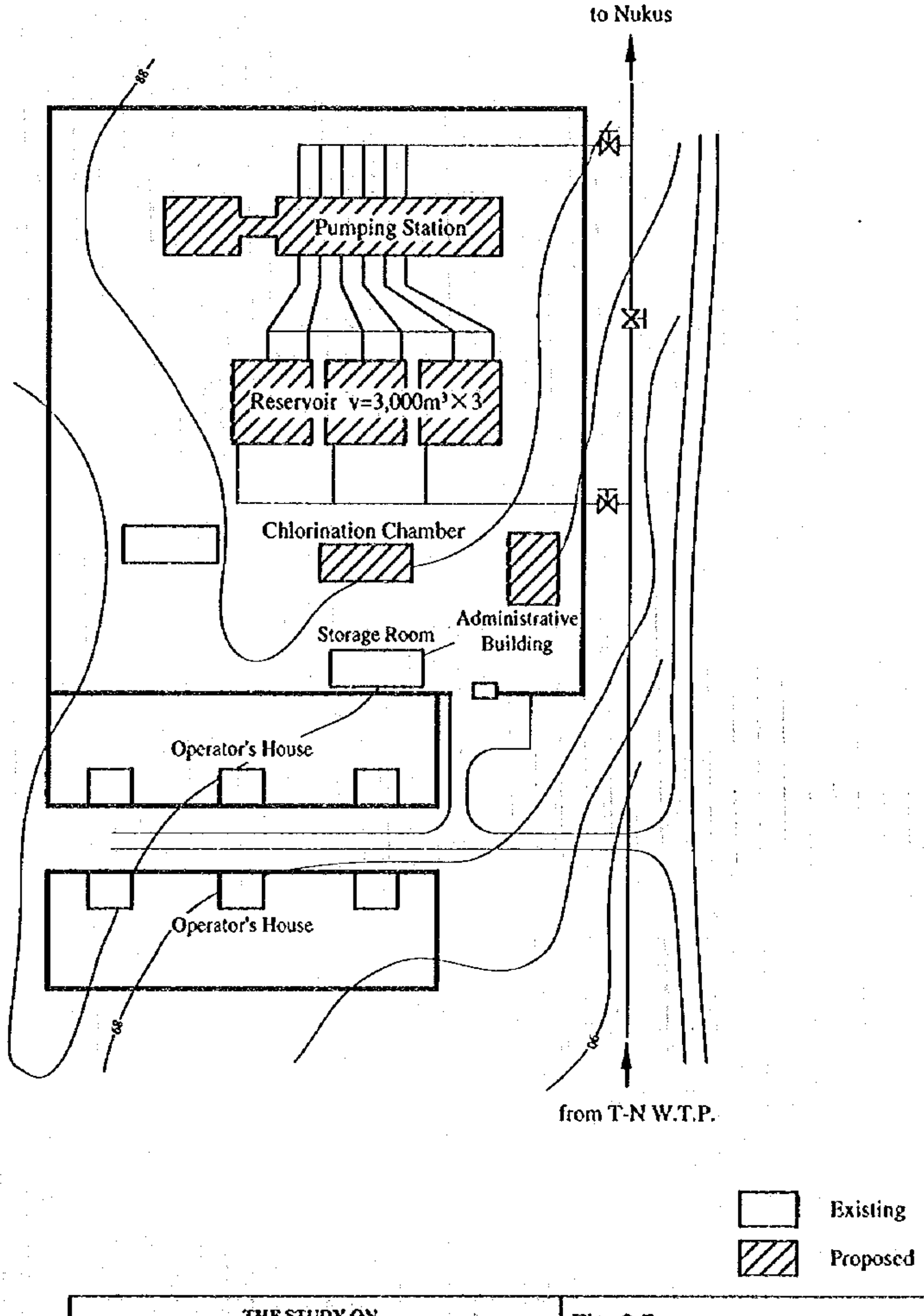
Fig. 2.4
Schematic Drawing of
Raw Water Main



THE STUDY ON WATER SUPPLY SYSTEM IN SIX CITIES OF THE ARAL SEA REGION IN UZBEKISTAN	Fig. 2.5 Tuyamuyun-Nukus Water Treatment Plant
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON WATER SUPPLY SYSTEM IN SIX CITIES OF THE ARAL SEA REGION IN UZBEKISTAN	Fig. 2.6 Proposed Transmission Sys. (Tuyamuyun-Nukus)
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON
WATER SUPPLY SYSTEM IN SIX CITIES OF
THE ARAL SEA REGION IN UZBEKISTAN

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Fig. 2.7 Pumping Station No.2

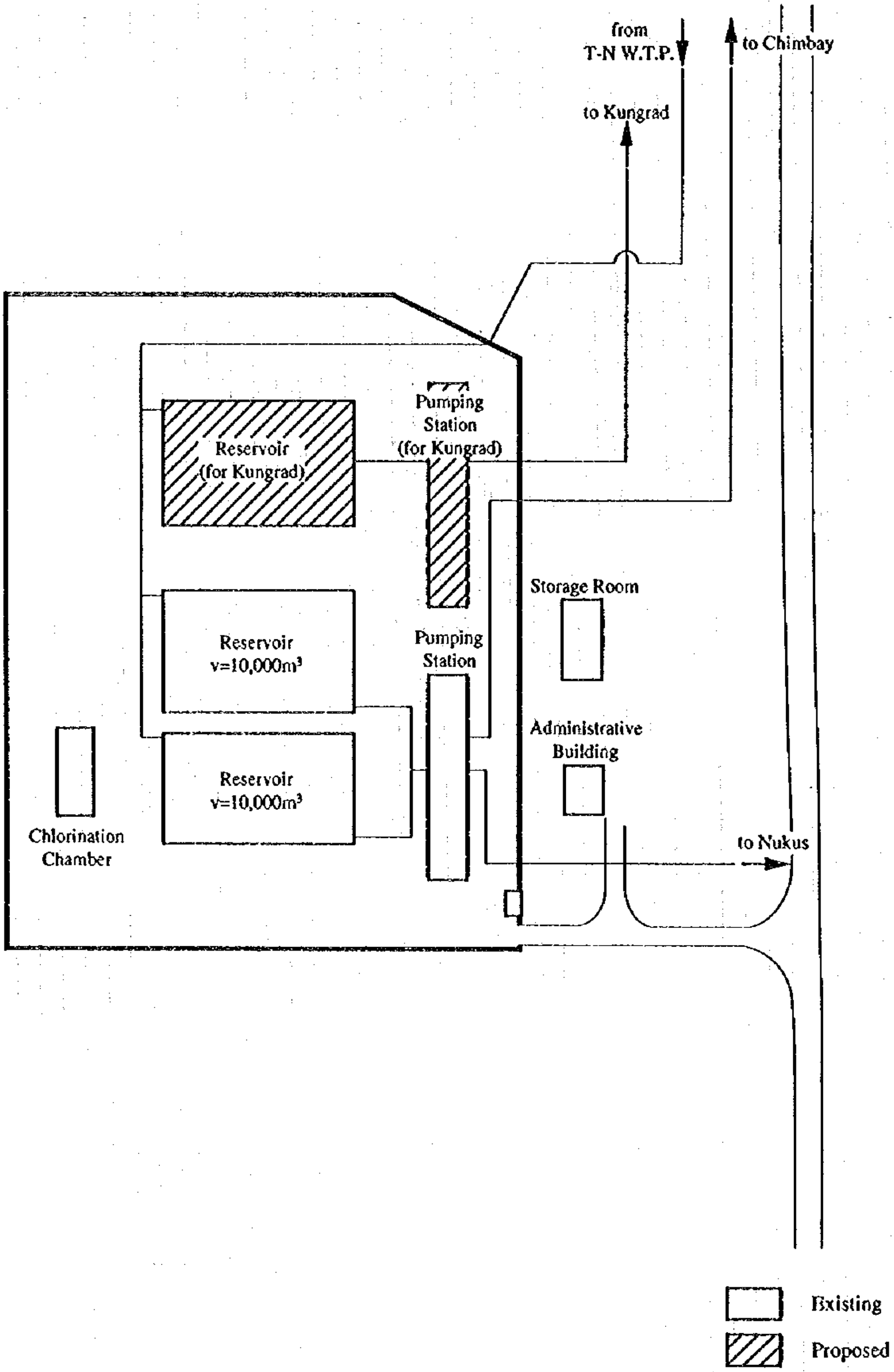

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Fig. 2.8
Nukus North
Distribution Station

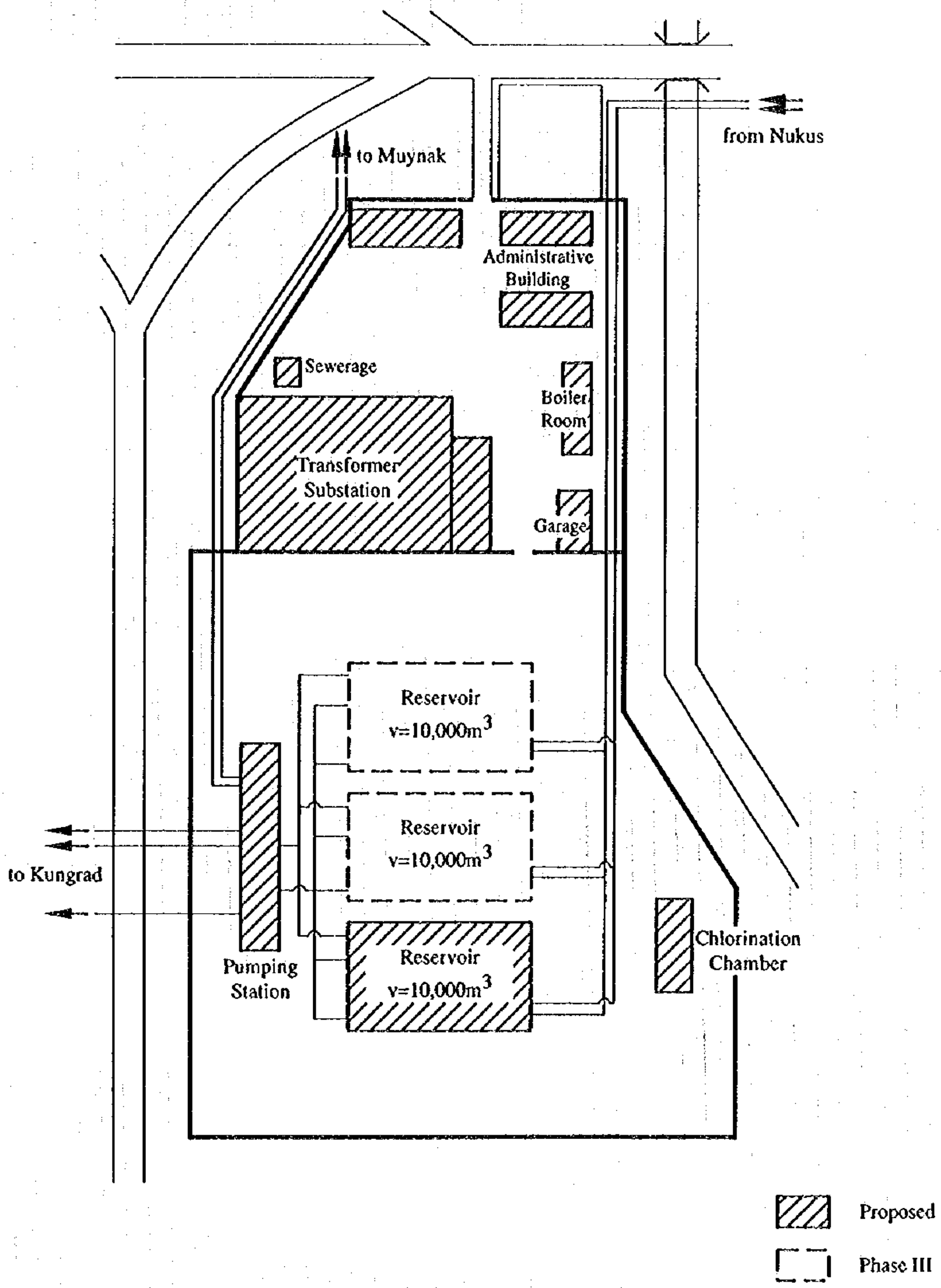

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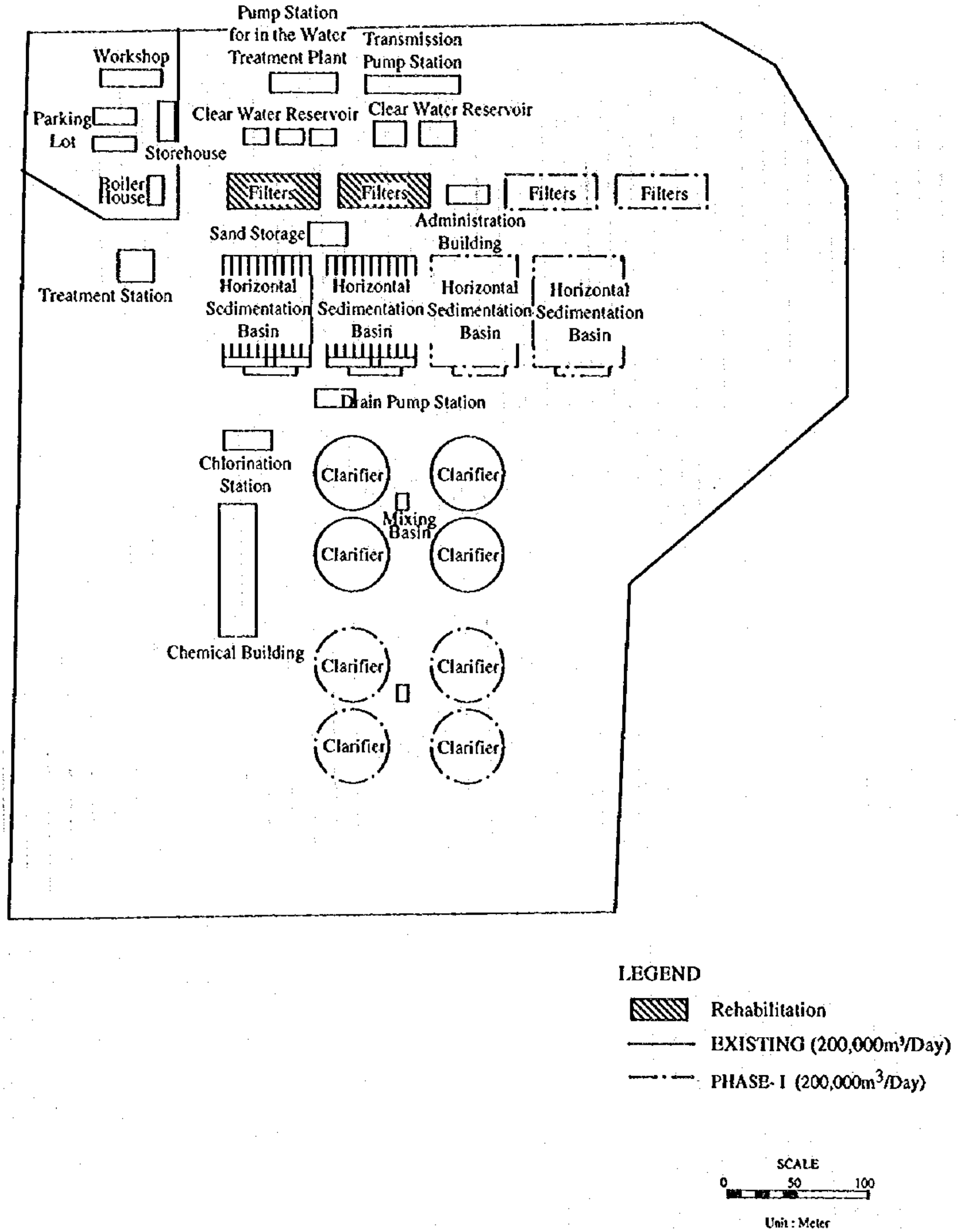
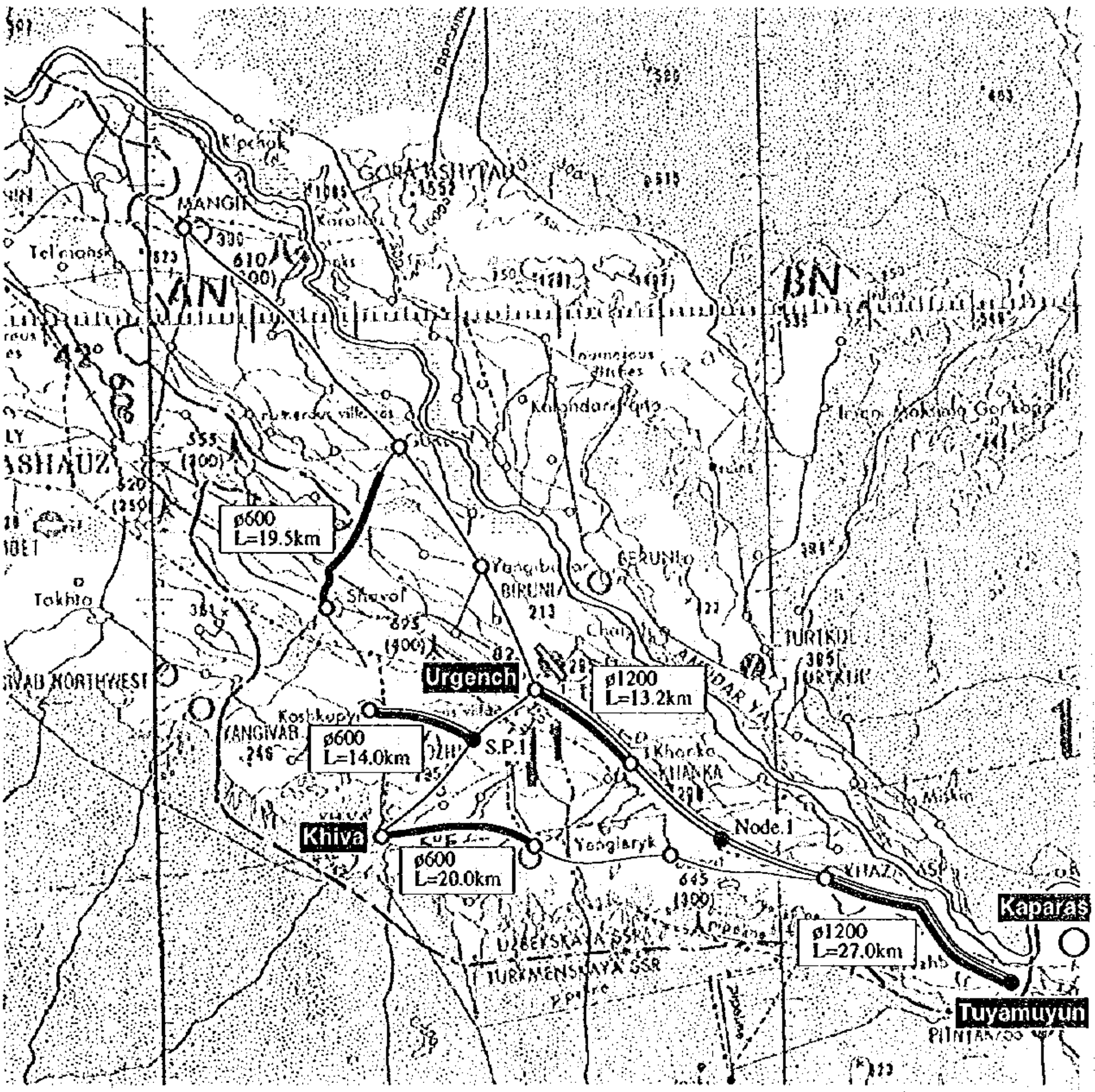
Fig. 2.9
Kungrad
Distribution Station



THE STUDY ON WATER SUPPLY SYSTEM IN SIX CITIES OF THE ARAL SEA REGION IN UZBEKISTAN	Fig. 2.10 Tuyamuyun-Urgench Water Treatment Plant
JAPAN INTERNATIONAL COOPERATION AGENCY	



LEGEND

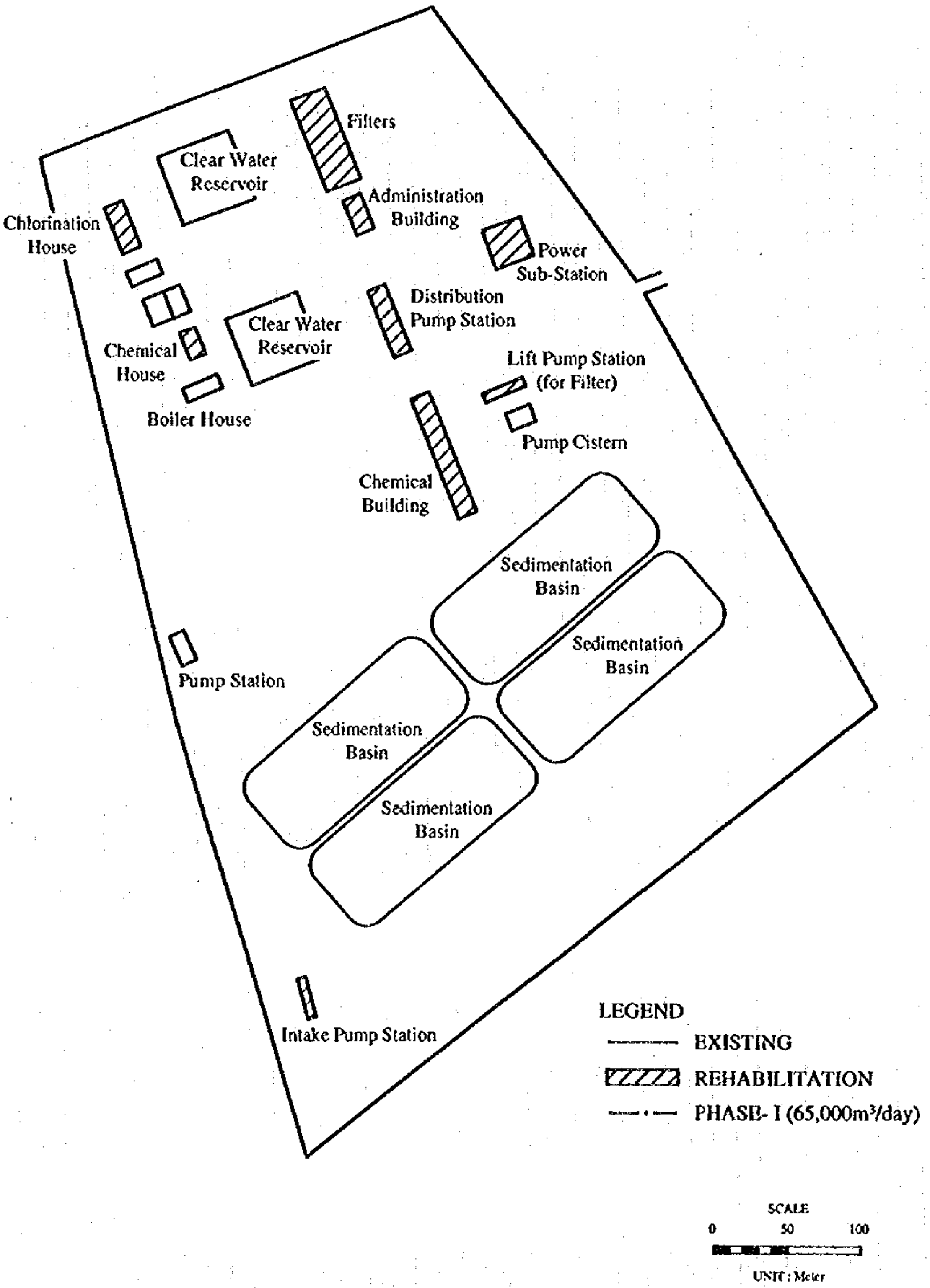
- Existing Transmission Pipeline
- Proposed Transmission Pipeline
- Boundary
- River
- Demand Nodes
- Nodes

SCALE

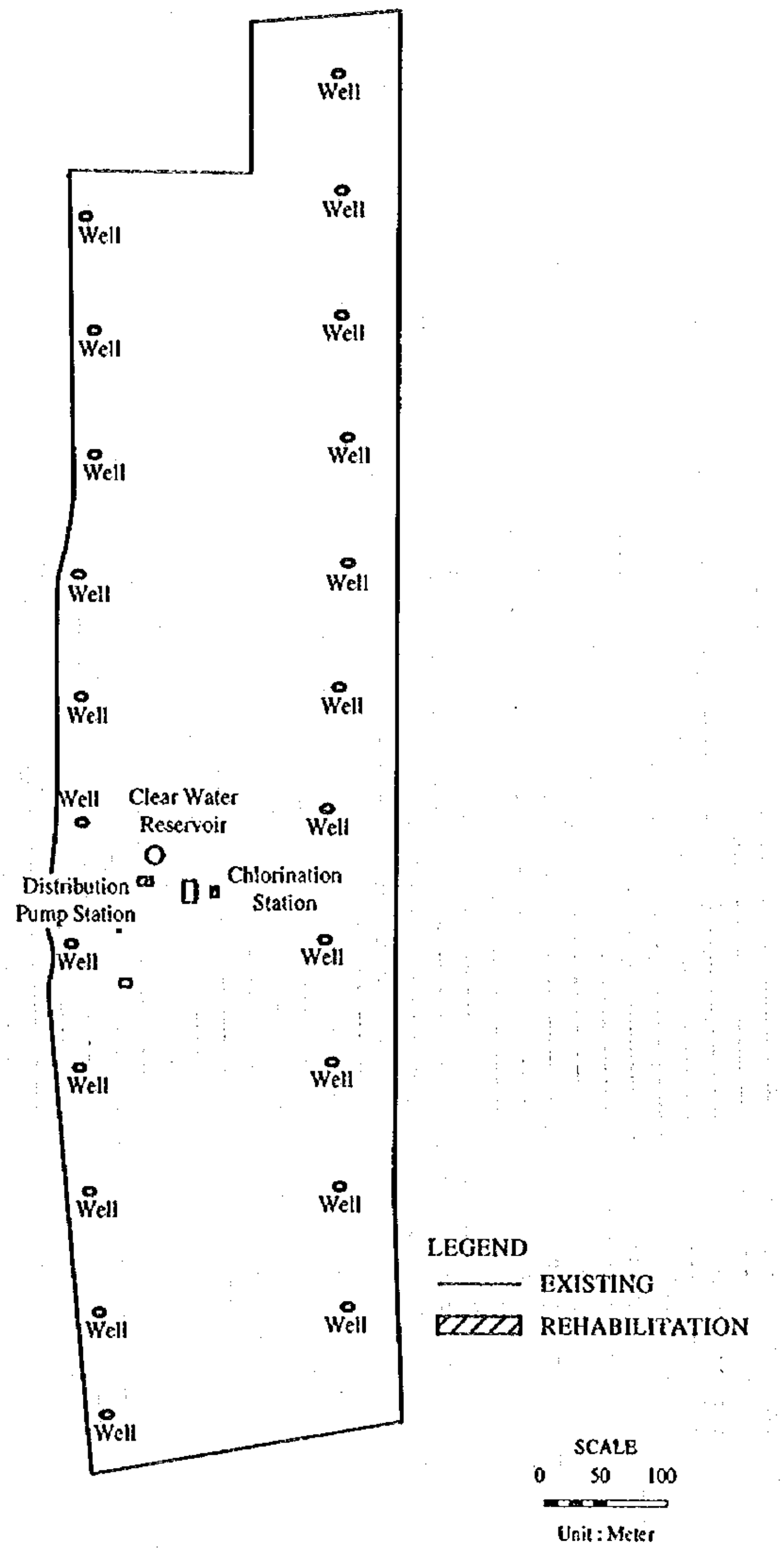
0 50 100

Unit : kilometers

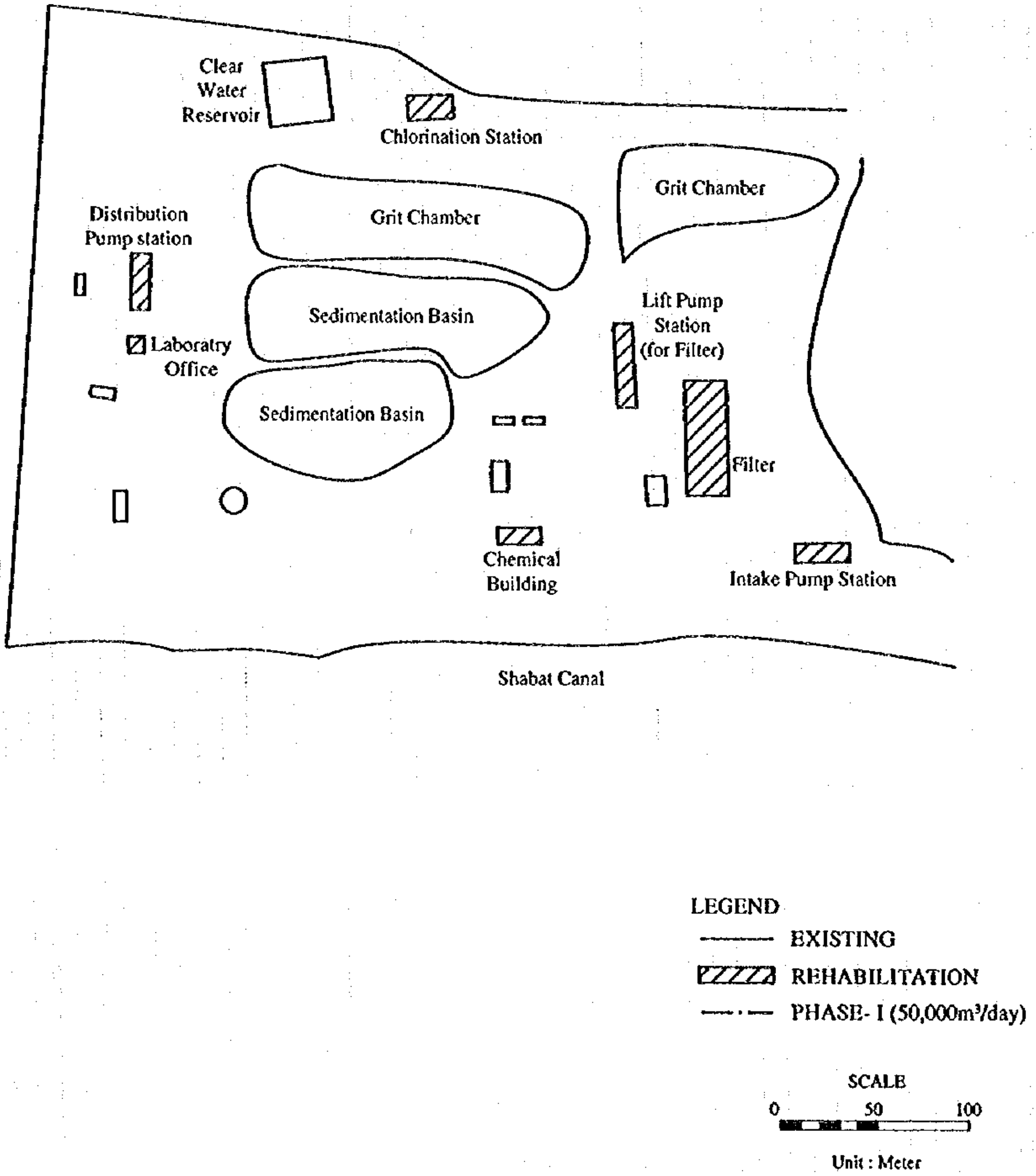
THE STUDY ON WATER SUPPLY SYSTEM IN SIX CITIES OF THE ARAL SEA REGION IN UZBEKISTAN	Fig. 2.11 Proposed Transmission Sys. (Tuyamuyun-Urgench)
JAPAN INTERNATIONAL COOPERATION AGENCY	



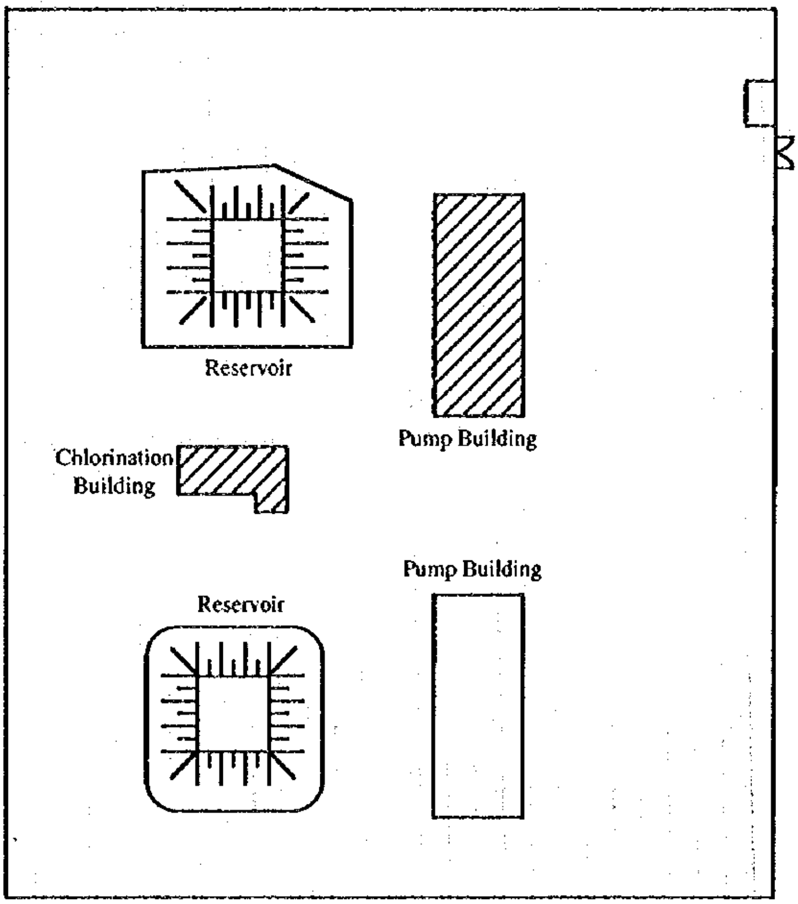
THE STUDY ON WATER SUPPLY SYSTEM IN SIX CITIES OF THE ARAL SEA REGION IN UZBEKISTAN	Fig. 2.12
JAPAN INTERNATIONAL COOPERATION AGENCY	Nukus Water Treatment Plant



THE STUDY ON WATER SUPPLY SYSTEM IN SIX CITIES OF THE ARAL SEA REGION IN UZBEKISTAN	Fig. 2.13 Chimbai Water Treatment Plant
JAPAN INTERNATIONAL COOPERATION AGENCY	

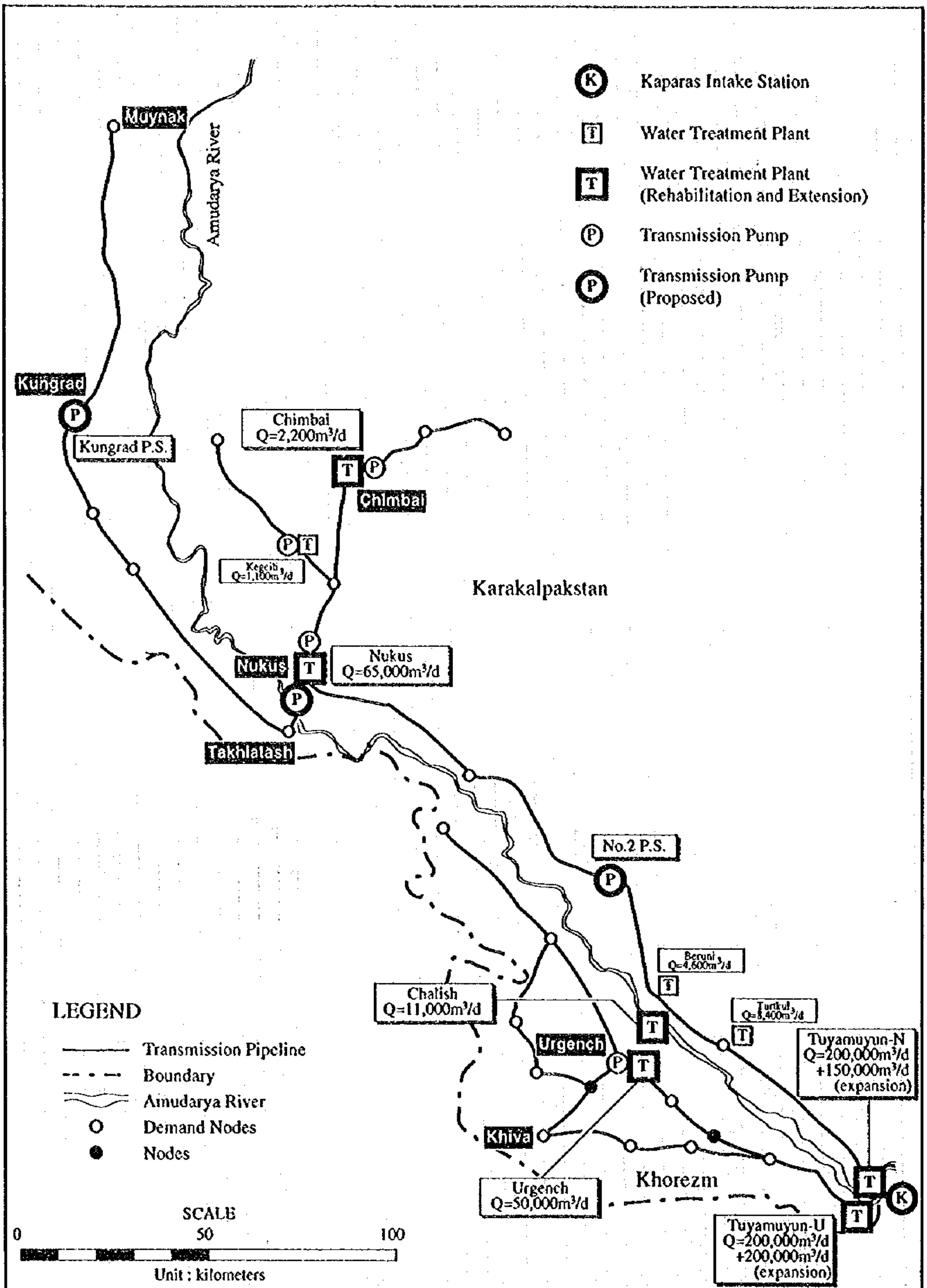


THE STUDY ON WATER SUPPLY SYSTEM IN SIX CITIES OF THE ARAL SEA REGION IN UZBEKISTAN	Fig. 2.14 Urgench Water Treatment Plant
JAPAN INTERNATIONAL COOPERATION AGENCY	



LEGEND
——— EXISTING
▨ REHABILITATION

THE STUDY ON WATER SUPPLY SYSTEM IN SIX CITIES OF THE ARAL SEA REGION IN UZBEKISTAN	Fig. 2.15 Chalish Well
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON WATER SUPPLY SYSTEM IN SIX CITIES OF THE ARAL SEA REGION IN UZBEKISTAN	Fig. 2.16 Proposed Water Supply Sys.
JAPAN INTERNATIONAL COOPERATION AGENCY	

CHAPTER 3

SYSTEM OPERATION AND MAINTENANCE

CHAPTER 3 SYSTEM OPERATION AND MAINTENANCE

3.1 Introduction

Until now, the water supply systems of Karakalpakstan and Khorezm have been developed centered around the Tuyamuyun inter-regional water supply systems for the two regions. Moreover, the development plan of the water supply systems of the two regions based on the Basic Plan of this report are also centered around the Tuyamuyun systems. In the Basic Plan, the Tuyamuyun systems use the Kaparas reservoir as the major source of water, and each system comprises water supply facilities such as the Tuyamuyun water treatment plant, transmission pipelines, and transmission pumping stations. The two areas also have water supply facilities of the regional water supply systems (Vodokanal and Agro-Vodokanal) receiving water from the Tuyamuyun system, such as water treatment plants and distribution networks.

Presently, the daily operation and maintenance of the facilities has almost no problems except for the problems like a shortage of chemicals for the water treatment plants. Consequently, daily operation and maintenance of each facility is not covered in detail in this chapter. The focus of attention in this chapter will be on the points listed below, which will be important and necessary when the water supply plan is implemented based on the Basic Plan.

1) Integrated operation of water resources of the Tuyamuyun hydro-unit including Kaparas reservoir
2) Integrated operation of water supply systems of Tuyamuyun and Vodokanal systems
3) Response in an emergency of the water supply system
4) Leakage control measures

3.2 Integrated Operation of Water Resources

3.2.1 Related Plans

When the Basic Plan is implemented, the operation plan of the Kaparas reservoir must be seriously considered. An efficient operation plan is necessary that enables the required domestic water demand quantity to be stored in the Kaparas reservoir from the Amu Darya river during the season when the quality of water in the Amu Darya river is satisfactory. The points mentioned below should be considered when framing the operation plan. The plans related to the Kaparas reservoir operation plan and their relationships are shown in Fig. 3.1.

1) Coordination between related plans such as water supply plans, irrigation water plans and hydraulic power generation plans
2) Integrated operation plan of water source for the Tuyamuyun hydro system including the Kaparas reservoir
3) Collection of water quality and water quantity data of the Amu Darya river, analysis of the data and predictions of water quality and quantity

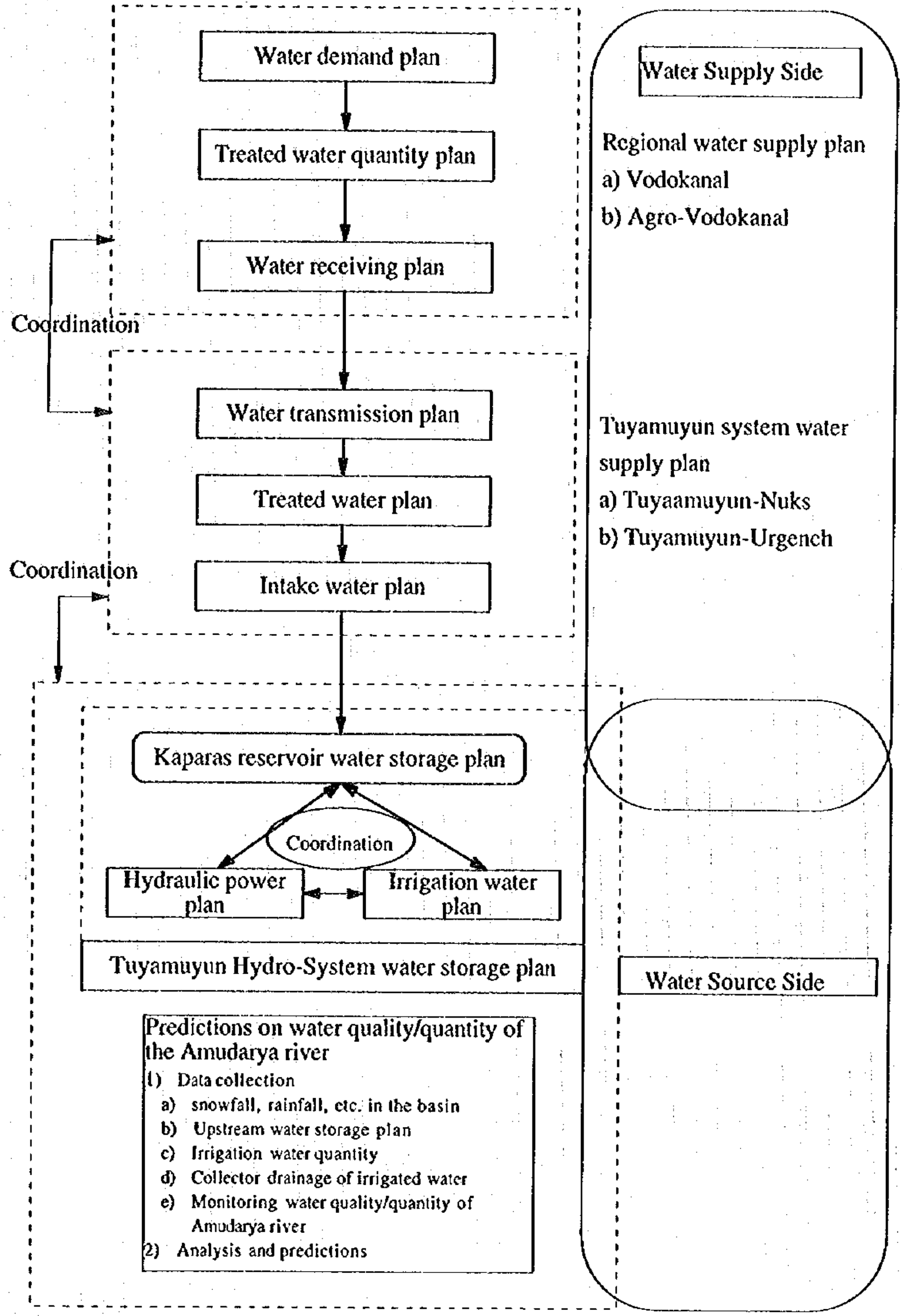


Fig. 3.1 Plans related to water supply and water sources

3.2.2 Establishment of Coordinating/Implementing Organizations

Many related organizations are concerned with the operation of the Kaparas reservoir. For example, Ministry of Melioration & Water Management (MM & WM) deals with water allocation and issues of the Amu Darya river basin including the Kaparas reservoir. Also the Inter- State Water Basin Department for Amu Darya River (IWBDAR) coordinates with the other countries concerned. SCNP deals with water quality monitoring and water pollution control of the Amu Darya river by constructing and operating the Right Bank Collector Drain, etc. Tuyamuyun Hydro System deals with management and operation of the whole Tuyamuyun reservoir system. MPU must be responsible for the management of the intake control gate of the Kaparas reservoir.

Plans and data related to the operation of Kaparas reservoir and related organizations are listed in Table 3.1 according to the data collected by the JICA Study Team (for details please refer to the Basic Plan in Chapter 6). As seen in this table, the number of organizations related to operation and management of the Kaparas reservoir is quite large. To check the consistency of the plans of the various organizations, and to frame a rational and efficient water source operation plan, a new coordinating organization needs to be established. In addition, an organization that will actually implement the management and operation plan for the Kaparas reservoir must be established.

Table 3.1 Plan and Data Organizations Associated with Management and Operation of Water Sources

Plans, data, information	Related organizations
1. Vodokanal Water supply system Water demand plan Treatment water plan Water receiving plan	Vodokanal, Agro-Vodokanal (Republic of Karakalpakstan) Vodokanal, Agro-Vodokanal (Khorezm Province)
2. Tuyamuyun water supply system Water transmission plan Treated water plan Intake water plan	Department for Operation and Maintenance of Tuyamuyun-Nukus Inter-Regional water pipeline Department for Operation and Maintenance of Tuyamuyun-Urgench Inter-Regional water pipeline Republican Production Amalgamation for Operation and Development of Regional Water Pipelines of the MPU of the Republic of Uzbekistan
3. Kaparas reservoir water storage plan	New coordinating organization must be established consisting of representatives of the Ministry of Melioration and Water Management of the Republic of Uzbekistan, Department for Operation of the Tuyamuyun Hydro-system, Republican Production Amalgamation for Operation and Development of Regional Water Pipelines of the MPU of the Republic of Uzbekistan
4. Tuyamuyun Hydro-system operation plan	Department for Operation of the Tuyamuyun Hydro-system of the Ministry of Melioration and Water Management of the ROU and Ministry of Energy of the ROU
5. Tuyamuyun hydraulic power plan	Ministry of Melioration and Water Management and Ministry of Energy of the ROU, Department for Operation of the Tuyamuyun Hydro-system
6. Irrigation Water Plan	Department for Operation of Irrigation Systems of the Ministry or Melioration and Water Management of the Republic of Uzbekistan, Ministry of Melioration and Water Management of the Republic of Karakalpakstan, Department for Water Management of the Khorezm Province
7. Amu Darya river water quantity and quantity predictions	International Water Basin Department of Amu Darya River, MM&WM SANIIRI, SCNP, GosSIAK, Vodgeo, Department for Hydrometeorology
8. Other related plans	Other related organizations

3.2.3 Monitoring and Predicting Amu Darya River Water Quality/Quantity

Water quality and water quantity models for the Amu Darya river including the Tuyamuyun Hydro-system should be formed and the quality and quantity of the Amu Darya river bed reservoir correctly predicted beforehand so that the operation plan for Kaparas reservoir can be framed by the coordinating or implementing organization established as mentioned above. Examples of data necessary for such predictions are given below.

a) Weather data (snowfall, rainfall, etc.)
b) Amu Darya river upstream water storage plan
c) Irrigation water plan
d) Collector drainage condition
e) Amu Darya river water quality and water quantity
f) Tuyamuyun Hydro-system water quality and water quantity

In addition to the predictions made by the models, the quality and quantity of water of Amu Darya river should be monitored by continuous measurements at fixed locations in the Amu Darya river, or by collecting data from the data monitoring organizations. A flexible response is necessary even for unpredictable conditions.

3.3 Integrated Operation of the Water Supply System

3.3.1 Establishment of a Joint Management Organization

When water can be stored in the Kaparas reservoir according to the plan by the coordinating organization mentioned above, or even if it cannot be stored as planned, water should be utilized efficiently among the various water supply systems and water supply facilities.

Until the Kaparas reservoir starts the operation, the T-Nukus and the T-Urgench systems will be operated and managed independently, but after the start of utilization of the Kaparas reservoir, the two Tuyamuyun systems will share the Kaparas reservoir and the Kaparas intake pumping station. Consequently, these facilities need to be jointly managed by the two Tuyamuyun systems. Therefore, a special organization for carrying out the overall management of the water supply systems in the two areas and for jointly managing these facilities will become necessary.
This joint management organization should be established under the RPADORWP, which is responsible for all inter-regional water supply systems in the country including T-Nukus and T-Urgench. Their office should be set up around the Tuyamuyun Hydro System to manage water supply systems of both areas effectively and comprehensively. In addition, a communication network among T-Nukus, T-Urgench, RPADORWP, and other related organization should be established. The roles of this special organization are given below.

a) Management of the entire water supply system from the water source to the distribution (Tuyamuyun system, Vodokanals and Agro-Vodokanal)
b) Study of water supply conditions, collection and analysis of data
c) Collection of water supply plans of each water supply system and area, analysis of these plans and coordination
e) Development of water supply technology for these areas
f) Coordination with related plans (irrigation water plan, hydraulic power generation plan)
g) Creating proposals for efficient, rational and comprehensive utilization of water
h) Response to an emergency in the water supply system

3.3.2 Response to an Emergency in the Water Supply System

The Tuyamuyun-Nukus inter-regional water supply system (T-N I-R WSS) comprises the Kaparas reservoir as the water source, and all water transmission systems up to approximately 450 km to the north of the Tuyamuyun-Nukus water treatment plant (T-N WTP). Similarly, the T-Urgench I-R WSS comprises the Kaparas reservoir as the water source, and transmission systems up to approximately 200 km to the north of the T-Urgench WTP. If the Tuyamuyun system consisting of one water treatment plan and a singular number of water transmission pipeline has an accident, and the intake water, treated water or transmitted water is stopped, the entire system will be subjected to a major loss. Particularly, the loss will be more severe as the accident occurs nearer to the upstream part of the system. Appropriate measures are necessary to prevent accidents and to minimize losses in the event of an accident.

Generally, accidents can be prevented by routine operation and maintenance therefore, operation and maintenance should always be carried out appropriately. Additionally, an emergency response system, including a backup system in the event of an emergency should be established. The measures given below may be considered. The necessary measures should be implemented sequentially considering the financial condition and the management level of the Tuyamuyun system. Judging from the water supply conditions in the study area, the provision of a backup system in an emergency by expansion of the capacity of the facilities, which will incur a large additional cost, is very difficult. It is more realistic to utilize existing facilities efficiently and prepare a manual in an emergency for responding promptly and appropriately to minimize losses.

1) Provision of water supply facilities and equipment
   a) Installation of multiple power supply systems or independent power generating equipment
   b) Installation of a bypass line connecting the inflow pipe to the water treatment plant and the water transmission pump
   c) Expansion of the water reservoir
   d) Dual transmission lines

2) Provision of a backup system for the facility
   a) Provision of a backup system from the intake pump station in the existing Tuyamuyun system to prepare for an accident to the Kaparas reservoir and the Kaparas intake pumping station
   b) Ensuring that a backup system from local water treatment plants is always available for use in the event of an accident to single long-distance transmission pipelines
   c) Local water treatment plants should not be completely abolished after the expansion of Tuyamuyun water treatment plants has been completed. The treatment plants should be operated all the time even if it supplies a small quantity of water.
   d) Ensuring that a backup system from the Urgench Transgas WSS is available
   e) Ensuring that important spare parts and chemicals are available all the time.

3) Information Control
   a) Grasp details of the damage quickly
   b) Prepare an emergency response manual and adopt prompt and appropriate measures
   c) Set up a communication system that operates during an emergency
   d) Shut off distribution water from reservoirs and use the water stored in the reservoirs effectively until transmission of water from Tuyamuyun system starts.

3.4 Leakage Control Measures

3.4.1 Target of Leakage Control

In the Basic Plan in this report, the current leakage ratio was estimated as 30% in the survey of Nukus by the JICA Study Team. However, according to Vodokanal, the leakage ratio varies depending on the regions or cities. For instance, the ratio in some city exceeds 50% or 60%, which is very serious. Such a high quantity of leakage means a wastage of money and precious water resources. To increase accounted for water and to use limited water resources effectively, leakage control measures are essential.

In the Basic Plan, Leakage ratio is to be brought down to 23 % in 2002, the target year of the feasibility study, and 15 % in 2010.

To achieve this target, it is necessary that Vodokanal takes more effective leakage control measures in addition to the existing measures as follows.

a) pressure control in the distribution network
b) repairs of reported visible leakage on the ground only

Although such measures are adopted, these alone are inadequate and not very effective because of the lack of spare parts, and machines and equipment for carrying out repair.

3.4.2 Leakage Control Measures

(1) Outline of Leakage Control Measures

In general, leakage control measures can be divided as below. Details are shown in table 3.2.

1) Preparatory works
2) Leakage repairs
3) Preventive measures

Table 3.2 Leakage Control Measure

Category	Item
Preparatory works	Arrangement of financial resources and organization
	Procurement of pipes, valves, equipment & machinery for repair
	Strengthening leakage repair and training team staff
	Research and development (R &D) 1) method of reducing leakage (lining, materials, fittings) 2) equipment and machinery for repair 3) method of detecting leakage, 4) detection of buried pipes 5) effective repair methods
Leakage repairs	Above-ground leakage repairs
	Underground leakage repairs 1) detection of leakage volume 2) discovery of leakage location 3) repair 4) monitoring and evaluation for effectiveness of repairs
Preventive works	Planning and design of distribution network against leakage
	Replacement of aged pipes including changes in pipe materials
	Improvement in pipes 1) anti-corrosion lining 2) cleaning 3) reinforcement
	Control of water distribution pressure 1) Division into distribution block 2) Installation of pressure-reducing valves.
	Distribution network patrolling

(2) Leakage Repairs

In this section, practical leakage repairs, to be adopted as urgent measures for improving the existing leakage conditions, are discussed.

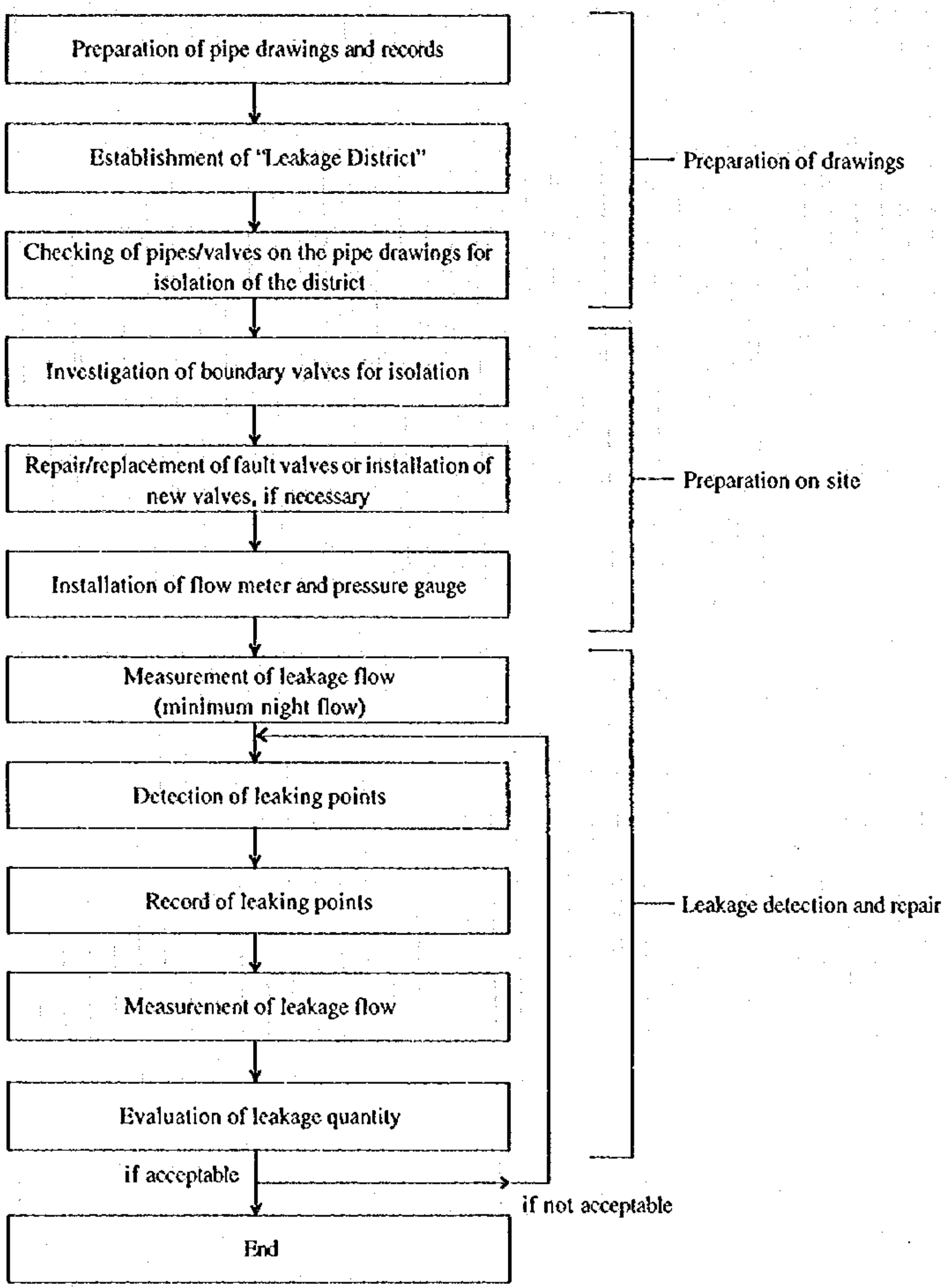
Leaks are of two kinds-visible on the ground leaks and invisible underground leaks. Leakage control measures should start with the former. Measures for the former can be started easily and will be very effective, especially during the initial stages. The measures for above-ground leakage control consist of patrolling, leakage detection, repair and recording leakage repairs.

Simultaneously, preparation should be started for underground leakage control. As illustrated in Figure 3.2, preparations should be systematic. Each "leakage district" should be "completely isolated hydraulically". The supply of water to the district is allowed through a single feed pipe, on which a flow meter and pressure gauge are installed. Minimum night flow (MNF) observed by measuring water flow in the district for 24 hours will show the amount of leakage. If the leakage volume is large, the exact location of leaks in the leakage district should be confirmed during night time by means of sounding rods and electronic leak detectors after the exact alignment of pipes is traced by the electronic pipeline detector, as well as from the records. Also, after leakage repair, MNF should be measured to confirm that leakage drops below the allowable level. Leakage detection and leakage repairs should be continued until observed MNFs are within the allowable range.

Leakage control should be enforced in with districts where leakage is high. Area-wise analysis of leakage level by measurements of minimum night flow is necessary, although this will take a considerable amount of time. As an alternative, high-leakage areas can be identified empirically, based on experience and prior information, both formal and informal. Such high leakage generally occurs in areas with 1) aged pipes, 2) long, small service pipes, 3) high pressures, 4) high saline ground water with high water level.

Prior to these measures, preliminary training should be given to the staff of the leakage repair team.

Fig.3.2 Procedure for Leakage Repair



CHAPTER 4

INSTITUTIONAL AND MANAGEMENT IMPROVEMENTS AND REFORM

CHAPTER 4 INSTITUTIONAL AND MANAGEMENT IMPROVEMENTS AND REFORMS

4.1 Introduction

The global trends in water supply policies, institution and systems, the basic principles/criteria for service delivery in the water supply sector, the goals and objectives, history, development and current situation of the water supply sector in the ROU are briefly discussed in Chapter 6 in Part One of this Main report. The issues, prospects, necessary improvements and reforms pertaining to the water supply sector in ROU are discussed in this chapter giving emphasis to the goals and targets to be achieved through the priority projects under this feasibility study.

4.2 Basic Project Criteria for Consideration of Institutional and Management Improvements

The institutional and management improvements and reforms suggested and recommended in this chapter are based on the Project criteria discussed in the preceding chapters. The basic Project items in the Feasibility Study for High Priority Projects are summarized below.

Project Item	Description
1. Water Source	
Shifting of main water source from water intakes on Amudarya River to Kaparas Reservoir	a) Completion of intake facilities at Kaparas Reservoir b) Construction of Control Building and Housing for Staff c) Installation of Electrical and Water Quality Monitoring Equipment
2. Water Supply System	
Completion of Tuyamuyun-Urgench and Tuyamuyun-Nukus Regional Water Supply Systems which are now under construction.	a) Construction/completion of Raw Water Pipelines from Kaparas Reservoir to the water treatment plants b) Improvements and expansion of Treatment facilities through Construction/reconstruction, installation/furnishing of equipment c) Construction of Transmission Facilities and installation of equipment d) Construction/expansion of Water Distribution Centers
Improvements to Nukus City Water Treatment Plant and Urgench Water Treatment Plant	a) Construction and re-equipment of facilities to upgrade treatment process b) Installation of Electrical and Water Quality Laboratory Equipment
Rehabilitation of Chimbai Water Treatment Plant and Chalish Water Treatment Plant	a) Rehabilitation of outdated wells b) Replacement of machinery and electrical equipment
Laying of Distribution Pipeline Networks	a) Replacement of outdated and laying of new distribution pipelines
Installation of Water Meters	a) Installation of Water Meters in the six cities

4.3 General and Specific Areas Requiring Institutional Strengthening

In the present Feasibility Study emphasis is given to 1) the improvement of the quality of water that will be supplied to the six cities and 2) the institutional and management improvements required for efficient operation of waterworks in the Study Area. Institutional and management improvements and/or reforms are considered necessary for the following purposes and reasons.

A) General Improvements and Reforms: To ensure smooth and early achievement of the overall goals and targets set up by the Government in the water supply sector through reform measures such as administrative decentralization and structural reorganization etc. These include improvements and/or reforms required for efficient operation and management of the waterworks in the Study Area aimed at better service delivery.

B) Specific Improvements and Reforms: To ensure smooth and efficient achievement of all goals and targets proposed in the priority projects under the feasibility study.

4.3.1 General Improvements and Reforms

Giving emphasis to the Study Area, issues, prospects and some suggestions for improvements and reforms that are considered necessary in general in the water supply sector pertaining to a) the water sector policy planning and management, b) national infrastructure and water resources, c) local production and distribution infrastructure and customer services, d) sector support from central and regional administration, e) management of waterworks at regional and local level, and f) organization etc., are discussed in the following sections.

4.3.2 Specific Improvements and Reforms

The issues considered to be closely related to smooth and efficient implementation and long term sustainability of the priority projects include; a) management of quality of water resources, b) management of intakes for public water supply, c) maintenance and management of treatment facilities, d) water metering for all consumer categories, e) reduction of non-essential water use, f) human resources development and training g) application of appropriate management techniques, h) water quality monitoring and i) institutional strengthening of waterworks. These are discussed below along with suggested improvements and reforms. As some of the suggestions or recommendations can not be implemented for the time being due to prevailing financial constraints and organizational difficulties such as lack of competent staff with experience in working under market economy conditions, priorities should be established for gradual implementation taking into consideration of the regional and institutional characteristics.

4.4 Issues, Prospects, Necessary Improvements/Reforms and Their Importance

1) Water Supply Policy and Systems

(a) Policy and Strategy Management in Water Sector

Responsibility for water policy is shared among a few agencies responsible for the sub-sectors, but these are coordinated through the Cabinet of Ministers of the ROU which has the power to determine major trends of national water policy for the use and protection of water resources, and accept country-wide state frameworks for water economics.

* Effective mechanisms are important to ensure that all sub-sectors and agencies can provide appropriate input and influence over water policy.
* Strengthened water policy analysis and development capability are needed to enable promulgating of comprehensive and long-term national water policy.

(b) Legislation and Regulation Development

With shifting to the market economy policy, a number of legislative changes have been introduced to implement the policy changes.

* These need to be supported by effective implementation and change management plans. Necessary legislative improvements may need to be considered particularly at the initial stages to check whether proposed changes take place effectively.

(c) Donor Coordination and Management

Enhanced assistance from external support agencies is anticipated in the water supply sector. With a view to utilize such assistance effectively and efficiently, it is important for the Government of ROU not only to identify, delineate and prioritize the areas and scope of cooperation by the donors, but also to identify an entity or set up a unit (involving ministries and committees responsible for foreign resources & relations, national & economic planning and water supply sector), at central level which shall be accountable to interface, negotiate and coordinate with the donors and among the agencies responsible for the sector in managing donor involvement.

(d) Subsidization

The government has given highest priority to drinking water supply ensuring accessibility of all citizens to safe drinking water which should be available at affordable price. At the same time, in the Study Area and elsewhere in the country, enormous production and delivery cost is incurred in distributing the water treated to drinking quality standards to a large population who receive them at a fraction of the cost. The VodoKanals which are required to manage as self supporting enterprises, charge low tariff from the 1st group of consumers and compensate for this by charging higher tariff from the other groups. Too low tariffs are counterproductive in water conservation efforts and moreover are too much a burden on the VodoKanal and on the other consumers who are forced to pay higher charges.

* The water tariff for the 1st group of consumers need to be increased appropriately.
* The state need to provide subsidies exclusively for individuals in lowest income groups until such time they become economically sound and afford to pay full charges of water received. The system for subsidies need to be devised taking into consideration of the overall and gradual changes that may require to the present social protection system under the market economy conditions.

(e) Separate System for Drinking Water Supply

In the Study Area, a large volume of treated drinking water is irrationally used by the households for gardening and irrigation. Although there had been a separate system of irrigation canals in the past, it is mostly defunct due to superannuation or damage.

* Existing water supply policy need to be implemented so that treated drinking water and gardening water are distributed to the urban population through two separate systems.

In remote areas like Muinak yet to be connected to the TWSS, the water that is supplied hardly satisfies the quality standards. Yet, the scarce, treated (chlorinated) water is inevitably used in large quantities for gardening. Socioeconomic conditions are pathetic and quality drinking water is an urgent requisite to the residents.

* Policy considerations and intermediate measures are needed for delivering drinking water that meets the standards (treated groundwater or desalinated water) as bottled water or in bowsers, until such time the TWSS water becomes available to this area in the future.

(f) Water Quality Standards

Uzbekistan has its own Gost Standards for water quality (e.g.Gost 2761-84,2874-82) of drinking and service water supply. The State Comittee for Stanadards and the State Comittee for Construction alongwith the MOH are responsible for formulation, revision and implementation water supply standards and their control. These authorities, recognizing the need to revise water quality standards taking into consideration of the changing environmental conditions and development needs in the country, have taken the initiative to revise the standards.

* Besides the present members of the existing committee responsible for revision of standards, all other parties whose participation, advice and suggestions etc. become useful and desirable in this task, need to be identified early and set up suitable subcommittees etc. for necessary consultation and deliberation.

2) National Infrastructure and Water Resources

(a) Development of Water Resources

The scarce water resources in ROU are limited mainly to the surface water from Amu Darya and Sir Darya rivers and groundwater.

* Regardless of the water source, central government, represented by the MWM&M, the SCGM and the SCNP must retain the ability to regulate, plan, control and protect the national water resources, and therefore shall be responsible for the direct cost of these functions. The ability to finance, manage and develop the resources should be at the national level.

(b) Planning, Development and Construction

In the FSU, these functions were handled centrally in Moscow. Some major national infrastructure development projects currently implemented are the result of master plans developed then. While planning functions for national infrastructure and resources are consolidated into one entity/authority which has control over the sub-sectors and agencies, several central agencies are now responsible for the other functions.

* Clear accountability need to be continuedly maintained for construction of national infrastructure as against construction of infrastructure for local water and sewerage service delivery.

(c) Operations, Maintenance and Management

These functions related to inter-regional infrastructures that are common to two or more administrative territories are the responsibility of the central government. A production amalgamation (RPADORWP) is set up under the MPU of the ROU to manage and coordinate development and operation of regional water pipelines (including Tuyamuyun/Nukus and Tuyamuyun/Urgench inter-regional pipelines which are now in operation but not to the full capacity).

* Even after construction of the TWSS is completed, it would be desirable to retain the responsibilities of the respective departments for operation and maintenance of the two inter-regional pipelines managed at national level.

3) Local Distribution Infrastructure and Customer Service

(a) Planning, Development and Construction

Some Provincial VodoKanals still depend largely on the center for advice on planning, design and development functions. Their construction activities are now limited to routine construction, minor rehabilitation works.

* VodoKanals practically do not have in-house capability for long term planning as these are not given the power to handle infrastructure planing. Such powers may be given when they prove to be self-sufficient in management.
* Clear accountability need to be continuedly maintained for construction, expansion and rehabilitation of infrastructure for local water and sewerage service delivery in urban and rural areas. In this context, role and responsibilities of Vodokanals and Agrovodokanals over water supply in the rural areas need to be well defined also considering the fact that their parent ministries are different.

(b) Corporate Planning

Corporate planning, or systematic planning to determine overall long term business goals of the enterprise and development of an agenda to achieve those goals, is aimed to increase institutional autonomy of the enterprise in decision making and to reduce reliance on the parent ministry/TCMA for all substantive policy related decisions. Planning responsibilities of Provincial VodoKanals are basically limited at present to routine and annual planning activities, one reason being the non-availability of funds to handle such responsibilities.

* Preparation and execution of a corporate plan is a fundamental step towards the delineating and achieving of corporate management objectives including self-sustenance.

(c) Operations, Maintenance and Management

In this respect, waterworks in the Study Area are confronted with many problems due to lack of funds and material supplies. The latter is partly due to the supply systems and supply depots not being organized properly to suit the conditions after decentralization.

* Clear accountability need to be maintained for repair and maintenance, operation and management of infrastructure for local water and sewerage service delivery in urban and rural areas, and for the support systems for supplies.

Also please refer to Chapter 3 of this report for details on system operaton and maintenance.

4) Sector Support

(a) Consultative Role of the MPU of the ROU/RPADORWP

Technical support by way of advice on design, issues on maintenance, training and man power development etc., and the managerial support to the Provincial VodoKanals come basically from the MPU of the ROU through the TCMAs (or MPU-ROK in Karakalpakstan).

* The VodoKanals, which are expected to operate as commercially oriented enterprises need to be looked at as a "water authority" in itself.

Water supply in the rural areas which are dealing with agriculture is now served by the Agrovodokanal. With the growth of population served, the AgroVodoKanal would find it difficult to continue serving the gradually urbanizing peripheral rural areas. There will be an increased trend towards handing over of water supply responsibilities in such areas to the Vodokanals which is also desirable. There is the need for better coordination between those involved with rural and urban water supply.

* For such shifting of responsibilities, consultative role and policy guidance of the MPU of the ROU are essential, besides coordination at central government level.
* To meet new responsibilities, the VodoKanals are required to continue develop and strengthen their capacities to function autonomously in the areas such as corporate and operational planning.

Scope of responsibilities of each department of the MPU of the ROU are specified. However, after the restructuring of the MPU of the ROU, some of its departments suffer with the lack of qualified specialists who are able to work under the conditions of market economy.

* The shift in role of the MPU of the ROU from direct management to consultation and support needs to continue. The MPU of the ROU needs to continue strengthening its departments through management improvement so that it can deliver the required support services efficiently and effectively. Specially, at the present stage of transition to market economy, training of present staff and/or employment of the services of specialists knowledgeable in market economy is desirable.
* The MPU of the ROU needs to provide continued and enhanced assistance to the Vodokanals in problem-solving and facilitating technology and experience exchanges from one territory to another.Currently such exchange is done through seminars, etc.

* The MPU of the ROU, the TCMAs and the MPU-ROK must examine to determine and implement the necessary additional institutional development (such as structural transformation through amalgamation, reduction/addition of departments/divisions) and extension of autonomy of the Vodokanals that needs to be carried out taking regional characteristics of each waterworks in to due consideration.

(b) Consumer Relations and Service Management

The VodoKanals must continue to have the capability to assess the water demand characteristics in each consumer sector taking into account of development trends, the level of service both in quality and quantity, appropriateness of tariff and impact of tariff changes on service level and consumer response.

* Capability of VodoKanals to conduct consumer/market needs assessment studies need to be developed.

In spite of the government instructions issued regarding payment for services and works delivered, still there had been difficulties in bill collections for water supplied to the population. To ensure that Vodokanals recover the water charges from this group of consumers, it is necessary to render subsidies to the poor strata of the population.

* Consumer management operations need to be well supported by a strong enforcement mandate and programs to ensure compliance with regulations and account payment.

5) Management of Waterworks

(a) General

To improve management of the waterworks, irrespective of their status as inter-regional, provincial or local level, it is necessary to evolve and develop their overall institutional capability in improving, developing and applying procedures and operating the systems for, budgeting; corporate planning; strategic problem solving; policy development; accounting and financial analysis; financial management; management information analyses; billing and collection; decentralization and delegation of functions, duties and responsibilities; application of modern management techniques; operation and maintenance and service delivery; human resources development; training, research and development; consumer education on reduction of non-essential water use, and relations with external entities and consumers, among others.

Waterworks in the Study Area, in their new capacity as self supported enterprises, have to develop new systems and methodologies appropriate to the market economy conditions. Although efforts are apparently made by the waterworks administration for improved management, some of their plans cannot be implemented right now due to lack of funds and material resources, technology and trained/qualified staff able to work under the new conditions of market economy.

To start with, it is important that the managerial staff at all levels become aware of and be alert to the issues and problems that hinder efficient management. Realizing the need for changes, endeavors must be made by themselves to identify and analyze such issues and problems and to device solutions, as most of the solutions are usually found to be available from among the staff who are involved with the routine activities and have gained enough experience through trial and error.

(b) Management Structure

Information collected on operational and management aspects through the present study would not be sufficient to comment fully on the management structure. Any deficiencies in the management structure will be well understood by the insiders with time and experience. Therefore, if the present management structure of the waterworks is judged to be ineffective or inadequate to achieve the corporate goals, it must be revised allowing for increased delegation of authority and delineation of functions to emphasize the need to provide satisfactory service to customers (commercial and operation and maintenance aspects) and to pursue financial goals (increased attention on billing, collection and accounting aspects). Specific opportunities need to be identified to achieve savings through integrating administrative support functions.

* To ensure that talent, knowledge and skills are being properly matched with the job requirements, increased attention need to be paid on staff assessment and position qualifications. Staffing practices, process for staffing decisions and work force adjustment policies need to be reviewed to achieve optimum work force.
* Retrenchment of redundant staff is a delicate issue and therefore their effective redeployment in other sectors/duties need to be considered. In dealing with work force rationalization, due consideration need be given to social security regulations etc., for which advice of the concerned authorities must also be sought.
* To maximize effective utilization of staff talent and experience, mechanisms need to be introduced to encourage staff participation in management decision making.

(c) Management Development Program

During the Study it was often observed that senior management staff (e.g. Directors, Chief Engineers) inevitably deal with even the sundry issues. This may perhaps indicate a lack of participation by, or insufficient delegation of duties to, the staff in middle (and lower) level management.

* It is necessary to study how to delegate functions and duties to the staff in lower management levels, thereby relieving the top management enabling them to attend to more important matters and crucial issues.
* While low salaries can not attract skilled/competent staff, it is not easy to simply raise the salary scales ignoring those in parallel institutions. There is a need to encourage staff to gain higher qualifications and motivate them with higher rank salaries.
* A management improvement program need to be introduced which involves grading of the water supply and sewerage schemes and establishing job duties and designation for each position according to the type and complexity of each scheme, and assigning staff to these schemes according to technical/managerial competence, abilities and disciplines of the employees. To make this program successful, support needs to be provided through setting up of promotional ladders and a significant training effort.

* To achieve goals and objectives set up in each scheme, or in respective departments, and in the organization as a whole, greater organizational cooperation and teamwork need to be encouraged by introducing suitable mechanisms and required training. These may include workshops designed for the staff to discuss each one's mission and responsibilities,approach and attitude towards one's duties, problems faced and solutions to them ,innovative ideas, and suggestions from colleagues etc., which will help the staff to recognize the collective mission of the group that they belong to.

(d) Personal Performance Evaluation System

Towards results orientation, a well designed performance evaluation system need to be established by which the managers are able to observe employee performance based on performance requirements and agreements, to compare behavior with standards/ norms, and document performance and conduct quarterly/annual performance reviews. This system must link personal objectives and the organizational objectives and the individuals role in team work.

* An evaluation scoring system need to be established to assess the employee performance, based on which the employees achieving scores above a certain level could be provided with incentive pay or other benefits while those achieving below a certain standard may be penalized, e.g. with deprived annual increases, bonuses or promotions.

(e) Management Training Program:

Management shortcomings are not unique to waterworks, but they are typical of any organization faced with a major role change. The degree of inadequacy is perhaps exacerbated by the fact that waterworks managers are mostly engineers or technicians. In general, engineers tend to be unrecognized as managers perhaps due to their training that makes them somewhat inflexible in understanding organizational and human issues, less socially oriented and feel less confident in management issues. Engineers who have received proper management training have shown same positive characteristics, in terms of human relations, as management graduates.

* If engineers or technicians are appointed as managers they need to be given appropriate management training.
* Management training and Human Resources development must be given high priority. Particularly the senior management staff be given management training through participation in seminar-workshops organized by competent training institutions. Training program must be aimed to develop: a base of management skills for achieving better results with staff and developing a responsible staff team, for defining mission and purpose, increased possibilities for risk-taking and taking individual responsibility for new initiatives, for communicating with staff, for presenting the waterworks to the public and to colleagues, for conducting meetings, and providing feedback to monitor staff. The mid-level and lower level management staff must also be given appropriate management training.
* Employees must be viewed as an asset to the organization requiring investment. In other words, the waterworks must spend for continued education, training and skill upgrading of its staff so that they could offer enhanced and lasting service in return. A comprehensive strategy for human resource development and staff training need to be established.
* The accountability of agencies/training centers responsible for the development of human resource policies and programs related to the sector need to be clearly established.

At present, staff are given on-the-job-training as one of the most effective and practical method, while selected staff members are trained at "Uzkommuniukuvzhorii" training institute under the MPU of the ROU in Tashkent or its affiliated training centers in the provinces. Special training courses, seminars, lectures, simulation workshops etc. are organized by this training institute, but training programs are drastically cut down due to financial difficulties and hence the employing of resource personnel. Besides, Vodokanals do not have adequate funds to send their staff for training at the center.

* Institutional strengthening of the training institute, which also promote research and development in water supply and sanitation sector, and its other affiliated centers within the Study Area need to be promoted for the benefit of concerned waterworks.

(f) Incentives to Staff

After the restructuring and decentralization of functions, the number of staff in some key departments of the MPU of the ROU has been drastically reduced. Specialists interviewed complain of not having adequate supporting staff to handle even the routine work. Salaries fixed by the government at different times adjusting with inflation are not necessarily considered by the employees as sufficient to fight inflation. Incentives, privileges and opportunities etc., given to the employees in the public sector are considered by them as inadequate to motivate them for better performance at work.

* Incentive schemes are needed to compensate the MPU and Vodokanal employees with salaries/privileges commensurable with their duties and responsibilities, in comparison to those in the private sector.

(g) Transfer of Technology

Application of modern management techniques are necessary. In the background of a sudden and drastic changes in the economic policy in the country, it is encouraging to note that management staff are not averse to, but welcome new ideas and advanced techniques. The senior management staff of waterworks, who have made recent overseas visits, have brought with them concepts of new methods and technologies. They have already tried to adopt some of the new concepts into their own systems with reasonable modifications to suit the local conditions.

* Knowledge on modern management techniques need to be promoted through transfer of technology taking the best opportunities of foreign technical assistance programs.

(h) Billing and Collection

Introduction of an efficient billing and collection system is a fundamental key to improving the financial status of the VodoKanals. Yet, improved billing systems alone would not necessarily result in improved collections if the service provided to the consumers did also not improve.

* Parallel interventions must take in the areas of service improvement (e.g. increased emphasis on rehabilitation, improved water quality, prompt and positive response to consumer complaints) and consumer relations. Attention must also paid to cost containment to lessen the severity of future water tariff increases.

(i) Marketing and Public Relations

Enhanced consumer education capability based on water conservation and water use policy need to be built up. Constant contact between the VodoKanal and the consumers through public relations and public awareness campaigns is essential to achieve proper understanding and cooperation of the consumers with respect to not only the services delivered, but also their lapses, difficulties confronted and the efforts taken by the VodoKanal to solve consumer problems.

* A well orchestrated public awareness campaign emphasizing the need to use water wisely and pay for it could mitigate the trend for negative reactions by consumers during tariff increase. Enhanced willingness to pay must be developed in the mind of the consumer. Some typical activities suggested under the campaign may include: TV coverage, documentary films, posters, radio and other media announcements, school level competitions, awareness and education campaigns, media interviews etc. on national and regional water supply issues (e.g.seasonal shortages, poor quality of water sources); efforts taken in water treatment, distribution etc.: save-water campaigns; value of water; explanation on the problems of VodoKanal and putting the problems in right perspective than mere propaganda and activities of VodoKanal.

(j) Public Image of VodoKanals

As a productive enterprise, public image of VodoKanal is very important and the value of good public relations need to be appreciated by VodoKanal staff at all levels. Surveys are needed to determine how the public image can be enhanced.

* It is necessary to design and deliver training courses on public relations particularly to those staff members coming into day-to-day contact with the public.
* A Consumer Relations Officer is generally assigned at the VodoKanal who shall be specifically responsible for dealing with consumer complaints. Introduction of a complaints monitoring and analysis system would help to gather basic information on the roots and causes of complaints as to why the supply has been stopped or why had the cost increased etc. and to expeditiously attend to such complaints.

(k) Reduction of Non-essential/Non-revenue Water Use

Reduction of non essential water use is important from the point of financial solvency of waterworks. Connections to many households, and some institutions and enterprises are not provided with water meters and the amount of water that is actually consumed, pilfered, irrationally used or wasted can not be precisely measured. Existing pipeline network in some areas is rather old and the actual volume of leakage can only be guesssed. By a recent decree (No.185) of the Cabinet of Ministers, steps are being taken to have water meters installed to all consumer connections. As installation of water meters alone can not help save water, the superannuated pipelines/networks need to be replaced/repaired simultaneously to minimize leakage. Internal pipelines of the dwelings and buildings, including damaged/leaking water taps also need to be replaced/repaired to reduce leakage. A staged programs for the replacement of outdated distribution pipelines and installation of water meters in the six cities are taken into consideration among the priority projects.

* A systematic program for reduction of non essential water use is needed before long and it would be desirable to set up a special unit at the waterworks and assign an officer responsible for this subject.
* Implementation of the proposed programme for installation of water meters to all consumer connections need to be prioritized and expedited. For this it is necessary to supply the Vodokanals with the required water meters through import/manufacture for which additional funds are required. While each Vodokanal is responsible for installation of water meters within its service area, nation wide or territory wise general consensus would be necessary regards to the sharing of the costs by consumers and the waterworks. It is considered necessary to set up a unit within the MPU of the ROU which can exclusively concentrate on these issues and conduct necessary research and planning into the financial and technical aspects at national level.
* Water meter installation program will be implemented in stages over a long period. A unit concentrating on the planning and programming of water meter installation, supply and installation, maintenance and repairs need to be identified/set up in the Vodokanals.

(l) Fines on Excess Claims by Waterworks

The Provincial Finance Department in Khorezm is authorized to check excess claims made by public utility agencies from the state or provincial budgetary organizations for the services provided and to recover such over-claimed monies with surcharges or to impose fines when agency -consumer agreements indicate overestimated volumes of supply. But, there is no fool proof method for fair arbitration under this system as the actually consumed volumes can not be correctly estimated when the consumer is not provided with meters.

* Particularly in public institutions, where water is generally likely to be wasted in large volumes by neglect, it is essential to install water meters not only to ensure collection of appropriate water charges, but also to discourage non-essential use and wastage.

(m) Management Information System (MIS):

Analyses of performance indicators at regular intervals and communicating their results and data are essential in dealing to management problems with timely countermeasures. Such data should not become mere statistics, but also be effectively utilized in policy making and planning processes, public awareness etc. Even at present, VodoKanals do possess some management information data which are presented in regular or ad-hoc reports. The Director and individual managers of respective departments have their own data banks, but there is no formal system now existing for exchange and utilization of such information for management purposes. Vodokanal in Khorezm has recently installed computer facilities which are being gradually and effectively used for information management.

* A reliable and timely MIS need to be introduced as an essential support mechanism for successful development of capabilities of Vodokanals in corporate planning, management development, commercially oriented operations, problem solving etc., aimed to achieve through the decentralization process. A well coordinated MIS will help not only in giving the correct perspective of the VodoKanal affairs to all concerned, but also in countering irrational directives and external pressures.
* The data or the parameters required in the MIS need to be sorted out in different levels according to the purpose of their communication/presentation. For easy compilation of regular reports, it is desirable to have all relevant data documented in detail with ready access to them.

(n) Research and Development (R&D)

R&D in the water sector is shared among several agencies under the relevant ministries.

* R&D requirements in the water supply sector need to be identified at national level and the capability for R&D need to be strengthened by pooling together effectively the limited resources available. Accountability of R&D in water supply and sewerage at different administrative levels need to be established. The capability of training institute "Uzkommuniukuvzhorii" and individual waterworks need to be strengthened for developing new scientific research and development programs to meet current and future needs of the waterworks.

(o) Computer Assistance for Management and Technical Services

A computerized system need to be developed with menu driven modules for ease of operation. These modules in the simplest form would include the following areas. Metering, Billing, Payment and installment plan, Consumer complaints, Technical service and Management information reports.

* Metering Module provides for entry of meter readings, verification and validations and checks for reasonableness of information and out put reports of water use above stipulated limits for follow up action. It can also be used to generate meter readers' itineraries and lists of unread meters. The validated readings will be transferred to the billing module which also obtains information from payment and other modules and process and print the bills.
* Payment Module provides for entry of all payments made to the collection units. The payments are matched against the relevant customers account, analyzed to the relevant monthly bills and transferred to the billing module after validation. A subsystem for control and monitoring of installment payments and arrears may be included.
* Consumer Complaints Module records the movement of billing related consumer complaints and provides reports on the time taken to handle individual complaints and aging of complaints by area and type and category of consumer.
* Technical Services Module records requests for new connections and movement of progress in installation and feeds the main system with all new connections installed.
* Management Information Module provides monthly statistical, accounting and other reports which include information on;
  - monthly analysis of water consumption, number of connections, revenue by area and category of consumers,
  - monthly summary of billings, payments and arrears,
  - Age analysis of debtors and overall debtors movement for the month
  - Statistical summary of collections and water use.

(p) Computer Assistance for Technical Areas

Application of computer assistance in technical areas need to be encouraged in order to implement water supply and sewerage system modeling, system mapping and CAD programs.

(q) Improved Communications

In Khorezm Province and still the more in the ROK, the service areas are distributed over a vast territory. Communication between the DOMIWPs and the Provincial VodoKanals, and the Provincial VodoKanal office and its branches in smaller cities, require improvements in order to achieve higher management performance for delivering a satisfactory or better service to the consumers in those remote cities.

* Besides the use of available telecommunication systems, communication through other facilities like wireless linkages, vehicular transport need to be considered as permanent features to meet emergency situations.

(r) Protection of Water Resources

Kaparas reservoir, when ready, will store snow-melt water from Amu Darya river. It has been pointed out that during some periods of the year, particularly between mid September to mid June, Amu Darya water does not fully satisfy the State Standards for drinking water sources. Environmental pollution that may take place due to adverse human activities in the upstream areas, including the territory outside Uzbekistan, could aggravate poor quality of water sources already prevailing during certain periods.

* It is desirable to have Turkmenistan counterpart authorities actively involved, where necessary, in joint environmental conservation and pollution control programs because a considerable part of Amu Darya river catchment upstream of Kaparas water source is in Turkmenistan territory. Institutional requirements and resources for such joint activities need to be planned in consultation with authorities on both countries.
* Construction of the proposed drainage collectors aimed at diverting polluted water from farmlands away from Amu Darya River need to be given priority and expedited.

(s) Water Quality Monitoring

The present Study leads to the improvement of quality of water supplied to the Study Area. Technical solutions and a system for maintaining improved water quality through improvement of facilities are considered under the Priority Projects. Now there are several institutions involved in water quality monitoring and control activities in the water supply sector, including some relevant departments, laboratories and affiliated agencies under the SCNP, the SCGM, the MPU, the MM&WM, the MOH and the MOA, and the respective waterworks in the Study Area. Many of the laboratories, responsible for water quality monitoring and analyses (with respect to water sources, raw water, treated water, tap water, sewage and waste effluents draining into the water sources) are poorly equipped. Non-availability of reagents, lack of trained personnel, available equipment being unserviceable, non availability of suitable transport facilities to reach distant sampling locations are some problems that hinder even the routine testing programs.

* Besides the water quality monitoring equipment considered for installation under the Priority Projects, the televant laboratories that are directly involved in water quality monitoring and control need to be strengthened with adequate staff and the essential equipment and facilities.
* A system must also be evolved for collection, documentation and exchange of water quality management information. The SCNP is learnt to have already taken the

initiative to establish a water quality management information center. Apart from identifying the resources and facilities required, appropriate arrangements for testing, analyses, reporting, and implementing of necessary actions must also be organized on a continuous basis involving the relevant agencies.

(4) Organization of Waterworks

(a) Organization Structure

Organization structures of the waterworks have been evolved through many years of experience. But, for efficient and effective performance of their corporate functions, modifications are needed from time to time to meet new functional requirements.

* Alternative structures must be suggested and reorganization issues must be taken up at waterworks meetings and be deliberated thoroughly involving all levels of staff. Great care must be taken not to fall into the trap of hastily agreeing to a new structure which may later found to be unworkable. All the key changes need to be approved by the higher authorities; the MPU of the ROU, Khokimiat and the TCMA. Changing a structure again at short notice would be embarrassing to say the least.
* Besides the new divisions required in connection with reduction of non-essential water use and water meter installation activities, it is considered appropriate to strengthen the repair and maintenance workshop facilities and construction units in the VodoKanals so that these can attend to minor construction, repair and maintenance works more effectively and efficiently.

(b) Service to Newly Urbanized/ing Areas

Some cities in the Study Area, e.g. Urgench, Nukus, Kungrad, are fast growing and the peripheral rural areas which are presently served by the AgroVodoKanal are gradually becoming urbanized. Handing over of water supply systems in such areas to the Vodokanal may become desirable. In Khorezm, TCMA is considering to bring the AgroVodoKanal system under it. But the advantages and disadvantages of such reorganizing of water supply administration needs careful consideration also taking into account that parent ministries of theVodokanals and the Agrovodokanals are different.

In the ROK, "Karakalpakselkhostvodoprovodtrest", or the agency responsible for water supply to the farms and rural areas, already finds it difficult to manage because recovery of revenue from water sales has become extremely difficult. Under such circumstances, VodoKanal-ROK may not find merging with this agency or taking over the water supply systems in fast urbanizing rural areas to its advantage, at least for the time being.

* The advantages and disadvantages of such reorganization/amalgamation needs careful consideration in the light of experiences gained by VodoKanalKz in this process which would be useful in planning such changes in other areas not limited to the Study Area.

(c) Strengthening of District/City Offices of VodoKanal:

Water supply and sewerage services in the district and city centers are operated under local offices subordinated to the regional VodoKanals.

* With gradual growth of consumer connections handled by the District/City Offices of VodoKanal, these area offices need to be developed with the transfer of following responsibilities:
  Meter reading, Data entry of readings, Validation and correction, Rendering of bills, Collection of amounts due and follow up of outstanding, Initiating reminders, red notices and disconnections, Attending to consumer queries and complaints, Repairs and rectification of defective meters.

(d) Separate Water Supply Systems for Domestic Use and Other Uses

If separate supply systems are to be adopted again for the drinking water and the water for gardening etc., some organizational changes will be necessary for operation of these systems.

* Existing departments under the TCMA/MPU-ROK responsible for gardening water supply need to be rejuvenated in order to handle repair, restoration and maintenance of any existing facilities or construction and maintenance of new distribution facilities and pipeline networks, and management of these systems.

CHAPTER 5

PROJECT COST ESTIMATION AND IMPLEMENTATION PLAN

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5.1 Construction Considerations

Construction materials, construction machinery, labor wages and construction conditions were studied. For materials procured overseas, the costs prevailing in Commonwealth of Independent States (CIS), Europe and Asia were used.

The cost of using the transmission pipeline of Urgench Transgas from Takhiatash to Kungrad has not been considered.

Since the following listed facilities are under construction, the estimated costs in the report consider only remaining portion, of these facilities.

(1) Kaparas Intake Station
(2) Raw Water Main Pipeline (Kaparas Intake Station to Tuyamuyun-Urgench Intake Station)
(3) Tuyamuyun-Nukus Water Treatment Plant (Receiving Basin, Clarifier, Horizontal Sedimentation Basin, Filter)
(4) Tuyamuyun-Urgench Water Treatment Plant (Receiving Basin Clarifier, Horizontal Sedimentation Basin, Filter)
(5) No. 1, No. 2, and No. 3 Booster Pumping Stations (Tuyamuyun-Nukus system)
(6) Transmission pipeline (Nukus to Takhiatash)

The machinery and equipment listed below and stored on site were procured in 1992. It is difficult to judge by visual inspection of these machinery and equipment visually whether there are problems in using these equipment, such as corrosion during the period of storage. However, these equipment should be used so that costs can be reduced. Detail are as proposed in Chapter One(1) of FS report. Inspections and operating tests should be carried out on the equipment below, repairs should preferably be carried out based on the results of the inspections and tests, and efforts made to utilize the equipment to the maximum. For this cost estimation, the cost of machinery and equipment is taken as 20% the cost of newly purchased machinery and equipment. For electrical equipment, the cost is taken as 70% of newly purchased electrical equipment.

(1) Machinery and electrical equipment for Kaparas intake station (without transformer)
(2) Machinery and electrical equipment for No. 1, No. 2 and No. 3 booster pumping stations (Tuyamuyun-Nukus system)

5.2 Construction Cost Estimation

The standards for estimates are already given in the Basic Plan, but repeated here for clarity.

(1) The major materials could be imported from the countries where the materials are reasonably available. However the countries written below only for estimation.

1) Mild steel pipe (transmission pipeline) :	Russia, Ukraine
2) Ductile cast iron pipe (distribution pipeline) :	South Korea
3) Mechanical and electrical equipment :	Japan
4) Water meters :	Uzbekistan (joint venture with Republic of China)

(2) Import route

1) Route from Asia to Uzbekistan

The materials/equipment will be unloaded at the Port of Bandar Abbas in Iran and transported to Uzbekistan via Turkmenistan.

2) Route from Russia, Ukraine to Uzbekistan

The material/equipment will be transported to Uzbekistan via Kazakhstan and Turkmenistan.

(3) Exchange rate

1 Uzbekistan Sum	=	0.025 US dollar
1 Uzbekistan Sum	=	2.75 Japanese yen
1 US dollar	=	40 Uzbekistan Sum
1 US dollar	=	110 Japanese yen

(as of July 1996)

(4) Engineering fees were taken as less than 10% of the construction cost.

(5) Physical contingency fees were taken as 5% of the construction cost.