Table 5.28 Annual Water Volume Required for Water Supply, Required Water Level in the Kaparas Reservoir and Period for Filling from LWL

	Required Annual Water Volume mil. m^3/year	Required Water Level m	Period Required for Storing the number of days
Basic Plan in 2010	300	124	18
FS Plan in 2002	190	122	15
FS Plan in 2010	238	123	13

Basic Plan : water demand plan in the Basic Plan
FS Plan : revised water demand plan in Feasibility Study

5.4.5 Conclusions and Recommendations for the Kaparas reservoir

(1) Water Rights

The water rights of the Kaparas reservoir as a domestic and drinking source for both regions have been established and confirmed. An agreement on the utilization of TMHU by ROU has been reached between the governments of ROU and Turkmenistan recently.

(2) Water Quality Evaluation

Under the recommended operation mode of the Kaparas reservoir, mineralization concentration is below the MAC and no problems are anticipated for other indicators except total hardness, which exceeds the MAC during the latter several months of reserved periods if leached salt from the reservoir bed and evaporation occur, according to a forecast by SANIIRI.

For the further improvement in water quality, especially in total hardness, the following countermeasures are expected.

1) establishing a system monitoring for water quality and distributing information using automated hardware and software for storing the best quality water in a year
2) partial or complete termination of any collector in the mid-stream part of the Amu Darya river during the filling period of the Kaparas reservoir

(3) Observed Stored Water Volume

Under current operation mode of Ruslovoye reservoir, effective volume of 260 mil. m^3 corresponding to the water level of 123 m can be stored on an average. This volume meets the annual water demand in 2010 for both regions according to revised water demand plan in Feasibility Study of the Part II report. However, in drought year such as 1986, it might be difficult to raise the water level up to the required level.

(4) Recommendations on the Further Study

The above preliminary study showed that Kaparas reservoir is suitable as a water reservoir storing raw water for domestic and drinking purposes. However, further detailed study with respect to the following points is necessary;

1) whether the water level of the both reservoirs can be raised to the required level to store effective water volume equivalent to annual water demand in discharge rate of Amu Darya river in drought year;

2) at least trial operation for one year of the Ruslovoye and Kaparas reservoirs under the recommended operation mode is necessary for a more accurate forecast of quality of the stored water in the Kaparas reservoir.

Now the Uzbek side is undertaking these study.

5.5 Groundwater Sources

5.5.1 Groundwater Resources in the Study Area

(1) Groundwater Resources for Drinking Water Use

There are several groundwater-bearing horizons and complexes in the Study Area, among which geological structure and hydrogeological conditions led to the existence of two water-bearing horizons suitable for drinking water: water-bearing horizon in alluvial Quaternary deposits and a water-bearing complex of the upper Cretaceous period within Senonian, Turanian, and Cenomanian deposits (upper Cretaceous complex) which are located in the first horizon and second horizon from the surface. The former can serve as a drinking water supply source, the latter can be used as a water source after desalinization.

The water-bearing horizon within alluvial deposits of the delta is the most promising water source for drinking supply purposes. During the period 1960 to 1995, more than 60 ground water fields were discovered which are essentially near-canal lenses. During the last few decades, river water quality decreased drastically and, for most of the year, does not comply with the standards for drinking water due to the decreased flow rate of the Amu Darya river and increased volume of irrigation water being discharged into the river. Accordingly, the quality of groundwater (closely connected to the irrigation canals which are the main sources of water supply for the lenses) has decreased, as well.

The upper Cretaceous complex at a depth of 350 to 450 m has a relatively low mineralization level (1.5 to 5.0 g/l) and low total hardness (3 to 6 meq/l). Moreover, it has a high degree of protection against pollutants, relatively close to the surface, and gives a high yield. However, the water in the left-bank section is highly mineralized thus needs of desalinization plants designed for treating water with high salinity level, with a high energy consumption rate is lower. Reportedly, when in use, this complex's resources can provide water for 230 desalination plants with an average production capacity of 50 m^3/day (130 plants are already in operation during the last 5 years), and supply quality water to about 300 thousand people.

(2) Artificial Replenishment

Decrease in flow rate of the Amu Darya river and increase in discharge from collectors into the river during the last decades have led to a qualitative depletion of the fresh lens ground water fields which are closely connected to surface waters. However, according to observations, changes in quality of the water pumped up from the current groundwater intakes are slower than the case of river water, and quality is still better than that of surface water. These observations have supported the hydrologists' opinion that changes in the water quality are reversible, leaching to the creation of a foundation for developing a special artificial intervention technology.

Technology of artificial replenishment of fresh water resources has been developed and successfully tested during a 15-year period at 10 current water intake sites, enabling quality of the groundwater to be maintained throughout the year in accordance with standards. The technology basically envisages stimulation of fresh water filtration processes in the water-bearing horizon during flood water periods (June through August) in order to accumulate good quality water in the porous medium thus creating a volume large enough to be drawn-off during the rest of the year.

(3) Quality of Wells Water

After the collapse of the Soviet Union and subsequent cuts in finance, the operation and maintenance of the water intake from wells deteriorated drastically because of the shortage of pumps for replacement and shortage of financial means for new drilling works, especially in Chimbai. Consequently, quality of water in wells seems to have deteriorated recently.

Fig. 5.11 shows the monthly mineralization concentration from April to December in 1995 for water sources of Urgench city: Shavat canal in Urgench and well in Chalysh. Mineralization of the canal water in summer is low and complies with the standards but in the other seasons, does not comply with the standard. On the other hand, mineralization of the well is constantly high during the monitoring period and does not comply with the standards. Similar tendency is observed in the Chimbai well and Kyzketken canal shown in Fig. 5.12. However, the mineralization of Chimbai well is slightly better than that of the Chalysh well. The recent deterioration of groundwater generated by artificial replenishment is probably due to lack of financial means, and lack of operation and maintenance of the water intake of wells, as stated above.

(4) Groundwater Resources in the Study Area

Water-bearing horizon of the alluvial Quaternary deposits is represented by near-river and near-canal lenses of fresh water. More than 60 such lenses have been discovered: about 40 in Karakalpakstan and 25 in Khorezm. The amount of fresh water estimated at during exploratory surveys was (ths. m^3/day) : 120.4 in northern Karakalpakstan with over 15 water deposits; 150 in the southern zone with over 17 water deposits; 496 in the Khorezm region with over 23 water deposits. 10 water deposits were disqualified during estimation stage as they were unsuitable for artificial replenishment.

After the revision of water quality in the 1989-90 and re-estimation of resources considering artificial replenishment technology, resources of fresh water were (thus. m^3/day) : 91.7 for the northern zone of Karakalpakstan, 110.8 for the southern zone, and 258.1 for Khorezm. Currently-assessed draw-offs of groundwater from the first water-bearing horizon (more accurately, from near-river and near-canal lenses) were (as of Jan. 1, 1995, ths. m^3/day) : 4.6 in the northern zone, 21,4 in the southern zone, and 39.8 in Khorezm which amounts to 5.14% and 15% of potential resources, respectively.

(5) Current Situation

Recently, groundwater usage has deteriorated considerably because of starting the operation of a trunk water pipeline from the Tuyamuyun water treatment plant. For example, the biggest groundwater intakes of Urgench, Nukus, Chimbai, Khalkabad, and Akmangit are practically discarded. Water supply variations in the groundwater for

Karakalpakstan and Khorezm are summarized in Table 5.29.

Table 5.29 Water supply variations of groundwater for Karakalpakstan and Khorezm in Jan. 1995

Administrative division	Groundwater intakes			Desalination machine using groundwater			Small wells with hand type pumps	
	No. of water intakes	Total productivity (ths m^3/day)	Population served by water (ths)	No. of machines	Total productivity (ths m^3/day)	Population served by water (ths)	No. of wells	Population served (ths)
Karakalpakstan	38	192	610	130	11.5	285	2,542	87
(a) North part		125	400	130	11.5	285	1,460	55
(b) South part		67	210	-	-	-	1,082	32
Khorezm	33	365	1,200	-	-	-	1,120	32
Total:	71	557	1,810	130	11.5	285	3,662	119

5.5.2 Groundwater in the Study Cities

Groundwater resources, including artificial replenishment of the alluvial Quaternary deposits in the vicinity of the Study Cities are summarized in Table 5.30.

Table 5.30 Description of Groundwater in the vicinity of the Study Cities

Water deposit	Predictable resources including those artificially recharged ths. m^3/day	Water consumer	Present intake amount ths. m^3/day
Nukus	-	VodoKanal, Nukus	0.08
Akmangit	6.28	Akmangit village	1.36
Chimbai	4.16	sovkhoz "Gigant"	0.96
Khodjeili	-	Khodjeili town	Out of operation
Chalysh	70.8	cities Urgench, Khiva, settlements Kipchak, Papvanbai, Kh , Nazarkhon.	13.40

Groundwater resources in the Study Six Cities are classified into three groups as follows;

i) Nukus and Khiva

There are less potential of groundwater resources which can be used as drinking water sources.

ii) Kungrad and Muynak

There is not even a single fresh water deposit because of the low-filtration properties of the deposits in the tail section of the delta and absence of a quality surface water source. The groundwater salinity is as high as the concentration level of sea water. High desalination will be required, if the water is to be used for drinking.

iii) Urgench and Chimbai

There are rather large fresh groundwater fields in the vicinity of the towns of Urgench and Chimbai.

Groundwater in the four cities, Nukus, Khiva, Urgench and Chimbai, with the potential for use as drinking water sources, are given below.

(1) Nukus

The Nukus fresh water field is located in the northern suburban section of the city along the Kyzketken canal and has rather impressive dimensions : width of 2,000 m, length of 45 m. Fresh water resources were estimated at 16.8 ths. m^3/day by Uzbeki experts. An obstacle in the use of this water is the high concentration of fluorine in the water (nearly to 4 mg/l in several sections while maximum allowable concentration is 1.5 mg/l). Thus, before the water can be used it should be treated to remove excess fluorine.

Recently, the water-bearing horizon is fed by low-quality water and the water field is gradually being depleted. Artificial replenishment is a very difficult task from the technical point of view because of the specific structure of the field : large depth of the productive horizon (35 m), thick surface silt (more than 3 m), presence of clay interlayers, and low filtration properties of sand of the first water-bearing horizon which must be replenished and used together with the lower horizon.

(2) Khiva

The Khiva water field is located at a distance of 2 km from the city of Khiva. Its resources were estimated at 3 ths. m^3/day, which is clearly inadequate for supply to such a large community. Presently, its capacity is low while replenishment is difficult due to the low filtration properties of water-accumulating rock. Moreover, because the field is located at a secondary canal quality water is available only for short period.

(3) Urgench

Chalysh water field was discovered in the 1978. It is located at a distance of 18 km east of Urgench along the Amu Darya river. It is large with a length of 500 m, width of 2,000 m , and thickness of water-bearing sand of 70 m. Water flow rate from the wells was 25 to 30 l/sec. Its resources were estimated at 151.8. ths. m^3/day. Water intake operation was planned in two stages. However, when construction works were already under way some technical difficulties emerged : construction enterprises could not drill wells having the rated flow rate while simultaneously preventing outflow of water-bearing sand through the filters. As a result, production capacity has never exceeded even a half of the planned capacity of the first stage(that is, 35 ths. m^3/day) during a 10-year operation period. The average flow rate from the wells was 12 to 15 l/sec with a large outflow of sand in many of the wells. Due to continuing outflow of the sand, submerged pumps often broke down. Procurement of new pumps and repairs to pumps has been constant. After the Tuyamuyun water pipeline was put into operation, this water intake gradually received lesser attention. Its production capacity reduced to more than one third and was 13.4 ths. m^3/day at the end of the 1994, which means that only 10 wells out of 30 were in operation at a flow rate of 10 to 15 l/sec. Quality of the produced water gradually decreased to the quality of river water but because of large volume of the field quality of water is still better than that of water in the river in seasons other than summer. Conditions for use of the artificial replenishment technology are quite good here, and its realization could produce about 70 ths. m^3/day of quality water which would cover the needs of more than 200 ths. people at a daily rate of 300 l/person.

(4) Chimbai

Chimbai water field is located south of the town along the trunk irrigation canal (the Kegeili Canal). It was discovered in the 1962 and re-assessed in the 1985 taking into account the artificial replenishment technology. Its resources were estimated at 4.16 ths. m^3/day. Upstream of the Kegeili Canal it has a neighbor : the Kazakh Darya (Mayab) water field with 7.8 ths. m^3/day capacity, which was also re-assessed in the 1993 based on the new technology. Starting from the 1963, the Chimbai water field has been used successfully at a production rate close to the planned one. Partial use of the artificial replenishment technology started in 1984. Quality of the water produced always complied with the standards. After disintegration of the Soviet Union and subsequent cut of financial means, operation and maintenance of the water intake deteriorated drastically : hardly a half of 15 wells were in operation (because of shortage of pumps for replacement and shortage of financial means for new drilling works). When the town of Chimbai was connected to the Tuyamuyun system, the water intake site became practically moth-balled. At present, its production capacity is 0.96 ths. m^3/day, equivalent to volumes for the operation of 2 wells at a flow rate of 5 l/sec each.

5.5.3 Proposal on Groundwater

The Six Study Cities should be divided into 3 groups. Nukus and Khiva are already using the Tuyamuyun system and do not have substantial groundwater sources. Kungrad and Muynak also do not have groundwater sources but in this case one should compare quality indicators, and economics efficiency of water delivered from the system or desalination plants operating on surface / groundwater.

The cities of Urgench and Chimbai have substantial groundwater resources. Although they are currently supplied with water from the Tuyamuyun water conduit, use of groundwater has definite advantages, and can be considered as an alternative or additional/reserve source. Fresh water resources are 70 ths. m^3/day for Urgench and 12 ths. m^3/day for Chimbai, which corresponds to supply for 200 ths. and 40 ths. persons, respectively.

5.6 Water Quality Standards

5.6.1 Introduction

At present, two water quality standards related to water supply have been prescribed and applied effectively in the ROU. The water quality standards for drinking water are stipulated by the GOST 2874-82, "Drinking Water Hygienic Requirements and Quality Control" of the Government Standard of the Soviet Union (hereinafter called "Drinking Water Requirements".), and the water quality standards for surface water are stipulated by the SanPiN#4630-88, "Sanitary Rules and Norms on Protection of Surface Water against Pollution" (hereinafter called "Sanitary Rules and Norms".)

5.6.2 Drinking Water Quality Standards

The Drinking Water Requirements is used for drinking water and technical water and determine hygienic requirements and quality control of the drinking water. This standard does not cover drinking water using local water sources, not supplied by piped water, which exist mainly in rural area. The water quality standards and controls of the Drinking Water Requirements is shown below together with the WHO Guideline, 1993 and Japanese standards, 1993.

Note: WHO standards values are divided into guideline values (WHO guideline) and values that may give rise to complains from consumers (WHO Complain)

(1) Drinking Water Hygienic Requirements and Quality Control

Drinking water should be safe from epidemiological concerns, rendered harmless by chemicals and have favorable organoleptical qualities. Indicators of water quality are classified into - microbiological, toxicological, organoleptical indicators and concentration of chemicals. Maximum Allowable Concentration (MAC), quantity or property of indicator are summarized in tables below.

1) Microbiological Indicator

Table 5.31 Microbiological Indicator

Indicator	Uzbekistan Standard	WHO Guideline	Japanese Standard
Quantity of microorganisms (CFU)	100/1 ml	-	100/1 ml *1
Quantity of E. Coli (CFU) (Colimorm bacteria)	3/1 ml	0/100 ml *2	should not to be detected *3

Source: GOST "2874-82", WHO Guideline 1993 and Water Quality Standards in Japan 1993
Note : Quantity of microorganisms in sampling volume (ml) should not exceed these standards.
*1: as standard plate count bacteria
**2 : as fecal coliform bacteria
***3 : as coliform bacteria
CFU : colony forming unit

2) Toxicological Indicator

Table 5.32 Toxicological Indicator

(unit : mg/l)

Indicator	Uzbekistan Standard	WHO Guideline	Japan Standard
Residual Aluminum (Al)	0.5	-	0.2[3]
Beryllium(Be)	0.0002	-	-
Molibden(Mo)	0.0002	0.07	0.07[4]
Arsenic (As)	0.05	0.01 P	0.01[1]
Nitrates	45.0	50(Nitrate) 3(Nitrite)	10[1] (as N)
Residual Polyacrilamide	2	-	-
Lead (Pb)	0.03	0.01	0.05[1]
Selenium(Se)	0.001	0.01	0.01[1]
Strontium (Sr)	7.0	-	-
Fluorine (F)*	1.5,1.2, 0.7	1.5	0.8[1]

Source: GOST "2874-82", WHO Guideline 1993 and Water Quality Standards in Japan 1993
Note: * depend on climate regions
[1]: Standard items relating to human health
[2]: Standard items relating to acceptability of drinking water to consumers
[3]: Complementary items relating to the comfortableness
[4]: Complementary items to be monitored
P: Provisional values

3) Organoleptical Indicator

Table 5.33 Organoleptical Indicator

Indicator	unit	Uzbekistan Standard	WHO Guideline	WHO Complain	Japan Standard
pH		6.0 - 9.0	-	below 8 is expected	5.8 - 8.6[2] 7.5[3]
Iron (Fe)	mg/l	0.3	-	0.3	0.3[2]
Total Hardness	meq/l (mg/l)	7.0	-	-	(300[2], 10-100[3]) 3.75, 0.125 - 1.25
Manganese (Mn)	mg/l	0.1	0.5 P	-	0.05[1], 0.01[3]
Copper (Cu)	mg/l	1.0	2 P	1	1.0[2]
Polyphosphates residual (PO_4^{3-})	mg/l	3.5	-	-	-
Sulfates (SO_4^{2-})	mg/l	500	-	250	-
Dry Residue, Mineralization	mg/l	1000	-	1,000	500[2]
Chlorides (Cl^-)	mg/l	350	-	250	200[2]
Zinc (Zn)	mg/l	5.0	-	3	1.0[1]

Source: GOST "2874-82", WHO Guideline 1993 and Water Quality Standards in Japan 1993

Note: 1. Concentration of chemicals should not exceed these standards.

2. For the water supplied without special treatment it is allowed that dry residue up to 1,500 mg/l, total Hardness up to 10 meq/l and manganese up to 0.5 mg/l are allowed in accordance with the sanitarium epidemilogic service permission.

3. The sum of the concentrations of chlorides and sulfates, expressed separately in portions of the MACs of each substance, should not exceed 1.

4. With respect to symbols [1], [2], [3], [4] and P, refer to the notes of Table 5.32.

Table 5.34 Required Organoleptical Qualities of Water

Indicator	unit	Uzbekistan Standard	WHO Complain	Japan Standard
Smell at 20℃ and when heating to 60℃	points	2	acceptable	not abnormal
Taste at 20℃	points	2	acceptable	not abnormal
Color	in degree	20	15 TCU	5[2]
Turbidity on standard scale	mg/l (NTU)	1.5	(5)	2[2], 0.1[3]

Source: GOST "2874-82", WHO Guideline 1993 and Water Quality Standards in Japan 1993

Note: 1. In accordance with the sanitarium epidemilogic service permission, color and turbidity (in spring floods) up to 35 and up to 2 mg/l, respectively are allowed.

2. Water should not contain visible organisms and should not have surface membrane.

3. With respect to symbols [1], [2], [3], [4] and P, refer to the notes of the Table 5.32.

4. TCU : true color unit

5. NTU : nephelometric turbidity unit

4) Concentration of chemicals not above-mentioned

Concentration of chemicals not above mentioned should not exceed the MACs adopted by the Ministry of Health of the USSR for the water source for drinking and cultural purposes on organic and toxicological indicator and the radioactive safetiness NRB-76.

If some chemicals are detected regardless of whether or not MAC is exceeded, the sum of the ratios of concentrations of the said chemicals to the corresponding MAC should be greater than 1. The calculation is done using the following formula.

$$\frac{C1}{MAC1} + \frac{C2}{MAC2} + \ldots\ldots + \frac{Cn}{MACn} < 1$$

where: C1, C2, Cn are concentrations of the detected chemicals in mg/l

(2) Example of actual application of drinking water quality standard

Drinking water quality standard is prescribed as stated above. In addition, the following water quality indicators are actually adopted, based on the water quality evaluation by MOH from 1987 to 92.

Table 5.35 Drinking Water Quality Standard (Additional Indicators)

Item	unit	Uzbekistan Standard	WHO Guideline	Japan Standard
Dissolved O_2	mg/ℓ	4	-	-
BOD total	mg/ℓ	3.0	-	-
COD	mg/ℓ	15	-	-
Oil Products	mg/ℓ	0.3	-	-
Phenols	mg/ℓ	0.001	-	0.005[2]
Specific Surfactants	mg/ℓ	0.05	-	0.2[2]
NH_4-N	mg/ℓ	2.0	-	-
NO_2-N	mg/ℓ	1.0	3 (as NO_2)	10 in total
NO_3-N	mg/ℓ	10.0	50 (as NO_3)	
Mercury (Hg)	mg/ℓ	0.005	0.001	0.0005[1]
Silica (Si)	mg/ℓ	30	-	-
Nickel (Ni)	mg/ℓ	0.1	0.02	0.01[4]
Titanium (Ti)	mg/ℓ	0.1	-	-
Cr^{3+}	mg/ℓ	0.5		-
Cr^{6+}	mg/ℓ	0.1		0.05[1]
α-BHC	mg/ℓ	0.02	-	-
Butyphos	mg/ℓ	0.003	-	-
Metaphos	mg/ℓ	0.02	-	-

Source: GOST "2874-82", WHO Guideline 1993 and Water Quality Standards in Japan 1993
Note: With respect to symbols [1], [2], [3], [4] and P, refer to the notes of Table 5.32.

(3) Water Quality Control in the ROU

According to the Water Hygienic Requirements and Quality Control, institutions and organizations responsible for water supply for drinking and technical purposes should always control the water quality at intake points, before water enters water network and inside of pipelines, in accordance with the above mentioned standard.

Laboratory control of the water quality before water enters the water network is enforced for microbiological, chemical and organoleptical indicators in accordance with the standard mentioned above, at the stipulated frequency.

Microbiological control is strictly regulated. When water is treated by chlorine or by oxygen (ozone) the residual clarion and residual ozone in the water network should be monitored at least once in every hour. Concentration of the residual chlorine in water after the reservoirs of treated water should be within the range mentioned below.

Table 5.36 Allowable Concentration of Residual Chlorine in Water Network

(unit : mg/l)

Form of Residual Chlorine	Uzbekistan Standard	WHO Guideline	Japan Standard
Free Chlorine	0.3 - 0.5	5	approximately 1
Combined Chlorine	0.8 - 1.2	(Chlorine)	

Source: GOST "2874-82", WHO Guideline 1993 and Water Quality Standards in Japan 1993

(4) Revision of drinking water quality standard

Presently, drinking water standards in Uzbekistan have been revised by a special task force of the Research Institute of Hygiene and Sanitation, in the Ministry of Health with the target year as 2000. This work shall be pursued and finalized inclusive of domestic information and foreign information such as WHO's guidelines.

5.6.3 Surface Water Quality Standard

Sanitary Rules and Norms for the purpose of protecting surface water against pollution deals with the risk level of 1,345 materials; inorganic and organic substances, chemicals, agro-chemicals, etc. showing limiting indicators of hazardousness (LIH). The risk level is classified as, Extremely High, High, Moderate and Allowable, and wastewater or drain water containing any hazardous material can not be discharged into surface water such as river, canal, lake.

5.6.4 Adopted Standards for Evaluation of Water Quality

Concept of adopted standards for evaluation of water quality in this report is as follows;

1. Basically, the Uzbekistan standards is adopted
2. WHO and Japanese standards are adopted if the Uzbeki standards do not have any standard of indicators of water quality.

The standards adopted for evaluation of water quality are shown in Table 5.37.

Table 5.37 Comparison of Standard of Drinking Water (DW), River Water for Drinking (RW), WHO Guideline for Drinking Water 1993 (WHO) and Drinking Water Standard in Japan 1993 (Japan)

Item	unit	DW	RW	WHO Guideline	Japan Standard	Adopted Standard DW	Adopted Standard RW
I. Microbiological indicator							
Quantity of microorganisms	CFU	100/1 ml		0/100 ml	100 / 1 ml	100/1 ml	
Quantity of E. Coli. (Colifom bacteria)	CFU	3/1 ml		0/100 ml	not to be detected	3/1 ml	
II. Toxicological Indicator							
Al	mg/l	0.5			0.2	0.5	
Be	µg/l	0.2				0.2	
Mo	µg/l	1.2				0.2	
As	µg/l	50	50	10	10	50	50
NH_4^+	mg/l	2	2			2	2
NO_2^-	mg/l	1	3	3	10	1	3
NO_3^-	mg/l	10	10	50	(in total)	10	10
Residual Polyacrilamide	mg/l	2				2	
Pb	mg/l	0.03	0.03	0.01	0.05	0.03	0.03
Se	µg/l	1.0		10	10	1.0	1.0
Sr	mg/l	7.0				7.0	
F* (depend on climate region)	mg/l	1.5, 1.2, 0.7	1.5	1.5	0.8	1.5	1.5
III. Organoleptic Indicator							
pH		6.0 - 9.0			5.8 - 8.6	6.0 - 9.0	6.0 - 9.1
Fe	mg/l	0.3	0.3		0.3	0.3	0.3
Total hardness	meq/l	7.0	7		3.75	7.0	7
Mn	mg/l	0.1		0.5	0.05	0.1	0.1
Cu	mg/l	1.0	1	2	1.0	1.0	1
PO_4^{3-}	mg/l	3.5				3.5	3.5
SO_4^{2-}	mg/l	500	500			500	500
Mineralization	mg/l	1000	1000	1000	500	1000	1000
Cl^-	mg/l	350	350		200	350	350
Zn	mg/l	5.0	1.0		1.0	5.0	1.0

Table 5.37 (Continue)

VI. Organoleptical Qualities of Water to be Required							
Odor		2			not abnormal	2	2
Taste		2			not abnormal	2	2
Color		20		15 TCU	5	20	20
Turbidity	mg/l	1.5	20	5 NTU	2	1.5	20
V. Residual Cl_2							
Free	mg/l	0.3 - 0.5		5	approx. 1	0.3 - 0.5	0.3 - 0.6
Combined	mg/l	0.8 - 1.2				0.8 - 1.2	0.8 - 1.3
VI. Additional Indicator							
COD	mg/l	15	15			15	15
Oil products	mg/l	0.3	0.3			0.3	0.3
Phenol	mg/l	0.001	0.001		0.005	0.001	0.001
Specific Surfactant	mg/l	0.05	0.5		0.2	0.05	0.5
Ni	mg/l	0.1		0.02	0.01	0.1	0.1
α-BHC	µg/l	20	20			20	20
γ-BHC	µg/l	4	4			4	4
VII. Other Indicator							
Ca	mg/l					no standard	no standard
Mg	mg/l					no standard	no standard
HCO_3	mg/l					no standard	no standard
Na + K	mg/l					no standard	no standard
Consumption of Potassium Permanganate($KMnO_4$)	mg/l				3	3	3
Cd	µg/l			3	10	10	10
Cr^{3+}	µg/l	500	500			500	500
Cr^{6+}	µg/l	100	100	500		100	100

5.7 Water Quality Analysis by the JICA Study Team

5.7.1 Analysis Preparation

(1) Instruments and Equipment

Instruments and equipment (for detail, see the Data Book) were brought into Uzbekistan for conducting water quality analysis and for testing treatment performance and distribution facilities in February and March of 1995. The instruments and equipment procured and brought by the JICA are mainly those for analysis of heavy metal and agro-chemicals.

(2) Arrangement for Water Quality Analysis

A meeting was held with the staff involved in sampling, storage, delivery, preparation and analysis of water samples. The goal was to obtain consensus and confirm the methodology.

A lecture and training session for metal analysis on the Atomic Absorption Method and the Gas Chromatography Mass Spectrometer (GC-MS) Method were executed. Also, a lecture and training session for agro-chemical analysis were held.

5.7.2 Sampling and Analysis

(1) Sampling Point

Sampling points (Table 5.38) were set under an agreement with the Uzbekistan side.

Table 5.38 Sampling Points

Cities or water source	Raw water	Treated water	Piping water
Existing sampling points by Uzbeki side in Amu Darya river	Tuyamuyun reservoir, Kaparas reservoir, Druzhba intake, Kipchak, Takhiatash, Kyzyl-Ui	Tuyamuyun-Urgench and Nukus water treatment plants	
Nukus	Kyzketken canal	received water from Tuyamuyun system city water treatment plant	1 point
Urgench	Shavat canal intake Chalysh well	received water from Tuyamuyun system city water treatment plant	1 point
Kungrad	canal intake for city and UrgenchTransgas water treatment plant	treated waters of the two water treatment plant	none
Chimbai	Well	received water from Tuyamuyun, system treated well water	1 point
Khiva			1 point
Muynak	Canal intake	treated water	1 point

(2) Analysis Conditions

1) Water Quality Indicators Analyzed

Water quality indicators (Table 5.39) for analysis were set taking into consideration the pollution sources in the upper reach of the Amu Darya river and the innate water quality of the Amu Darya river.

Table 5.39 Water Quality Indicators Analyzed

	Water Quality Indicators
Basic properties	Odor, Taste, Turbidity, Color, pH, NH_4, COD, Coliform index, Residual Chlorine
Inorganic substances	NO_2, NO_3, SO_4^{2-}, HCO_3^-, PO_4^{3-}, F, Ca, Mg, Oil, Phenols, Surfactant, K+ Ca
Gustatory sensation	Total hardness, Dry residue(Mineralization), Chlorides
Metals	Fe, Cu, Zn, Mn, Pb, Cd, Ni, Cr, Se, As
Agro-chemicals	33 items (indicators are shown in the Tables of the Data Book.) are planned to analyze.

2) Organizations Responsible for Analysis

Indicators excluding metal and agro-chemicals were analyzed by the Uzbekistan side using existing water quality analysis equipment and the standard methods in Uzbekistan. Metal and agro-chemicals were analyzed by the GosSIAK under the guidance of the JICA Study Team using instruments and equipment procured by the JICA Study Team.

3) Analysis Period and Frequency

a) Period : March 1995 - February 1996

Supplementary analysis for the important indicators of mineralization, total hardness, metals and agro-chemicals was conducted up to September 1996.

b) Frequency : once in a month

5.7.3 Results of Water Quality Analysis

Results of water quality analysis are shown in the Data Book together with maximum, average, and minimum values, the number of samples and its graphs.

Analyzed data was compared with the adopted standards (Standard) shown in section 5.6.3 and then was evaluated.

5.7.4 Evaluation of Water Quality Indicators Excluding Agro-chemicals

(1) Water Quality of Tap water, Treated Water and Well Water

The quality of tap water, treated water and well water were analyzed. 16 indicators did not comply with the standards in some points and periods. 14 indicators except taste and odor were evaluated as follows.

1) As

The value at Nukus treatment plan in February exceeded the MAC of 5 μg/l. However all measured values for tap water including Nukus are less than the MAC. No problems should occur.

2) $N\text{-}NH_4^+$

In September, a value greater than 2 mg/l was observed at Muynak. Ammonia nitrogen consumes a large amount of chlorine, therefore, when its concentration increases, the chlorine injection rate in water treatment plants must be carefully controlled.

3) Se

No particularly noticeable trends were observed in seasonal fluctuations, but generally the level of selenium is high. At almost all the measurement locations, the measured value exceeds the MAC of 1 μg/l for most of the month. The MAC of Se of the Uzbeki standard is ten times as low as those of WHO and Japan, 10 μg/l. When the MAC of 10 μg/l is adopted, all values lie within the MAC. Therefore, the JICA Study Team judged Se not to be a problem.

4) Fe

The values measured exceeded the standard of 0.3 mg/l at most of locations during February to August. This means that chlorine treatment and coagro-sedimentation are insufficient. The value of raw water increases especially during June to September at many locations, with instances of the value exceeding 10 mg/l. However, the fluctuations similar to those in turbidity can be observed in Fe, indicating that Fe is included in the inflow soil and mud from the bed. If the coagro-sedimentation is conducted appropriately Fe can removed along with turbidity.

5) Turbidity

The turbidity exceeded the MAC of 1.5 degree during the spring flood season. To decrease turbidity, appropriate coagro-sedimentation is necessary.

6) Mn

The values exceeded the MAC during January to February and the maximum value was 0.276 mg/l at Urgench. When the values of Mn become high, appropriate coagro-sedimentation is necessary.

7) Total Hardness

Total hardness exceeded the standard value for drinking water quality of 7 meq/l at all locations from September to May. Especially, Muynak showed values exceeding the MAC for almost all months. The period exceeding the MAC is almost equivalent to the period of rise in total hardness of raw water. Measures such as softening or use of the Kaparas reservoir must be taken for these periods. These measures are show in the Chapter 8.

8) Dry residue (Mineralization)

The trend of mineralization is similar to that of total hardness. It exceeded the MAC of 1,000 mg/l at almost all location from October to May. As in total hardness, some measures must be taken for these periods. These measures are shown in the Chapter 8.

9) Sulfate ion and Chloride ion

The concentration of both ions have same trend as that of total hardness and mineralization. Compared with them, however, both ions basically comply with the standard. If mineralization is decreased to comply with the standard, both ions follow suit as both are compositions of mineralization.

10) Residual chlorine

Several values did not comply with the standard, especially for treated water, but residual chlorine is judged to be less problematic since the coliforms indicators comply with the standard. However careful control is necessary for residual chlorine.

11) COD and consumption of KMnO4

COD was measured during only two months, both of which exceeded the MAC. The value is almost similar to that of raw water. The values at Nukus, Kungrad and Muynak shows high value. This means the downstream is still polluted by organic substances. The effect of elimination in the treatment process is not observed. Whether the cause is soluble COD or insufficient coagro-sedimentation cannot be identified. Countermeasures to these high concentration are appropriate coagro-sedimentation and activated carbon treatment. At first, appropriate coagro-sedimentation is necessary.

12) Ni

The two values exceeded the MAC in February for tap water and in May for treated water at Kungrad. It is almost no problem since the exceeding frequency is very low and the location is limited. Care should be taken at Kungrad.

(2) Water Quality of Raw Water

The water of Amu Darya river and canals did not comply with the standard of raw water for turbidity, Fe, Mn, total hardness, mineralization, sulfates, chlorides, COD, and KMnO4 same as the water quality of treated water. The other indicators complied with the standard or did not pose any effect since the frequency that does not comply with the standards is considerably low.

5.7.5 Evaluation of Agro-chemicals

Agro chemicals were analyzed by the GC of the Uzbeki side until July 1995 and by GC-MS after August because of the breakdown of GC-MS

Although 26 agro-chemicals in the water were analyzed at first, analysis of many of them were stopped after several months because they were not detected. Agro-chemicals analyzed during almost all months are the following 6 indicators. The other agro-chemicals were not detected so that the analysis was p, p'-DDT, p, p'-DDE, p p'-DDD, α-BHC, β-BHC, γ-BHC,

These 6 agro-chemicals were detected and the other indicators were not detected during the analysis period so evaluation of agro-chemicals in the water is conducted on these 6 indicators.

According to the results of GC analysis as for BHC isomers, β-BHC was detected at more than 1μg/l in five samples between May and July. The highest value was 2.984μg/l. As for DDT compounds, only p,p'- DDE were detected at less than 0.2μg/l mainly in September. The other agro-chemicals were also detected, but at less than 1μg/l.

In addition to GC analysis, gas chromatographic and mass spectrometric (GC-MS) analysis were used for samples taken after August, 1995. In this analysis, agro-chemicals including BHC isomers and DDT compounds were not detected.

The minimum detection limit for GC-MS are higher than GC. By GC analysis, agro-chemicals are determined only by the retention time. As a result, if the retention time of the other agro-chemicals is incidentally the same as that of the specified agro-chemicals, the other agro-chemicals are judged as the specified agro-chemicals.

The minimum detection limits for GC-MS are set at 1μg/l, lower than WHO guideline for drinking water in 1993 (where allowable limits for γ-BHC and DDT are set at 1μg/l). Samples of more than 1μg/l in β-BHC may contain collector drain water. However, judging from 1) allowable daily limit of β-BHC per day is considered the same as of γ-BHC and 2) only one sample exceeds 2μg/l (maximum allowable concentration of γ-BHC in WHO guideline) at Kyzyl-Ui in June, agro-chemicals are considered not to pose any serious effect on water.

Nonetheless, agro-chemicals should continue to be monitored by GC-MS analysis because the may be drained into the Amu Darya river, particularly in summer. β-BHC was detected, between May and July, at more than 1μg/l in the five samples.

5.7.6 Removal Characteristics of Flat Film Cell

For the preparation of introduction of a membrane filter facility in future plan to remove mineralization and agro-chemicals, preliminary testing by batch cell was conducted. Testing batch cell of flat films were done by reverse osmosis type synthesized polymer (thin film composite) membrane (NTR-729HF, NTR-759HR, NTR-7250, NTR-7410 and NTR-7450) with water samples taken in October. Analyzed data are shown in the Data Book.

Results of test, the NTR-759HR membrane had the highest removal efficiency of total hardness, mineralization, chloride ion and sulfate ion in tested membranes, and NTR-729HF was the second best. The features of these membranes are for low pressure and high flux, the main usage is desalination of river water, brackish water and sewage purified with advanced waste treatment.

On pesticides, the result of α-BHC by gas-chromatography (GC) analysis was showed that NTR-7250 had the highest removal efficiency, NTR-729HF and NTR-759HR were the second best. The NTR-7250 is for low pressure and high flux as NTR-729HF and NTR-759HR, the main usage is concentration and refining of amino acids and sugars.

The results of these tests were suggested that NTR-729HF, NTR-759HR and NTR-7250 have the high removal efficiency of minerals and pesticides, but charged membranes (NTR-7410 and NTR-7450) can not remove these components.

5.8 Conclusions of Water Sources and Water Quality

The Amu Darya river gets polluted from Termez due to waste water discharge from industrial enterprises, utilities, and collector discharge, which is highly polluted by mineralization after washing out surface soil of irrigated land. During last few decades, the Amu Darya river quality deteriorated drastically because of irrigated land development.

Drinking water sources of the Study Area are composed of the Amu Darya river main stream, irrigation canals drawn from main stream of the Amu Darya river and groundwater. The latter two sources are interconnected with main stream directly or indirectly so that their quality of water affects main stream.

According to the results of water quality analysis by the JICA Study Team, the Amu Darya river water did not comply with the standards of raw water for drinking water for turbidity, Fe, Mn, total hardness, mineralization, sulfates, chlorides, COD, and $KMnO_4$. The other indicators complied with the standard or did not pose any effect as the frequency that does not complies with the standard is considerably low. Agro-chemicals were not detected at the levels to pose any effect on drinking water quality.

The quality of groundwater, which is closely connected to the irrigation canals, has deteriorated as the quality of the river water and the canal water has decreased. Technology for artificial replenishment of groundwater sources has been developed and successfully implemented. After the collapse of the Soviet Union, however, the operation and maintenance of water intake from wells deteriorated drastically due to shortages in finance and engineers. Consequently, the quality of water in wells seems to have deteriorated recently. In the Six Study Cities, Urgench and Chimbai have substantial ground water resources, although they are currently supplied from the Tuyamuyun water pipeline.

According to the analysis of the treated water and tap water by the JICA Study Team, 7 indicators of turbidity, Fe, Mn, total hardness, mineralization, COD, and KMnO4 do not comply with the standards. Fe and Mn together with turbidity can be decreased by appropriate coagro-sedimentation. High concentrations of COD and KMnO4, which show high values at Kungrad and Muynak, indicate pollution by organic substances. These substances can be removed by appropriate coagro-sedimentation to some degree and an activated carbon treatment. At first, these should be removed by appropriate coagro-sedimentation. Consequently, only two indicators, total hardness and mineralization will not comply with the drinking water standard and pose effect to the drinking water quality, even if appropriate coagro-sedimentation is conducted.

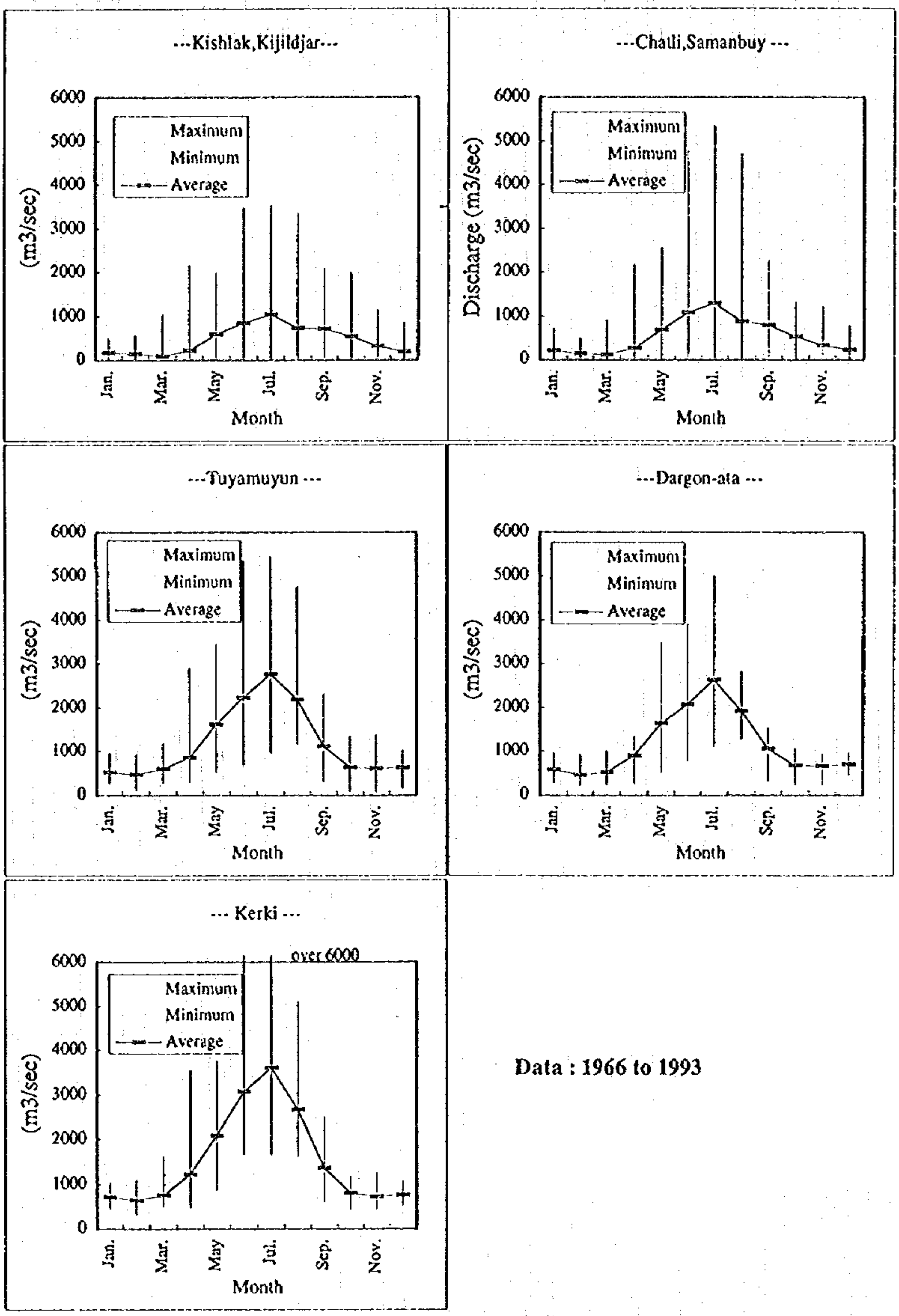
The JICA Study Team forecasts the mineralization concentration at the Tuyamuyun Hydro-unit and Sumanbay in the drought and low water flow rate of the Amu Darya river. The results show mineralization complies with the standard during June to August at the Tuyamuyun Hydro-unit and during July and August at Sumanbay. For the other months, total hardness and mineralization should be reduced by desalinization treatment or the countermeasure that stores good quality water of the Amu Darya river in a reservoir during summer season.

According to the Tuyamuyun Water Supply Master Plan, Kaparas reservoir is planned to use for storing good quality water during the flood season of the Amu Darya river. Under the recommended operation mode of filling during June or July to September and supplying raw water during the rest of the year, quality and quantity of the stored water in the Kaparas reservoir are studied and the potential of the reservoir as domestic and drinking water source was evaluated as below.

Under the recommended operation mode of the Kaparas reservoir, mineralization concentration is anticipated to be below the MAC but total hardness exceeds the MAC during the latter several months of reserved period when leached salt from the reservoir bed and evaporation are considered based on the forecast by the SANIIRI. For further improvement in water quality, especially in total hardness, it is necessary to terminate partially or completely collectors in the mid-stream part of the Amu Darya river during the filling period

Under the current operation mode of the TMHU reservoirs, effective volume of 260 mil. m^3 corresponding to the water level of 123 m can be stored on an average. This volume meets the target water demand for the rescheduled plan in the Feasibility Study part of this report (Part II). However, further detailed study is necessary for more accurate forecast of water quality and possible stored water volume with the discharge rate of the Amu Darya river in drought or low water year.

Fig. 5.1 Monthly Discharge Variation



Data : 1966 to 1993

Fig. 5.2 Yearly Discharge Variation

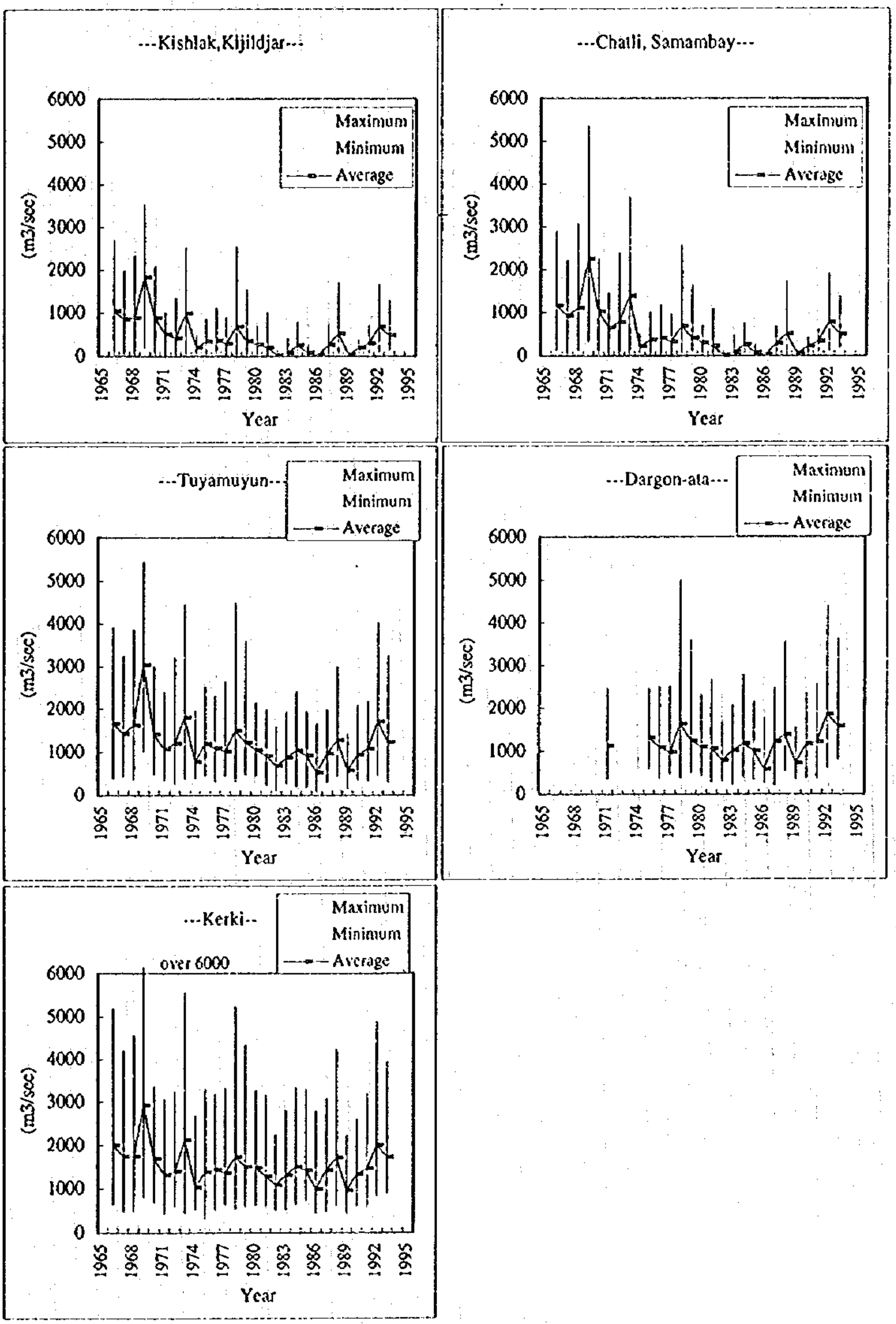


Fig.5.3-(a) Outflow Rate of Canal to AmuDarya River by Section

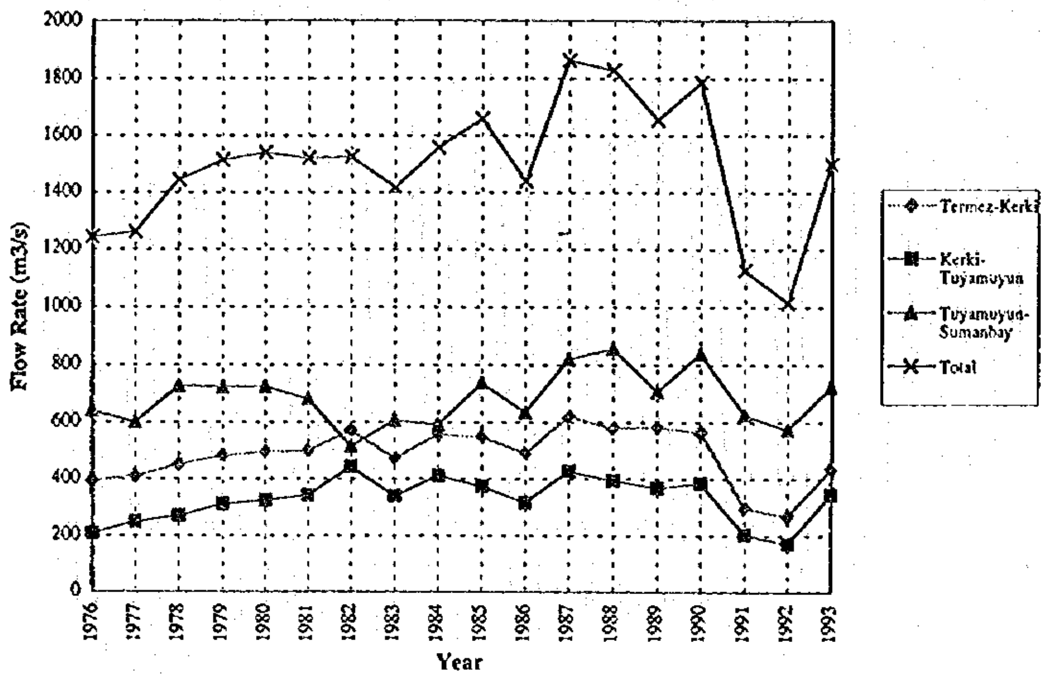


Fig.5.3-(b) Inflow Rate of Collector Drain to AmuDarya River by Section

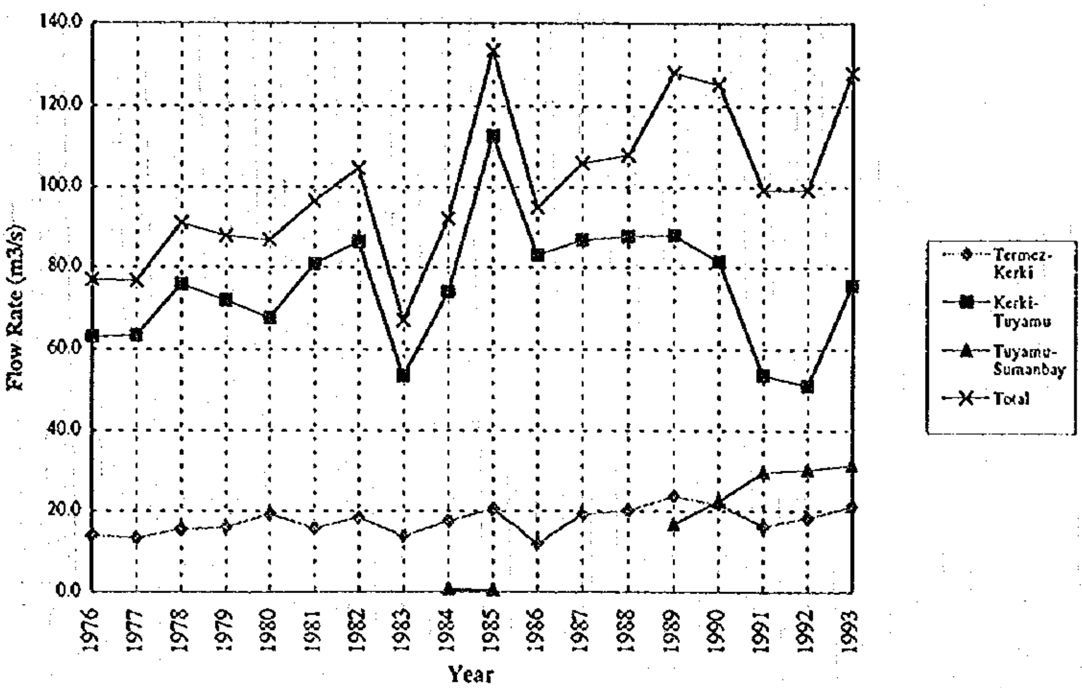


Fig.5.4-(a) Average Inflow Rate of Canal to AmuDarya River from 1976 to 1993 by Section

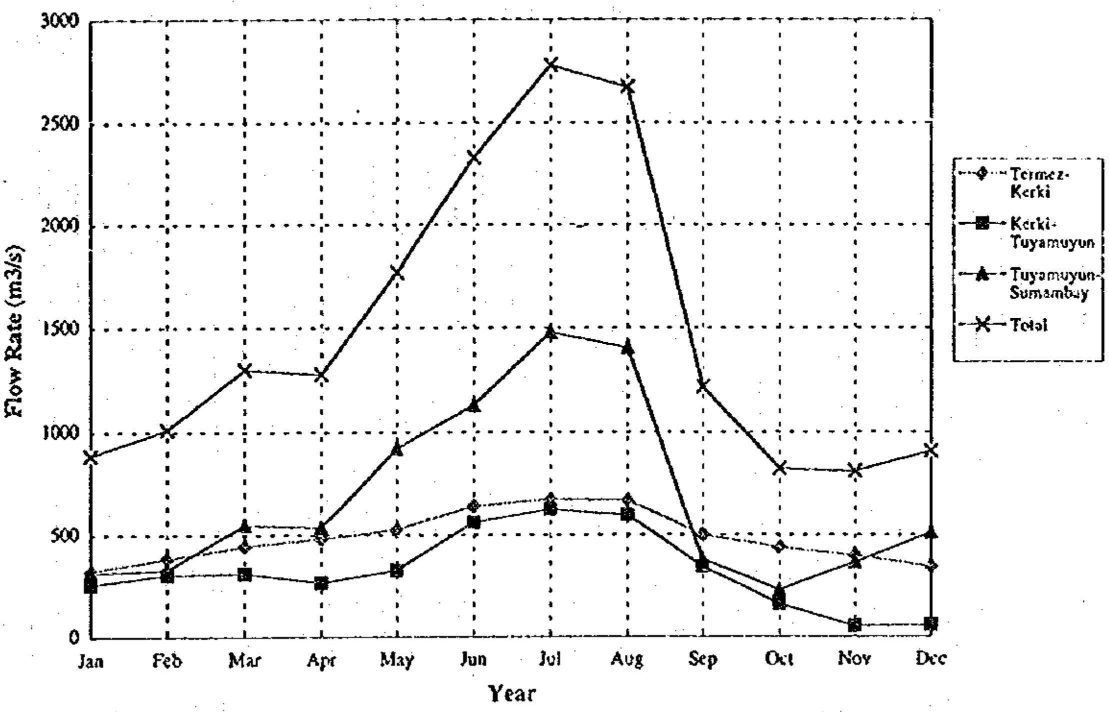


Fig.5.4-(b) Average Outflow Rate of Collector Drain to AmuDarya River from 1976 to 1993 by Section

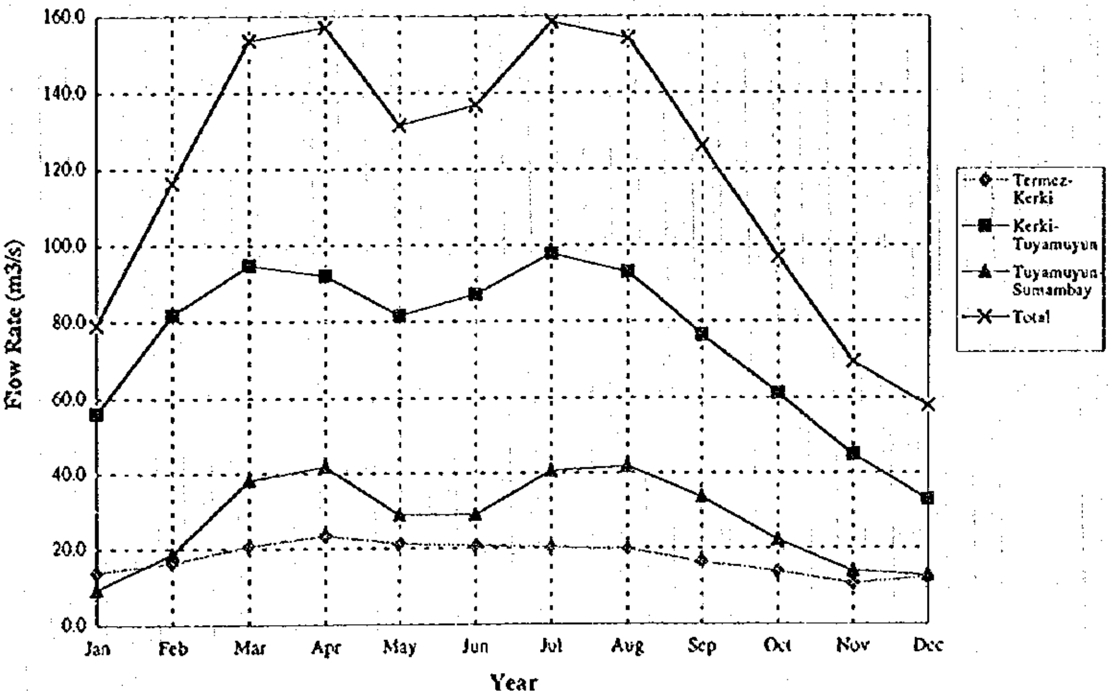


Fig.5.5-(a) Trend of Average Mineralization of Major Collector Drains by Section

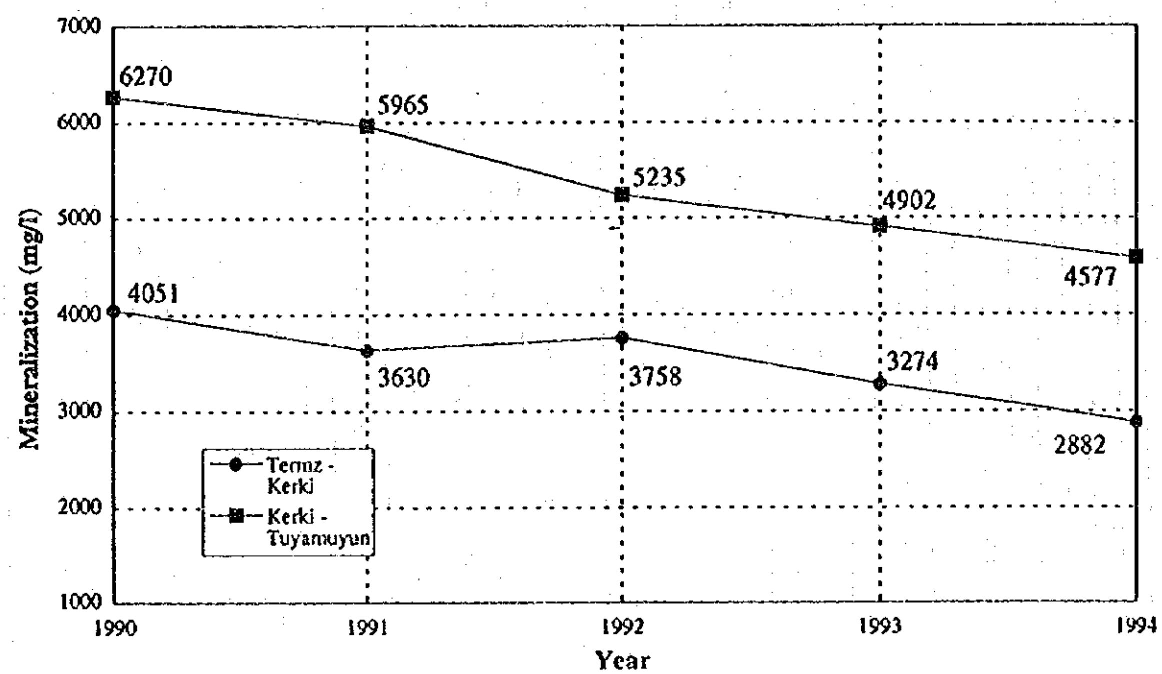


Fig.5.5-(b) Annual Total Mineralization Volume by Section

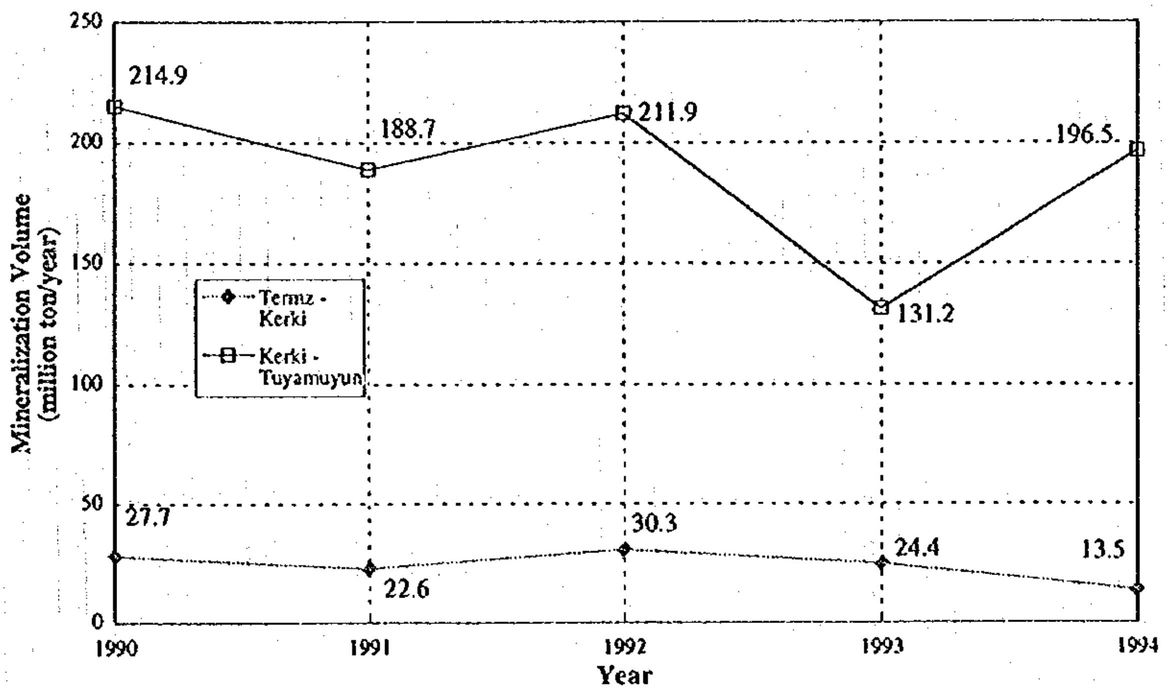


Fig.5.6-(a) Monthly Mineralization Trend by Section of Major Collector Drains

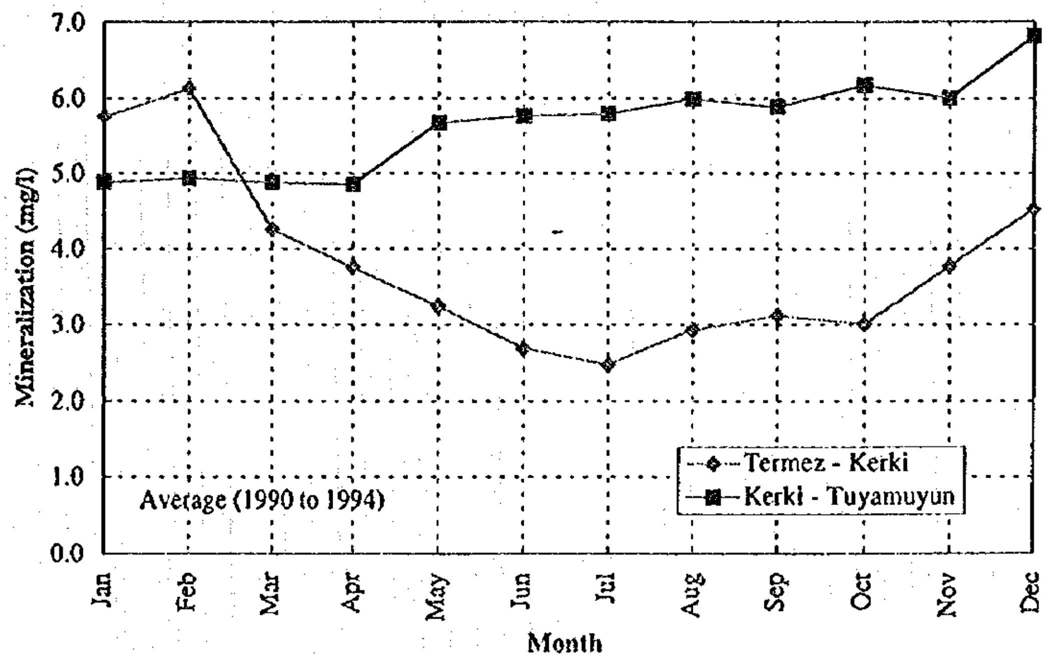


Fig.5.6-(b) Monthly Total Mineralization Volumeby Section of Major Collector Drains

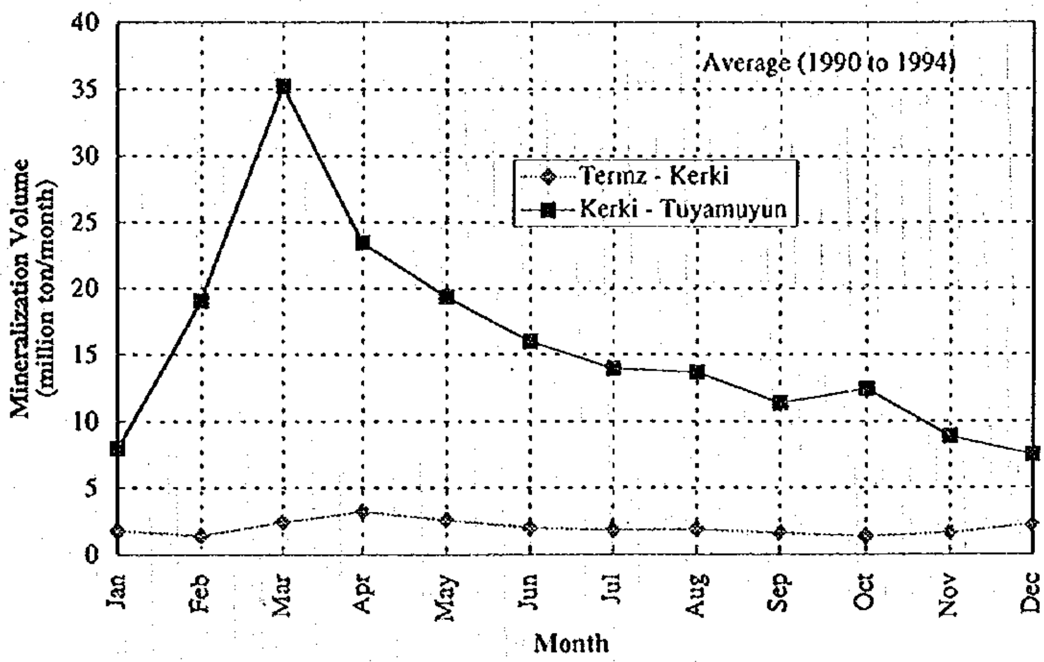
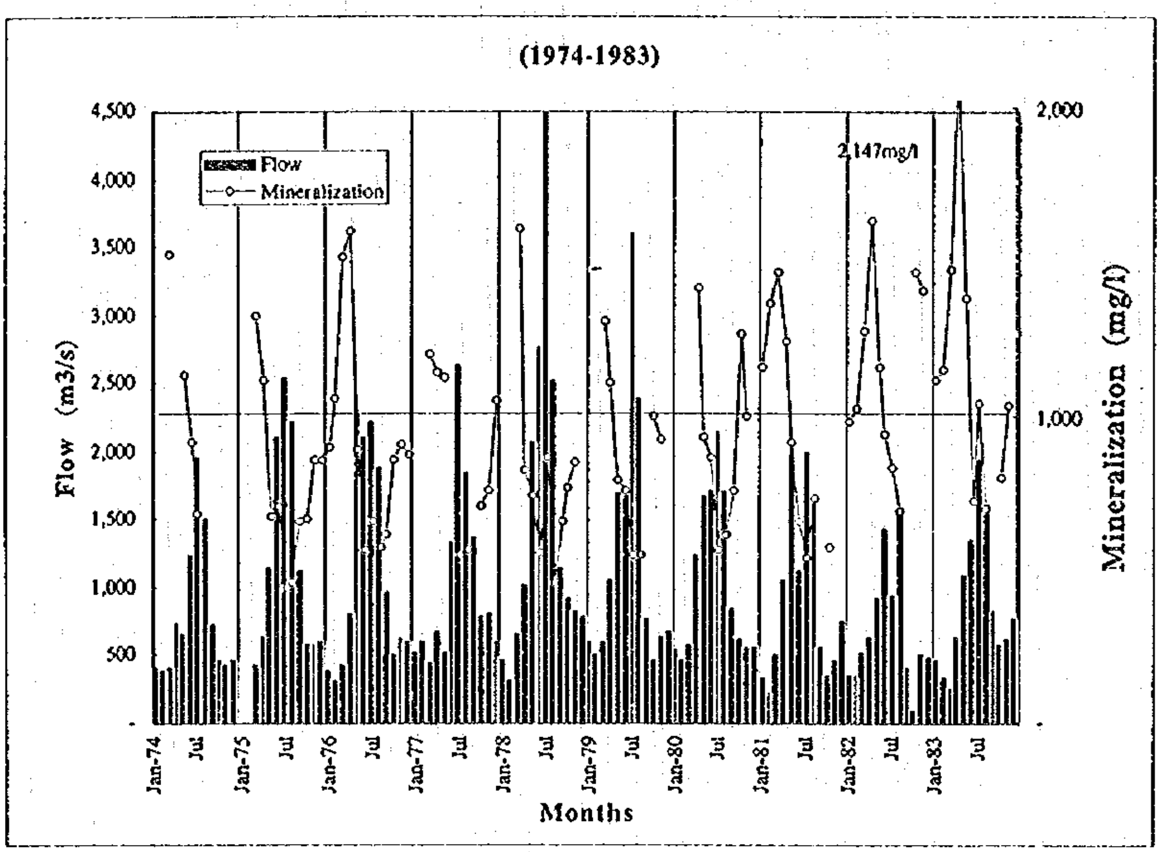


Fig. 5.7-(a) Flow and Mineralization in Amu Darya River at Tuyamuyun Gorge (1974 - 1993)



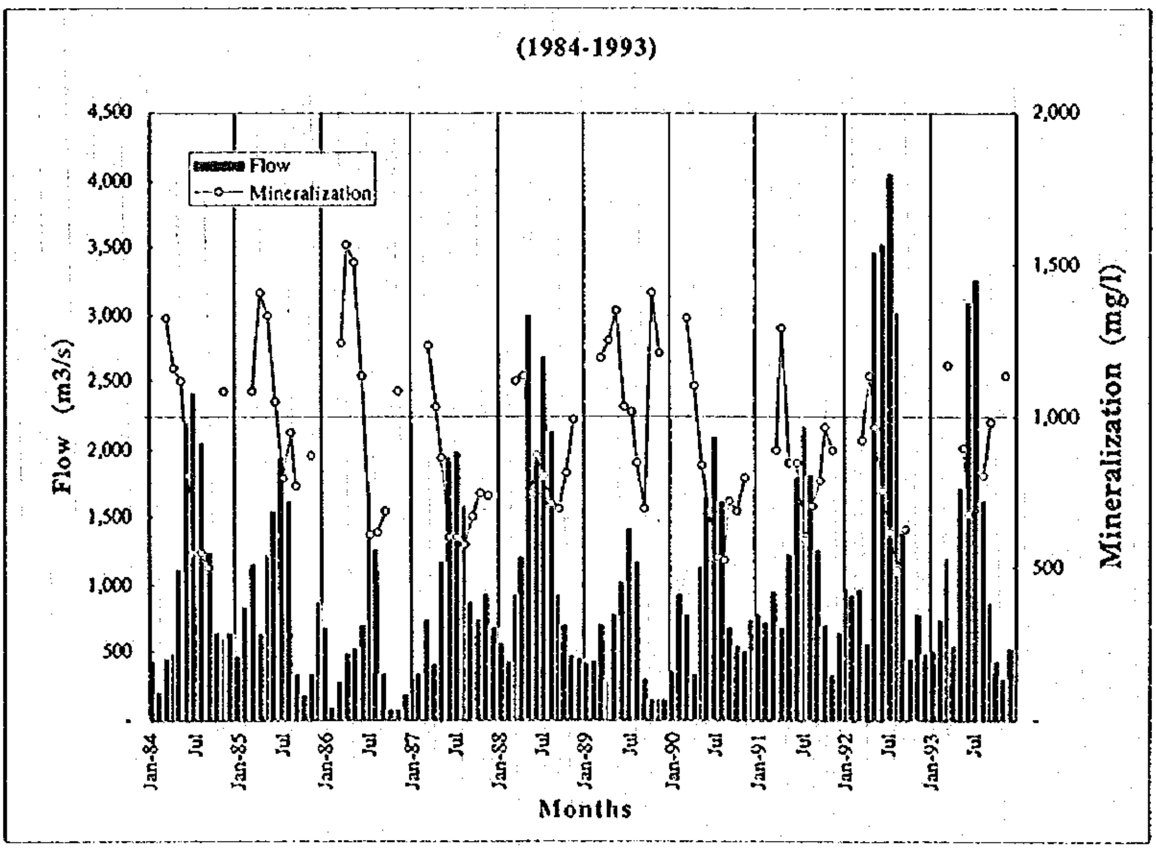


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Fig. 5.7-(b) Flow and Total Hardness in Amu Darya River at Tuyamuyun Gorge (1974 - 1993)

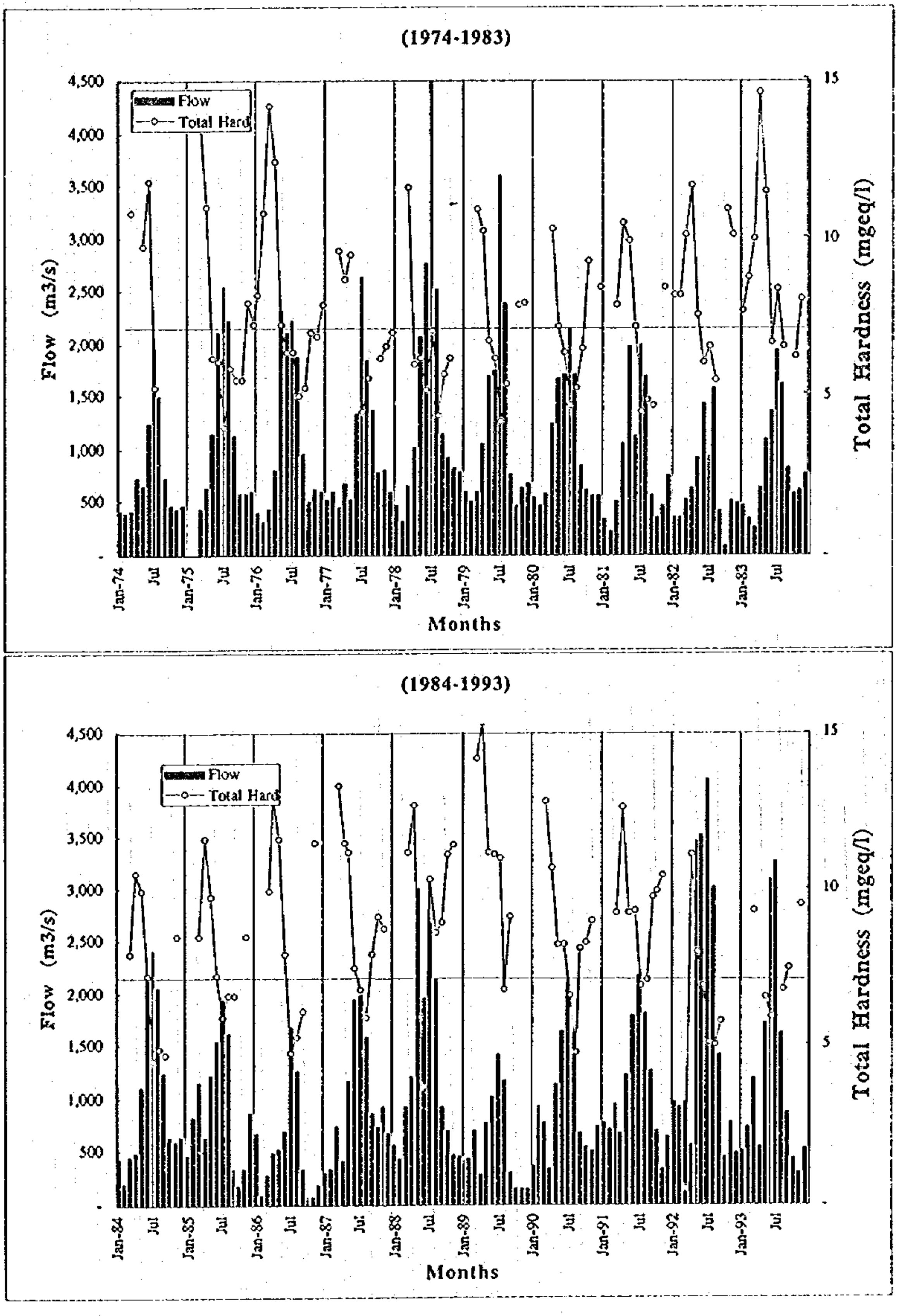
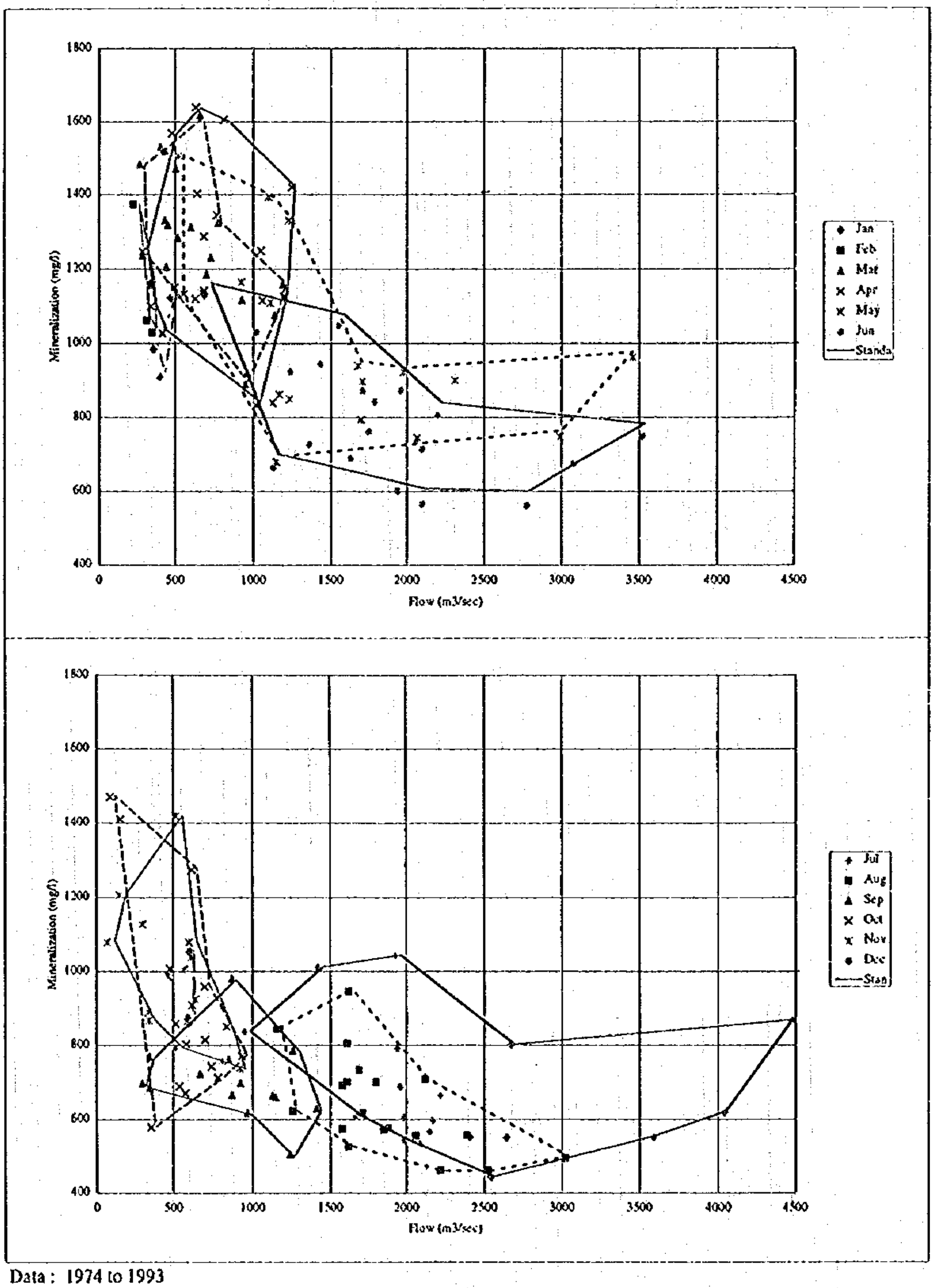
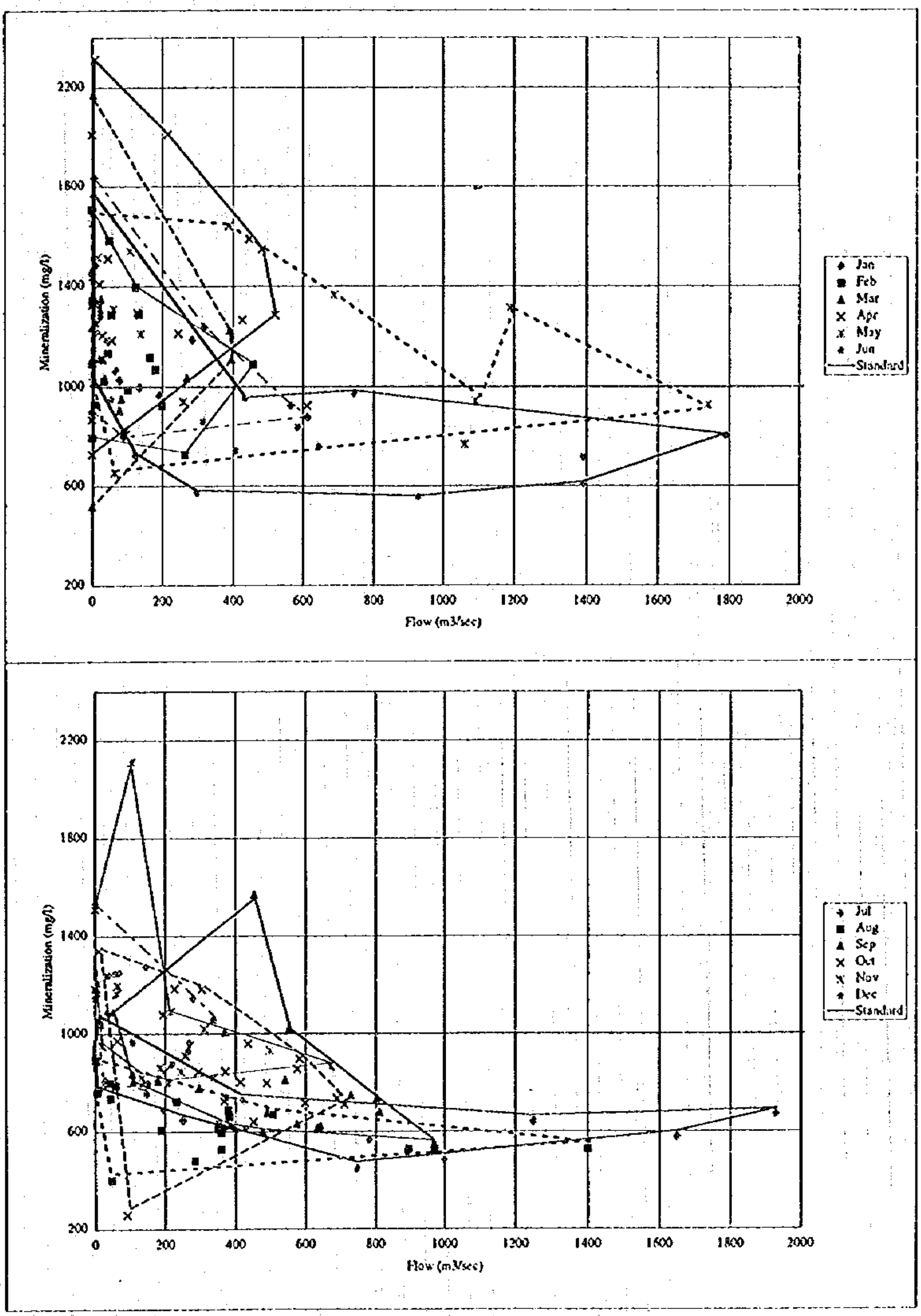


Fig. 5.8-(a) Relationship between Mineralization and Discharge Rate of AmuDarya river at Tuyamuyun Gorge

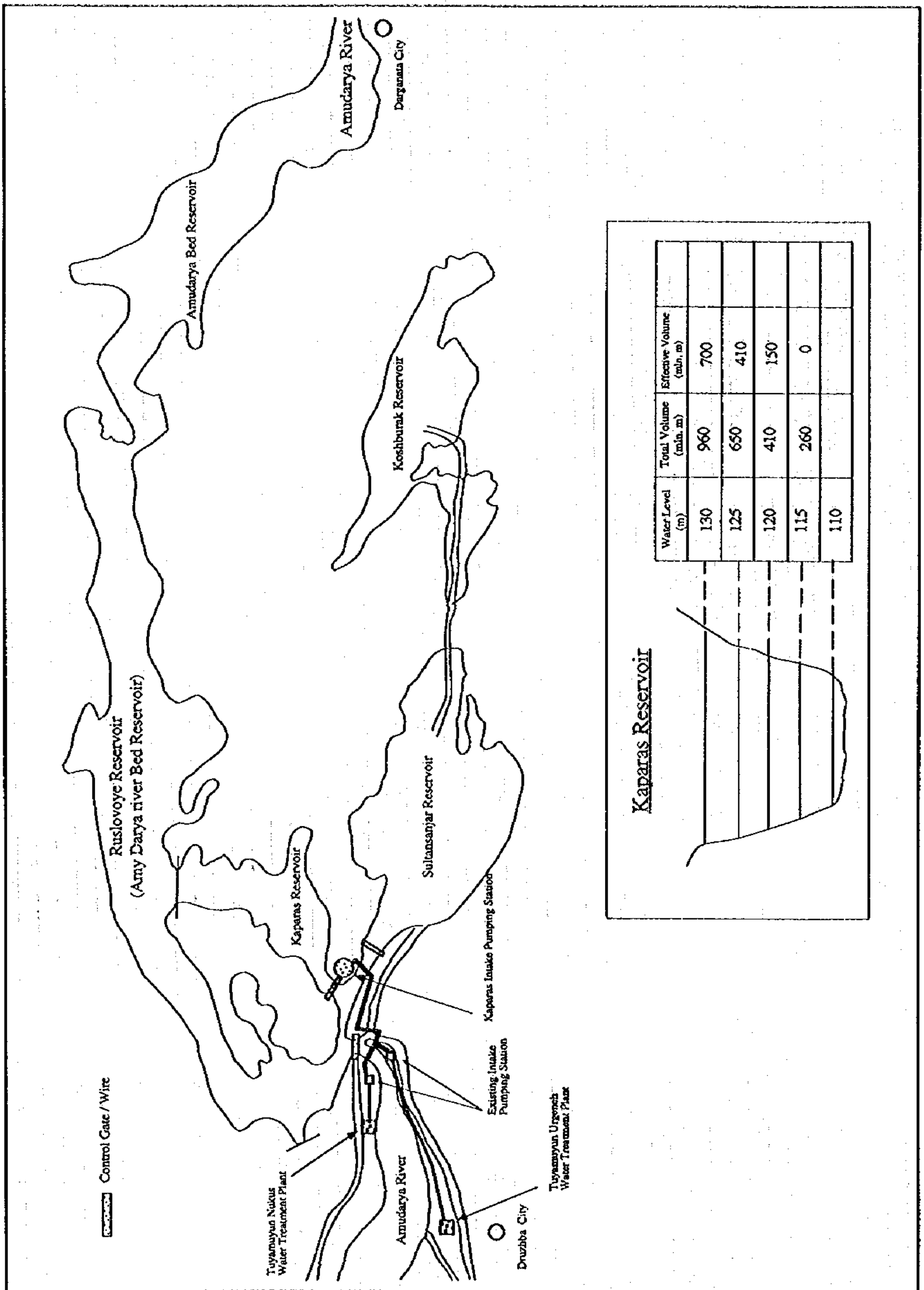


Data : 1974 to 1993

Fig. 5.8-(b) Relationship between Mineralization and Discharge Rate of AmuDarya river at Sumambay



Data: 1974 to 1993



Water Level (m)	Total Volume (mln. m)	Effective Volume (mln. m)
130	960	700
125	650	410
120	410	150
115	260	0
110		

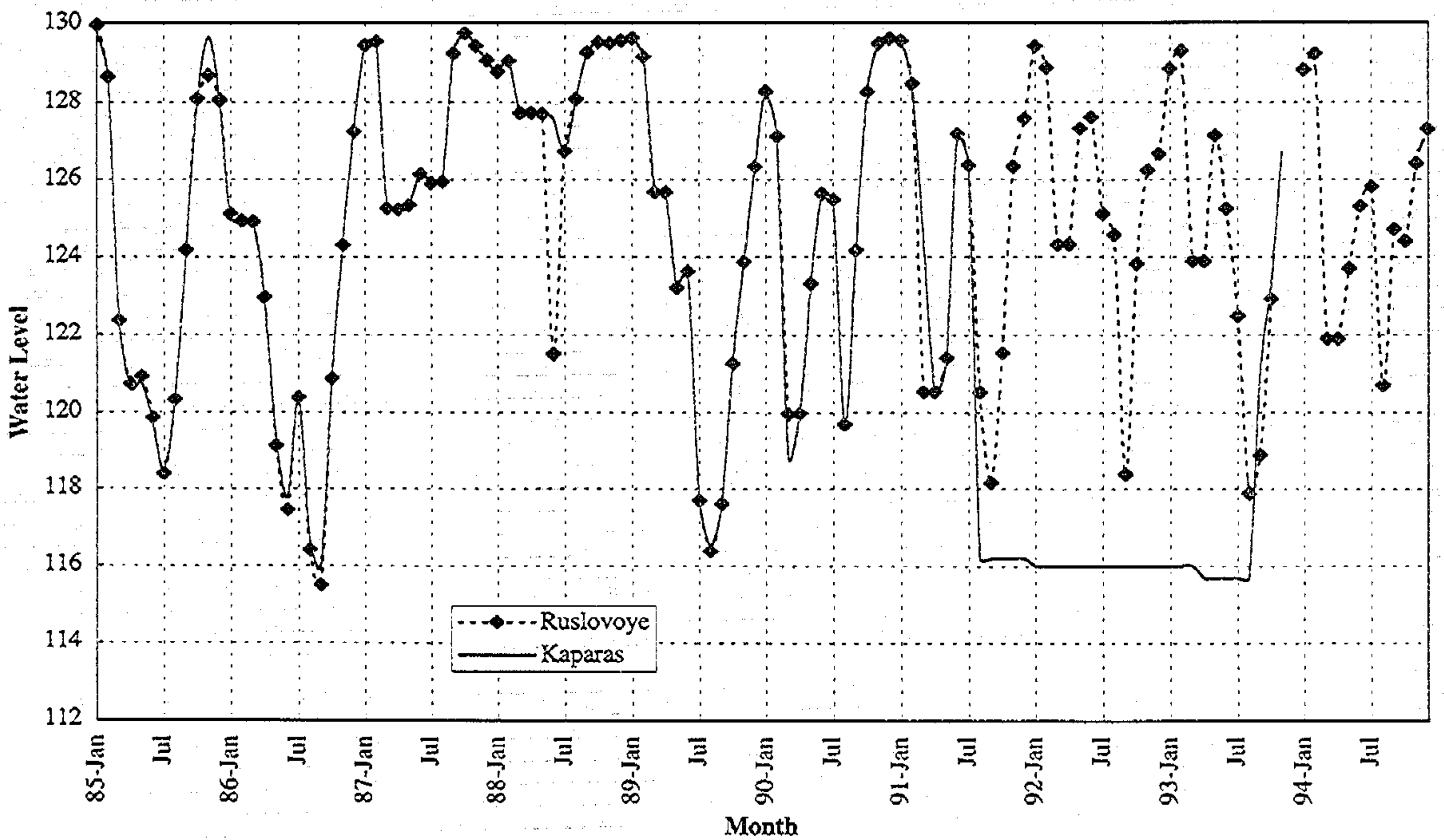
THE STUDY ON
WATER SUPPLY SYSTEM IN SIX CITIES OF
THE ARAL SEA REGION IN UZBEKISTAN

JAPAN INTERNATIONAL COOPERATION AGENCY

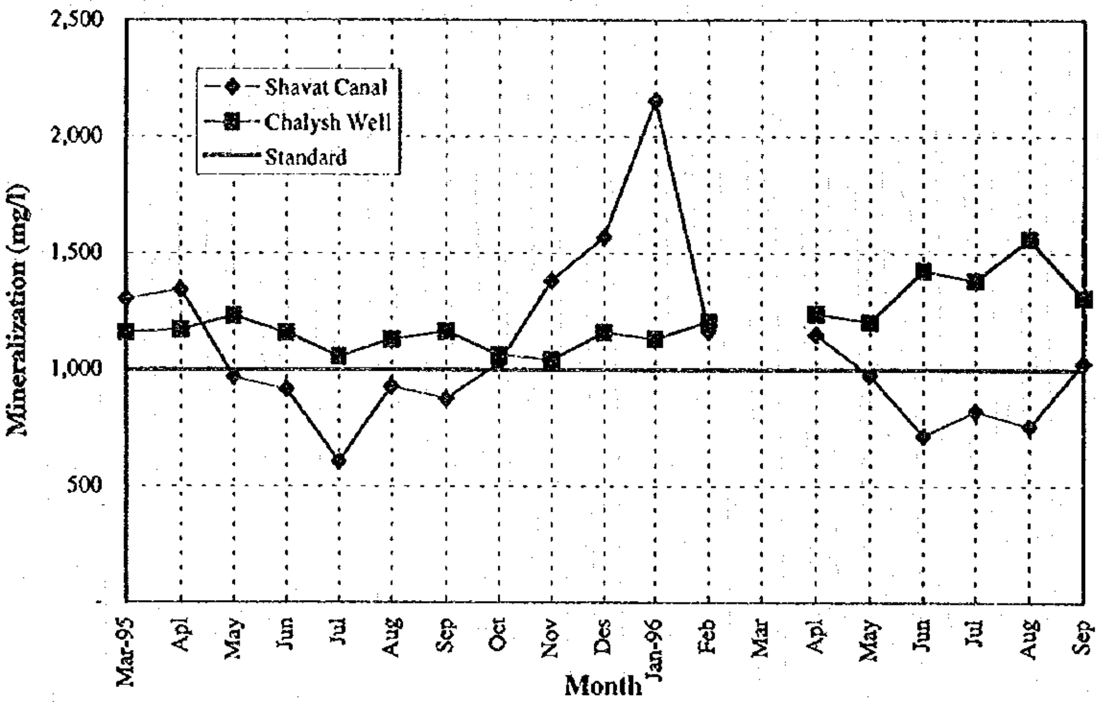
Fig. 5.9
Tuyamuyun Hydro Unit

B/P

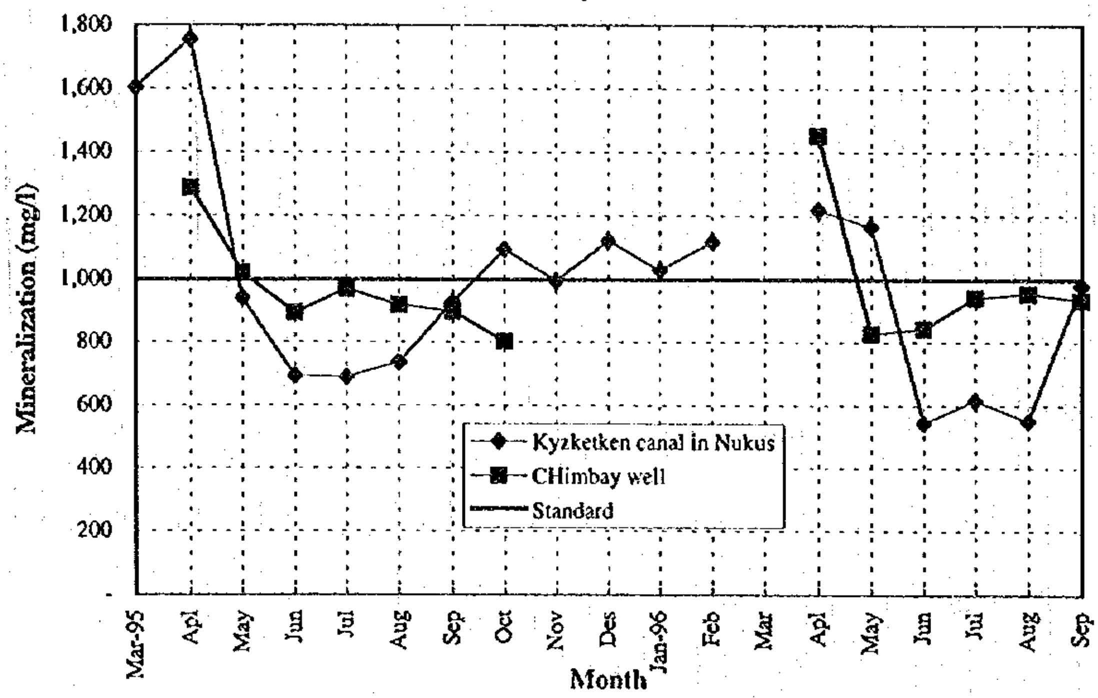
Fig. 5.10 Average Monthly Water Levels of Ruslovoye and Kaparas Reservoir



Fig, 5.11 Monthly Mineralization Concentration of Canal and Well in Urgench



Fig, 5.12 Monthly Mineralization Concentration of Kzketken Canal and Chimbay Well



Source: Data Measured by the JICA Study Team and GosSIAK

CHAPTER 6

INSTITUTIONAL AND ORGANIZATIONAL ASPECTS

B/P

CHAPTER 6 INSTITUTIONAL AND ORGANIZATIONAL ASPECTS

6.1 Global Trend in Water Supply Policies, Institution and Systems

6.1.1 General

In the last five decades, over 100 countries have emerged as sovereign states and their economic, social and political development has become a major goal of the international community. Though many of them have passed through the process of industrialization to different degrees, many basic development problems still remain unsolved.

Water Supply and Sanitation Sector (WS&SS) has been one of the most important sectors for development - a process resulting at least in improved health and longevity, higher living standards and productivity, enhanced local problem solving capacity and increased access to essential commodities and services. The United Nation's International Decade for Drinking Water Supply & Sanitation (1981-90) declared with the goal to avail "Water & Sanitation for all by 1990" has lead to worldwide concentrated development efforts towards upgrading the WS&SS. The Decade's campaign had encouraged the nations to put their resources into installing facilities but with little attention given to human behavior and institutional needs. Experiences of such efforts have shown that long-term success of the WS&SS was dependent on good planning, supportive policies, strong community participation, and adequate financing with emphasis stressed upon areas of community participation, policy dialogue, financing and management, training, institutional and human resources development. Traditions of governmental responsibilities and policy formulation and implementation also play a key role. Administrative systems may require changes so that the government can rationally and objectively develop and implement policies, plans, programs and projects. Sustainable development of the WS&SS provokes change in how authority and responsibilities are distributed and technologies are disseminated.

While the donor's role is to assist, the responsibility for development ultimately belongs to the recipient nation. Partnership among donors, governments and NGOs help empower individuals and communities, and increase accountability of governmental and non-governmental institutions to the people they serve. The global trend in development and technical assistance is therefore to lay emphasis on institution strengthening and capability building of the authorities and agencies responsible for the Sector.

6.1.2 Basic Principles/Criteria for Service Delivery in the Water Supply Sector

Ultimate objective in water supply sector is to provide a service to the satisfaction of the customers assuring stable and adequate supply of water that meets the required quality standards at reasonable price. To provide a satisfactory service efficiently and with the lowest possible and necessary financial, administrative and technical input at attractive prices, the water supply authorities, must essentially be supported with well set government policies and systems, legislation, strategic planning, funds and clearly defined institutional responsibilities. Besides, they need authority with reasonable flexibility to function effectively without being confronted with rigid civil and administrative rules and conditions. Appropriate inputs by all institutions responsible for sector governance, service delivery and service support at both national and local levels must be guaranteed besides maximum coordination and interaction among them.

Some basic principles/criteria for better service delivery in the sector are listed below;

1) Accountability must be established,
   a) of the government for;
      - national policy and strategic planning on water management and water supply,
      - legislation and regulation development,
      - planning and control of national water resources, and funding on their development, protection and conservation as well,
      - planning and development of institutions and systems,
      - planning , development and funding of national infrastructures,
      - necessary sector support
   b) of the regional/local governments for;
      - implementing the government policies and plans
      - planning and development of institutions and systems,
      - planning, development and funding of local infrastructures,
      - necessary sector support.
2) Financial Viability of all service delivery systems should be targeted by operating them on self-financing/commercial basis with gradual reduction in subsidies granted.
3) Sound Management of each individual institution in a cost conscious manner must be established.

4) Measurable Performance

Inputs and performance of functions by the institutions within the mandated authority and responsibility/ies must be measurable and accountable.

6.2 Goals and Objectives of the Water Supply Sector in the ROU

6.2.1 Overall Goals Set Out for Government Operations

A major policy goal set out by the Government of the ROU after its independence is the shifting to the market economy. To achieve this goal, the government has established a series of specific objectives focusing on;

* formulation of systems for legislative and organizational aspects to facilitate administrative decentralization and increased level of public participation,
* promoting decentralization of executive-administrative functions of the government,
* reorganization and decentralization of ministries, central departments and public institutions in order to achieve efficiency and rationalization of functions,
* promoting privatization and increased participation of private sector in the appropriate sectors.

Accordingly, proceeding from the need to consolidate executive power in the conditions of transition to the market economy, the Supreme Council of the ROU has enacted legislation to establish in the provinces, districts and cities of the ROU posts of Khokims who will serve as heads of local representative and executive-administrative authorities. The ministries, state committees and central departments were reorganized and decentralized with delegation of authority to prevent/minimize duplication and overlapping of functions of different departments. Decentralized functional departments were subordinated to the respective Khokimiat. Service or production departments were reorganized for them to operate as commercially oriented self supported enterprises.

6.2.2 Overall Goals Set Out in the Water Management Sector

Legislation has been formulated on water management and water usage with the following objectives;

* regulation of water relations,
* rational utilization of water resources for the needs of both population and national economy,

* protection of water resources against pollution, contamination and deterioration,
* prevention and elimination of harmful impact on the waters,
* improvement of conditions of water bodies/objects,
* protection of rights and responsibilities of enterprises, agencies and offices of farms and individuals as regards to water relations.

6.2.3 Overall Goals Set Out in the Public Water Supply Sector

Public water supply falls under the public utilities for which the Ministry of Public utilities is responsible. Various resolutions have been passed and decrees, directives and guidelines have been issued identifying the following among the overall goals;

* Reorganization of the activities of the MPU of the ROU aimed at improvement in management of public utilities in the country, and staged conversion of public utility services on self supported basis,
* Establishing standards and legal basis for staged conversion of public utilities payment system towards a self-repayment system, but in line with the measures aimed at social protection of the population in the form of purposive subsidies for partial cover of public utility service expenses,
* Stage by stage reduction of state subsidies on the financing of public utilities expenses,
* Giving mandate to the Council of Ministers of the ROK, Regional Khokimiats and Tashkent City Khokimiat to approve the consumption limits and tariff of public utilities within their respective territories,
* Gradual and complete shifting from the existing system whereby the population pay for water and sewerage services according to estimated water consumption rations, to a system of payment for actual consumption based on water meter readings.
* Taking measures to increase responsibility of the heads of public utility enterprises in order to ensure timely settlement of payments by consumers for services provided.

As evident from these goals, introduction of market economy policies has positively contributed the ROU to fall in line with the global trends in water sector development and service delivery. The changes and progress made towards achieving the goals in the water supply sector are encouraging in the light of factors such as; severe economic crisis the country had to face soon after its independence, sudden shift in policies and logistical difficulties in the overall system in adjusting to the required changes etc. Such factors that influence the intended progress in the implementation of sector policies can not therefore be ignored in making future improvements through institutional and managerial strengthening, policy considerations etc.

6.3 History and Development of Water Supply Policies and Systems

In Uzbekistan, policies and systems in the water supply sector have been originally developed by the central administrative organ of the FSU. After gaining independence, the government of the ROU has revised/replaced them where necessary to suit the new socioeconomic policies of the country. In the FSU, management of the interstate river waters for common use by member republics was determined in Moscow. But now the concerned states collectively make necessary adjustments in the policies regarding the rational use of interstate river water sources common to them, and to take necessary measures to protect the resources from pollution and contamination.

The national policies on water management and water rights are learnt to have evolved over the past two thousand years, with minor modifications done from time to time to adjust with the changing political and socioeconomic climate. The limited resources of surface water, mostly dependent on two interstate rivers which themselves are regulated by interstate bodies, are managed by the Ministry of Melioration and Water Management (MM&WM) which is responsible for overall management of water in the ROU. Exploitation of ground water resources is managed by the State Committee for Geology and Mineral Resources (SCGMR).
The policies on water management and allocation of water to the different branches of the economy are determined and guided by the legislative acts of the government. The policy on the rights of water use determines the priorities in the order of; public drinking water supply, industrial water supply, agricultural and irrigation water supply. This indicates the priority and importance given to domestic water by the government which has set in its policy a target to have all citizens accessible to safe and stable drinking water supply by year 2010. Taking into account of prevailing socioeconomic conditions, for the time being, tariff is kept comparatively low on domestic water, along with some state subsidies for social protection of the population, to ensure availability of potable water to the people at affordable prices.

6.4 Legislations Related to Water Supply

6.4.1 Basic Concepts on Public Water Supply

By law, the entire responsibility of public water supply rests with the State and therefore, the government's responsibilities and obligations are performed through the various state agencies discussed in Section 6.5. Though the overall supervisory responsibilities remain with the central ministries, decentralization of services have been effected recently to achieve improvements in the level of service and management at regional level. Through reorganization by shifting some responsibilities from the center to the regional administration and local bodies, it is targeted to have the local public water supply agencies that serve urban areas and regional centers operate as commercially oriented and self-supported enterprises. However, water supply being considered as an essential communal service, privatization of this sector was not considered until by a new decree in August 1995, infrastructure for water supply and sewerage were added to the list of facilities and enterprises which can be privatized subject to the decision of the Cabinet of Ministers.

6.4.2 Fundamental Acts and Laws on Water Supply

Some of the important laws, regulations, decrees and other legislative documents and standards etc., pertaining to water supply sector in the ROU are listed in Table 6.1.

Table 6.1 Some Important Acts, Laws, Regulations, Decrees, Standards etc., Related to Water Supply Sector

Government	
1	**The Constitution of the Republic of Uzbekistan-December 8, 1992** - Stipulates: Administrative and Territorial Structure and State System (Part IV), Organization of State Authority (Part V), Citizens' duty to protect environment (Art.50), Natural resources shall be rationally used and protected by the State (Art.55).
Water Management	
2	**The Law of the Republic of Uzbekistan on Water and Utilization of Water Use-June 12, 1993** - Dictates on management and use of water resources.
3	**The Decree (No.385 dated 3rd August1993) of the Government of Uzbekistan on Limited Water Use-August 3, 1993** - Dictates rational use of water resources.
Nature Protection/Sanitation	
4	**Law of the Republic of Uzbekistan on Protection of Nature**
5	**Standard Regulations for State Basin (Territorial) Inspectorate for Regulation of Use and Protection of Waters.**
6	**Sanitary Rules and Standards for the Protection of Surface**
7	**Rules on the State Committee for Nature Protection of Uzbekistan.**
8	**Law of the Republic of Uzbekistan "On the State Sanitary Inspection"-July 3, 1992**
9	**State Standard 2761-84 Sources of the Centralized Drinking and Service Water Supply- Sanitary, Technical Requirements and Rules of Selection of Water Intake Collectors.**
10	**Government Standards on Drinking Water, Hygienic Requirements and Quality Control-Gost-2874-82.-October 18, 1982**

Institutional/Organizational

11 Rules on the State Committee for Nature Protection of Uzbekistan

12 Law of the Republic of Uzbekistan "On the Reorganization of the Local Authorities of the Republic of Uzbekistan"-January 4, 1992

13 The Decree of the President of the Republic of Uzbekistan About Improvement in Management of Public Utilities in the Republic of Uzbekistan

14 Resolution No.371 of the Cabinet of Ministers of the Republic of Uzbekistan Regarding the Issues of Organization and Activities of the Ministry of Public Utilities of the Republic of Uzbekistan-July 22, 1993 - Suggests typical organization structure of the MPU of the ROU and enterprises under it

15 The Decree No. 307/XII of the Chairman of the Supreme Council of the Republic of Karakalpakstan in Regarding the Issues of Organization and Activities of the Ministry of Public Utilities of the Republic of Uzbekistan. August 23, 1993

16 The Decree No. 239/9 of the Council of Ministers of the Republic of Karakalpakstan "About Organization and Activities of the Ministry of Public Utilities of the Republic of Karakalpakstan-September 20, 1993

17 Resolution No. 54 of the Cabinet of Ministers of the Republic of Uzbekistan Regarding Staged Conversion of Public Utility Services on Self-Sufficient Basis-February 7, 1994

Enterprises

18 Law of the Republic of Uzbekistan "On Enterprises in the Republic of Uzbekistan"-February 15, 1991

19 Law of the Republic of Uzbekistan "On Denationalization and Privatization"-November 19, 1991

20 Law of the Republic of Uzbekistan "On Taxes from Enterprises, Associations and Organizations"-February 15, 1991

21 Law of the Republic of Uzbekistan "On Entrepreneurship in the Republic of Uzbekistan"-February 15, 1991

Tariffs and Taxes

22 Instructions on Settlements with Population for Water Supply and Sewerage Services in the Republic of Uzbekistan- Approved by the Decree (31/22 of 22.09.92) of the Cabinet of Ministers of Uzbekistan -September 22, 1992 - Guides fixing of ceiling tariffs and guides water supply enterprises to determine monthly tariffs for water supply and sewerage services based on availability of conveniences and water meters.

23 Ministry of Finance Decree N49/34 on Tariff- Additional Price List for Pipe Water and Sewerage-June 21, 1994 - Defines revised ultimate tariff for water supply and sewerage services applicable to the First Group of consumers.

24 Decree of the President of the Republic of Uzbekistan "On Measures to Increase the Responsibility of the Heads of the Enterprises and Organizations for Timely Settlements in the National Economy"-May 12, 1995 - Measures to strengthen financial status of enterprises; ensure timely settlement by clients for products / work / services provided; increase responsibility of heads of agencies for payment discipline with fines imposed.

25 Scheme No.1: Taxes, Payments, Deductions, Deposits, State Duties and Collections existing in the Territory of the Republic of Uzbekistan.

26 Supplement to the Decree No.185 -"Regulations on the installation and maintenance of gas and water meters in the housing facilities and social and cultural institutions"-May 26, 1995.

6.4.3 Water Management and Water Rights

In Uzbekistan, once known as the country between two rivers (namely, Syr Darya and Amu Darya), severe natural conditions of continental climate, scanty rainfall and arid terrain have determined the behavior of its people towards rational use of the scarce water sources. Thus, concepts of water management have been well developed from the early days with few modifications done in the recent past.

Amu Darya River is an interstate river that flows through the Central Asian states; Tadjikistan, Uzbekistan and Turkmenstan, and bordering the northern territory of Afghanistan. Syr Darya River is another interstate river common to Uzbekistan, Kirgiztan and Kazakhstan. After independence, these countries agree among themselves upon policies and norms on the management of the interstate river waters. An Interstate Coordinating Committee (ICC) was established for this purpose with its secretariat in Leninbad in Tadjikistan where the ministers in charge of water management of these five states meet regularly to make policy decisions related to limits and distribution of the river waters. As for Amu Darya River, which is the main source of surface water to the Study Area, maintenance of river, management of river flow and distribution of water to the concerned three states are executed by the Interstate Water Basin Department of Amu Darya River (IWBDAR) that was established in 1988 with its headquarters in Urgench City in Uzbekistan. The IWBDAR is responsible for reporting to the ICC quarterly about its activities and performance including the results of water distribution as against the limits agreed upon by the ICC for each year/season.

Two main legislative documents namely, "the Law of the Republic of Uzbekistan on Water and Utilization of Water Use" and "the Decree of the Cabinet of Ministers of the Republic of Uzbekistan on Limited Water Use" dictate the activities of the MM&WM. Legislation provides for the MM&WM to fix the limits of water for each branch of water use and to issue water within the fixed limits. As for the rights of water use, priority is given to public water use followed by the water uses for industrial, agricultural and irrigation purposes in that order. A shortage in one branch of water use may be compensated by adjusting allocation to another branch that is given a lower priority. Limits for each branch of water use are fixed in each territory based on requests made by the recipients and arrangements made with the regional departments of the MM&WM. Agreements on water use specify the purpose, source, quantity and time of water usage.

Legislation provides for protection, rational use and management of groundwater resources which are used for both urban and rural water supply. Overall responsibility for management of groundwater resources lies with the SCGMR. The State Hydrogeological Enterprise (SHE) under the SCGMR is responsible for exploration, conservation and setting up norms for rational use of groundwater resources, construction of groundwater wells and offers consultancy services on groundwater exploitation. Groundwater can not be exploited without approval by the SCGMR.

6.4.4 Public Water Supply

When Uzbekistan was a member republic of the FSU, importance had been given to production of cotton and other cash crops. Even today, a major portion of exploitable water resources is being utilized for irrigation. But, after independence, to boost up economy backed by a healthy nation, the government has given high priority to public water supply, and particularly to the drinking water supply.

Public water supply in the cities and urban centers were formerly under the purview of the central organization "UzVodokanal" (Water Supply and Sewerage Services Department) under the then Ministry of Housing & Utility Services (MH&PU), while water supply in the rural areas was mainly the responsibility of the central organization "Uzagrovodokanal" (Agricultural Water Supply Department) under the Ministry of Agriculture (MOA). Structural changes to the agencies in charge of public water supply were made through the major legislations; the Law of Republic of Uzbekistan "On the Reorganization of the Local Authorities of the Republic of Uzbekistan", the Presidential Decree "About Improvement in Management of Public Utilities in the Republic of Uzbekistan" and the Resolution No.371 of the Cabinet of Ministers of the Republic of Uzbekistan "Regarding the Issues of Organization and Activities of the Ministry of Public Utilities of the Republic of Uzbekistan".

By the Presidential Decree, the former MH&PU was reorganized to the present MPU of the ROU (see Fig.6.1). The functions and responsibilities of "UzVodokanal" were decentralized and delegated to respective territorial governments and their subordinate agencies. Public water supply and sewerage services in cities, towns and regional centers of the ROU are now managed by the Territorial Communal Services Maintenance Amalgamations (TCMA) under the Khokimiats of the Provinces and Tashkent City and in the Republic of Karakalpakstan (ROK) by the Ministry of Public Utilities of the ROK (MPUK). Management of water supply and sewerage services in the rural settlements (except in the ROK) remains unchanged.

However, the departments responsible for construction, operation and maintenance of regional water pipelines that supply water to urban and rural population of two or more provinces were not included under the TCMAs, but were reporting directly to the MPU of the ROU. Later in 1995, the Republican Production Amalgamation for Development and Operation of Regional Water Pipelines (RPADORWP) was set up to supervise these departments with a view to solve all problems arising from operation and development of regional water pipelines.

In reorganizing the territorial systems, the respective governments have passed resolutions and issued their own decrees or guidelines basically in line with the directives from the center for prompt implementation of such directives.

After reorganization, the role of the MPU of the ROU in water supply and sewerage sector has basically reduced to overall supervision of facilities, coordination of activities of the newly organized amalgamations, and within the limits of its competence, formulating of policy, concepts and norms, state programs for development of water supply and sewerage facilities and a consultative role, besides allocating of funds needed for the five inter-regional pipeline projects which are now under construction or partly being constructed.

6.5 Water Supply Administration

6.5.1 Authorities Responsible for Water Supply

In the ROU, water supply related activities are administered under several agencies depending on the purpose and the service area. The key ministries involved are the MM&WM, the MOA and the MPU of the ROU. Most of the freely exploitable water resources are utilized for irrigation and this is administered by the MM&WM through its regional agencies "VodRem" and "VodKhoz" which have their own regional subdivisions for decentralized management and operations. The main users of irrigation water are the collective and private farms.

Prior to administrative reorganization, the responsibility of producing and supplying public water to the cities and urban centers was lying with the central government department "UzVodoKanal". This responsibility now lies mainly with the production enterprises "VodoKanal" managed under a Deputy Khokim in the 12 provinces (and Tashkent City) through the TCMA, or under the Deputy Minister, MPUK, and supervised by the MPU of the ROU. The enterprise "GasProm" under the central department "UzTransGas" that is mainly responsible for production and distribution of gas also produces drinking water that is supplied to some urban areas, for example in Kungrad City in the Study Area, where the water distribution is done by VodoKanal-ROK. In the Study Area, local waterworks have their own water sources (groundwater or canals) and treatment facilities, but now depend largely on the bulk producers namely; the Department for Operation and Maintenance of Tuyamuyun~Urgench Inter-regional Water Pipeline (DOMIWP-T/N) and the Department for Operation and Maintenance of Tuyamuyun~Nukus Inter-regional Water Pipeline (DOMIWP-T/N), who deliver Amu Darya water from Tuyamuyun Reservoir after treatment.

Management of water supply and sewerage services of rural settlements in the ROU is done by the Republican Production Amalgamation Uzagrovodokanal under the MOA of ROU and the Joint-Stock Company "Obi Hayot" (except in ROK where this function is handled by the Council of Ministers). The main source of water is the irrigation canals serving the farms, though ground water is also used for this purpose in some rural areas. Agrovodokanal enterprises in the Study Area purchase water also from the DOMIWPs and Vodokanals where such facility is available.

The various authorities and agencies directly responsible for, or indirectly involved with, water supply in the Study Area are outlined in Table 6.2.

6.5.2 Administrative Mechanism

(1) Situation before Independence

a) Planning

Until 1990, there was a State Planning Committee (GosPlan), existing under the Council of Ministers of the UzbekSSR, in charge of formulating plans and monitoring and analyses of plan implementation. Sector-wise, five year plans were prepared here. National plan on water supply development was formulated in accordance with Decree No.1110 (September 19, 1988) of the Central Committee of the Communist Party and the Council of Ministers of the USSR.

Under the FSU system, the concept of water supply plan is initiated by the UzVodoKanal/UzAgrovodokanal who then requests the MPU and/or MOA of the ROU, as the case may be, to proceed with master plan or feasibility studies. The ministry in charge after deciding to embark on a master plan for the entire republic or a specific region, proceeds the matter with the GosPlan. Master plan or feasibility study must be appraised and approved by the competent agencies, including the ministries/committees involved with water management and water supply and the SCNP. Consent of the concerned Khokimiats must also be obtained.

b) Design

The ministry in charge then requests a professional design agency to prepare the basic design and detailed design based on the approved feasibility study. This work is usually entrusted to the respective design institute of the MPU/ MOA of the ROU. The design is then checked by the State Committee for Construction (GosStroi) with necessary adjustments and amendments done at this stage. After the implementing agency is decided, approval is sought for the funds. GosPlan and GosStroi are requested to allocate funds and materials from the government.

c) Funding

By the Decree No.1110, responsibilities on the construction of main pipelines, water intakes, desalination plants, intra-village water pipe networks, etc., were given to the Council of Ministers of the UzbekSSR. Based on this decree, the Joint Soviet Union-Republican Program was designed, wherein all the control figures were amended throughout implementing agencies and the construction limits were calculated annually. Funding was done from the central budget of the FSU.

(2) Situation after Independence

After independence, responsibilities of financing of water management and related construction were fully shifted to the ROU. The Council of Ministers of the ROU issued Decree No.275 basically similar in context to the Decree No.1110. After restructuring the MPU of the ROU, with the republican organizations such as the UzVodokanal being abolished and their responsibilities having transferred to the local authorities, planning and reporting activities are now performed at local level by the TCMAs. The system for forecasting and monitoring of plan implementation still exists, but this is now performed by the local committee for forecasting and statistics.

The process from formulating a plan to the construction of facilities is outlined below. For example, in the ROK, in October~November every year the forecast data on the plans for the following year are sent to Tashkent for the MOF of the ROU to estimate the budget capacity and arrive at the final figures of budget allocation. These figures are sent down to implementing ministries or agencies, who concretize them subject wise. After approval of these figures by the SCFS, funding is arranged through banks. This procedure has not changed even now. But, state financing would be extended for the construction of large water main pipes, whereas the intra-farm (intra-village) pipeline networks should be constructed using funds from the local budget and residents' fees. Construction of the water supply facilities in the ROK is being implemented mostly by the three main agencies: Republican United Directorate "PRIARALYE"-which handles rural water supply; the Directorate for Construction of "Tuyamuyun-Nukus-Chimbay-Takhtakpir" Water Pipeline-which builds the water mains and, the production enterprise VodoKanal of the ROK-which implements the construction of water and sewerage networks in cities and regional centers. Limited financing is allocated to these subjects from the budget of ROU through the credit line of the MOF.

In Khorezm, the procedure is similar, but done under the corresponding administration, i.e. the Provincial Khokimiat, in contrast to the Council of Ministers in the ROK. Capital construction of public utilities at provincial level is done with funds allocated or credit from the MOF. To obtain funds, the Khokim has to prepare and submit proposals to the SCFS for checking and approval. The Provincial Finance Department (PFD) is responsible for requesting funds from the center. The budget, when approved and allocated to the Khokim, is distributed to three parties; Capital Construction Management Department of the Khokimiat; United Directorate for Construction in Aral Area and the TCMA.

6.5.3 Organization of Waterworks

(1) General

The organization for public water supply in the Study Area involves a number of authorities and institutions inter linked at different levels. Institutional involvement at interstate, central and local levels, could be summarized as in Fig.6.2.

(2) Typical Organizational Structure of Waterworks

VodoKanals are organized based on the typical organizational set up of public waterworks recommended by the Decree No. 371 of the Cabinet of Ministers of the ROU and subsequent resolutions etc. The organization structure of the (territorial level) VodoKanals of the ROK and Khorezm Province are shown in Figs. 6.3 and 6.4 respectively. The organization structure of a typical city level waterworks enterprise is shown in Fig. 6.5 giving the VodoKanal of Khiva City as an example.

The organization structure of the DOMIWP-T/U and the DOMIWP-T/N (the two departments responsible for construction, operation and maintenance of regional pipelines in the Study Area) is shown in Figs 6.6 and 6.7 respectively, while that of the RPADORWP which supervises the two departments is shown in Fig. 6.1.

(3) Organizational Mechanism for Planning and Design

The general planning system of public water supply is outlined above in Section 6.5.2. Steps have been already taken to implement the water supply master plan for the Study Area which was formulated by the FSU in the '80s. Planning and design of the reservoir complex at Tuyamuyun is under the purview of MWM&M. The Uzbek Public Utilities Engineering Project Institute (Uzgipro), the design institute under the MPU of the ROU, is mainly responsible for feasibility studies and design of the facilities from water intake to the distribution networks under the master plan while several other planning and design/research institutes of the relevant ministries and committees are assisting it with technical data, information and advice.

The planning responsibilities of the regional and local waterworks are basically limited to routine planning activities such as;

a) Financial planning and assessment on monthly, quarterly and annual basis,
b) Annual planning for new clients, new connections,
c) Planning of the quantity of water to be produced or purchased,
d) Planning of material supplies and services,
e) Planning of staff requirements, training and human resource development, and
f) Operational planning and preventative maintenance planning.

Each VodoKanal has a Planning and Economic Department where planning is presently done on a yearly basis because planning for longer periods would not make much sense under the rapid transitional nature of socioeconomic affairs prevailing in the country. The Planning Officer is responsible for conclusion and registration of consumer agreements and working according to the concluded agreements. Programming of work and planning of expenditure for the next year, determining of the amount of bonuses and lump sums for relief, recreation and welfare, and calculation of the number of no-pay leave and payments are also done by the Planning and Economic Department.

(4) Organizational Mechanism for Construction

Based on the master plan, major construction works of the Tuyamuyun Water Supply System (TWSS) are being executed under the MPU of the ROU while construction of Kaparas Reservoir is undertaken by the Tuyamuyun Amu Darya Hydro Knot (TAHK) under the MW&WM.

For developing the TWSS, construction of reservoirs, water treatment plants and regional water main pipelines etc., were undertaken by a number of national and regional level construction agencies such as the Tuyamuyun Hydro-Construction Trust (Tuyamuyungidristroi) and Irmontazhstroi under the "Uzvodstroi" Concern, Khorezm Collective Farm Water Construction, Naip Gas Construction and South Gas Construction of the "Uzgazstroi" Trust, "Uzelectromontazhkurilish" under the Ministry of Energy of the ROU and more than 20 subcontractors. In the ROK, there is a special United Directorate for the construction of Tuyamuyun-Nukus-Chimbay-Tahtakupir water main pipeline.

The VodoKanals in Karakalpakstan and Khorezm have their own Departments for capital construction or construction and repairs to handle routine construction works of water supply and sewerage networks. This department also has a division for scientific research, engineering design and construction supervision. Proceeding from plans and designs for development of facilities, VodoKanal determines the estimates jointly with scientific research and design institutes who also assist in monitoring the work progress at a later stage. Upon receiving the estimates from the design institute, VodoKanal appropriates the expenditures. For large scale projects, Vodokanal usually depends on Tashkent for expertise work, and in other cases, it manages with the in-house expertise available. Upon completion of expertise work, VodoKanal selects contractors to conclude the contracts. It then starts financing the project through banks, giving down-payment to start construction and places orders for materials and equipment and engineering services for construction supervision.

(5) Organization for Operation and Management of Intake and Treatment Facilities

The organizations responsible for the different types and systems of water intakes and treatment facilities catering to the Study Area are summarized in Table 6.3. Each of these agencies have its own system for operation and management.

Table 6. 3 Organizations Responsible for Intake and Treatment Facilities in the Study Area

Organization	Responsibilities and Functions
"Tuyamuyun Amudarya Hydro Knot" or Tuyamuyun Reservoir Complex Management Authority under the MM&WM (TAHK)	From a reservoir complex developed across Amudarya River, water is issued for the Tuyamuyun-Nukus and Tuyamuyun-Urgench Pipeline systems which in future will receive snow melt water stored in Kaparas Reservoir, intake facilities of which are under construction.
Department for Operation and Maintenance of Tuyamuyun - Nukus Inter-regional Water Pipeline in Nukus (DOMIWP-T/N)	With an intake on the right bank canal and a treatment plant located downstream of Tuyamuyun Amudarya Reservoir Complex, water is treated and sold to VodoKanals, AgroVodoKanal and other clients along the transmission pipeline for supply mainly to the right bank areas (and Kungrad City) of the Study Area.
Department for Operation and Maintenance of Tuyamuyun- Urgench Inter-regional Water Pipeline in Urgench (DOMIWP-T/U)	With an intake on the left bank canal and a treatment plant located downstream of Tuyamuyun Amudarya Reservoir Complex, water is treated and sold to VodoKanals, AgroVodoKanal along the transmission pipeline for supply mainly to the left bank areas (and Mangit City) of the Study Area.
Production Enterprise "VodoKanal" of ROK in Nukus	In different parts of the ROK, it has several water intakes from canals and treatment plants some of which are now defunct or kept on stand by where water is purchased from the Tuyamuyun-Nukus system.
Production Enterprise "GasProm" of "UrgTransGas" Company in Urgench	With intakes from canals of Amudarya River and treatment plants at Tahiatash and Kungrad it sells treated water to the VodoKanal for Khodjeili, Tahiatash and Kungrad City.
Production Enterprise "VodoKanal" of Khorezm Province in Urgench	It has a water intake from Shavat Canal and a well field in Charish and a treatment plant in Urgench.
Production Enterprises "AgroVodoKanal"	These have their own water intakes from canals and ground water wells to supply water to the rural areas. These also purchase water from the DOMIWPs.

(6) Organization for Distribution Facilities

VodoKanals of the ROK and Khorezm Province, and their subordinate city/district level units are responsible for the distribution of water to the consumers in the cities and urban centers within the Study Area. Distribution facilities including the distribution reservoirs, post chlorination facilities, pumping stations, and pipelines are maintained by a water distribution unit under each VodoKanal.

VodoKanal has a Production and Technical Department which keeps records of water pipeline networks and capacity of intakes, determines of the volume of capital works and gives technical advice to consumers. Vodokanal provides technical advice to clients seeking water supply connection for new institutions/enterprises. VodoKanal decides whether to give the connection from a network existing nearby, or from a new or proposed water pipe network for which additional funds are sometimes required and a part of which the consumer has to bear. Based on water requirement and supply capacity available, VodoKanal decides on the type of connections to be given. In some local authorities which have already spent money on the pipeline network, a new consumer may have to pay a membership fee to join the network. Payment norms are decided as per technical conditions of the Vodokanals. Payment may be made in terms of equipment etc., on barter exchange. When a new housing complex is built, VodoKanal may request a few housing units for its employees.

(7) Organization for Monitoring and Control of Water Quality

Each waterworks is equipped with its own laboratory to carry out the routine water quality controls required in different unit operations and distribution stages. The general and routine tests are regularly conducted at most of the laboratories in accordance with the ROU State Standards which are basically transformed from the standards of the FSU. For groundwater, tests are done at source, after treatment and at the outlets. For surface water, test are done at the reservoir/intake and at different stages of unit operations to ensure consistency of quality. As for sources, groundwater is tested once a year and surface water once every month.

The Central Laboratory of the MPU in Tashkent is responsible for formulating methodology, assisting the subordinate laboratories with advice, preparation/supply of standards and guidelines, supervision and assessment of performance, staff training, upgrading skills and qualifications and issuing of vocational certificates. The Chief Technologist is responsible for chemical and bacteriological control service. Nation wide, there are 13 large laboratories at provincial level and a total of 66 laboratories exclusively for water supply service. Laboratories are graded according to the population served. Monthly tests are done for 32 parameters at the provincial laboratories, whereas in the lower level laboratories in cities and towns, only 15 water quality items are tested on a daily basis. Some smaller waterworks in the regional centers in the Study Area do not have facilities for bacteriological tests and these are done at the provincial level laboratories attached to the VodoKanals in Nukus or Urgench. The tests which can not be handled by the Provincial or Central laboratories are done at the Tashkent Geology Laboratory on contract basis.

The quality of drinking water supplied by different agencies is controlled by the MOH. Regular checks, inspections and water quality tests are conducted at regional level by the Sanitary and Epidemiologic Laboratories that are usually affiliated to the regional hospitals. The MOH has a major independent but controlling role in collecting and testing water samples when and where necessary and advising the concerned Khokim and the waterworks if any problems arise regarding the quality of water. On MOH's recommendations, waterworks are required to take immediate measures to rectify the water quality situation to satisfy the safety standards.

The MOH, through its Sanitary and Epidemiologic Service, not only keeps a close eye on the quality of drinking water, but jointly with the SCNP also monitors the quality of effluents, sewerage and wastewater discharged into surface waters. While MOH does this from a point of view of sanitation control, SCNP's role is mainly from the aspects of environmental protection. The State Special Inspection Agency for Analytical Control (GosSIAK) in Tashkent, a subordinate agency of the SCNP, and its regional laboratories are responsible for testing and analyses work.

(8) Consumer Relations

The DOMIWP-T/N and the DOMIWP-T/U sell treated water in bulk to the VodoKanals and the AgroVodokanals in the Study Area for distribution to ultimate consumers on the respective networks. The DOMIWP-T/N caters also to a limited number of industries/enterprises/settlements along its transmission pipeline. Their relations with such bulk consumer are simple and well defined, but there have been problems on timely collection of revenue from some enterprises along the pipelines.

Consumers of the VodoKanals are households in Group I, public institutions etc. in Group II and industrial enterprises in Group III. Consumer affairs are handled by the Water Sales and Subscriptions Department. Solvency of the VodoKanal depends also on the performance of this department whose duties include; dispatching inspectors and controllers who issue subscription books to households, inventorizing water consumption, sending of official notices to errant consumers warning of supply disconnection and ensuring of timely payments by consumers.

Consumer complaints are generally centered on issues such as, low water pressure and lack of flow, particularly in areas with buildings having more than two stories, high turbidity during summer periods, or excessive salinity and hardness, specially in remote cities like Muynak. A special team is set up within the VodoKanals to study the consumer complaints, with the Director of VodoKanal being responsible for implementation of remedial measures, and a 24-hour work team available to attend to repairs.

(9) Management Information System (MIS)

Each waterworks has its own system for transfer of management information. Although these are not sophisticated systems that use computers and modern communication techniques, management information is communicated among the management staff through regular reports which compare planned/estimated figures with actuals, sometimes using performance indicators, and at regular meetings of the management staff held weekly, monthly or quarterly. Reports are also sent to the superior administrative authority/ies for information and necessary action.

For example, in Khorezm, at the VodoKanal-Kz, management information is communicated to its senior staff and relevant external agencies through regular reports prepared for each area of operation covering data on; a) target fulfillment for water supply, water sales and sewerage services, b) revenue from water sales and sewerage services, c) paid services, d) fund for staff remuneration, e) revenue and expenditure, f) operational balance sheets and financial calculations, g) personnel (employment, enrollment and dismissals), h) professional training and military service, i) salvage of waste metals, j) utilization of fuel, heat energy and electricity, k) maintenance and repair works, l) inventions, m) consumer applications and complaints and, n) water taken from Shavat canal, treated and supplied.

(10) Accounting, Administrative, Personnel and Labor Affairs

VodoKanals have a Chief Accountant's Department for financial administration and a Personnel Department for the personnel management. The Director and Chief Accountant are responsible for timely collection of payments due from consumers and proper utilization of the moneys. Auditing and tax inspections are done here annually. Auditing is done also by the PFD under the Khokim's Office (in Khorezm) or the Ministry of Finance (in the ROK). All settlements of wages and issues relative to settlements are dealt with monthly. The Chief Accountant prepares the quarterly and annual balance of payment sheets.

Personnel Department keeps records of all employees including workers who are subject to military service. Employees are warned and sometimes punished if the quality of their performance deteriorates. Director and the trade union jointly decide on the method of punishment (e.g. not to pay bonus). Appeals are made to the labor court when employee or employer violates labor regulations.

The VodoKanals employ persons with higher education and also sponsor education programs to send their specialized technicians for refresh training to Tashkent and the CIS countries. It also organizes summer camps, recreation and welfare activities for the employees. At the discretion of the Director, employees are exempted from paying water charges.

(11) Material Supplies and Technical Services

VodoKanals have a procurement and supply department for materials, technical and maintenance services, and departments under the Chief Energy Engineer and Chief Mechanical Engineer. The Chief Energy Engineer, who has a special workshop and support staff, is responsible for uninterrupted power supply and proper functioning of all electric systems. The Chief Mechanical Engineer is responsible for ensuring sound performance of all pumps, machinery and equipment, and spare parts.

(12) Technical and Managerial Support

Technical support by way of advice on design, issues on maintenance, training and man power development etc., to the water supplying agencies come basically from the MPU of the ROU or through arrangements made with other agencies of the central government. Vodokanals receive managerial support and overall policy guidance from the MPU of the ROU through the TCMAs and the territorial administration (Khokimiat in Khorezm or MPU in the ROK).