社会開発調査部報告書

No. 42

JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF PUBLIC UTILITIES
STATE COMMITTEE OF UZBEKISTAN FOR NATURE PROTECTION
REPUBLIC OF UZBEKISTAN

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

## FINAL REPORT

## (MAIN REPORT)

DECEMBER 1996

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# PREFACE

In response to the request from the Government of the Republic of Uzbekistan, the Government of Japan decided to conduct the Study on the Water Supply System in six cities of Aral Sea Region and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Uzbekistan a study team headed by Mr. Hidetoshi HAGA, Tokyo Engineering Consultants Co., Ltd. in association with Kyowa Engineering Consultants Co., Ltd., 7 times between September 1994 to October 1996.

The team held discussions with the officials concerned of the Government of Uzbekistan, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Uzbekistan for their close cooperation extended to the team.

December, 1996

Kimio Fujita
President
Japan International Cooperation Agency

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

DECEMBER, 1996

Mr. Kimio FUJITA
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit you the final report entitled "THE STUDY ON WATER SUPPLY SYSTEM IN SIX CITIES OF THE ARAL SEA REGION IN UZBEKISTAN".

This report has been prepared by the Study Team in accordance with the contracts signed on August 1994, May 1995 and May 1996 between the Japan International Cooperation Agency (JICA) and the Joint Venture of Tokyo Engineering Consultants and Kyowa Engineering Consultants.

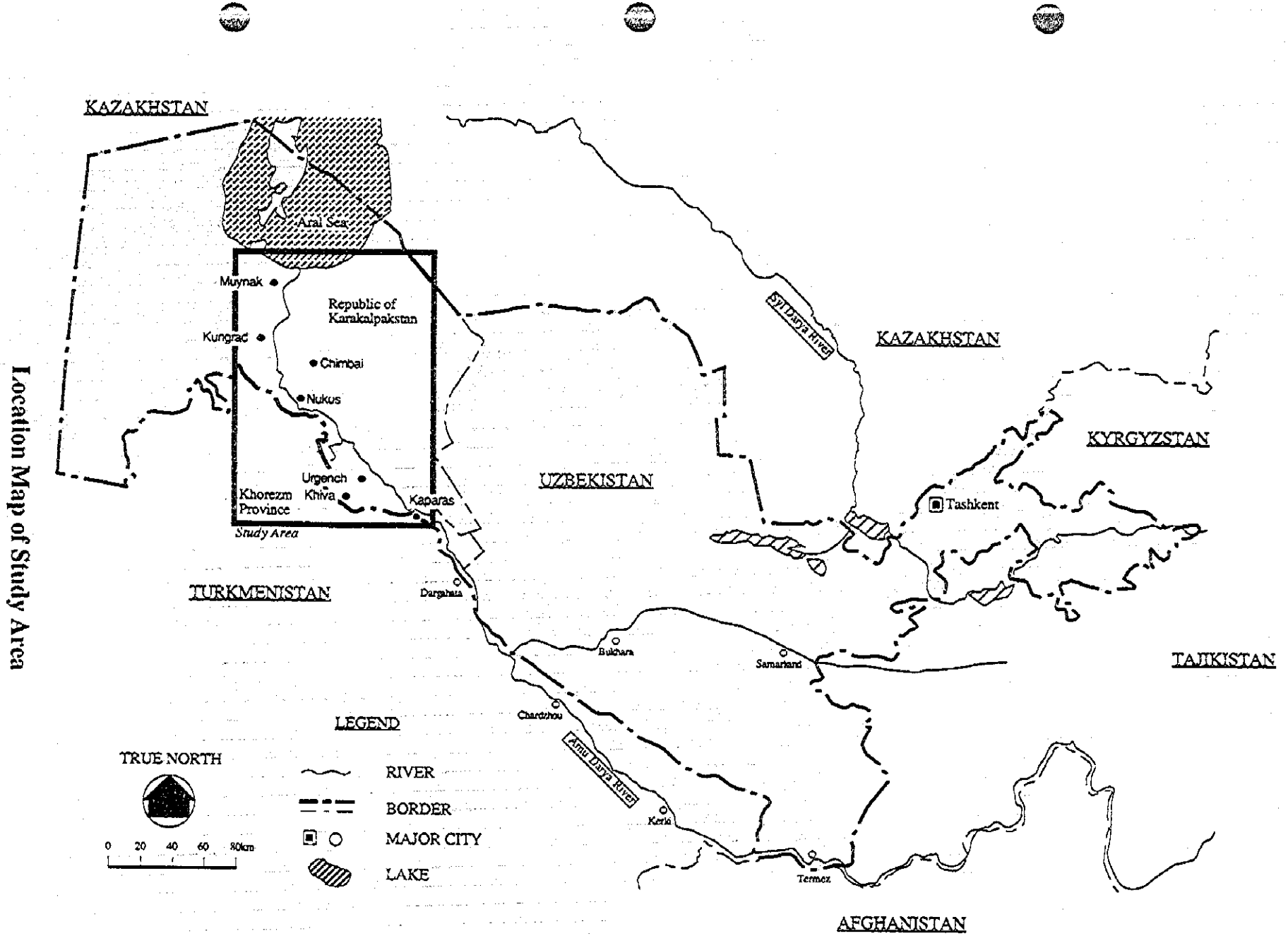
The report consists of the Main Report, Summary Report, Supporting Report and Data Book. The Main Report contains the results of survey, analysis and explains about Basic Plan and Feasibility Study. The Summary Report summarizes the results of all studies. The Supporting Report includes data, details of investigations and analysis. The Data Book contains the results of water quality analysis by the JICA Study Team and Uzbeki counterpart.

All member of the Study Team wish to express grateful acknowledgment to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Health and Welfare and Embassy of Japan in Uzbekistan, and also to the officials of the Government of Uzbekistan for all assistance extended to the Study Team. The Study Team sincerely hopes that the results of the study will contribute to the improvement of health and sanitary conditions of people in the Aral Sea Region in Uzbekistan.

Yours faithfully,

芳賀秀寿

Hidetoshi HAGA
Team Leader




Location Map of Study Area

# EXECUTIVE SUMMARY

## 1. Introduction

The Aral Sea region of the Republic of Uzbekistan (ROU), the Study area, is located in the autonomous Republic of Karakalpakstan and Khorezm Province, and in the downstream part of the Amu Darya river. The problems faced by the water supply system in this region are degradation of drinking water quality due to deterioration of quality of the water sources and inability to raise funds to cover maintenance and operation costs because of the low water tariffs. Particularly, the degradation of water quality in the water sources has resulted in adverse effects on the health of the inhabitants. In view of this background, the Study focused on improvements to the quality of drinking water.

## 2. Existing Water Supply System

Karakalpakstan and Khorezm have the Tuyamuyun-Nukus (T-N) and the Tuyamuyun-Urgench (T-U) inter-regional water supply systems respectively. Regional water supply corporations, Vodokanal (urban water supply) and Agro-Vodokanal (rural water supply), are currently supplying water directly to the residents of these areas by purchasing treated water from the inter-regional water supply systems and adding treated water produced by themselves. The inter-regional water supply systems currently produce about 60% of the total water supply.

## 3. Measures to Improve the Water Quality

Water supply sources for the Study area are mainly surface water derived from the Amu Darya river and underground water. The degradation of water sources is attributed to the inflow of irrigation waste water containing high concentration of salinity from the large agricultural land. The main problem in water quality is that the evaporated residue (mineralization) and the total hardness do not satisfy the drinking water quality standards. To solve these problems, the Study Team prepared and analyzed alternative plans for improving the water quality. As a result, it is proposed that water should be stored in the Kaparas reservoir during the period when the quality of Amu Darya river water is good and that water should be treated at Tuyamuyun water treatment plant.

## 4. Basic Water Supply Plan

Based on these measures for improving the water quality, a basic water supply plan with 2010 as the target year was formulated. The Kaparas reservoir will become the main water supply source. The treatment plants in the existing T-N and T-U inter-regional water supply systems will be extended. A part of the regional water treatment plants will also be used. The existing T-N transmission system and the T-U transmission system will be extended and used as trunk transmission pipeline systems. Aged distribution pipelines will be renewed for reducing leakage and new pipelines will be laid for increasing the population served. Water meters will be installed for all resident users for achieving effective utilization of water.

## 5. Revising the Project

The results of the project assessment showed implementing the entire project would be very difficult due to enormous construction cost. Therefor, the scale of the project was cut down by taking two measures: utilization of the existing transmission pipeline of the Urgench Transgas and cutting down the expansion plan of the water treatment plants. The total construction cost for the rescheduled project was estimated as 603 million US dollars, out of which the construction cost for the first priority project with the target year of 2002 was estimated as 278 million US dollars. A feasibility study was carried out for the rescheduled project. Details of the project and the proposed water supply system are shown in the attached figures.

## 6. Total Served Population, Demand and Supply

The percentage of population served in the urban area will increase from 76% (Karakalpakstan) and 87% (Khorezm) in 1995 to 100% by the year 2010 for both regions. The served population in the urban area will increase from 502,000 persons and 292,000 persons to 851,000 persons and 397,000 persons respectively in 2010 in the two areas. The maximum daily demand for both areas including urban and rural populations in 2010 is estimated as 413,000 $m^3$/day (Karakalpakstan) and 415,000 $m^3$/day (Khorezm). The total maximum daily supply capacity is 828,000 $m^3$/day and the additional capacity of 325,000 $m^3$/day (T-N water treatment plant: 145,000 $m^3$/day; T-U water treatment plant: 180,000 $m^3$/day).

## 7. Maintenance and Operation of Water Supply System

The items listed below need to be considered for the successful implementation of this project.

1) Establishment of integrated management system for the Tuyamuyun Hydro-unit including the Kaparas reservoir
2) Effective management between the Vodokanal and the Tuyamuyun water supply systems
3) Adequate response in case of an emergency in the inter-regional water supply system
4) Control of water leakage.

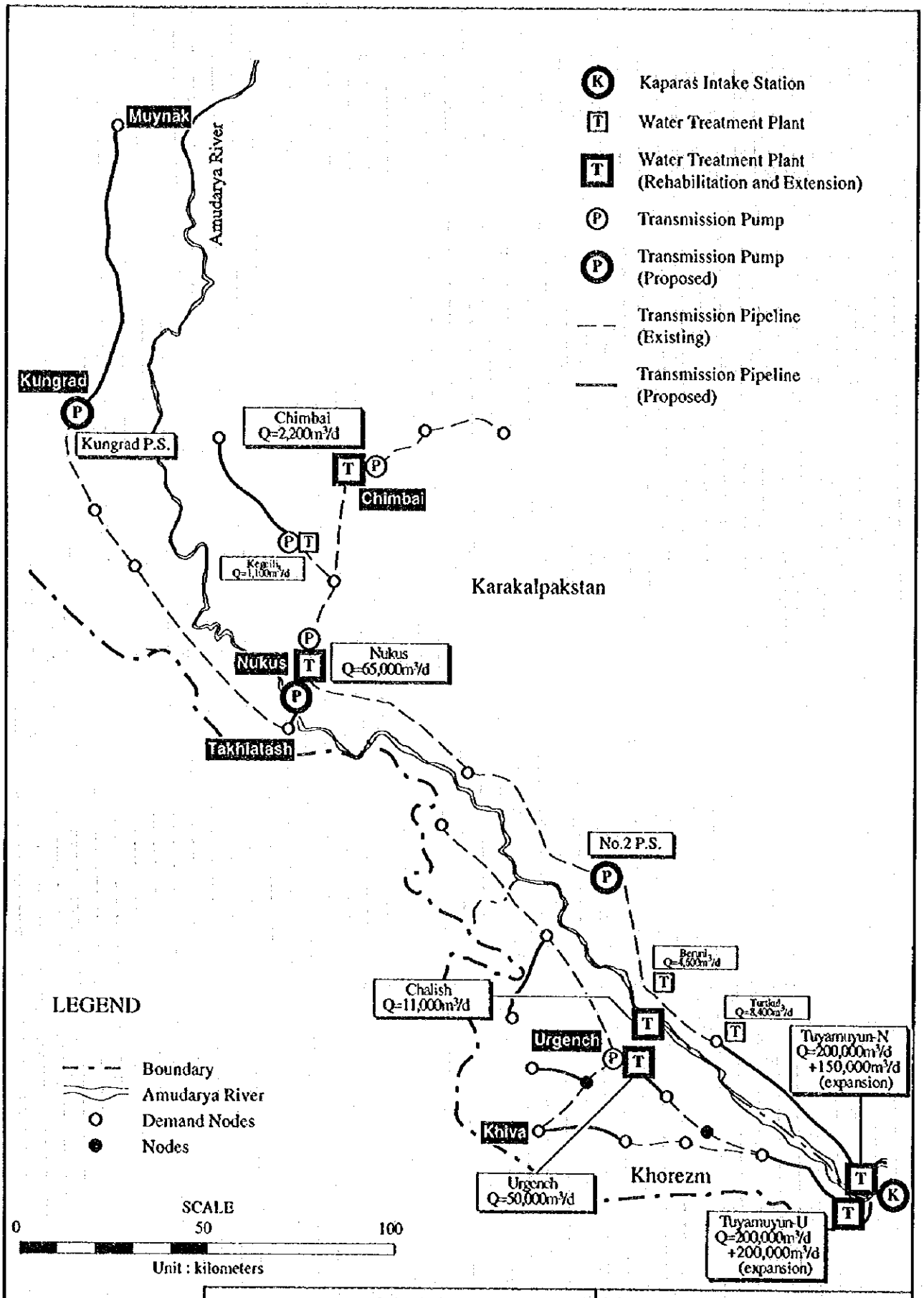
## 8. Project Assessment

The Economic Internal Rate of Return (EIRR) for the first priority project was 8.4%. If benefits that cannot be quantitatively assessed are taken into account, the feasibility for this project will be high. Results of financial analysis showed that the ROU government should give subsidies for covering the construction cost so that an adequate water tariff level is maintained and the project is implemented successfully. The water tariff for household consumers needs to be increased to a reasonable level (2% of the average household income).

## 9. Environmental Impact Assessment

Three activities were identified as the main environmental impacts, and the results of an assessment and relief measures to mitigate them are summarized below.

(1) Operation of the Kaparas reservoir (No eutrophication. Impact on the hydrosphere are negligible. Silting can be neglected. Problem of water rights was solved.)
(2) Operation of water treatment plants (Adequate disposal of sludge is necessary)
(3) Increase in the amount of sewage with the increase in served population (Development of sewage system is necessary.)




THE STUDY ON
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JAPAN INTERNATIONAL COOPERATION AGENCY

Fig.
Proposed Water Supply Sys. in 2010

# Fig. Implementation Schedule

| Description \ Year | | First Priority Project | | | | | | Second Priority Project | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 1997 | 1 1998 | 2 1999 | 3 2000 | 4 2001 | 5 2002 | 6 2003 | 7 2004 | 8 2005 | 9 2006 | 10 2007 | 11 2008 | 12 2009 | 13 2010 | |
| Loan Arrangement | | | | | | | | | | | | | | | | |
| Preparation of Tender (Bids, Evaluations) | | | | | | | | | | | | | | | | |
| 1. Kaparas Raw Water Intake System | | | | | | | | | | | | | | | | |
| 1.1 Kaparas Intake Station | Q=750,000 m³/d | | | | | | | | | | | | | | | |
| 1.2 Raw Water Mains Pipeline | | | | | | | | | | | | | | | | |
| 1.2.1 Kaparas I.S. to T-N Existing Intake Station | D=1,400 L=10.7 km | | | | | | | | | | | | | | | |
| 1.2.2 Kaparas I.S. to T-U Existing Intake Station | D=1,400 L= 1.0 km | | | | | | | | | | | | | | | |
| 1.2.3 Kaparas I.S. to T-U Existing Intake Station | D=1,400 L= 9.0 km | | | | | | | | | | | | | | | |
| 2. Tuyamuyun-Nukus Water Supply System | | | | | | | | | | | | | | | | |
| 2.1 Water Treatment Plant | Q=350,000 m³/d | | | | | | | | | | | | | | | |
| 2.1.1 Rehabilitation | Q=200,000 m³/d | | | | | | | | | | | | | | | |
| 2.1.2 Expansion | Q=150,000 m³/d | | | | | | | | | | | | | | | |
| 2.2 Transmission and Distribution Pumping Station | | | | | | | | | | | | | | | | |
| 2.2.1 No. 2 Booster Pumping Station | Q=234,410 m³/d | | | | | | | | | | | | | | | |
| 2.2.2 Nukus North Distribution Station | Q=122,950 m³/d | | | | | | | | | | | | | | | |
| 2.2.3 Kungrad Transmission and Distribution Station | Q= 42,130 m³/d | | | | | | | | | | | | | | | |
| 2.3 Transmission Pipeline | | | | | | | | | | | | | | | | |
| 2.3.1 W.T.P. - No. 1 Pumping Station | D=1,400 L= 63.0 km | | | | | | | | | | | | | | | |
| 2.3.2 Nukus - Takhiatash L=21 km | D=1,200 L= 11.0 km | | | | | | | | | | | | | | | |
| 2.3.3 Kungrad - Muynak (Q=8,870 m³/d) | D=500 L= 96.5 km | | | | | | | | | | | | | | | |
| 2.3.4 Kegeili - Bozatau | D=400 L= 50.0 km | | | | | | | | | | | | | | | |
| 3. Tuyamuyun-Urgench Water Supply System | | | | | | | | | | | | | | | | |
| 3.1 Water Treatment Plant | Q=400,000 m³/d | | | | | | | | | | | | | | | |
| 3.1.1 Rehabilitation | Q=200,000 m³/d | | | | | | | | | | | | | | | |
| 3.1.2 Expansion | Q=200,000 m³/d | | | | | | | | | | | | | | | |
| 3.2 Transmission Pipeline | | | | | | | | | | | | | | | | |
| 3.2.1 W.T.P. - Khazarasp Pumping Station | D=1,200 L=27.0 km | | | | | | | | | | | | | | | |
| 3.2.2 Khanki - Urgench | D=1,200 L=13.2 km | | | | | | | | | | | | | | | |
| 3.2.3 Yangiaryk - Khiva | D=600 L=20.0 km | | | | | | | | | | | | | | | |
| 3.2.4 S.P.I - Koshkupyr | D=600 L=14.0 km | | | | | | | | | | | | | | | |
| 3.2.5 Gurlen - Shavat | D=600 L=19.5 km | | | | | | | | | | | | | | | |
| 4. VodoKanal Karakalpakstan | | | | | | | | | | | | | | | | |
| 4.1 Water Treatment Plant | | | | | | | | | | | | | | | | |
| 4.1.1 Nukus W.T.P (Rehabilitation) | Q= 65,000 m³/d | | | | | | | | | | | | | | | |
| 4.1.2 Chimbai W.T.P (Rehabilitation) | Q= 2,200 m³/d | | | | | | | | | | | | | | | |
| 4.1.3 Water Treatment Plant (Rehabilitation), 3Cities | Q= 14,000 m³/d | | | | | | | | | | | | | | | |
| 4.2 Distribution Network | | | | | | | | | | | | | | | | |
| 4.2.1 Replacement D=100~D=400 | L=228.8 km | | | | | | | | | | | | | | | |
| 4.2.2 Expansion D=100~D=400 | L=119.6 km | | | | | | | | | | | | | | | |
| 4.3 Metering System | | | | | | | | | | | | | | | | |
| 4.3.1 Meter Installation D=20 | N=115,960 Pieces | | | | | | | | | | | | | | | |
| 5. VodoKanal Khorezm | | | | | | | | | | | | | | | | |
| 5.1 Water Treatment Plant | | | | | | | | | | | | | | | | |
| 5.1.1 Urgench W.T.P (Rehabilitation) | Q= 50,000 m³/d | | | | | | | | | | | | | | | |
| 5.1.2 Chalish (Rehabilitation) | Q= 11,000 m³/d | | | | | | | | | | | | | | | |
| 5.2 Distribution Network | | | | | | | | | | | | | | | | |
| 5.2.1 Replacement D=100~D=400 | L=170.3 km | | | | | | | | | | | | | | | |
| 5.2.2 Expansion D=100~D=400 | L= 71.5 km | | | | | | | | | | | | | | | |
| 5.3 Metering System | | | | | | | | | | | | | | | | |
| 5.3.1 Meter Installation D=20 | N=60,970 Pieces | | | | | | | | | | | | | | | |

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C : WATER SOURCE AND WATER QUALITY

D : WATER SUPPLY IMPROVEMENT PLAN

E : ENGINEERING DESIGN

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G : INITIAL ENVIRONMENTAL EXAMINATION BY UZBEKI SIDE

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# DATA BOOK ON WATER QUALITY ANALYSIS BY JICA

SAMPLING POINT AND ABBREVIATION

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RESULTS OF WATER QUALITY ANALYSIS (TABLES)

RESULTS OF WATER QUALITY ANALYSIS (FIGURES)

LEVELS OF AGRO-CHEMICALS IN SOIL IN KARAKALPAKSTAN

# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AFW | Accounted for Water |
| AgroVodoKanal | Agricultural Water Supply Department AgroVodoKanal |
| AVK | Agro-Vodokanal |
| Basic Plan | Basic Plan by the JICA |
| CabMin | Cabinet of Ministers of the ROU |
| CCMD | Capital Construction Management Department under the Khakim |
| CIS | Commonwealth of Independent States |
| CMO/Chi | Chimbai City Mayor's Office |
| CMO/Khi | Khiva City Mayor's Office |
| CMO/Kun | Kungrad City Mayor's Office |
| CMO/Muy | Muynak City Mayor's Office |
| CMO/Nuk | Nukus City Mayor's Office |
| CMO/Urg | Urgench City Mayor's Office |
| CounMin | Council of Ministers of the ROK |
| DCWM | Directorate for Construction of Tuyamuyun-Nukus Chimbai-Takhtakupir Water Mains |
| DOMIWP | Department for Operation and Maintenance of Inter-Regional Water Pipeline |
| DOMIWP-T/N | Department for Operation and Maintenance of Tuyamuyun-Nukus Inter-Regional Water Pipeline |
| DOMIWP-T/U | Unit for Operation and Maintenance of Tuyamuyun-Urgench Inter-Regional Water Pipeline |
| EBRD | European Bank for Reconstruction and Development |
| EOJ | Embassy of Japan |
| Feasibility Study/FS | Feasibility Study by the JICA |
| FPP | First Priority Project |
| GasProm | Productive Enterprise GasProm |
| GosSIAK | State Special Inspection Agency for Analytical Control |
| GOU | Government of Uzbekistan |
| ICC | Inter-state Coordinating Committee |
| IWBDAR | Inter-state Water Basin Department for Amudarya River |
| KPP | Republic of Karakalpakstan |
| KKPVodKhoz | KKP Irrigation Department |
| Kz/KZ | Khorezm |
| KzPCFS | Khorezm Provincial Committee for Forecasting and Statistics |
| MFER | Ministry of Foreign Economic Relations |
| MM&WM | Ministry of Melioration & Water Management |
| MM&WMK | ROK Ministry of Melioration & Water Management ROK |
| MOA | Ministry of Agriculture |

| | |
|---|---|
| MOAK | ROK Ministry of Agriculture |
| MOF | Ministry of Finance |
| MOFK | ROK Ministry of Finance |
| MOH | Ministry of Health |
| MOHK | ROK Ministry of Health |
| MOJ | Ministry of Justice |
| MPGS | Ministry of Petroleum & Gas Construction |
| MPU | Ministry of Public Utilities |
| MPUK | ROK Ministry of Public Utilities |
| MSIN | Meteorological Survey Institute, Nukus |
| | |
| O&M | Operation and Maintenance |
| | |
| PFD | Provincial Finance Department |
| PHE | Pre Aralskaya Hydrogeological Expedition |
| PMOKz | Khorezm Provincial Mayor's Office |
| President | President of the ROU |
| PRIARALYE | Republican United Directorate for Construction in Aral Region |
| PS | Pumping Station |
| PUMBKz | Khorezm Provincial Public Utilities Management Board |
| PUMBN | Public Utilities Management Board, Nukus |
| | |
| RBCD | Right Bank Collector Drain |
| RemVod-ROK | Productive Society KarakalpakRemVod |
| RO | Reverse Osmosis plant |
| ROK | Republic of Karakalpakstan |
| ROU | Republic of Uzbekistan |
| RPA | Republic Oroduction Amalgamation |
| | |
| SANIIRI | Central Asian Scientific Research Institute for Irrigation & Land Reclamation |
| SCFS | State Committee for Forecasting and Statistics |
| SCFSK | ROK State Committee for Forecasting and Statistics |
| SCGMR | State Committee for Geology and Mineral Resources |
| SCNP | State Committee for Nature Protection |
| SCNPK | ROK State Committee for Nature Protection |
| SCNPKz | Khorezm Provincial Committee for Nature Protection |
| SHE | State Hydrogeological Enterprise |
| SPP | Second Priority Project |
| | |
| T-N, T-Nukus | Tuyamuyun - Nukus |
| T-U, T-Urgench | Tuyamuyun - Urgench |
| TAHK | Tuyamuyun Amudarya Hydro Knot |
| TCMAKz | Territorial Communal Services Maintenance Amalgamation |
| TSIN | Topographical Survey Institute, Nukus |
| | |
| UAE | Uzbek Aerogeodetic Enterprise |
| UDCAR | United Directorate for Construction in Aral Region |
| UFW | Unaccounted for water |

| | |
|---|---|
| URM-T/N | Unit for the Repair and Maintenance of Tuyamuyun-Nukus Inter-Regional Water Pipeline, Nukus City |
| URM-T/U | Unit for the Repair and Maintenance of Tuyamuyun-Urgench Inter-Regional Water Pipeline, Urgench City |
| UrTransGas | Productive Enterprise Urgench TransGas |
| USSR | Union of Soviet Socialist Republics |
| Uzgipro | Uzbek Public Utilities Engineering Project Institute |
| UzTransGas | Gas Production Department under MPGC |
| VK | Vodokanal |
| VodGeo | Tashkent Scientific Institute for Water Supply, Sewage, Hydro-engineering Facilities and Engineering Hydrology |
| Vodokanal-Khiva | Productive Enterprise Vodokanal of Khiva City |
| Vodokanal-Kz | Productive Enterprise Vodokanal of Khorezm Province |
| Vodokanal-ROK | Productive Enterprise Vodokanal of the ROK |
| WSS | Water Supply System |
| WTP | Water Treatment Plant |

# LIST OF UNIT AND ABBREVIATIONS

| | |
|---|---|
| A | square |
| Ave. | average |
| C | capacity |
| cm | centimeter |
| sum | currency unit of Uzbekistan |
| D | diameter |
| d | day |
| g | gram |
| H | height |
| km | kilometer |
| kv | kilovolt |
| kw | kilowatt |
| L | length |
| l | litter |
| lcd / l/ca./day | litter per capita per day (l/ca./day) |
| m | meter |
| m2 | square meter |
| m3 | cubic meter |
| Max | maximum |
| mg | milligram |
| mil. | million |
| Min | minimum |
| min | minute |
| mld | million liters per day, thousand cubic meter per day |
| mm | millimeter |
| P | motor power |
| Q | flow |
| r.p.m | revolutions per minute |
| sec | second |
| ths. | thousand |
| US/USD | United States Dollar |
| V | volt or velocity |
| W | width |
| Z | depth |

# PART I BASIC PLAN

# CHAPTER 1

# INTRODUCTION

# CHAPTER 1 INTRODUCTION

## 1.1 Authorization and Background

### 1.1.1 Authorization

On the basis of the Scope of Work agreed upon between the Ministry of Public Utilities (MPU), the State Committee for Nature Protection (SCNP) of the Republic of Uzbekistan (hereinafter referred to as the "Uzbek Side") and the Japan International Cooperation Agency (hereinafter referred to as "the JICA") on 31st March 1994 in Tashkent, the JICA signed a contract with Tokyo Engineering Consultants Co., Ltd. in association with Kyowa Engineering Consultants Co., Ltd. on September 1994 to conduct the Study on Water Supply System in Six Cities of the Aral Sea Region in Uzbekistan (hereinafter referred to as the "Study").

The JICA, the official agency responsible for the implementation of technical cooperation programs of the Government of Japan (hereinafter referred to as the "GOJ"), undertook the Study in accordance with the relevant laws and regulations in force in Japan, in close cooperation with the authorities of the Government of the Republic of Uzbekistan (hereinafter referred to as the "GOU"). The MPU and the SCNP acted as the counterpart agencies to the Japanese Study Team (hereinafter referred to as the "Study Team") and as the coordinating bodies for other relevant organizations for the smooth implementation of the Study.

### 1.1.2 Background of the Study

Presently, the main sources of water for the six cities (Nukus, Chimbai, Kungrad, Muynak, Urgench and Khiva, with a total population of about 500,000) in the Aral Sea region are the AmuDarya River or canals, while two of these cities use groundwater as the source of water supply.

The quality of raw water has, however, been deteriorating year after year due to industrial effluents and agricultural waste waters returning to the river. The quality of treated water at times does not satisfy the Uzbekistan Standards by some parameters. The existing system of water quality management with regard to agricultural chemicals and heavy metals, is inadequate compared to International Standards. In addition, the present water charges are low, therefore, management efficiency cannot be guaranteed.
In order to supply better quality water, the GOU is implementing a project for constructing

reservoirs and water intake and treatment facilities at Tuyamuyun by shifting the water intake to the upstream part of Amu Darya river, and constructing two pipelines to deliver the treated water to the cities in the Aral Sea region. The quantity of water supplied on completion of this project is considered to be adequate for this region.

In view of this background, the GOU requested the GOJ in April 1993 to study the water supply project for the six cities mentioned above and to recommend necessary improvements. On receipt of this request, the JICA conducted a Preliminary Study in October of the same year, and in March 1994, agreed on the Scope of Work for the Study.

The Study Team consisting of nine experts from the consultants selected to carry out the Study, was dispatched to Uzbekistan from September 11 to November 9, 1994 to undertake the Study of the First Works in Uzbekistan.

## 1.2 Objective of the Study

The objective of the Study includes : 1) formulation of the basic plan for water supply in the six cities of the Aral Sea Region for improving water quality, institution, and financial/management of the water supply service, and 2) for implementing of a feasibility study for priority project(s) selected under the basic plan. Another objective is the transfer of technology to the counterparts through implementation of the Study.

## 1.3 Study Area

The Study Area includes the six cities of the Aral Sea Region : Nukus, Chimbai, Kungrad and Muynak in the Republic of Karakalpakstan (hereinafter referred to as the "ROK" or "Karakalpakstan"), Urgench and Khiva in Khorezm Province(hereinafter referred to as "Khorezm"), and the Tuyamuyun hydro-system from where raw water is withdrawn and delivered to the Tuyamuyun-Nukus and Tuyamuyun-Urgench water treatment plants. The existing intake points of the Amu Darya River and canals are also included in the study area because water quality studies for these locations are to be conducted at the Research Institute of the State Committee for Nature Protection at Tashkent. Other water quality studies are implemented at the Research Institute in Nukus and Urgench.

In addition to these six cities, there are 17 main cities in the Republic of Karakalpakstan and 11 main cities in Khorezm Province including regional centers. In some cases, especially, in estimating water demand, it is necessary to analyze water supply conditions of these cities in the Study. The location map of these cities and regions is shown in the figure 1.1 and the table 1.1.

Water in rural areas is being supplied through water mains as well, and sometimes from local intakes.

**Table 1.1 Administrative-Territorial Regions of Karakalpakstan and Khorezm**

| Karakalpakstan Center; Nukus | | | Khorezm Center; Urgench | | |
|---|---|---|---|---|---|
| No City name | | | No City name | | |
| 1 Nukus<br>2 Beruni<br>3 Kungrad<br>4 Takhiatash<br>5 Turtkul<br>6 Khodjeili<br>7 Chimbai | | | 1 Urgench<br>2 Druzhba<br>3 Khiva | | |
| Region name | No. in Fig.1 | Regional Center | Region name | No. in Fig.1 | Regional Center |
| 1 Amudarya | 12 | Mangit | 1 Bagat | 9 | Bagat |
| 2 Beruni | 13 | Beruni | 2 Gurlen | 1 | Gurlen |
| 3 Bozatau | 3 | Kazanketken | 3 Koshkupyr | 5 | Koshkupyr |
| 4 Karauzyak | 5 | Karauzyak | 4 Urgench | 4 | Karaul |
| 5 Kegeili | 7 | Kegeili | 5 Khazarasp | 10 | Khazarasp |
| 6 Kungrad | 1 | Kungrad | 6 Khanka | 8 | Khanka |
| 7 Leninabad | 9 | Leninabad | 7 Khiva | 6 | Khiva |
| 8 Muynak | 2 | Muynak | 8 Shavat | 3 | Shavat |
| 9 Nukus | 10 | Akmangit | 9 Yangiaryk | 7 | Yangiaryk |
| 10 Takhtakupyr | 6 | Takhtakupyr | 10 Yangibazar | 2 | Yangibazar |
| 11 Turtkul | 15 | Turtkul | | | |
| 12 Khodjeili | 11 | Khodjeili | | | |
| 13 Chimbai | 4 | Chimbai | | | |
| 14 Shumanai | 8 | Shumanai | | | |
| 15 Ellikkala | 14 | Bustan | | | |

Note : Location of regions and regional centers are given in Fig. 1.

## 1.4 Scope of the Study

### 1.4.1 Scope of the Whole Study

The study will be implemented in the two phases described below. For details of study items and implementation schedule, refer to the Inception Report. The phases are described below.

Phase 1 Formulation of a basic plan related to improvements in water quality and water supply institution and management

A basic plan will be formulated for improving the water supply facilities with emphasis on improving the quality of water supplied to the six cities. A basic plan will also be formulated for improving the institution and the management for efficient operation of the system. Studies related to quantity of water supplied will be restricted to those relating to increase in water supply quantity and operation efficiency which accompany functional improvements to the treatment plants. The target year for the basic plan will be finalized after discussions with the Uzbek Side.

Phase 2 Implementation of feasibility study for priority project(s)

A feasibility study will be implemented for priority project(s) selected from the basic plan for improving water quality. The project(s) for the feasibility study will be selected after careful consideration of investment possibilities, and the technical and institutional aspects will be studied to formulate a project that is also acceptable socially.

Both phases consist of the study items below.

Phase I : Basic plan study

1. Collection and review of the following data
   a. Social and economic conditions
   b. Natural conditions
   c. Ongoing and planned water supply projects
   d. Topographical, geological, and hydrological maps and data
   e. Existing water sources
   f. Existing water supply systems
      - Existing treatment plants
      - Existing and planned transmission lines
      - Existing distribution networks
   g. Management system, laws and regulations on water works
2. Water quality survey and analysis
   a. Water sources for six cities
   b. Treated water
   c. Tap water
3. Water demand study
   a. Unit consumption
   b. Distribution amount

4. Environmental study
5. Formulation of basic plan
   a. Delineation of planning framework ( service area, water quality, water demand etc.)
   b. Determination of goals and targets
   c. Analysis of alternatives for systems and facilities for improving drinking water quality
   d. Operation and maintenance plan
   e. Rough estimation of cost
   f. Recommendations for institution and management
   g. Initial environmental examination
   h. Project evaluation
   i. Implementation plan
   j. Identification of priority project (s)

Phase II: Feasibility study

1. Confirmation of planning framework
2. Supplementary data collection and analysis
3. Preliminary design
4. Operation and maintenance plan
5. Cost estimation
6. Plan for strengthening the institution and management
7. Environmental impact assessment
8. Project evaluation
9. Implementation plan

### 1.4.2 Study Schedule

The schedule for the study is shown in figure 2.

## 1.5 Composition of the Reports

JICA shall prepare and submit the following main and summary reports in Russian and English to the Uzbek side. Progress Report (2) will be submitted to the Uzbek side at the end of the third field study. The schedule for submission of reports is shown in figure 2.

Phase 1

1. Inception Report
Twenty (20) copies in Russian and English at the beginning of the first field study in Uzbekistan.

2. Progress Report (1)
Twenty (20) copies of main report in English and twenty (20) copies of the summary report in Russian at the beginning of the second field study in Uzbekistan.

3. Progress Report (2)
Twenty (20) copies of main report in English and twenty (20) copies of the summary report in Russian at the end of the third field study in Uzbekistan.

4. Interim Report
Twenty (20) copies of main report in English and twenty (20) copies of the summary report in Russian at the beginning of the fourth field study in Uzbekistan.

Phase 2

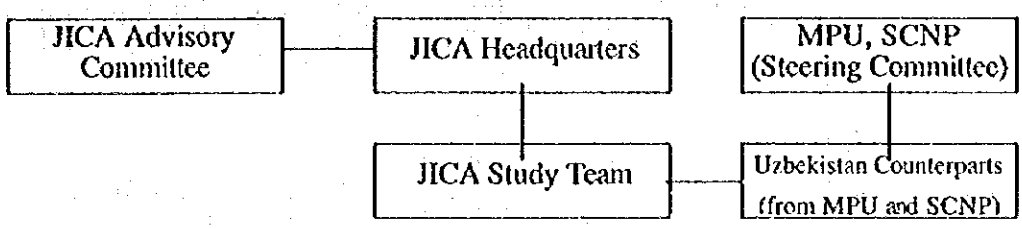
5. Draft Final Report
Twenty (20) copies of main report in Russian and English at the beginning of the sixth field study in Uzbekistan.
The Government of Uzbekistan shall submit its comments within one (1) month after the receipt of the Draft Final Report.

6. Final Report
Forty (40) copies of main report in Russian and English within two (2) months after JICA's receipt of the said comments on the Draft Final Report.

## 1.6 Organization and Staffing

The study was conducted by the JICA Study Team under the guidance of the JICA Advisory Committee and with the cooperation of the Uzbekistan counterparts. The counterparts are mainly from the State Committee of Uzbekistan for Nature Protection (SCNP) and from the Ministry of Public Utilities (MPU).

The overall organizational structure is shown below.




Steering Committee (from MPU and SCNP)

Co-Chairmen:

Co-Chairmen of the Steering Committee are the Deputy Minister of the MPU in charge of Water Supply and the First Deputy Chairman of the SCNP in charge of Water Resources.

Secretaries-Coordinators:

MPU Deputy Head, Department of Supplies.

SCNP Deputy Chairman

Members:

1) MPU Representatives

Central Level:

Head, General Department of Water Supply and Ecology
Head, Department of Economics and Prognosis
Leading Specialist, Group of Foreign Economic Relations
Director, Design Office "Uzbekkommunalloiiha"
Chief Engineer, Design Office "Uzbekkommunalloiiha"
Leading Specialist, Design Office "Uzbekkommunalloiiha"
Chief Engineer of Projects, Design Office "Uzbekkommunalloiiha"

Local Level:

Republic of Karakalpakstan

Deputy Minister of the MPU of Republic of Karakalpakstan-Head
Director, Production Department "Suvokava" (Water Supply and Sewerage Authority)
Director, Department of Repairs and Management of Tuyamuyun-Nukus Inter-regional Water Pipeline

Khorezm (oblast) Province

First Deputy Head-Chief Engineer, Territorial Public Utilities Corporation of Khorezm Province

Director, Production Department "Suvokava" (Water Supply and Sewerage Authority)

Director, Department of Repairs and Management of Tuyamuyun-Urgench Inter-regional Water Pipeline

2) SCNP Representatives

Central Level:

Manager, State Specialized Inspection Agency for Analytical Control (GosSIAK)

Manager, Tashkent Research Institute VodGeo

Local Level:

Republic of Karakalpakstan

First Deputy Chairman of the SCNP of Karakalpakstan in charge of Water Resources

Manager, Republic Inspection Agency for Analytical Control

Manager, Republic Inspection Agency for Protection and Usage of Water Resources

Khorezm (oblast) Province

First Deputy Chairman of the Province Committee on Nature Protection in charge of Water Resources

Manager, Provincial Inspection Agency for Analytical Control

Manager, Provincial Inspection Agency for Protection and Usage of Water Resources


**Fig. 1.1 Location Map of Cities and Regions in Karakalpakstan and Khorezm**

( For the numbers in the map, refer to the table 1.1 )

## Fig. 1.2 Study Schedule

| Year | 1994 | | | | | 1995 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Aug. | Sep. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. |
| Work in Uzbekistan | | □ | ——— | □ | | | □ | ——— | □ | | | | | □ |
| Work in Japan | □ | | | | | | | | | | | | | |
| Submission of Reports | | IC/R | | | | | | | | P/R (1) | | | | |
| Phase | P h a s e I | | | | | | | | | | | | | |
| | | | | 1996 | | | | | | | | | | |
| Month | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | |
| Work in Uzbekistan | □ | | | | | □ | | □ | ——— | □ | | | □ | |
| Work in Japan | | □ | ——— | □ | | | | | | □ | ——— | □ | | □ |
| Submission of Reports | P/R (2) | | | | | IT/R | | | | | | | DF/R | F/R |
| | | | | | | | P h a s e 2 | | | | | | | |

IC/R : Inception Report
P/R(1) : Progress Report (1)
P/R(2) : Progress Report (2)
IT/R : Interim Report
DF/R : Draft Final Report
F/R : Final Report

# CHAPTER 2

# GENERAL CONDITIONS AND STUDY BACKGROUND

# CHAPTER 2 GENERAL CONDITIONS AND STUDY BACKGROUND

## 2.1 Natural Conditions in Uzbekistan

### 2.1.1 Topography

Uzbekistan (447.4 $km^2$ in area,) is located in Central Asia (Fig. 2.1). The eastern part of the country faces the Tienshang and Zcravshansky mountains several thousand meters high, while the western part faces the Aral Sea which is about 38 meters above sea level. The central part of the country is a large desert called Kyzylkam Desert which was formed because wet trade winds from the Indian Ocean were intercepted by the mountain ranges of Tienshang, Gizal and Alai, stretching across the eastern and southern parts of the country, and converted to dry winds.

There are two large rivers, the Amu Darya River in the southern part, and the Syr Darya River in the northern part of the country. The Amu Darya river, flowing from the mountains to the Aral Sea, originates in the eastern mountains of Tajikistan and flows through the middle of the desert in Turkmenistan and Uzbekistan.

Many large canal systems drawing water from the Amu Darya river have been constructed in Uzbekistan and Turkmenistan, mainly for irrigation.

### 2.1.2 Geology

To the east, the country has boundaries with the republics of Kirgiz and Tadzhikistan, and it is located under the high-mountainous zone of Tienshang and the Pamir Highland. Except the river basin of Syr Darya which has a 100 km-wide basin, the area is new tertiary and/or lower quaternary. The area in the highland consists of Cretaceous complexes mainly appearing as intensive rocks. The Turkistan and Gissar mountains ranges in south central Uzbekistan and north-west of Tadzhikistan form an "anticlinal ridge", and has mainly the geological belt zones of intrusive rocks. Also in some areas in the central/western desert, such as Kulkduk and Tamdybulak, the intrusive rocks are being exposed by folding. Other desert/steppe areas in the western part of the country, such as both sides of the Amu Darya river, and Karakalpakstan surrounding the Aral Sea, are mainly covered by quaternary deposits of the Aral-Caspian basin.

### 2.1.3 Climate and Hydrology

The country has high mountains in the east and wide desert and steppes in the west.

### (1) Temperature

The average temperature is about 11°C in the desert area surrounding the south Aral Sea and about 13°C in the steppes area surrounding Tashkent located in the eastern part of the country as shown below.

**Table 2.1 Temperature by Month**

(unit: °C)

| | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Ave. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| desert area | -2.9 | -2.4 | 3.5 | 13.6 | 19.2 | 27.3 | 28.4 | 26.1 | 19.1 | 9.9 | -4.2 | -5.0 | 11.1 |
| steppes area | -6.2 | 2.7 | 7.3 | 14.5 | 20.1 | 24.8 | 27.1 | 24.8 | 19.1 | 12.6 | 5.4 | 0.9 | 13.1 |

### (2) Precipitation

The annual precipitation in the high mountainous area in the east is over 1,500 mm, while in the steppes area surrounding Tashkent, it is 417 mm, as shown below.

**Table 2.2 Precipitation by Month**

(unit: mm)

| | Jan. | Feb. | Mar | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| desert area | 19 | 6 | 16 | 23 | 18 | 2 | 4 | 1 | 1 | 0 | 58 | 21 | 169 |
| steppes area | 49 | 51 | 81 | 58 | 32 | 12 | 4 | 3 | 3 | 23 | 44 | 57 | 417 |

### (3) Humidity

The humidity fluctuates from about 40% in summer to about 90% in winter, and the average humidity is about 60% as shown below.

**Table 2.3 Humidity by Month**

(unit: %)

| | Jan. | Feb. | Mar | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Ave. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| desert area | 79 | 70 | 62 | 48 | 44 | 44 | 50 | 48 | 49 | 53 | 80 | 91 | 60 |
| steppes area | 74 | 69 | 67 | 60 | 55 | 44 | 40 | 44 | 46 | 56 | 67 | 75 | 58 |

### (4) Hydrology

Almost the total area of the country lies on the Aral Sea Basin, west of the Pamir Mountains and has two large rivers, the Syr Darya in the north and the Amu Darya in the south, flowing from the eastern high mountainous area to the Aral Sea traversing the country.

The annual average flow rate downstream of the Amu Darya river and the Syr Darya river is shown below:

**Table 2.4 Annual Average Flow Rate of Syr Darya river**

(unit : $m^3$/sec)

| Year | 1966 | 1970 | 1975 | 1980 | 1985 | 1990 | 1993 |
|---|---|---|---|---|---|---|---|
| flow rate | 203 | 205 | 68 | 106 | 90 | 103 | 177 |

Location : Urtepe village of 7 km from the mouth of Aral Sea

**Table 2.5 Annual Average Flow Rate of Amu Darya river**

(unit : $m^3$/sec)

| Year | 1966 | 1970 | 1975 | 1980 | 1985 | 1990 | 1993 |
|---|---|---|---|---|---|---|---|
| flow rate | 1,160 | 1,025 | 360 | 294 | 71 | 217 | 491 |

Location : Chatli village of 230 km from the mouth of Aral Sea (from 1974, Samambay of 215 km from the mouth)

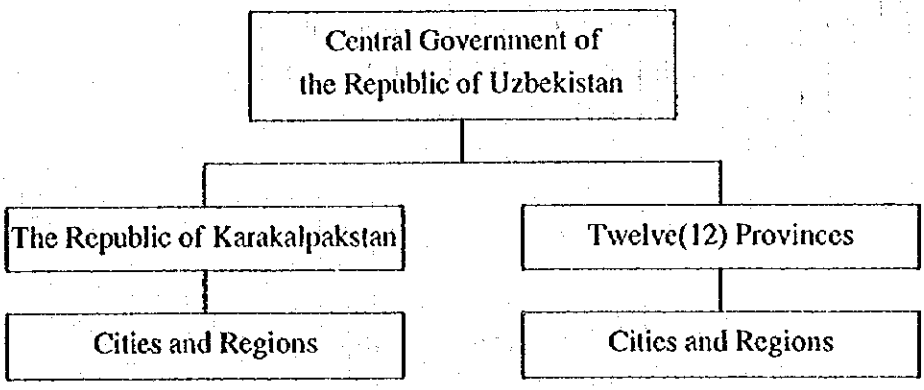
## 2.2 Socioeconomic Conditions in Uzbekistan

Uzbekistan was established in 1924 as the fourth republic of the former Soviet Union (USSR). Since 1924 it was one of the 15 republics in the USSR, until it became an independent country in 1991. The ROU is now one of the member countries of the CIS.

### 2.2.1 Social Aspects

#### (1) Administration

The Republic of Uzbekistan consists of the ROK and 12 Provinces, and includes 118 cities and 157 rural regions. The relationship between the Central Government, the ROK and twelve (12 ) Provinces is shown in following chart.



## (2) Political Situation

The political Situation is summarized below, referring to Country Report 1995, 4th. Quarter by the Economic Intelligence Unit (EIU).

### 1) Political Structure

i) Official name: Republic of Uzbekistan

ii) Legal System: The former Soviet republic of Uzbekistan declared its sovereignty in 1991. A new constitution was adopted on December 8, 1992, declaring Uzbekistan a multiparty democracy and a presidential republic.

iii) National legislature: Unicameral legislature

iv) Head of state: President of Republic of Uzbekistan, Islam Karimov

v) National government: Cabinet of Ministers, headed by the chairman, Islam Karimov

### 2) Policy Aims

According to the EIU report, the president, Islam Karimov, laid out his domestic policy aims during the fourth anniversary celebrations of Uzbekistan's independence. Mr. Karimov stated his mission statement for Uzbekistan. He aims to:

- ensure stability ;
- create a class of property owners ;
- end the dependency culture; and
- foster greater pride in Uzbek independence.

## (3) Population

Uzbekistan has the largest population of the four Central Asia Republics amounting to 21.7 million in 1993, 60 percent of which live in rural communities. The population of Tashkent, the capital of the Republic, is over 2 million. The current population growth rate and density are 3.4 % and 48.5 persons per $km^2$, respectively.

The population consists of Uzbeks (71%), Russians (8%), Tajics (4%) Kazafs (4%) and Tatars (2%).

The demography by administrative regions in 1993 is shown below;

**Table 2.6 Demography by Administrative Regions in 1993**

| Names of the Regions | population thousand persons | Territory thousand km² | population Density persons / km² |
|---|---|---|---|
| Karakalpakstan | 1,344.3 | 165.3 | 8.1 |
| Province | | | |
| Andijan | 1,881.2 | 4.2 | 447.9 |
| Bukhara | 1,262.1 | 40.4 | 31.2 |
| Jizak | 831.8 | 20.5 | 40.6 |
| Kashka Darya | 1,813.0 | 28.6 | 63.4 |
| Navoi | 718.5 | 110.9 | 6.5 |
| Namangan | 1,651.5 | 7.4 | 223.2 |
| Samarkand | 2,324.4 | 16.8 | 138.4 |
| Surkhan Darya | 1,449.6 | 20.1 | 72.1 |
| Syr Darya | 598.3 | 5.0 | 119.7 |
| Tashkent | 4,370.2 | 15.6 | 280.1 |
| Fergana | 2,341.1 | 6.8 | 344.3 |
| Khorezm | 1,132.2 | 6.4 | 176.9 |
| Total | 21,718.2 | 447.4 | 48.5 |

### 2.2.2 Economy

#### (1) Current Economic Situation

Since the collapse of the Soviet Union, the country has been facing various difficulties such as inefficient production and highly monopolistic market structure, then gradual price liberalization, and an economic reform program for transition to a market-based economy.

The program of macroeconomics stabilization and reforms in 1995 was aimed at achieving the following priority goals:

- bringing down inflation rate
- expediting system changes and structural changes in the economy
- preventing the fall of production levels
- improving of the balance of payments
- providing social security for the population

#### (2) Economic Indicators

Based on the EIU Country Report, 1995 4th. Quarter, the major economic indicators of Uzbekistan, given in the roubles, are shown as following table.

Table 2.7 Economic Indicators by EIU

| | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|
| GDP at current prices Rb bn. | 32 | 61 | 447 | 4,428 | 46,971 |
| GDP at purchasing power parity us$ bn. | 61.2 | 63.4 | 58.0 | 58.3 | 58.3 |
| Real GDP growth | 1.6 | -0.5 | -11.1 | -2.4 | -2.6 |
| Consumer price inflation % | 3.1 | 82.2 | 645.0 | 534.0 | 746.0 |
| Export Rb mil. | 9,801 | 19,535 | 869 | 721 | 943 |
| Import Rb mil. | 14,662 | 21,475 | 929 | 958 | 1,121 |
| Trade balance Rb | -4,861 | -1,940 | -60 | -237 | -178 |

note; September 11, 1995 Sum31.5 : us$1
EIU estimates

## (3) Economic Activity

### 1) Outline

Agriculture was the main activity in Uzbekistan when it was part of the former USSR. The USSR developed the desert area between Amu Darya and Syr Darya rivers into irrigated farmland using the water of both rivers, aiming to increase the agricultural products, mainly cotton. Newly-irrigated farmland developed over the last thirty five years accounts for more than seven million ha.

Other important developments were in the mining industry - gold, silver, copper, etc. in the eastern part of the country, and the manufacturing industry - construction machines, chemicals and building materials, etc.

As for the energy industry, the country is self-sufficient in natural gas and electricity, but coal and petroleum are in short supply necessitating outside procurement. Recently, large efforts are being made for increasing oil production with the foreign capital.

For future development, it is important to make changes in the main framework of industries, to shift from the production of raw materials to value-added manufacturing goods, which will contribute to the country's balance of payment.

### 2) Agriculture

Major agricultural activities are shown in the following tables

## Table 2.8 Amount of Agricultural Products in Uzbekistan

(unit: million Rouble)

| | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|
| Total | 10,031.2 | 10,456.2 | 11,113.7 | 10,993.6 | 11,047.8 |
| Farm Products | 7,289.4 | 6,691.9 | 7,043.6 | 6,671.9 | 6,737.8 |
| Grain | 400.6 | 316.9 | 363.5 | 367.7 | 401.9 |
| Potato | 59.0 | 62.1 | 64.3 | 67.1 | 83.6 |
| Vegetables & Melon | 967.4 | 938.3 | 998.5 | 1,102.5 | 1,169.8 |
| Fruit | 705.5 | 534.8 | 748.4 | 547.5 | 737.0 |
| Cotton | 4,462.9 | 4,170.9 | 4,240.3 | 3,854.3 | 3,569.2 |
| Livestock Products | 3,641.8 | 3,764.3 | 4,070.1 | 4,321.7 | 4,313.0 |

Source: SCFS, Uzbekistan

## Table 2.9 Cotton Production in Uzbekistan

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|
| Output (ths. tons) | 5,058 | 4,646 | 4,128 | 4,264 | 3,935 | 3,970 |
| Yield (tons/ha) | 2.76 | 2.70 | na | 2.60 | 2.57 | 2.56 |
| % output change on previous year | -4.4 | -8.1 | -11.1 | 3.3 | -7.8 | 0.9 |

Source: World Bank, Uzbek authorities

## Table 2.10 Grain Production in Uzbekistan

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|
| Output (ths. tons) | 1,899 | 1,908 | 2,257 | 2,101 | 1,500 | 3,190 |
| Yield (tons/ha) | 1.88 | 1.72 | 1.86 | na | 2.28 | 1.86 |

Source: World Bank, Uzbek authorities

### 3) Manufacturing Industry

Industrialization has not progressed in the country, but there are small scale cotton processing plants and machine manufacturing plants manufacturing various farm tools, cotton gin machines, cotton seed squeezing machines and so on, which have more relevance to cotton growing.

Besides, the manufacture domestic food products, products for manufacturing industry, and chemical products such as chemical fertilizers, agricultural chemicals, shows an increasing trend.

#### 4) Mining Industry

The country is rich in natural resources. There are many mines producing about 90 kinds of mineral resources including gold, silver, copper, zinc, lead, saltpeter, rare metals. It is rich in energy resources such as oil, coal and uranium ore, but investments for developing these natural resources are at a low level.

## 2.3 Water Supply and Sanitation Service

### 2.3.1 Water Supply Policy and Systems[1]

The policies and systems in Uzbekistan's water supply sector were developed by the central government of the former Soviet Union. After independence in 1991, the Government of Uzbekistan changed the system to suit the new socioeconomic policies of the country. The policies relating to water rights give priority to domestic water. After independence, greater emphasis was laid on drinking water in line with the policy. Low tariffs were set on domestic water supply to make drinking water accessible to citizens at a reasonable price by many provincial authorities.

### 2.3.2 Water Supply and Sanitation Service

In 1995 Public waterworks (or Centralized waterworks) supplied 84.6% of the water demand in urban areas and 59% of the water demand in rural areas as shown in the following table . The remaining quantity is obtained from wells and surface water. Water is available in many areas, but the quality of water, is a problem in some areas showing presence of mineralization, total hardness, agrochemical and phenol.

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[1] This Section is mainly derived from the report "Needs Assessment for the Proposed Uzbekistan Water Supply, Sanitation and Health Project".

**Table 2.11 Percentage of Population Served by Centralized Water Supply**

as of Jan. 1st (unit: %)

| Name of the regions | 1990 | | 1991 | | 1992 | | 1993 | | 1994 | | 1995 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Urban | Rural | Urban | Rural | Urban | Rural | Urban | Rural | Urban | Rural | Urban | Rural |
| Republic of Uzbekistan | 81.0 | 52.0 | 82.0 | 55.0 | 82.5 | 56.0 | 83.0 | 57.6 | 84.0 | 58.9 | 84.6 | 60.0 |
| Karakalpakstan | 66.0 | 21.4 | 76.5 | 33.7 | 77.0 | 35.4 | 80.0 | 38.7 | 82.9 | 70.5 | 83.7 | 32.1 |
| Andijan | 79.0 | 69.0 | 73.5 | 71.3 | 75.0 | 70.2 | 78.0 | 70.7 | 83.0 | 71.1 | 83.4 | 71.6 |
| Bukhara | 80.0 | 23.0 | 81.0 | 18.8 | 81.5 | 26.0 | 82.0 | 28.4 | 83.0 | 30.8 | 83.3 | 33.5 |
| Dzhizak | 76.0 | 47.7 | 84.0 | 68.6 | 84.5 | 51.8 | 85.0 | 53.0 | 86.0 | 54.8 | 86.4 | 55.3 |
| Kashkadarin | 69.0 | 52.7 | 76.0 | 40.0 | 76.5 | 55.0 | 77.0 | 56.2 | 82.0 | 56.9 | 84.8 | 60.0 |
| Navoi | | | 83.0 | | 83.5 | | 84.0 | 34.0 | 85.0 | 36.4 | 85.7 | 44.8 |
| Namangan | 77.0 | 62.3 | 84.0 | 72.0 | 85.0 | 63.0 | 86.2 | 63.6 | 86.5 | 64.1 | 86.7 | 64.6 |
| Samarkand | 85.0 | 47.7 | 80.0 | 48.5 | 80.5 | 50.1 | 81.0 | 53.1 | 82.0 | 54.1 | 83.0 | 55.1 |
| Surkhandarya | 76.0 | 54.1 | 78.0 | 68.3 | 79.0 | 60.8 | 81.0 | 62.9 | 82.0 | 63.5 | 83.0 | 64.0 |
| Syrdarya | 90.0 | 87.8 | 88.0 | 82.6 | 89.0 | 87.8 | 90.0 | 87.9 | 91.0 | 87.9 | 91.3 | 88.1 |
| Tashkent | 86.0 | 68.7 | 90.0 | 69.1 | 90.1 | 69.0 | 90.2 | 76.8 | 90.0 | 76.8 | 90.6 | 77.1 |
| Fergan | 86.0 | 62.2 | 86.0 | 63.9 | 87.0 | 63.7 | 88.0 | 64.6 | 89.0 | 65.4 | 89.5 | 66.1 |
| Khorezm | 80.0 | 23.2 | 77.0 | 31.0 | 79.0 | 47.6 | 80.0 | 54.2 | 80.2 | 55.2 | 81.0 | 57.2 |
| Tashkent city | | | 93.2 | | 93.7 | | 94.0 | | 95.1 | | 95.3 | |

46% of the urban population is covered by centralized sewerage systems. In the rural areas these are practically non-existent. Sewerage systems managed by the MPU of Republic of Uzbekistan have been partially provided in 61 urban settlement.

For increasing cotton production in the desert area, a large quality of chemical fertilizers has been used. For instance, in the former Soviet Union, the average quantity of chemical fertilizers used was 2.5 kg/ha/year, while 30-50 kg/ha/year of 60 types of chemical fertilizers were used in Uzbekistan. As a result, agricultural chemical residue was detected in 14% of the reservoirs in the Karakalpakstan, 90% of which exceeded the maximum permissible content for human consumption. Agricultural chemical residue has also been detected in 37% of the food samples and 32% of the milk samples in 1989.

A Decree on the supply of good quality water, especially to the rural population was adopted by the Government in 1990. The plans envisaged construction of 16,768 km of water mains, including 2,006 km in the urban areas (intake capacity 1,491 thousand $m^3$/day) and small pipelines of 14,727 km in the rural areas (capacity 207 thousand $m^3$/day). During 1990-1994 13,500 km of water pipelines were made operational, including 11,110 km in rural areas. This work continues even today.

## 2.4 Study Areas

### 2.4.1 Natural Conditions

#### (1) Topography

Karakalpakstan and Khorezm are neighboring territories situated north-west of Uzbekistan. Both Karakalpakstan and Khorezm occupy the western half of the Kizilcum desert, Amu-Darya delta and south-eastern part of the Usturt plateau. Both region are surrounded by Kazakhstan (Uztyurt plateau) in the north-west, Turkmenistan (Karakum desert) in the south and the Bukhara province of Uzbekistan in the east.

Karakalpakstan is situated on both the right and left banks of the lower Amu Darya river and is washed by the Aral Sea in the north. The study cities of Nukus and Chimby are located on the right bank, and Kungrad & Muynak are on the right and left bank. It occupies 37 % of the land area of Uzbekistan (164,900 $km^2$).

Khorezm is situated in the northwestern part of Uzbekistan, on the left bank of the Amu Darya river at its downstream end. In the north and east, it borders with Karakalpakstan; and in the south and west, with Turkmenistan. The province covers an area of 64,000 $km^2$, most of which contains cultivated and irrigated soils and meadows that cover 60 % of the area.

#### (2) Climate

The Study Area generally has a continental climate. The temperature fluctuates from 50°C maximum to -20°C minimum. There are storms in winter and dry dusty storms in summer.

The temperature and humidity conditions up to a 100-km zone roughly along the coast of the Aral Sea are influenced significantly by the sea. With the shrinkage in the area of the Aral Sea, the influence of the sea on the climate of the region in the vicinity of the Aral Sea has diminished. Summer has become hotter, winter colder, and frost can be observed as late as spring, and as early as autumn. Humidity has decreased, and in general, there is an increasing trend of the climate to approach the continental climate. A comparison of the climate of Kungrad, situated about 100 km from the Aral Sea, for the period 1935 to 1960, and the period 1960 to 1981, shows that the relative humidity has reduced significantly, and the average temperature in May has increased by 3 to 3.2 degrees.

Climatic characteristics of the two main cities Nukus and Urgench located in the Study Area are given below, based on observation data from 1991 to 1993.

### a. Temperature

The average annual temperature is as low as 10 to 13 degrees but features of a continental/desert climate are predominant, such as an extremely wide difference between maximum and minimum temperature. The maximum temperature occurs during the three summer months (June, July and August) and reaches nearly 45 degrees. After September, the temperature drops steeply and reaches -26 degrees during the winter months of December and January, indicating severe weather conditions with a temperature difference of nearly 70 degrees.

**Table 2.12 Monthly Average Temperature (1993)**

(unit : °C)

| | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nukus | -2.9 | -2.4 | 3.5 | 13.6 | 19.2 | 27.3 | 28.4 | 26.1 | 19.1 | 9.9 | -4.2 | -5.0 |
| Urgench | -1.4 | 0.8 | 5.2 | 14.7 | 19.9 | 27.3 | 28.3 | 24.9 | 18.6 | 9.6 | -1.7 | -3.0 |

### b. Humidity

The Study Area has features of a desert climate with very dry conditions of high temperatures and little precipitation in summer, with humidity of about 10% in summer. In contrast, the precipitation or snowfall is extremely heavy in winter, and the humidity reaches a high of 60 to 80% in winter.

**Table 2.13 Monthly Average Relative Humidity (1993)**

(unit : %)

| | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nukus | 79 | 70 | 62 | 48 | 44 | 44 | 50 | 48 | 49 | 53 | 80 | 91 |
| Urgench | 82 | 76 | 69 | 55 | 47 | 44 | 52 | 57 | 56 | 57 | 80 | 89 |

### c. Precipitation

In general, there is almost no rain in the four months of June, July, August and October. Precipitation starts gradually from the end of October. The annual precipitation is low at about 100 mm, and there is very little precipitation in the comparatively long period between winter to spring.

**Table 2.14 Monthly Precipitation (1993)**

(unit : mm)

| | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nukus | 19.2 | 6.6 | 15.6 | 23.2 | 17.7 | 1.5 | 3.7 | 0.6 | 0.7 | 0.2 | 58.4 | 20.6 | 168.0 |
| Urgench | 9.7 | 10.4 | 25.0 | 12.3 | 0.3 | 23.8 | 1.1 | 0.0 | 0.0 | 0.0 | 3.8 | 1.8 | 88.2 |

## (3) Hydrography and Hydrogeology of Amu Darya river[2]

### (a) Hydrography

The Hydrographic system is represented by the Amu Darya river, Tuyamuyun reservoir, irrigation and collector-drain network, and lakes.

Irregularity in annual flow distribution of Amu Darya river is expressed as follows; April to September take up to 80%, December to February take about 10% of total annual flow.

The regime shows steady characteristics, getting ice-bound in winter and drifting of ice in spring. Duration of drifting of ice is to 3.0 to 3.5 months. Ice-formation starts at the beginning of December, finishes at the end of February. The temperature of water in the river is +25°C in July, and +0.2 to +0.5°C in January.

The water in the Amu Darya river is characteristic of high turbidity. Its monthly average value is measured from 0.3 to 5.5 kg/m$^3$. Mineralization of water in the river in winter time changes from 0.5 to 2.1 g/l. In summer the mineralization of water decreases.

A large number of irrigation canals is typical for the left bank area. There are many lakes in the territory, whose water is salty.

The Tuyamuyun reservoir was constructed in the area of the lower Amu Darya river to re-distribute a part of the flow and to supply the population with domestic water. Natural depressions, such as Suitansanzhar, Koshbulak and Kaparas are reservoirs for regulating water within the range of the hydro-complex. The total useful volume of the reservoirs is 5.2 billion m$^3$ and the total volume is 7.36 billion m$^3$.

### b) Hydrogeology

The soils are represented by loess-like loam, inter-layered lenses of sand and gravel of thickness from 2 to 40 m by their geomorphologic structure.

Loamy soils are referred to the second type of subsidence. Soil water is deposited at a depth of 0.7 - 3.5 m in certain areas at a depth of up to 5 m. Soil water is fed by the underground inflow from the side of Amu Darya river and canals, and by infiltration of irrigation water and precipitation. Soil water is characteristic of varying mineralization from 0.7 to 50 g/l.

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[2] This Section is mainly derived from the report "Water Supply Master Plan of Karakalpakstan in 1992".

## 2.4.2 Socioeconomic Conditions[3]

### (1) Administration

The Republic of Karakalpakstan and the Khorezm Province are two administrative territories. The Republic of Karakalpakstan is a part of the Republic of Uzbekistan. There are 15 administrative regions incorporated into the Republic of Karakalpakstan and 30 cities and urban settlements. The capital is Nukus. Khorezm province has 10 administrative regions and three big cities: Urgench, the main city of the province, Durushaba and Khiva.

### (2) Population

Karakalpakstan has a population of 1.4 million. The population density is 8.5 people per $km^2$, one of the lowest in Uzbekistan (6 times lower than the average density of the country).

The Karakalpakstan population consists of three principal nationalities: Karakalpaks (32.3 %), Uzbeks (32.8 %), and Kazakhs (26.7 %). Turkmens (5 %) and other nationalities (3.2 %) account for a considerably smaller share of the population.

Between the urban and rural areas, the difference in population growth rates is relatively small. In addition, the infant mortality rate is much higher in Karakalpakstan than in the rest of the country with almost no difference between the urban and rural population.

The population of Khorezm is 1.2 million and the population density is 190.5 persons per $km^2$. The rural population accounts for 74.8 % of the population.

Ninety-five percent of Khorezm's population are Uzbeks. The age structure of the population is not unlike that of Karakalpakstan, except that the number of people younger than 19 years old is a little higher. In terms of other population characteristics, the birth rate in Khorezm is a little lower than in Karakalpakstan, but higher than the national average; the average family size is higher than in Karakalpakstan, and infant mortality is substantially lower than in Karakalpakstan (38.9 per 1,000 live births). The natural growth rate is similar in both regions. The average size of a family is higher in Khorezm than in Karakalpakstan.

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[3] This Section is mainly derived from the report "Needs Assessment for the Proposed Uzbekistan Water Supply, Sanitation and Health Project".

### (3) Economic Activity

Although officially only 51 % of the population is rural, agriculture provides the basic income to a larger share of the population. Even in the major cities of Nukus and Takhiatash, domestic garden agriculture is a major source of livelihood of many households. Indeed a large proportion of the water consumed by households connected to the piped water supply system serving urban and rural households is used to irrigate gardens. Agriculture is oriented to cotton growing, and to a lesser extent, rice growing and cucurbit cultivation. The most-developed industrial sectors are those dealing with processing of farm products, manufacture of construction materials, and metal-working.

Karakalpakstan is one of the poorest regions in Uzbekistan and the area hardest hit by the Aral Sea crisis. Fishing and related activities, which provided 50 % of the Republic's income prior to the crisis, were abandoned in the late eighties. Commercial shipping stopped at the about the same time. Agricultural output declined by 20 to 30 %, a direct result of soil salinization, climatic changes, and reduced labor efficiency associated with health problems. Consequently, an increasingly larger number of chemicals were needed to maintain a certain output level, leading to economic inefficiencies and further deterioration of cultivated land. Finally, Karakalpakstan's tourist industry along the southern shore of the Aral Sea was abandoned in the mid-eighties.

Cotton growing, Khorezm's main branch of agriculture, is threatened by the conditions of the Aral Sea. Economic losses from these conditions are due primarily to increasing soil salinization, which results in ever diminishing crop yields. Today, nearly 40 % of the agricultural land is considered saline and unfit for major crops.

## 2.5 Background to the Problems in the Aral Sea Area

### 2.5.1 Aral Sea Crisis

The Aral Sea is an inland lake into which flow the Syr Darya and Amu Darya rivers, which are the sources of water supply to the border regions of China and Afghanistan. After the Second World War, under the guidance of the Central Committee of the Soviet Communist Party a massive artificial irrigation scheme was developed to convert the barren Central Asian desert area into an agricultural granary. The result was that a massive irrigation scheme was put into operation, and 6,200,000 hectares of land used the waters of the two rivers mentioned above for irrigation.

However, the volume of water that flowed into the Aral Sea from the two rivers was approximately 50 $m^3$ in the sixties; with the irrigation scheme in operation, this volume of

water reduced drastically so that in the eighties there was practically no flow of water from the rivers into the Aral Sea. This resulted in a shrinkage in the area of the surface water in 1989 to 60% of the original area; in 1992, the Aral Sea split into a small Aral Sea in the west and the big Aral Sea in the east. With the drop in the water level, the salinity of sea water which was approximately 10,000 ppm in the sixties increased sharply to about 30,000 ppm in 1989. Again, with the reduction in the water level, the marshland in the surroundings started drying up, and animal and plant life disappeared from the area. Practically all marine life also disappeared because of the rise in salinity of the sea water and the change in the composition of salts. The annual catch of 40,000 tons of fish per year became zero.

Furthermore, defoliants were used in order to introduce mechanical pickers for picking flowers, then the main crop. Agricultural chemicals were used to develop the land in the upstream flower-cultivating areas, and these defoliants polluted the underground water and the river water; this water was used as drinking water in the downstream areas, resulting in the outbreak of various types of diseases. For instance, the percentage of diseases such as hepatitis, anemia, deformities in newborn children, miscarriage, etc. rose among people using this polluted water as drinking water, resulting in an infant mortality rate of 110 deaths per 1,000 live births in some areas. With increasing aridity, salt crystallized on the dry bed of the lake. Salt dust was blown by the wind over the surrounding area to cause salt damage to agricultural land and adverse affects on the health of the people, such as eye diseases.

Due to the introduction of the irrigation system, more than 40% of the cultivated land has suffered salt damage to some extent. The main cause for this is: that most of the canals carrying water for irrigating land from the rivers are not paved, resulting in leakage of water from the canals.

The result was that the level of underground water increased over a wide area in the vicinity of irrigation canals and arable land. The underground water with increased levels dissolved the salts in the soil, and as a result of the capillary phenomenon, the highly saline underground water was carried to the surface where the water evaporated forming salt precipitate and causing salt damage. This kind of damage to arable land occurred in all the republics of the Aral Sea region.

The complex and wide-ranging environmental damage cause may be attributed to the background described below.
The main reason for this state of affairs was the imperfect structure of the economy with heavy emphasis on the water-consuming agricultural sector, artificially implanted by the

Central (Moscow) Government. This, in turn, has slowed the pace of industrialization and urbanization creating a conforming employment structure. Other causes are:

(1) The Central Committee of the Soviet Communist Party by virtue of its supreme authority, promoted large-scale irrigation schemes in a region where the soil contained alkaline salts, and where salt damage was liable to occur easily. Furthermore, there was no coordinating and controlling organization that could contain the environmental damage during the implementation of the irrigation schemes; therefore, the spread of damage could not be restricted.

(2) There was a world-renowned scientific academy with research organizations under its umbrella which had to cooperate with the Central Government and participate in the large-scale project. Non-participation in the project would have resulted in funds for research for this community being cut off. Moreover, the scientific community had no freedom in selecting topics for research, nor any freedom for promoting and publishing their investigations. Consequently, there were many researchers who were compelled to work in fields in which they had no interest.

(3) The former Ministry of Melioration and Water Resources of the USSR concentrated on achieving its own narrow work targets specified by the center, neglected quality control of the work, and failed to assess the possibility of consequences and their scope.

(4) In collective farms, only the required quota of agricultural work was carried out; even when confronted with reduced yield of crops because of salt damage, no improvements in work were implemented by independent judgment.

In this way, the failure of environmental controls in the vicinity of the Aral Sea can be attributed more to the nature of the former communist system with centralized authority and irrational use of natural resources rather than a particular case of associated technology.

### 2.5.2 Health Conditions[4]

Poor sanitation and hygiene in Karakalpakstan and Khorezm, as well as unavailability of treated water from centralized water supply systems, especially rural areas and a general

[4] Most of the content is derived from the report "Needs Assessment for the Proposed Uzbekistan Water Supply, Sanitation and Health Project".

lack of awareness of the links between sanitation, hygiene, and health appear to be among the main causes of poor health in the Study Area. Although the direct causes of illnesses in the Study Area are not always clear, official statistics and the findings of the needs assessment of needs related show that these environmental conditions, among other causes, are having adverse effects on health. According to official statistics, the incidence of viral hepatitis, tuberculosis, cancer, and skin disease is increasing:

- **Childhood mortality.** In the Aral Sea Region child mortality is high, especially in Karakalpakstan, with 45 deaths per 1,000 births.
- **Viral hepatitis.** The incidence of this disease in Karakalpakstan increased over the past 10 years from 624 to 948 per thousand persons.
- **Tuberculosis.** During the period 1985 to 1991, the incidence of tuberculosis increased in Karakalpakstan from 66 to 97 per 100,000; in Khorezm, the incidence increased from 33 to 44. Among children, the incidence of tuberculosis increased from 13 to 27, and in Khorezm, from 14 to 24.

- **Cancer.** During the period 1985 to 1992, the incidence of cancer in Karakalpakstan increased from 163 to 183 per 100,000; in Khorezm, it rose from 210 to 249 cases.
- **Skin Disease.** In Karakalpakstan, there are 983 cases of skin disease per 10,000 (or twice the rate of the Republic as a whole) and in Khorezm, the incidence rate is 520 per 10,000. In children up to 14 years, there are 649 cases in Karakalpakstan (1.5 times the national rate) and 294 cases in Khorezm.

The WHO reported health conditions of this area in the report "Background Paper on the Health Dimension of the Aral Sea Crisis".

Literature abounds with statements concerning the health effects of the Aral Sea disaster and ill health due to environmental causes in the disaster zone. The degree of substantiation behind many of these assertions is sometimes found to be inadequate.

The principal health concerns in the disaster zone are reported diversely by different authorities, and include the following:

- kidney and liver disorders, arthritic diseases, chronic bronchitis, typhoid and hepatitis A which have increased dramatically in the last 10 - 15 years;
- reportedly high maternal and infant mortality rates;
- increased rate of congenital disorders;
- childhood diseases, typhoid, tetanus, etc. which are vaccine-preventable;
- waterborne diseases related to the unavailability of treated water and poor waste management in many small towns and villages, notably diarrhoeal diseases
- acute respiratory illnesses especially in childhood; and

- anemia - almost all women are anemic but it is extremely common in children and men also.

**Table 2.15 Cases of Disease**

(unit : cases of illness per 100,000 people)

| Place | Respiratory | Viral Hepatitis | Typhoid Paratyph | Cancer | Intestinal | Kidney etc. | Anemia | Dysentery |
|---|---|---|---|---|---|---|---|---|
| Karapalkia | 1,344.9 | 506.7 | 6.9 | 79.0 | 311.8 | 209.6 | 589.8 | 51.9 |
| Kazakhstan Syr Darya | 493.0 | 7,867.0 | 35.0 | na | 373.0 | na | na | na |
| Khorezm (UZB) | 685.6 | 497.4 | 3.4 | 57.0 | 787.0 | 166.9 | 237.9 | 37.7 |
| Tashauz (TURK) | 2,189.4 | 492.9 | 4.7 | na | 387.0 | na | 4,434.5 | 11.2 |

Source: Ministries of Health Protection, cited in The Bank/UNEP/UNDP, May/June 1993

The Epidemiological Services and Nutrition in Min. of Health have stressed high incidents of anemia among women, high mortality during pregnancy due to malnutrition or dietary imbalance, and handicapped children. These may be attributed to the drinking water with high salt content.

Table 2.16 shows incidence of urolithiasis and cholelithiasis, which might be caused by drinking water with highly salt content and high total hardness over extended periods. These diseases occur at a high rate all over the Uzbekistan, especially in adults in Karakarpakstan and Khorezm.

**Table 2.16 Incidence of Urolithiasis and Cholelithiasis in Karakalpakstan, Khorezm and Uzbekistan**

| | | Urolithiasis | | | Cholelithiasis | | |
|---|---|---|---|---|---|---|---|
| Year | | 1992 | 1993 | 1994 | 1992 | 1993 | 1994 |
| Karakalpakstan | | | | | | | |
| adults | ads. rate | 2,290 | 2,320 | 2,409 | 8,205 | 7,562 | 7,984 |
| | int. indic. | 352.7 | 349.1 | 356.2 | 1,264 | 1,138 | 1,181 |
| teenagers | ads. rate | 33 | 32 | 47 | 129 | 112 | 113 |
| 15 to 18 | int. indic. | 37.7 | 35.7 | 51.5 | 147.3 | 124.9 | 123.8 |
| children | ads. rate | 132 | 161 | 403 | 286 | 251 | 189 |
| up to 14 | int. indic. | 22.4 | 26.6 | 66.3 | 45.4 | 41.5 | 30.7 |
| Khorezm | | | | | | | |
| adults | ads. rate | 2,086 | 2,178 | 2,273 | 5,576 | 6,051 | 6,611 |
| | int. indic. | 383.7 | 387.9 | 394.6 | 1,026 | 1,078 | 1,148 |
| teenagers | ads. rate | 60 | 61 | 60 | 126 | 132 | 116 |
| 15 to 18 | int. indic. | 77.9 | 76.7 | 73.5 | 163.6 | 166.1 | 142.2 |
| children | ads. rate | 166 | 266 | 288 | 417 | 522 | 578 |
| up to 14 | int. indic. | 33.5 | 51.9 | 54.8 | 94.1 | 101.9 | 110.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Uzbekistan | | | | | | | |
| adults | ads. rate | 20,853 | 23,203 | 24,454 | 80,301 | 83,697 | 91,965 |
| | int. indic. | 186.3 | 202.9 | 235 | 717.4 | 731.9 | 687.5 |
| teenagers | ads. rate | 644 | 774 | 992 | 2,344 | 3,015 | 3,545 |
| 15 to 18 | int. indic. | 8.3 | 56.7 | 71.4 | 175.6 | 220.9 | 255.2 |
| children | ads. rate | 3,471 | 4,853 | 5,438 | 6,170 | 6,167 | 7,385 |
| up to 14 | int. indic. | 38.8 | 53.1 | 53.9 | 69.1 | 67.4 | 79.1 |

Source: Ministry of Public Health of Republic of Uzbekistan

Table 2.17-(a) and 2.17-(b) show incidence of various diseases in the Study cities of Karakalpakstan, where health of inhabitants is seriously affected by the Aral crisis. Among the cities, Muynak has a high incidence of total morbidity, active tuberculosis, cancer, bacterial, dysenteria and salmonerosis, comparing to the other cities and the whole of Uzbekistan.

**Table 2.17-(a) Cases of Disease in the Study Cities in Karakalpakstan in 1995**

| | Total mortality per 1000 | Infant mortality per 1000 | Total morbidity among adults and juveniles per 1000 | Morbidity among juveniles under 14 per 1000 | Active tuberculosis morbidity per 100000 | Cancer morbidity per 100000 |
|---|---|---|---|---|---|---|
| Kungrad | 6.8 | 41.8 | 1,385.7 | 797.8 | 101.3 | 53.6 |
| Muynak | 9.2 | 34.9 | 2,507.7 | 1,379.4 | 39.5 | 118.7 |
| Chimbai | 7.6 | 37.7 | 1,734.5 | 880.6 | 120.7 | 52.0 |
| Nukus | 5.8 | 39.0 | 759.8 | 1,081.1 | 99.6 | 84.2 |
| Nukus region | 7.0 | 55.3 | 1,626.2 | 867.4 | 88.3 | 49.7 |
| Karakalpakstan | 6.8 | 36.1 | 1,295.0 | 948.5 | 82.4 | 66.5 |

Source: State Committee for Natural Protection of Republic of Uzbekistan

**Table 2.17-(b) Cases of Disease in the Study Cities in Karakalpakstan in 1994**

| | Anemia per 10000 | Bacterial Dysenteria per 1000 | Hepatitis per 1000 | Salmonerosis per 1000 |
|---|---|---|---|---|
| Kungrad | 7.2 | 44.0 | 254.2 | 1.0 |
| Muynak | 10.1 | 135.4 | 142.5 | 50.8 |
| Chimbai | 32.3 | 8.4 | 149.2 | 1.2 |
| Nukus city | 4.5 | 152.1 | 196.6 | 33.6 |
| Karakalpakstan | 19.8 | 56.1 | 210.8 | 12.5 |

Source: State Committee for Natural Protection of Republic of Uzbekistan

## 2.6 Relevant Water Supply Projects

Water supply projects in the Study Area are reviewed.

### 2.6.1 Relevant Domestic Water Supply Projects

The main relevant water supply projects in the country are listed below.

a) Water Supply Master Plan for the Republic of Karakalpakstan and Basic Water Supply Project for the Khorezm Province
1984 project (project target year: 2000), 1990 project (project target year: 2005), 1992 project (project target year: 2010); the 1992 project is the latest project and is a revised version of the 1984 and 1990 projects.

b) Kungrad, Takhiatash, Khogeyli Water Supply Plan (UzTransGas in-charge)
Water Supply Project from Takhiatash Hydro-system through Kungrad-Kulsary Pipeline to the towns of Kungrad, Takhiatash and Khogeyli

c) Right Bank Collector Drain (RBCD) Project (Srdazgiprovodkhlopik Institute in-charge)
Right Bank Collector Drain (RBCD) of Amu Darya River

d) Rural Water supply was also carried out according to Basic Development Schemes and specific projects. The Schemes were worked out in correlation with the projects and Development Schemes for cities. (Source : SCFS)

The outlines of the above-mentioned projects are described below.

#### (1) Water Supply Master Plan

The Government of Uzbekistan recognized the deterioration in water quality in the downstream areas of the Amu Darya river since the beginning of the eighties because of large-scale use of agricultural chemicals and pesticides in the mid reaches and downstream areas of the Amu Darya river, salt damage to the agricultural lands, and contamination by sewage at the downstream end of the river. It has formulated a plan for maintaining water quality at the source, for assuring new and improved water supply sources, and for improving water treatment systems.

As a countermeasure, a plan has been formulated to store the downstream Amu Darya river water with comparatively good quality in July and September because of the melting of snow in the Kaparas Reservoir (useful capacity 550 million $m^3$), and to use this water to satisfy the water demand for the remaining nine months of the year.

As a result, plans were formulated to consolidate the Kaparas Intake Plant, the Tuyamuyun Water Treatment Plant and their distribution systems. As of today, the Kaparas Intake Plant is incomplete; a part of the Tuyamuyun Water Treatment Plant and distribution systems have been completed and are in operation.

The capacity of the Kaparas Reservoir satisfies the drinking water demands of the Republic of Karakalpakstan and the Khorezm Province in Uzbekistan, as well as the Tashauz Province in the Republic of Turkmenistan until 2005. The calculations of per capita daily water consumption rate were based on the 500-600 l/day per capita norm. Considering that by 2005 water meters will be installed in all places and water tariffs will increase considerably, the actual per capita daily water consumption will be about 250-300 liters per day, which gives rise to the hope that the capacity of Kaparas Reservoir will be adequate to satisfy drinking water needs of the region until the year 2010.
To account for cover the shortage of drinking water later on eight possible solutions were considered in the "Master Plan for Developing Water Supply and Sewerage in Cities, Towns and Regional Centers of Republic of Uzbekistan until the Year 2010". At this stage taking water from the upstream part of Amu Darya, upstream of Termez city in Uzbekistan, is considered the best option.

A project comprising Stage 3, described below, has been proposed as a countermeasure.

1. A plan has been proposed to set up drinking water bottling plants in the areas (Samarkhand, Kokan and Gazalkent) where drinking water (tap water) of good quality from the upstream areas of rivers is supplied so that drinking water in limited quantities can be sold, as an extraordinary measure until the Kaparas Intake Plant is completed.

2. Treatment processes such as activated carbon, chlorammonization and ozonization, water softening without desalinization should be used for treating the Kaparas Reservoir water in order to satisfy the drinking water quality standards.

3. As a final measure, good quality water from the upstream part of Amu Darya river should be used as the water source. To use this water, a canal to Tuyamuyun must be constructed by 2010. This project however, requires huge capital investment and its implementation in the next few years is unrealistic. That is why it is necessary to look for more technically and economically feasible projects.

This project has started; a part of the water supply facilities has been completed and some facilities are in operation but construction of the remaining part of the facilities has been

currently suspended because of the difficulties in procuring funds.

### (2) Kungrad, Takhiatash, Khogeyli Water Supply Project

Currently Urgench Transgas has been producing water for supply to some of the cities located on the west coast of Karakalpakstan. This water (treated water) is sold to the public waterworks corporation of the country and supplied by the corporation (VodoKanal). Water is also being supplied to Kungrad, one of the cities under investigation in this Study.

This plan envisages supply of water for gas pipeline facilities, particularly cooling water for pumps and compressors, and supply of tap water to inhabitants of the towns where gas pipeline facilities are installed, and to Kungrad, Takhiatash and Khogeyli. The water source is the Amu Darya river near Takhiatash.

### (3) Right Bank Collector Drain (RBCD) Project

This project is expected to contribute to the improvement in quality of water in the Amu Darya river; in future, it aims to improve the water quality in areas under the scope of the JICA Study. Consequently, this project is likely to influence the future of the Study, particularly the study on water resources. An outline of the project is given below.

A large number of collectors collect a large quantity of contaminated drain water that flows from irrigated land into the Amu Darya river. This polluted drain water degrades the water quality of the Amu Darya river excessively. The pollution sources for mineralized drain water are concentrated in the middle and lower regions of the river. The plan is to block and collect the polluted drain water at the middle and lower regions of the river before it flows into the Amu Darya river, prevent contamination of the river and improve the quality of water in the Amu Darya river. The mineral content in the water is expected to be reduced to below 1 g/l.

The collectors will stretch across Uzbekistan and Turkmenistan, and will be extended southward of Bukhara to the Aral Sea for a total length of 665 km and with an additional 100 km of branch collector drainage canals. This work will consist of three phases.

In Phase 1, the drain water on the Uzbekistan will be collected by collectors and discharged into the Dry Ancient River near the Aral Sea. This work is in progress, and a part of the work has been completed.

In Phase 2 and Phase 3, the drain water on the Turkmenistan side will be collected, finally all the drain water in the middle and lower regions of the river will be collected and diverted from the river. The discharged water, however, will be untreated water.

Note: Phase 1 is in progress currently; it has been delayed because of the difficulty in the procurement of funds. A World Bank loan is under consideration.

### 2.6.2 Aid Projects from Other Countries and International Organizations

#### (1) World Bank

The World Bank is considering policies from wide-ranging aspects relating to the environmental problems of the Aral Sea. A program of specific measures for improving the environment of Aral Sea Basin is given below.

i) Efficient water use and water-resource protection strategy (management and dams)
ii) Introduction of a water resource and environmental assessment program which shall be used for the whole Aral Sea Basin (hydro-and meteorological service, database on water use, its quality and environmental situation)
iii) Water quality management and control (irrigation water quality measurements and control etc. )
iv) Analysis of the environment of the Aral Sea Basin (land)
v) Pure water and health (5 countries in Central Asia)
vi) Long-term water supply and waste treatment strategy
vii) Automated management and procurement systems

#### (2) USAID

USAID is implementing a short-term project for improving the quality of drinking water. In order to improve drinking water supply facilities of the Aral Sea Region USAID has supplied the regional water pipelines with laboratory equipment for drinking water quality control, equipment for chlorination and water treatment facilities and has developed programs for ecological, sanitary and hygienic education of the local residents, training of water supply personnel.

### (3) Germany

The German Red Cross has established a Reverse Osmosis (RO) plant costing 2,000,000 marks at Takhtakupur in 1993. The capacity of this plant is 100 $m^3$/hour, or 2400 $m^3$/day. But due to the shortage of reagents used for desalination of water, the plant is operating for only 5-6 hours a day. As water consumption in Takhtakupur is 3,000 $m^3$/day the remaining volume of drinking water is covered by supplying the town with water from the Tuyamuyun-Nukus-Chimbay-Takhtakupur Regional Water Pipeline.

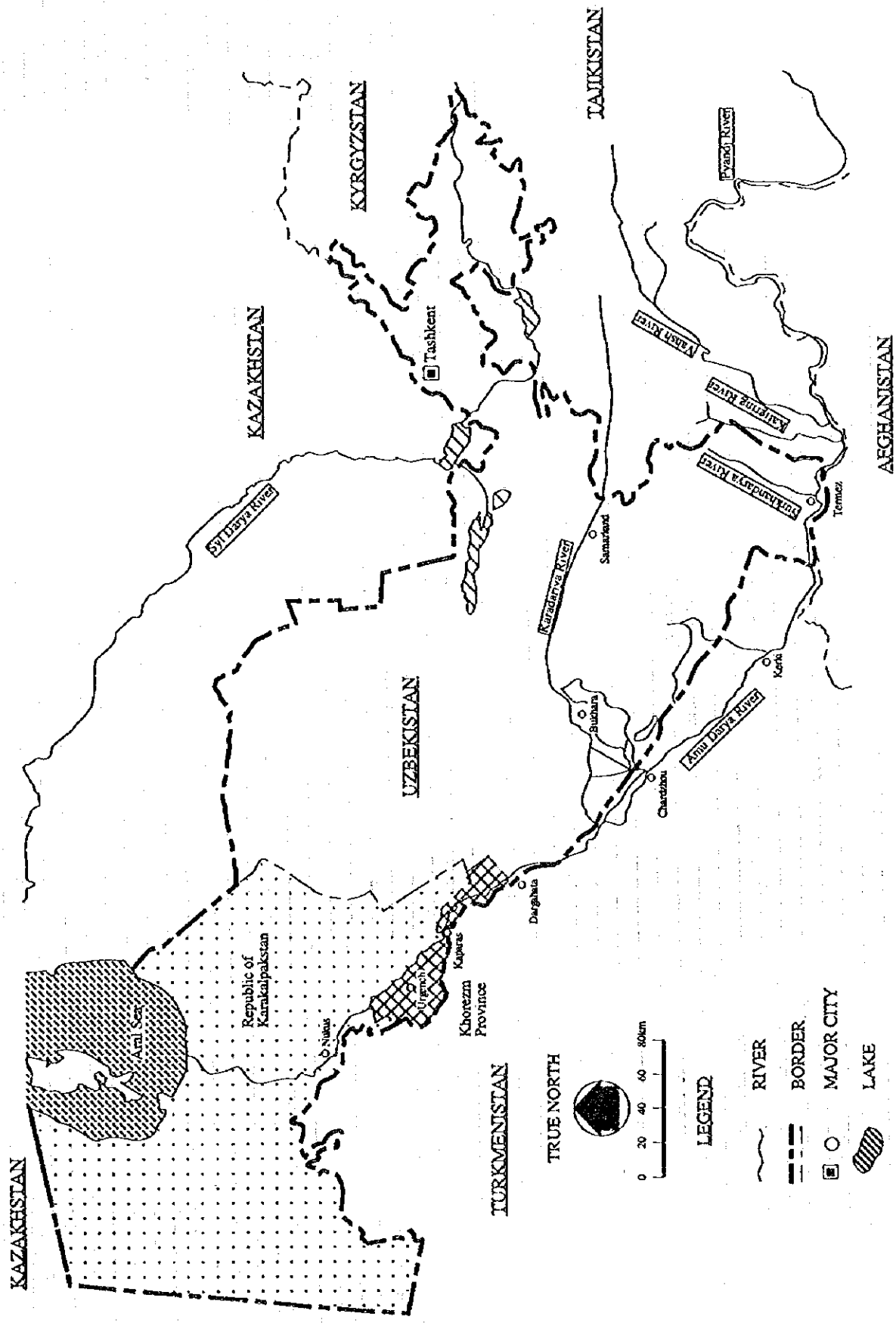



**Fig. 2.1 Map of Uzbekistan**

# CHAPTER 3

# EXISTING WATER SUPPLY SYSTEM

# CHAPTER 3 EXISTING WATER SUPPLY SYSTEM

## 3.1 General

In the study areas, water supply systems have been developed for the waterworks using water extracted directly from the Amudarya river or through canals connected to the river, as the source of water. Sometimes water supply is being taken from underground sources, but in most cases these sources are connected hydraulically to the surface waters.

In 1983, the Tuyamuyun Water Supply plan was drawn up as a solution to the increasing water demand in the study areas and to improve the quality of water taken from the Amudarya river. This plan has been implemented in stages.

Presently, water supply systems using the treated water supplied by Tuyamuyun-Nukus-Chimbai-Takhtakupyr System and Tuyamuyun-Urgench-Gurlen-Mangit System as water sources, have partially or fully replaced the old systems in residential areas.

## 3.2 Water Supply System in the Study Area

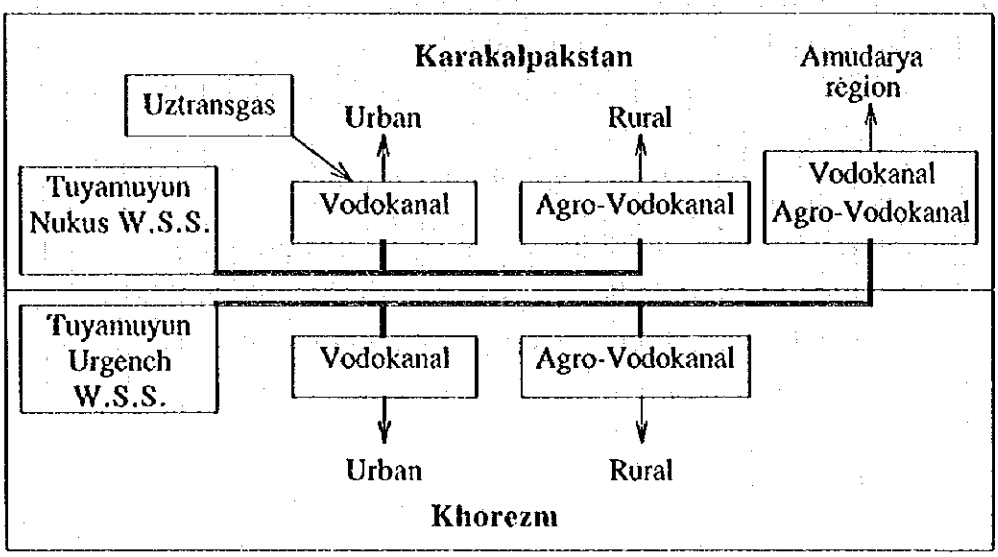
### 3.2.1 Outline of Water Supply System in the Study Area

There are two public waterworks corporations in each region: VodoKanal and Agro-Vodokanal, which are responsible for urban and rural water supply respectively. Both waterworks supply water directly to the residents in the Study area through their own water networks. However, their sources of supplied treated water are not only from their own water treatment plants or wells but also from Tuyamuyun water supply system (Tuyamuyun system) through the water trunk mains. In addition to these systems, the natural gas supply company, UzTransGas, supplies treated water to the cities on the left bank of the Amudarya river in Karakalpakstan, through the VodoKanal water supply system. Both VodoKanal and Agro-Vodokanal purchase treated water from these water supply systems and supply it.

In other words, the Tuyamuyun system, which sells treated water to VodoKanal, is an inter-regional water supply system, while VodoKanal system is a regional water supply system distributing both treated water and purchased water to the residents in a city.

The Tuyamuyun-Nukus water supply system and the Tuyamuyun-Urgench water supply system cover Karakalpakstan and Khorezm respectively. As an exception, the Amudarya region in Karakalpakstan is covered by Tuyamuyun Urgench system because of its topographic location. The relationships between the systems are shown in the following figures.

**Fig. 3.1 Outline of Water Supply System in the Study Area**




### 3.2.2 Water Treatment Facilities in the Study Area [1]

There are several kinds of water treatment plants in the study areas:

**Ordinary Treatment Plants**

There are several treatment plants using the flocculation-sedimentation chlorination process. The flocculation-sedimentation process is sometimes absent and/or sometimes non-functional. Because of the lack of chemical aluminum sulfate, the chemical coagulation system cannot be used sometimes. In some plants coarse particles of suspended matter can settle without chemicals in sedimentation basins or large reservoirs.

**Electrodialysis Equipment**

There are many desalinization equipment called EKOS installed in different locations

[1] This section is mainly derived from the report "An Assessment of the Drinking Water Situation in Karakalpakstan".

in the countryside. These machines produce purified water by the electrodialysis technology. They are installed in groups of 1-3 machines. Every plant has a small distribution network with pipes extending from 1-10 km with stand pipes. Water is usually supplied from deep wells from the deep aquifer that is uncontaminated.

These machines were manufactured in Russia and brought to these areas during 1989 - 1991. Inspections show that, many of the equipment are not in operation due to unavailability of spare parts. A department responsible for these machines says that the cooperation with the factory in Russia was suspended because of the lack of funds. With funds, maintenance of the machines can be restarted.

**Reverse Osmosis Equipment**

There are a few desalination equipment using reverse osmosis technology in operation. The German Red Cross has built a Reverse Osmosis desalination plant in Takhtakupyr. This plant commenced operation in April 1993 and produces 100 $m^3$/hour.

There are also some small Reverse Osmosis Machines in hospitals in the Muynak district. These are made by a factory in Tashkent. The membranes are manufactured in Vladimir in Russia. The machines in Muynak take water from the canal.

**Bio-Engineering**

UNESCO has started a pilot plant in the Muynak region using bio-engineering to treat drinking water. Special plants are built in ponds and water is naturally purified in the soil and in the root system under combined aerobic, anoxic and anaerobic conditions. Pesticides, nitrates and other chemicals are effectively disposed in this way.

**Shallow Well and Handpump**

These exist in many rural settlements, which also have a piped-water supply system but are still used to supplement water-supply needs especially for watering gardens and animals.

### 3.2.3 Existing Water Treatment Plant

In the Study area, although there are many water treatment plants, there are only a few major plants with relatively large capacity: Nukus, Urgench, Tuyamuyun Nukus, Tuyamuyun Urgench water treatment plant and also water treatment plants of UzTransGas in Takhiatash and Kungrad. Only these plants have relatively advanced treatment facilities for sedimentation, filtration and chlorination. The other

small plants have chlorination process or sedimentation and chlorination only.

The conditions of the existing water treatment plants are summarized in the following table.

## Table 3.1 Existing Water Treatment Plants

(unit: thousand $m^3$/day)

| Name | Design capacity | Present operating cap. | Source of water | Type of existing W.T.P. | Owner |
|---|---|---|---|---|---|
| Karakalpakstan | | | | | |
| 1 Nukus | 65.0 | 60.0 | canal | sedimentation filtration | V.K. |
| 2 Muynak | 7.2 | 5.2 | canal | sedimentation | V.K. |
| 3 Turtkul | 8.4 | 8.4 | ground water | | V.K. |
| 4 Khodjeili | 17.0 | 4.8 | canal | | V.K. |
| 5 Beruni | 4.6 | 4.6 | ground water | | V.K. |
| 6 Chimbai | 5.7 | 1.0 | ground water | | V.K. |
| 7 Mangit | 7.0 | 7.0 | ground water | | V.K. |
| 8 Karatau | - | 0.2 | ground water | | V.K. |
| 9 Djumurtay | - | 0.2 | r. Amudarya | | V.K. |
| 10 Shumanai | 6.9 | 2.5 | canal | | V.K. |
| 11 Kungrad | 7.2 | 2.7 | canal | | V.K. |
| 12 Kegeili | 2.5 | 1.0 | ground water | | V.K. |
| 13 Akmangit | 2.2 | 0.2 | ground water | | V.K. |
| 14 Karauzyak | 6.9 | 2.8 | canal | | V.K. |
| 15 Takhtakupyr | 2.3 | 0.6 | ground water | | V.K. |
| 16 Altynkul | - | 0.8 | canal | | V.K. |
| 17 Kanlykul | 6.9 | 2.6 | canal | | V.K. |
| 18 Kazanketken | 7.7 | 1.5 | canal | | V.K. |
| sub total | 157.5 | 106.1 | | | |
| 19 Beruni | - | 8.0 | ground water | | A.V. |
| 20 Ellikkala | - | 4.0 | ground water | | A.V. |
| 21 Amudarya | - | 2.0 | ground water | | A.V. |
| 22 Nukus | - | 1.0 | ground water | | A.V. |
| 23 Turtkul | - | 14.0 | ground water | | A.V. |
| sub total | | 29.0 | | | |
| 24 Kungrad | - | 60.0 | canal | sedimentation filtration | UzTransGas |
| 25 Takhiatash | - | 60.0 | canal | sedimentation filtration(part) | UzTransGas |
| sub-total of UzTransGas | | 120.0 | | | |
| 26 T-Nukus W.T.P. | 200.0 (170.0) | 140.0 | | sedimentation filtration | T-N |
| total | | 395.1 | | | |
| Khorezm | | | | | |
| 1 Urgench | 50.0 | 45.0 | canal | sedimentation filtration | V.K. |
| 2 Urgench | 18.0 | 6.0 | ground water | | V.K. |
| 3 Shavat | 10.0 | 6.4 | canal | sedimentation | V.K. |
| 4 Chalish | - | 10.0 | ground water | | V.K.(A.V.) |
| 5 Khanka | 10.8 | | ground water | | V.K. |
| 6 Gurlen | 4.3 | 1.7 | ground water | | V.K. |
| 7 Druzhba | 11.0 | | | | V.K. |
| 8 Khazarasp | 8.0 | | | | V.K. |
| sub-total | | 69.1 | | | |
| 9 T-Urgench W.T.P. | 200.0 | 180.0 | | | T-U |
| total | | 249.1 | | | |

Note: A part of capacity of UzTransGas is used for the public water supply managed by VodoKanal.
V.K. : VodoKanal, A.V. : Agro-Vodokanal

## 3.3 Development of Tuyamuyun Water Supply System and Kaparas Reservoir

Prior to 1981, the population of Karakalpakstan and Khorezm was supplied with drinking water from the riverside and near-canal lens. The quality of tap water depended on the chemical composition of the water in the Amudarya river and its canals.

### 3.3.1 Tuyamuyun Water Supply System

In 1981, the construction of the Tuyamuyun Waterworks, dam and reservoir was completed. During the design and development stage of the project, the effect of down-stream water intakes was not taken into account. After the river was dammed, a large amount of highly-mineralized drainage water began to fill the downstream area eventually causing deterioration of water quality in the said water pipelines.

Water Supply & Discharge Development Guidelines for Cities and Counties until 2000 were drawn up in both areas in 1986. This document proposed the quantity of drinking water needed and main technical solutions for treatment and transportation of water, and operation of the facilities. Based on these guidelines, two water supply systems were developed in both areas-Tuyamuyun-Nukus (T-N) water supply system with a capacity of 170,000 $m^3$/day and Tuyamuyun-Urgench (T-U) water supply system with a capacity of 200 $m^3$/day. Each system consists of a water treatment plant at Tuyamuyun, with a capacity of 1,117 $m^3$/day, and a main water conduit to supply the water to the projected cities, regional centers and rural areas.

Construction of the water treatment plant and pipelines was planned stage-by-stage. The capacity of Tuyamuyun-Urgench treatment plant was estimated to reach 577 $m^3$/day with stage-by-stage completion of facilities at the rate of 200, 200 and 177 $m^3$/day. respectively and for the Tuyamuyun-Nukus plant, 540 $m^3$/day with stage-by-stage completion of facilities at the rate of 170, 170 and 200 $m^3$/day respectively. Because of the lack of funds, construction fell behind schedule and the existing capacity of operational facilities of Tuyamuyun-Urgench is 200 thousand $m^3$/day, and the existing capacity of Tuyamuyun-Nukus is 170 thousand $m^3$/day.

According to the plan, the construction of second stage facilities, with a rate of 200 and 170 thousand $m^3$/day respectively, should have been completed and become operational in 1996. Also, the Government of Uzbekistan is planning to step up the construction of the above-mentioned regional pipelines to achieve a total capacity of

1,117 $m^3$/day by 2001. However, implementation of these plans is difficult with the available funds.

### 3.3.2 Kaparas Reservoir

Because of new farm land development projects in Bukhara and Kashka Darya Regions in 1983, the inflow of drainage water into the Amudarya river has increased, adversely affecting the quality of water at the intake point of Tuyamuyun. In winter, mineralization of water reaches 1.5-1.8 g/l. Thus, there has been a proposal to use the Kaparas water storage basin for drinking water supply.

The purpose of this proposal is to accumulate good quality water during spring and summer flood seasons and distribute water when the quality of river water deteriorates.

The design of Kaparas water intake project has been developed and, the project is being implemented. Nevertheless, According to Uzbek side because of industrial activities, the water in Kaparas may also become polluted with phenols and chloro organic compounds which may adversely affect the health of the inhabitants. The Tashkent VodGEO Institute has proposed recommendations on deep treatment of water which are to be implemented during a separate project for increasing the capacity of the Tuyamuyun-Nukus pipeline from 340 to 540 thousand $m^3$/day.

## 3.4 Existing Water Supply System in the Six Cities

### 3.4.1 Nukus

#### General

Until the water supply from the Tuyamuyun Water Supply System became available, the waterworks in Nukus city was using the treated river water taken from the Kyzketken Canal and underground wells by Nukus Water Treatment Plant, as its own water source.

The existing waterworks uses the treated water from Tuyamuyun Water Supply System mainly.

#### Nukus Water Treatment Plant

This treatment plant commenced operation in 1985, and was used until water supply

from the Tuyamuyun-Nukus Water Supply System became available. At present this plant is operated as a standby plant for the Tuyamuyun-Nukus Line when necessity arises. The planned treatment capacity is 100,000 $m^3$/day but the actual capacity is 65,000 $m^3$/day currently. The treatment process of this plant is formed by sedimentation with the addition of coagulants, rapid sand filtration and chlorination.

#### Distribution System

Nukus has a zonal water supply system, which consists of 2 water distribution pumping stations (North and South), a system of water pipelines and a distribution network with a total length of 306 km. The source of water is the treated water delivered from two pumping stations connected to the Tuyamuyun-Nukus System.

### 3.4.2 Chimbai

Since 1964 fresh lens water has been pumped and supplied from some of the 22 boreholes in Chimbai. Artificial Recharge Technology is used at the lens. The existing water supply facilities have a maximum total capacity of 5,000 $m^3$/d, and its breakdown is max. 100 $m^3$/d of lens water and about 4,900 $m^3$/d of treated water purchased from Tuyamuyun-Nukus System, which went into operation at the end of 1993. The existing total length of the water network is 57 km.

As of June 1996, about 6,000 $m^3$/day of all the treated water consumed in Chimbai is being supplied by the Tuyamuyun Nukus System. Consequently, the wells are used as standby facilities and operated for maintenance for only 3 hours in a week, although only 6 to 9 of the 14 wells can be used. VodoKanal is planning to install two new wells.

### 3.4.3 Kungrad

#### General

Kungrad is a city that has developed together with the installation of pipelines for transporting natural gas by UzTransGas. The water supply system has two lines; one is based on the water intake from Amudarya river and the other is based on the water intake from the Rafshan Canal.

When the water-main of Tuyamuyun-Nukus Water Supply System from Nukus to Takhiatash is completed, the treated water supplied by this system will replace the

old water sources because the water-main from Takhiatash to Kungrad is completed already.

The waterworks are managed by VodoKanal. Urgench Transgas, which is a regional agency of the UzTransGas, and having a water supply department in Kungrad, manages the intake and treatment plant and sells the water produced by them to VodoKanal.

**Water Supply Facilities**

The present waterworks consists of the two systems described below.

a. UzTransGas Line

The UzTransGas Line was installed for supplying sealing water to the booster compressor station, together with the installation of natural gas pipe lines. Raw water is taken directly from the Amudarya river and is treated in the treatment plant by sedimentation, up-flow filtration and chlorination. The plant's planned capacity is 74,000 $m^3$/day, but the actual capacity is 65,000$m^3$/day. A water supply pipeline (dia. 1,000 mm) running for a long distance parallel to the gas pipeline up to a point near the Caspian Sea has been completed. Water is being branched off from an intermediate water main to the city at the rate of 16,000 $m^3$/day in summer and 9,000 $m^3$/day in winter.

b. VodoKanal Line

Existing water supply facilities consist of a water intake on Rafshan canal, a two-stage pumping system and a treatment plant having of natural precipitation, filtration and chlorination facilities. The capacity of the treatment plant is 7,200 $m^3$/day, and the actual consumption of drinking water in Kungrad is 15,800 $m^3$/day. The remaining capacity of water is being covered by procuring the water from UzTransGas.

### 3.4.4 Muynak

Drinking water in Muynak is mainly supplied by the ordinary treatment plant. The quality of supplied water is unsuitable for domestic drinking purposes. In some organizations, in addition, EKOS machines and Reverse Osmosis plant, which is a small-scale plant for drinking water, supply a limited amount of water.

Existing ordinary treatment plants and supply facilities are summarized below.

- Water source : Cartabay canal connecting Amudarya river

- Intake and distribution : Raw water is delivered from the canal to the ground sedimentation basins by the intake pump (stage 1 pump). The settled water is pumped up from here to the reservoir in the city by a 2-stage pump and fed with bleaching powder. The treated water is distributed to the city by a 3-stage pump in the distribution pump station.

- Treatment process : Sedimentation and chlorination by bleaching powder

- Distribution network : Total length of 25.7 km

- Distribution Reservoir : 1,000 $m^3$ x 2 basins and 2,500 $m^3$ x 1 basin

### 3.4.5 Urgench

#### General

The water sources of existing waterworks in Urgench city consist of 3 lines : the treated water purchased from the Tuyamuyun-Urgench system, the water treated by the Urgench water treatment plant, and the lens water.

The total length of water pipelines and the network is 314.8 km.

The waterworks are managed by Regional VodoKanal under the Deputy Mayor in charge of public utilities, and operates as a self-supported enterprise.

#### Urgench Water Treatment Plant

The existing water treatment facilities have a capacity of 50 thousand $m^3$/day. Water is being taken from the Shavat canal. Water sedimentation is carried out in ground sedimentation basins. To intensify the process, coagulant (aluminum sulfate) is being added. After sedimentation, water is being filtered in rapid filters and then chlorinated by liquid chlorine. As water from Tuyamuyun-Urgench pipeline is not yet being supplied in sufficient quantity, treatment facilities are operating continuously and their condition is satisfactory. Treated water is being supplied to the Industrial Zone of Urgench City, Khiva City, Koshkupyr and Karaul Regional Centers. Daily supply of water to Urgench, including the water from Tuyamuyun-Urgench pipeline, is 101,400 $m^3$/day on an average.

**Water source by lens water**

The waterworks have 30 wells for pumping up the lens water, from which 6 wells are in operation. The available capacity is about 10,000 $m^3/d$.

### 3.4.6 Khiva

Until the supply from Tuyamuyun System became available, lens water was used as the water source for waterworks in the city. Presently, the water source is treated water derived from Urgench. At the distribution plant it is being disinfected and then supplied to users. The total length of water pipelines and distribution network is 112.9 km. The daily average supply is 21,200 $m^3$/day. The distribution plant has two clear water reservoirs with a capacity of 1,000 $m^3$ each, and chlorination and pumping facilities.

At present, water is being rationed from May to September because of a shortage of treated water in Urgench.

## 3.5 Tuyamuyun Water Supply System

### 3.5.1 General

The Tuyamuyun Water Supply Plan for the target year of 2000 was drawn up in 1983. Its objective is to improve the water supply situation in Karakalpakstan and Khorezm, which are faced with increasing degradation in water quality of the Amudarya river and increasing water demand.

The plan takes into consideration the Kaparas Reservoir, the Tuyamuyun-Nukus water supply system and the Tuyamuyun-Urgench water supply system. The construction of the system is handled directly by the Republican Production Amalgamation for Operation and Development of Regional Water Pipelines of the MPU of Republic of Uzbekistan.

The pipeline has been under construction for many years. As more cities are connected, more pipelines will be connected in the future.

The outline of Tuyamuyun water supply system is shown Fig 3.2.

### 3.5.2 Kaparas Reservoir

The Kaparas Reservoir (550 million $m^3$ of planned useful storage capacity) is included in Tuyamuyun Hydro-System which also comprises Surtansanjal Reservoir (1,690 million $m^3$), Koshbulak Reservoir (1,020 million $m^3$) Amudarya River Bed Reservoir (2,070 million $m^3$) and is a natural depression. In order to use the Amudarya river water with better quality as the raw water source for Tuyamuyun Water Supply System, the Kaparas Reservoir will be used for storing abundant snow melted water with better quality. Better water quality can be obtained in early summer from June to August.

To use this reservoir as a source of domestic and drinking water supply, intake control gate has completed in 1993 and the intake pumping station and raw water main from the pumping station to Tuyamuyun-Nukus and Tuyamuyun-Urgench treatment plants is under construction. The outline of the intake facilities of the Kaparas Reservoir is shown Fig 3.3.

### 3.5.3 Tuyamuyun-Nukus Water Supply System

#### (1) General

The system was planned to supply treated water to areas near the Amudarya river in Karakalpakstan: Nukus, Chimbai, Kegeili, Kazanketken, Takhtakupyr, Kungrad, Muynak, and some communities along T-N water-main.

This system is managed by the Unit for Repair and Maintenance of T-N Inter - Regional Water Pipeline, Nukus City, under the RPA for Operation and Development of Regional Water Pipelines of the MPU, Republic of Uzbekistan. The treated water in the system is sold to VodoKanal or Agro-Vodokanal in the area, and supplied through the water-main.

#### (2) Tuyamuyun-Nukus Water Treatment Plant

The planned treatment capacity is 340,000 $m^3/d$. The current available treatment capacity is 170,000 $m^3/d$. The outline of the flow and the unit processes is shown below.

1. First Stage Station Pumping 6,300 $m^3/h$ x 27 m head x 630 kw x 4 sets

| | | |
|---|---|---|
| 2. | Coagulant Feeding | Alum |
| 3. | First Coagulo-sedimentation | Radial clarifiers 50m(dia.) x 5.52m(height) x 4 basins<br>Treatment capacity 50,000$m^3$/day/basin |
| 4. | Second Coagulant Feeding | Alum, polyacrylamide, bleaching powder |
| 5. | Second Coagulo-sedimentation | Horizontal flow type (2 facilities, 100 thousand $m^3$/day each) 6.0m(wide) x 58.5m(long) x 4.5m(depth) x 18 basins |
| 6. | Rapid Sand Filter | Conventional type 54$m^2$ x 18 basins<br>velocity = 144 - 162 m/day<br>Capacity of each basin 12 thousand $m^3$/day |
| 7. | Chlorination | Liquid chlorine |
| 8. | Clear water reservoir | 3,240 $m^3$ x 3 basins |
| 9. | Transmission pump | 4,000 $m^3$/h x 95 m head x 1,600 kw x 6 sets<br>type D-4,000 x 95<br>3,600 $m^3$/h x 195 m head x 2,500 kw x 6 sets<br>type HM-3,600 x 230 |

### (3) Tuyamuyun-Nukus Water Main

The planned water mains are two in number, one from the water treatment plant to Nukus, Chimbai and Takhtakupyr, and the other from the water treatment plant to Nukus, Takhiatash, Kungrad and Muynak. Construction of the former is completed, while construction of the latter is in progress.

a) Water Treatment Plant to Nukus

The planned water main from the water treatment plant to Nukus consists of two 1,400 mm pipelines each 243 km in length, and intermediate booster pumping stations.

One water main has been constructed and is in operation, while the other is under construction.

b) Nukus to Chimbai and Takhtakupyr

The water main from northern Nukus to Chimbai is connected by a 1,000 mm pipeline, 52.8 km in length. Furthermore, the main from Chimbai to Takhtakupyr is connected by dia. 720 mm x 11.8 km, dia. 630 mm x 19.2 km and dia. 530 mm x 29 km pipelines.

c) Nukus to Takhiatash, Kungrad and Muynak

This main is connected as shown below.
Nukus to Takhiatash dia. 1,200 mm x 21 km (under construction)
Takhiatash to Khodjeili dia. 1,200 mm x 9 km (already constructed)
Khodjeili to Kungrad dia. 1,200 mm x 102 km (already constructed)
Kungrad to Muynak 2 x dia. 400 mm x 81 km (planned)

### 3.5.4 Tuyamuyun-Urgench Water Supply System

#### (1) General

The above-mentioned system was planned to supply water to cities, towns, regional centers, and villages close to the water main in Khorezm province and Amudarya Region, including Mangit city and villages in the Republic of Karakalpakstan.
The system is managed by the Unit for Repair and Maintenance of T-U Inter-Regional Water Pipeline, Urgench City, under the RPA for Operation and Development of Regional Water Pipelines of the MPU, Republic of Uzbekistan.

#### (2) Tuyamuyun-Urgench Water Treatment Plant

The planned treatment capacity of the First Stage is 577,000 $m^3$/day. The present treatment capacity is 200,000 $m^3$/d. The capacity and the treatment process are almost same as the Tuyamuyun - Nukus treatment plant except for the velocity of rapid filter and the capacity of the transmission pump. The outline of the flow and unit processes is shown below.

| | |
|---|---|
| 1. First Stage Station Pumping | 5,000 $m^3$/h x 50 m head x 1,200 kw x 4 sets |
| 2. Coagulant Feeding | Alum |
| 3. First Coagulo-sedimentation | Radial clarifiers dia. 50m(dia.) x 5.52m(height) x 4 basins<br>Treatment capacity 50,000$m^3$/day/basin |

| | |
|---|---|
| 4. Second Coagulant Feeding | Alum, polyacrylamide, bleaching powder |
| 5. Second Coagulo-sedimentation | Horizontal flow type 2 facilities, 100 thousand $m^3$/day each 6.0m(wide) x 58.5m(long) x 4.5m(depth) x 18 basins<br>Capacity of each basin 12 $m^3$/day. |
| 6. Rapid Sand Filter | Conventional type 54$m^2$ x 18 basins<br>velocity = 108-120 m/day |
| 7. Chlorination | Liquid chlorine |
| 8. Clear water reservoir | 2,000 $m^3$ x 3 basins (distribution use)<br>1,000 $m^3$ x 3 basins (including one for distribution to Durzhba and two for the plant) |
| 9. Transmission pump | 4,000 $m^3$/h x 90 m head x 1,250 kw x 4 sets<br>3,200 $m^3$/h x 90 m head x 1,250 kw x 2 sets<br>1,250 $m^3$/h x125 m head x 630 kw x 2 sets<br>1,200 $m^3$/h x 35 m head x 152 kw x 3 sets<br>(distribution to Durzhba) |

### (3) Tuyamuyun-Urgench Water Main

This water main distributes drinking water to urban and rural settlements of Khorezm Province as well as Mangit[3] Region of the Republic of Karakalpakstan. In the design documents circular routing of the pipeline in Khorezm Province is envisaged. In order to provide for supply of 400 thousand $m^3$/day of drinking water, it is necessary to build a transmission pumping station in the vicinity of Khazarasp City.[4] The water main consists of the following parts:

a) Water Treatment Plant to the Transmission Pumping Station at Khazarasp
b) Transmission Pumping Station at Khazarasp to Urgench
c) Transmission Pumping Station at Khazarasp to Khiva
d) Urgench to Khiva

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[3] The Amudarya Region is meant here, Mangit city is the administrative center of this region.(Remark by translator)

[4] This seems to differ from what Mr. Miryusupov has been telling to the JICA Study Team in October.(Remark by translator)

e) Urgench - Gurlen - Mangit
f) Gurlen - Shavat - Koshkupyr

a) Water Treatment Plant to the Transmission Pumping Station at Khazarasp
The Uzbek Plan envisages construction of 3 1,200 mm main pipelines of 27 km length. At present two lines are constructed.

b) Transmission Pumping Station at Khazarasp to Urgench
This water main is in operation and consists of a pipeline of 1,200 mm, 43.8 km in length, which is in operation, and a 1,200 mm pipeline which is not yet constructed.

c) Transmission Pumping Station at Khazarasp to Khiva
This pipeline passes through Bagat and Yangiaryk Regional Centers and consists of the following parts:

- Pumping Station at Khazarasp - Bagat, 1,000 mm in diameter and 33.3 km in length, which is built and in operation.
- Bagat - Yangiaryk, 1,000 mm in diameter and 22.5 km in length, which is built and in operation.
- Yangiaryk - Khiva, 800 mm in diameter and 20 km in length. Construction has not begun. At present an old 500 mm pipeline, 20 km in length is in operation here.

d) Urgench to Khiva
This water main consists of two lines, 1,000 mm and 800 mm in diameter, each 30 km in length.

e) Gurlen - Shavat - Koshkupyr[5]
The water main of dia.600 mm to Shavat and Koshkupyr is under construction.

### 3.5.5 Progress of Tuyamuyun Water Supply System

As of the end of 1994, the half-scale of the water treatment plants and partial water-mains for the system and Kaparas Reservoir included in the first stage of the plan is almost complete. The treated water from the system is being transmitted and supplied to consumers in the cities of Nukus, Bustan, Akmangit, Karauzyak, Chimbai, Urgench, Khiva, Beruni, Druzhba, Mangit, towns of Khalkabad, Kegeili,

[5] Urgench - Gurlen - Mangit is left out.(Remark by Translator)