No.

THE STUDY FOR
SUSTAINABLE RURAL WATER SUPPLY SYSTEM
IN THE SOUTHERN KHATLON OBLAST
IN
THE REPUBLIC OF TAJIKISTAN

FINAL REPORT

MAIN REPORT

APRIL 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

EARTH SYSTEM SCIENCE CO., LTD.
JAPAN TECHNO CO., LTD.

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In this report, project costs are estimated based on the price as of July 2008 with an exchange rate of US$ 1.00 = Tajikistan Somoni (TJS)340.0 = Japanese Yen (¥)107.0.

PREFACE

In response to a request from Government of the Republic of Tajikistan, the Government of Japan decided to conduct a study on rural water supply and sewage systems and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Yasumasa YAMASAKI of Earth System Science Co., Ltd. between August 2007 and April 2009.

The team held discussions with the officials concerned of the Government of Tajikistan and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of RT for their close cooperation extended to the study.

April 2009

Ariyuki MATSUMOTO,
Vice-President
Japan International Cooperation Agency

THE STUDY FOR SUSTAINABLE RURAL WATER SUPPLY SYSTEM IN THE SOUTHERN KHATLON OBLAST IN THE REPUBLIC OF TAJIKISTAN

April 2009

Mr. Ariyuki MATSUMOTO
Vice-President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit you the final report entitled "The Study for Sustainable Rural Water Supply System in the Southern Khatlon Oblast in The Republic of Tajikistan". This report has been prepared by the Study Team in accordance with the contracts signed on 11 August 2004 and 20 May 2005 between Japan International Cooperation Agency and the Joint Study Team of Earth System Science Co., Ltd. and Japan Techno Co., Ltd.

The report examines the existing conditions related to rural water supply, potential of water sources and socio-economy in the southern Khatlon Oblast, proposes master plan for the rehabilitation and expansion plans for the Vakhsh conduits and existing rural water supply systems, and presents results of the feasibility study on the Vakhsh Conduits and priority rural water supply systems identified in the master plan, and summarizes results of a pilot project carried out in order to examine the effectiveness of the operation and maintenance system proposed in the Study.

The report consists of the Main Report and the Supporting Report. The Main Report contains the existing conditions, the proposed master plan, the results of the feasibility study on the proposed rehabilitation and expansion plans, and conclusions and recommendations. The Supporting Report includes technical details of the Study.

All members of the Study Team wish to express grateful acknowledgement to Japan International Cooperation Agency (JICA), JICA Advisory Committee, Ministry of Health, Labour and Welfare, Ministry of Foreign Affairs, Embassy of Japan in the Republic of Tajikistan, and other donors, NGOs and also to Tajik officials and individuals for their assistance extended to the Study Team. The Study Team sincerely hopes that the results of the study will contribute to the improvement of water supply situation in the southern Khatlon Oblast, and that friendly relations of both countries will be promoted further by this occasion.

Yours Faithfully,

Yasumasa Yamasaki
Team Leader for the Study for Sustainable Rural Water Supply Systems in the Southern Khatlon Oblast in the Republic of Tajikistan


Republic of Tajikistan
Dushanbe
N
Baljuvom
Khovaling
Nurek
Yovom
Temurmalik
Mamimobod
Khurosom
Dangara
Jomi
Kulyab
Sarband
Bokhtar
Vose
Shurobod
Vakhsh
Khamadomi
Dzhilikul
Kolkhozobod
Farkhor
Shakhritus
Kabodiyon
Kumsangir
Pyandzh
Nosiri Khisrav
Legend
Oblast Boundary
Rayon Boundary
Study Area
Khatlon Oblast
Dushanbe
0 5 10 20 30 40 50
km
Study Area

EXECUTIVE SUMMARY

1. PROJECT BACKGROUND AND EXISTING CONDITIONS

In Tajikistan, a Water Sector Development Strategy (2006-2015) was established under the assistance of UNDP, aimed at attaining the Millennium Development Goals of the UN. The Strategy targets improving water supply coverage up to 80% in the rural area by the year 2015. A Presidential Decree related to the National Water Supply Plan (2007-2020) indicated to raise the water supply ratio to 90% in the rural area.

The rural water supply sector in Tajikistan presents many challenges from the viewpoints of social, organic and institutional aspects. The rural water supply service in Tajikistan started as a water supply to Sovkhozs (state farms) and Kolkhozs (collective farms). The Vakhsh pipeline which passes through the center part of the study area was constructed in 1977 as part of the water supply development. Construction of this pipeline largely contributed to improving water supply service coverage. Development of water supply facilities had been supported by budget subsidies from the Soviet Union. However, such system was stopped by the collapse of the USSR in 1991. Since then, the development of water supply services was retarded and most facilities were not properly maintained due to lack of funds. The Vakhsh pipeline has aged and part of the planned pipeline routes have not been constructed. Sovkhozs and Kolkhozs were divided into private farms by the agricultural revolution in 1992. Because of this, ownership of water supply facilities became unclear. Thus, maintenance of proper water supply facilities and most of other facilities were obliged to stop services due to aging and malfunctions. 83 facilities out of approximately 150 were listed by RWSA, 60% of the facilities have already stopped functioning.

The reasons why most existing water supply systems are not functioning are the unclear situation of ownership by the systems, lack of ownership of community people, lack of affordability and unwillingness to pay the water tariff, etc.

The Study aims to formulate rehabilitation and extension plans of the existing water supply systems considering the Presidential Decision Directive which targets improving water supply coverage up to 90%. Therefore, it is necessary to rehabilitate the existing water supply systems taking into consideration the capacity of Vakhsh pipeline and groundwater potential and to study the operation and maintenance of a system that meets the socio-economical situation of the communities in the Study area.

In the Study area, water-borne diseases break out every year, therefore, this is also an issue for improvement. Since the breakout of water-borne diseases is likely caused by the deterioration of the water source, it is important to study the improvement of people's behavior from the viewpoints of health and hygiene. Thus, improvement of personal hygiene and behavior, and the promotion of community participation are to be considered in the study.

Assistance to the rural water supply and, health and hygiene sectors are carried out by UNDP, UNICEF, ADB, ECHO (European Commission Humanitarian Aid Office) and NGOs. Exchange of information with these organizations and exploitation of such experience and knowledge are indispensable in the implementation of the Study.

2. WATER SUPPLY SITUATION IN THE STUDY AREA

It was revealed that there exist a total of 103 water supply systems (excluding systems owned by Vodokanal) in the Study Area. Out of these, 61 systems are receiving water from the Vakhsh Conduits and 41 systems are independent from the Vakhsh Conduits.

The total of 47 systems is currently operating including systems working incompletely. 30 systems are connected to the Vakhsh conduits and 17 systems are free from the Conduits.

The population of the Study Area is about 812 thousand persons (2007) and about 15% of the population is receiving water from the water supply systems. This water supply coverage is much lower than the target in the Water Sector Development Strategy. People who are receiving no water supply are obliged to use water in the irrigation canals and shallow groundwater for domestic use. This causes water borne diseases every year.

3. CURRENT SITUATION OF THE VAKHSH CONDUITS AND DEVELOPMENT ISSUES

The Vakhsh Conduits were constructed in 1977. The conduits supply water to 83 water supply systems in Sarband, Bokhtar, Kolkhozobod, Kumsangir and Dzhilikul Rayons, and Kurgan Tyube City taking water from the Stalin Canal which originates from the Sarband Dam. The total length of the Conduits in the Study Area is about 132km. There are the Bokhtar Head Pump Station, Uzun Pumping Station and Kalinin Pumping Station along the route. They are not operating and water is supplied by gravity.

Outflow from the Sarband Settling Basin is estimated as 610 L/sec (52,700 m3/day). The total water demand will increase to 123,900 m3/day in 2028. The result of hydraulic analysis revealed the following issues. These are important issues to be considered in the formulation of the rehabilitation and expansion plan of the Vakhsh conduits.

(1) Capacity of the pipeline between the Sarband Settling Basin and Uzun is insufficient.

(2) The critical point in terms of flow rate appears in the Uzun downstream.

(3) It is not economical to convey water to Kumsangir.

(4) The diameters of several connecting pipelines between Vakhsh Conduits and water supply systems are insufficient.

(5) It is ineffective to use the Bokhtar Pumping Station because increased pressure is released at the Uzun Pumping Station.

(6) The Kalinin Pumping Station will be not required since it will become possible to convey water to Dzhilikul directly from the Sarband Settling Basin by gravity.

As for water treatment plants, it is concluded as reasonable to apply a decentralized water treatment system.

4. CURRENT SITUATION OF THE RURAL WATER SUPPLY SYSTEMS AND DEVELOPMENT ISSUES

The Rural water supply systems are generally tapping groundwater. Only 17 out of 41 systems are working. The Major reasons are malfunctions and/or burn out of submersible pumps and deterioration of the facilities. Many water wells are filled with sand intruded into the well from the aquifers. Furthermore, sand intrusion into the well caused land subsidence around the water well. No expansion of the water supply facility was observed although the resident area of the village has much expanded after the construction of the water supply system due to of population increase.

The water quality of the rural water supply systems satisfies the drinking water standards in GOST which is applied in Tajikistan. The influence of organochlorine insecticides on groundwater was investigated by WHO, FEA and Tajik Ministry of Health in 2002. According to the result,

organochlorine insecticides were detected, however their density levels are lower than the WHO Guideline Values for drinking water quality (Version 3, WHO 2004)

It is required in the formulation of rehabilitation and expansion plan to consider the construction of new water wells with proper structure and covering the expanded residential area.

5. OPERATION AND MAINTENANCE OF THE RURAL WATER SUPPLY SYSTEMS

(1) Current Development Issues for Operation and Maintenance

The Study reviewed and identified various development issues and needs for improved operation and maintenance of rural water supply systems in the Study, which could be summarized as follows:

- Insufficient policy and legislative framework for improved operation and maintenance, which defines system ownership, tasks and duties of stakeholders involved in operation and maintenance, national standards for system management, and so forth;
- Lack of community and community-based organization's capacity in operation and maintenance. Although relative competence of state entities, such as RWSA, Vodokanal, and Kolkhoz/farm associations in operation and maintenance is observed, they are not actively taking over currently malfunctioning supply systems, due to undefined system ownership, and lack of a state budget for rehabilitation;
- Undefined ownership issues, which prevent systematic institutional and community development for improved operation and maintenance;
- Lack of community participation in operation and maintenance, due to less community mobilization in planning, implementation, and monitoring, placing emphasis on addressing emergent needs to rehabilitate rural water supply systems after the civil war. It also prevented enhancing the sense of ownership for the rehabilitated supply system among communities.
- Less community awareness in water users and sanitation, which decreases the impact on personal hygiene through rehabilitation of the supply system.

Reviewing these development issues and needs for improved operation and maintenance, current undertakings to cope with each of these issues and needs are also identified in the Study. These undertakings include the initial steps taken for development of a Law on Drinking Water and Water Supply, establishment of community-based organizations (i.e. WUA and WUC) for improved operation and maintenance, active engagement of state entities in system management, establishment of water fees, and improved sanitation and personal hygiene. Examining these undertakings, the strategy and plan for improved operation and maintenance are prepared under the Study.

(2) Strategy for Improved Operation and Maintenance

Reviewing the said development issues, the following strategy and plan for improved operation and maintenance in the Study area is suggested to determine approaches taken in the possible future implementation of projects planned under the Study. The strategy and plan shall satisfactorily cope with current development issues for operation and maintenance, namely:

- Undefined ownership of the rural water supply facilities
- Undefined roles and responsibilities among state entities, communities, and local authorities in operation and maintenance
- Lack of community participation in operation and maintenance
- Less community affordability to pay for water fees
- Poor community awareness in water use and sanitation

An insufficient policy and legislative framework is also an important development issue for improved operation and maintenance in order to define system ownership, tasks and duties for stakeholders involved, national standard for system management, and so forth. Therefore, based on the interpretation of existing policy and legislative framework with consideration on their future improvement, strategy and plan for improved operation and maintenance of rural water supply system under the Study was been developed. Considering the development issues stated above, the following strategy and plan for improved operation and maintenance has been prepared.

1) Transfer of Ownership of Rural Water Supply System to State Entities Specialized for Water Supply

The water Code defines in principle that the ownership of rural water system belongs to the state, and the state authority and state entity appointed by the state is responsible for operation and maintenance of the system. On the other hand, as it is reviewed in the Study, most of the rural water supply system currently not functioning in the Study area is owned by local authority or Jamoat as an expedient, but de facto responsibility for the system operation and maintenance is blamed on the community. Thus, less capacity of Jamoat and community in operation and maintenance is observed.

The Study suggest that ownership currently vested to the Jamoat shall be transferred to the state entities that are already equipped with capacity in operation and maintenance of the rural water supply system, such as Vodokanal and state firms. Utilization of existing capacity of those state entities in human, technical, institutional, and financial aspect could be feasible and cost effective for improved operation and maintenance.

2) Establishment of Water User Association

Although the Study suggests state entities to own, operate and maintain the rural water supply system as it is described above, it does not mean that the communities are exempted from system operation and maintenance. The Study suggests formulating Water User Association (WUA) among user communities through consultation with Jamoat, user communities, and the system owners. WUA is expected to be a focal point for community mobilization and participation in system operation and maintenance, as well as a facilitator for proper use of the system and payment of water user fees by the communities.

3) Defined and Agreed Roles and Responsibility to be Shared among Stakeholders

Undefined roles and responsibilities among system owners system operators, WUA, user

communities, and local authorities has been one of major problems in operation and maintenance of the rural water supply system in the Study area. The Study advocates the clear definition of roles and responsibility to be shared among these stakeholders through consultation. Consensus on the shared roles and responsibility in the system operation and maintenance shall be made among stakeholders, defining roles and responsibilities in the categories of 1) service activities, 2) routine maintenance, and 3) breakdown of maintenance and replacement.

4) Establishment of Water Fee and State Subsidies for Improved Operation and Maintenance

In the given impoverished state of the rural population, it is understood that the rural communities in the Study area can afford only the cost for daily operation and minor maintenance of the rural water supply system. Although it could be very difficult for the user community to cover the cost for major maintenance and replacement of the system, water fees shall be established and collected from users in order to enhance the sense of community ownership. The Study also advocates that state subsidies shall be made for major maintenance and replacement of the rural water supply system, which the community can not afford.

(3) Activity for Improved Operation and Maintenance

The following activities are considered to realize the above stated strategy for improved operation and maintenance of the rural water supply system.

Stage 1: Pre-Planning

- Conduct orientation for stakeholders involved to discuss and make achieve consensus on the strategies for improved operation and maintenance, including ownership transfer, establishment of the WUA, roles and responsibilities among stakeholders, and establishment of user fees.

Stage 2: Formation of WUA

- Conduct community meetings
- Formulate executive organ of the WUA

Stage 3: Participatory Planning

- Conduct “management” consultation
- Conduct “operation” consultation
- Conduct “maintenance” consultation
- Conduct “operation and maintenance cost” consultation
- Prepare memorandum of understanding among stakeholders
- Identify the capacity gap and prepare a training plan for the WUA to satisfy the roles and responsibilities determined through a series of consultations.

Stage 4: Capacity Development of the WUA for Improved Operation and Maintenance

Stage 5: Operation and Maintenance, and Monitoring

6. PUBLIC HEALTH

It is characteristic in Tajikistan that infectious and parasitic diseases as well as cardiovascular diseases and neuropsychiatric conditions for both sexes are at the head of the top ten leading causes of total DALYs which is used as a measure that combines the impact of illness, disability and mortality on population health.

Unsafe water, sanitation and hygiene are counted as the fourth leading risk factor of disease for both sexes in the country. Actually a considerable rate of reported cases of infections in Tajikistan are water-borne or caused by unsafe drinking water.

From the findings of relevant surveys and field reports by agencies concerned, there is no small room for improvement of people's health knowledge and practice.

7. REHABILITATION AND EXPANSION PLAN FOR THE VAKHSH CONDUITS

A rehabilitation and expansion plan for the Vakhsh conduits was formulated on the basis of the result of hydraulic analysis and the study on the alternative of water treatment system (Refer to Figure 1). Major contents of the plan are as follows:

- A total of 15 water treatment systems is planned applying a decentralized system.
- A new conduit is planned in the section between Sarband at the point about 0.5km southwest from Uzun. Therefore, the Conduits become a double pipeline in this section.
- Water supply systems distributed in Kolkhozobod Rayon and in the area to Kumsangir from Kolkhozobod are planned to collect water from the Kumsangir Canal, separate of from the Vakhsh conduits.
- Pipes are replaced with the same diameter of pipes in the following sections:
  - between the Sarband Sedimentation Pond and the Bokhtar Head Pump Station
  - between the junction to Bokhtar and the Uzun Pumping Station
- Pipes are replaced with a larger diameter of pipes in the following sections:
  - between the point about 0.5km southwest from Uzun and the Sattarov Water Supply System
  - Part of the section to Bokhtar

The approximate implementation cost of the rehabilitation and expansion plan of the Vakhsh Conduits is 441 million TJS (US$ 130 million). The implementation schedule is planned as 20 years from the start of the study in 2007 to the completion of the rehabilitation and expansion work in 2028.

8. REHABILITATION AND EXPANSION PLAN FOR THE RURAL WATER SUPPLY SYSTEMS

A total of 16 rural water supply systems in 19 villages were selected as priority systems from deteriorated rural water supply systems. A rehabilitation and expansion plan for these villages was formulated (Refer to Figure 2) and approximate implementation cost was also estimated. The location and contents of the rehabilitation and expansion plan are shown in Figure 2. The number of recipient of the implementation of the plan is about 71 thousand persons in the target year 2015. Total water demand in the year is about 1.6 thousand m3/day. Pumping test and water quality on the priority systems were carried out using the existing water wells. As a result, it was confirmed that those wells had enough capacity of groundwater yield with suitable quality for drinking.

Although residential areas of villages are much expanded due to increase of population, no expansion was made after the construction of the water supply systems. Accordingly, such areas are receiving no water supply. Therefore, it is taken into consideration in formulating the

rehabilitation and expansion plan to include the expanded areas in the service areas. Most of the water supply system has been deteriorated because of aging since more than 30 years have passed after construction. In addition, because water supply systems stopped their operation at least several years ago, tanks and pipelines are considered deteriorated. The water wells should be replaced with new wells with proper structure to prevent sand intrusion into the wells. Considering this situation, construction of new water supply systems is considered in the plan. The target water supply systems are shown in Table 1.

The approximate implementation cost of the rehabilitation and expansion plan of the rural water supply system is estimated as 104 million Tajikistan Somoni (US$ 30.6 million). Implementation schedule is planned from 2009 to 2014 (6 years).

Table 1 Population to be Served by the Priority Systems

No.	Rayon	Jamoat	Village	Population to be Served	
				2007	2015
K-2	Kabodiyon	S. Khudoikulov	Yangi Yul	3,618	4,342
K-5	Kabodiyon	Navobod	Navruz	820	984
K-7	Kabodiyon	S. Khudoikulov	Jarkurgan	3,917	4,700
K-9	Kabodiyon	U. Nazarov	Kabla	6,180	7,416
			Boshkala	11,384	13,661
K-11	Kabodiyon	S. Khudoikulov	Bolshevik	3,816	4,579
N-1	Nosiri-Khisrav	Istiklol	Oltinsoy	1,500	1,800
			Olzu	900	1,080
			Traganov	1,300	1,560
			Bahor	3,400	4,080
S-4	Shakhritus	Obshoron	Vatan	5,300	6,360
S-5	Shakhritus	Pakhtaobod	Sultanabod	6,065	7,278
S-9	Shakhritus	Obshoron	Binokor	4,902	3,170
P-13	Pyandzh	Sarmantoy	Sarmantoy	5,900	7,080
Total				59,002	70,802

9. ECONOMIC AND FINANCIAL ANALYSES ON THE REHABILITATION AND EXPANSION PLANS FOR THE VAKHSH CONDUITS AND THE RURAL WATER SUPPLY SYSTEMS

From the economic and financial point of view, two water supply projects, Rural Water Supply Project (RWSP) and Vakhsh Conduit Water Supply Project (VCWSP), are analyzed and evaluated.

- The following currency exchange rate as of July 2008was applied for the analysis

  One (1) Tajikistan Somoni (TJS) = 0.294 US$ = 31.5 Japan Yen (JPY).

- The yearly increase rate is connected to the GDP growth rate. GDP growth rate 2009 and after is considered to be 5% after 2008 (IMF).

Economic and financial analyses were discussed with two (2) costs. One is the labor cost of the rural people in fetching water, and the other is the cost of water transportation by water supply trucks. Implementation of the rehabilitation and expansion plan of the Vakhsh conduits and rural water supply systems will make it possible to supply safe water to community people. It will lead

decreasing water borne diseases. However, this benefit is not considered in the economic analysis because there is no available data.

(1) Economic and Financial Analyses on the Rehabilitation and Expansion Plans for the Vakhsh Conduits

Because it takes along period to complete the rehabilitation and expansion of the Vakhsh conduits, it is necessary to review water demand, economic conditions, etc. and adjust the engineering specification of the water supply systems before starting to be stage 7. The Life cycle of the facilities and equipment to be installed by the project is assumed 30 years. And the residual value of these facilities and equipment at year 2028 is included in the financial and economic evaluation calculation. Regarding operation and maintenance costs, 0.02US$/m3 (obtained from IBNET of the World Bank) is to be used as the operation and maintenance cost in discussing the present water supply situation. VCWS system does not have distribution facilities and distribution conduits, thus economic and financial analysis of the cost of water distribution is not included. Table 2 shows the results of the economic and financial analysis of VCWS.

Table 2 Results of Economic and Financial Analyses on VCWSP

Vakhsh Conduits	Item	NPV	B/C	EIRR	FIRR
	Water fetching	19,214	1.35	16.2%	cannot be obtained
	transportation by water tanker	102,097	1.87	26.2%	

As shown in Table 2, both EIRR and FIRR calculation results are positive with either benefit, benefit of water fetching labor cost reduction or benefit of water truck transportation cost saving. Thus, this project is feasible from the economic viewpoint. The water charge to water distributors is supposedly set at 0.08 TJS/m3 and 10% up yearly after 2008 for the financial analysis. The result of calculation of FIRR with the water rate above says that, because of the size of the initial investment being large, the project is not feasible from the financial point of view. However, if the yearly increase ratio of the water rate is changed to 20% from 10%, FIRR changes to positive, 3.2%, and the project changes to be feasible financially.

Table 3 FIRR of VCWSP with Water Rate Change

Water tariff in 2008 (Assumption)	Escalation rate after 2008 (yearly rate)	FIRR
0.1 TJS/m^3	+10%	cannot be obtained
	+20%	4.6%
0.08 TJS/m^3	+10%	cannot be obtained
	+20%	3.2%

A large amount of funds is required to implement the rehabilitation and expansion of VCWSP. Thus a long term loan and low interest from an international lending agency shall be taken into account for fund provisions.

(2) Economic and Financial Analyses on the Rehabilitation and Expansion Plans for the Rural Water Supply Systems

The economic benefit is calculated based on how many labor hours of the rural peoples will be reduced in water fetching. the labor hour value is assumed as 2.2 TJS/m3, considering water fetching time and average salary of the Khatlon Oblast with consideration of the unemployment

rate and unskilled labor wage. Cost for water transportation by trucks is considered the equivalent value to the benefits of the project. The water charge at the intake is considered as 0.1 TJS/m3. The revenue of the rural water supply systems is only the amount collected from the water users, the village people. Table 4 shows the results of Economic and Financial Analyses on rural water supply systems.

Table 4 Results of Economic and Financial Analyses on Rural Water Supply System

Rural Water Supply System	Item	NPV	B/C	EIRR	FIRR
	Water fetching	-25,915	0.10	cannot be obtained	cannot be obtained
	transportation by water tanker	-18,908	0.34	cannot be obtained	

As a result, EIRR and FIRR cannot be obtained because costs for construction, and operation and maintenance are much higher than the benefit. However, If construction costs and O&M costs are set to one sixth (1/6) of the planned amount in case of water fetching and one half (1/2) in case of water transportation by truck, EIRR is able to change to positive (EIRR = 0.9% and 4.3%, respectively). If the water tariff increases 45% yearly, the FIRR will change to positive (FIRR = 5.8%) in the period from 2009 to 2028. Table 5 shows the changing of FIRR according to the increasing rate of the water tariff.

Table 5 FIRR of RWSP with Water Rate Raising

Rate for 2008 (assumption)	Yearly raising rate after 2008	FIRR
0.1 TJS/m^3	+10%	Unable to get FIRR
	+45%	5.8%

Even if the water tariff increases 10% yearly, financial difficulty of the water supply operation is foreseen. Therefore, financial support (subsidy) by the government is indispensable. In addition, because of the financial difficulty, funds for the capital investment for construction and renewing water supply systems, shall be provided by the government.

10. PROPOSALS THROUGH THE IMPLEMENTATION OF THE PILOT PROJECT

(1) Rehabilitation of Existing Rural Water Supply System

Bolshevik village in Kabodiyon Rayon was selected as the site of the pilot project. The following rehabilitation works were made on the existing water supply system to recover it's function.

Table 6 Rehabilitation Work Performed

Rehabilitation Work	Quantity
Rehabilitation of pipeline	593m
Installation of additional public tap	4 sites
Other works	
Rehabilitation of valve box	5 sites
Installation of sand drain pipe	1 lot
Rehabilitation of taps in the school	1 lot

(2) Implementation of Component Program for Improved Operation and Maintenance in Pilot Project

In order to verify the feasibility and applicability of the strategy mentioned above in operation and maintenance of the water supply system, component programs for improved operation and maintenance have been introduced and implemented in Bolshevik village since August 2008, where the pilot project was implemented.

Under the component program, activities for improved operation and maintenance described above (Stage 1 to Stage 5) were duly undertaken. Reviewing the output obtained and challenges identified through implementing the program, lessons learnt and suggestions are summarized.

1） Outputs

(i) Defined Roles and Responsibilities among Stakeholders for Improved Operation and Maintenance

Prior to the implementation of the pilot project, all actors involved in operation and maintenance of the supply system, namely village representatives, Jamoat, system owner (i.e. farm organization), and RWSA and Ministry of Land Reclamation and Water Resources concluded agreement on the system management. Based on the strategy for improved operation and maintenance described above, this agreement defines basic principles in system ownership and management, establishment of community management entity, as well as roles and responsibility of each entity in system operation and maintenance including operation and maintenance cost. The agreement defines that the system ownership is belong to Kolkhoz “Avesto”, assuming thereby major responsibility for operation and maintenance in cloze collaboration with Water User Association and other relevant stakeholders.

(ii) Formation of Water User Association

Series of consultative meetings were held among community representatives (i.e. representatives of Mahalla Committee), representative of Kolkhoz, and Jamoat for improvement of operation and maintenance, through which the necessity and significance to create small Water User Groups (WUGs) that fall under the unbrella of the Water User Association (WUAs) is confirmed. WUG is formed at each public water supply point (i.e. communal tap) consisted of all user sharing the tap with two representative, one of which serves as a technician and the other one serves as community promoter to take care of its respective tap. The assembly of WUGs is called as Water User Association, which served as decision making and auditing body in supply scheme management of significance, such as account and financial management, undertakings for maintenance and repair, conflict resolution among user communities, and so forth.

(iii) Establishment of Water Fee

In the given socio-economic condition in the Bolshevik village where rural poor is

obvious, it is reviewed under the Study that full cost recovery from the user communities for operation and maintenance, including cost for major maintenance and replacement of the supply scheme, could evidently aggravate rural poor. However, instituting payment for water supply services, even it can not cover the cost for major maintenance and replacement, can be an important contribution toward sustainability and may deepen a sense of ownership in a symbolic manner among the user community towards the rural water supply system. Thus, water fee is determined among Water User Association (WUA) and system owner, limiting amount enough to cover the cost for daily operation and minor repair of the supply system. Water fee is set at 1.0 diram per m3, just to cover expense for electricity to operate submersible pump and miscellaneous for minor repair, while deciding fund for major maintenance and replacement shall be borne by the system owner of Kolkhoz that has financial capabilities.

(iv) Development of Operation and Maintenance Manual and Provision of Training for Water User Associations

The newly established Water User Association and system operators were provided with several training to improve capacity for the system management. There are three major trainings provided for relevant target group. Those are "Technical Training" was provided for system operator and WUG technicians, to improve their capacity to operate and maintain the water supply system in a technical sense. "Organizational Development Training" was provided to WUA to facilitate their organizational management, including group administration, financial and accounting management, development of organizational regulation, task and responsibility sharing with other stakeholders, and water fee collection. "Hygiene and Sanitation Training" is also provided for WUA members under this component program to improve their sense of hygiene and sanitation.

2) Lesson Learnt and Suggestion

It is observed significant to determine ownership of the rural water supply system and roles and responsibility in the system management through consultative meeting with stakeholders. Through consultative meeting with stakeholders to define ownership of the supply system as well as tasks and duties in the system management, all stakeholders dully committed themselves for improved operation and maintenance.

It is reviewed that utilization of existing technical and financial capacity of state entity for the system management, operation and maintenance is efficient and effective. In addition, community-based entity could not financially sustain its management in the rural area where full cost recovery for operation and maintenance could not expected, while state entities are supported by their financial backbone. Considering less capacity of local government and community to provide technical and financial undertakings for the system operation and maintenance, involvement and commitment of those entities competent for water supply is rather inevitable.

It becomes rather obvious that community's capability to pay for water is extremely low to satisfy operation and maintenance cost except direct cost for daily operation (i.e. expense for electricity). Therefore, financial backup of Kolkhoz and other state entity as the system owner to cover cost for major maintenance and replacement is necessary to sustain the supply scheme. However, introduction of water fee, although small, enhanced a sense of community ownership in a symbolic manner as well as participation in operation and maintenance of the supply system.

Creation of WUA also facilitates community participation in the system operation and maintenance, with provision of training for their capacity building. Registration of WUA as legal entity also facilitates partnership and sharing responsibility with Kolkhoz and other supply entity in operation and maintenance of the supply system. Community leaderships in the pilot project were raised through provision of "Technical Training", "Hygiene and Sanitation Training", and "Organizational Development Training". It is

expected that relevant governmental organization monitor and follow-up community participation and partnership with Kolkhoz.

(3) Implementation of Component Program for Public Health in Pilot Project

1) Output from the implementation of the Pilot Project

Activities for public health education in the pilot project was carried out utilizing the health promoters in Bolshevik village. Contents of the activities were retraining of the health promoters, education of community people, radio-broadcasting, theatre shows, distribution of posers and broche ours and education in the school, and so on.

After the completion of the activities, a KAP survey was carried out to evaluate the effectiveness of the activities. Jarkurgan village, next to Bolshevik village, was also surveyed to compare with Bolshevik village. Following data were collected in the survey.

To assess the target population's awareness of water-borne diseases including disease transmission, symptoms, risk factors and prevention practice,

- To assess the target population's awareness of priority health risks such as children's excreta disposal, lack of hand washing, and the hygiene practice that create greatest risk to health,
- To assess household access to safe drinking water, including water treatment practices, and
- To assess awareness and good practice in dealing with children's diarrheal episodes.

As the result of comparison of obtained data from both villages, it was confirmed that impsct of public health education much appeared in Bolshevik village. The evident impacts are;

- Knowledge that diarrhea, hepatitis, typhoid and dysentery were transmitted through untreated drinking water;
- Understanding the relationship between personal hygienic behavior and the above mentioned water-borne diseases;
- Knowledge of the symptoms of Dysentery Hepatitis and Typhoid Fever; however; some misconceptions regarding typhoid still remain.
- Knowledge of concrete steps that beneficiaries could take to reduce their risk of contracting water-borne diseases;
- Understanding that no matter its origin, only boiled water could truly be considered to be clean.

2) Conclusion and Recommendation of Public Health Education

There exist many needs of Improvement in the living conditions in the rural villages. Even a water supply system is rehabilitated, cleanness of water cannot be kept if the water is left unclean condition in a kitchen. People’s custom to wash hands and body will not be kept if places to wash hands and body are inconvenient although it becomes easy to use water. Especially in Bolshevik village, channels are flowing fro place to place in the village and the channels are actual washhouses and sculleries. There are often no washhouse and kitchen in the houses. Under such environment, effect on the living environment is limited. In addition, conditions other than safe water such as locations of kitchen, toilet in the house and nourishment may make varnish the effect by safe water. Therefore, it is recommended plan to include movement for improvement of living conditions into rehabilitation and expansion plan of the water supply systems integrating the improvement activities for housing, toilet and nourishment.

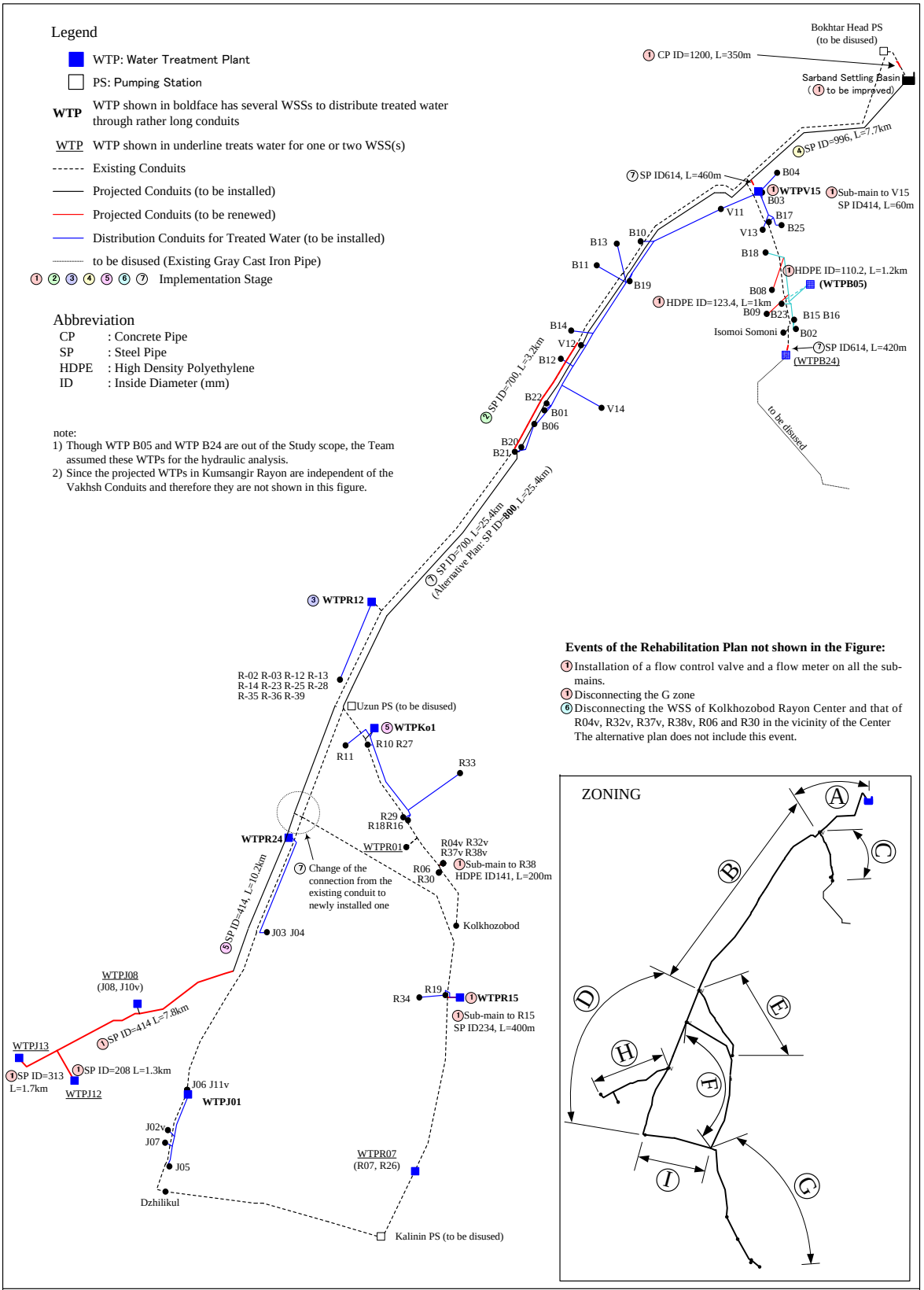

Figure 1 Outline of the Rehabilitation Plan for the Vakhsh Conduits

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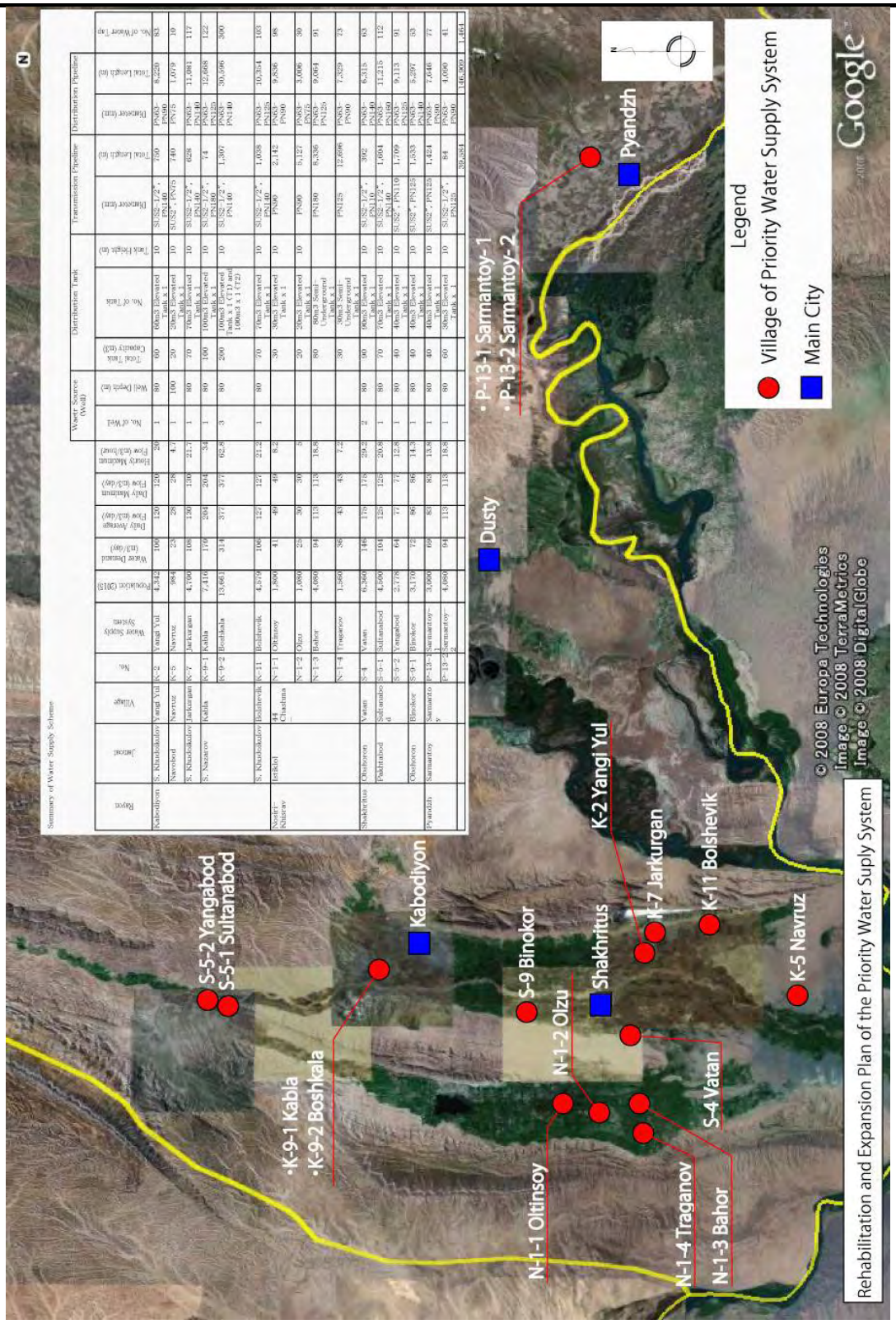

Rayon	Jamoat	Village	No.	Water Supply System	Population (2015)	Water Demand (m3/day)	Daily Average Flow (l/s.day)	Daily Maximum Flow (l/s.day)	Hourly Maximum Flow (l/s/hour)	Water Source (Well)		Distribution Tank		Transmission Pipeline		Distribution Pipeline		
										No. of Well	Well Depth (m)	Total Tank Capacity (m3)	No. of Tanks	Tank Height (m)	Diameter (mm)	Total Length (m)	Diameter (mm)	Total Length (m)	No. of Water Tap
Kabodiyon	S. Khuhokalov	Yangi Yul	K-2	Yangi Yul	4,342	906	120	120	20	1	80	60	60m3 Elevated Tank x 1	10	SUS2 -1/2", PN140	650	PN63-PN90	8,220	83
	Navobod	Navruz	K-5	Navruz	894	224	28	28	4.1	1	100	20	20m3 Elevated Tank x 1	10	SUS2 -, PN16	740	PN16	1,019	10
	S. Khuhokalov	Jarkurgan	K-7	Jarkurgan	4,160	1,008	130	130	21.7	1	80	70	70m3 Elevated Tank x 1	10	SUS2 -1/2", PN140	628	PN63-PN90	11,081	117
	S. Nazarov	Kabla	K-9-1	Kabla	7,410	1,760	204	204	34	1	80	100	100m3 Elevated Tank x 1	10	SUS2 -1/2", PN140	74	PN63-PN125	12,668	122
			K-9-2	Boshkala	13,661	3,14	377	377	62.8	3	80	200	100m3 Elevated Tank x 1 (72) 100m3 x 1 (72)	10	SUS2 -1/2", PN140	1,397	PN63-PN140	30,596	300
	S. Khuhokalov	Boldnevik	K-11	Boldnevik	4,259	1,06	127	127	21.2	1	80	70	70m3 Elevated Tank x 1	10	SUS2 -1/2", PN140	1,038	PN63-PN90	10,354	103
Nesbit-Khtaraw	Istiklol	14 Chashma	N-1-1	Oltinsoy	1,899	41	49	49	8.2			30	30m3 Elevated Tank x 1	10	PN90	2,142	PN63-PN90	9,836	98
			N-1-2	Olzu	1,060	25	30	30	5			20	20m3 Elevated Tank x 1	10	PN90	5,127	PN63-PN75	3,006	30
			N-1-3	Bahor	4,060	94	113	113	18.8			80	80m3 Semi-Underground Tank x 1		PN180	8,336	PN63-PN125	9,064	91
			N-1-4	Traganov	1,860	38	43	43	7.2			30	30m3 Semi-Underground Tank x 1		PN125	12,896	PN63-PN90	7,329	23
Shakhritus	Obuhoron	Vatan	S-4	Vatan	6,360	146	176	176	29.2	2	80	90	90m3 Elevated Tank x 1	10	SUS2 -1/2", PN140	392	PN63-PN140	6,315	63
	Pakhtabod	Sultanabod	S-5-1	Sultanabod	4,560	1,01	125	125	20.8	1	80	70	70m3 Elevated Tank x 1	10	SUS2 -1/2", PN140	1,604	PN63-PN180	11,215	112
		Yangabod	S-5-2	Yangabod	2,778	64	77	77	12.8	1	80	40	40m3 Elevated Tank x 1	10	SUS2 -, PN110	1,709	PN63-PN110	9,113	91
	Obuhoron	Binokor	S-9-1	Binokor	3,170	72	86	86	14.3	1	80	40	40m3 Elevated Tank x 1	10	SUS2 -, PN216	1,633	PN63-PN140	8,597	93
Pyandzh	Samantoy	Samantoy	P-13-1	Samantoy-1	3,000	69	83	83	13.8	1	80	40	40m3 Elevated Tank x 1	10	SUS2 -, PN125	1,424	PN63-PN125	7,048	77
			P-13-2	Samantoy-2	4,060	94	113	113	18.8	1	80	60	60m3 Elevated Tank x 1	10	SUS2 -1/2", PN250	84	PN63-PN90	4,060	41
																39,684		146,969	1,464

FIGURE 2. SUMMARY OF REHABILITATION AND EXPANSION PLAN OF PRIORITY SYSTEMS

THE STUDY FOR SUSTAINABLE RURAL WATER SUPPLY SYSTEM IN THE SOUTHERN KHATLON OBLAST, THE REPUBLIC OF TAJIKISTAN | **JICA**

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ABBREVIATIONS

AAH	Action Against Hunger
ACTED	Agency for Technical Cooperation and Development
ADB	Asian Development Bank
BPWSP	Bakhsh Pipeline Water Supply Project
CIP	Cast Iron Pipe
CIS	Commonwealth of Independent States
DALY	Disability-adjusted Life-year
DEES	Department of Environmental and Emergency Situations
DRD	Direct Rule Districts
EBRD	European Bank for Reconstruction and Development
EC	Electric Conductivity
ECHO	European Commission Humanitarian Aid Office
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate f Return
FEA	Federal Environmental Agency (of Germany)
FIRR	Financial Internal Rate of Return
FTU	Formazin Turbidity Unit
GBAO	Gorno Badakhshan
GDP	Gross Domestic Product
GIS	Geographical Information System
HCSE	Housing and Communal Service Enterprise
IEE	Initial Environmental Examination
IMF	International Monetary Fund
JDC	Jamoat Development Committee
JICA	Japan International Cooperation Agency
JRC	Jamoat Resource Center
KAP	Knowledge, Attitude and Practice
MDG	Millennium Development Goal
MDWD	Maximum Daily Water Demand
MICS	Multi Indicator Cluster Survey
MMWR	Ministry of Melioration and Water Resources
NCD	Non-communicable Disease

NDS	National Development Strategy
NGO	Non-Governmental Organization
NPV	Net Present Value
NWSP	National Water Supply Plan
OM/M	Operation, Maintenance and Management
PI	Profitability Index
PS	Pump Station
RWSA	Rural Water Supply Authority
RWSP	Rural Water Supply Project
SCEP	State Committee for Environmental Protection
SCF	Standard Conversion Factor
SES	Sanitary and Epidemiology Service
SP	Spontaneous Potential
TDS	Total Dissolved Solid
UFW	Unaccounted-for Water
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
USD	United States Dollar
USSR	Union of Soviet Socialist Republics
VAT	Value Added Tax
WHO	World Health Organization
WSDS	Water Sector Development Cost
WSS	Water Supply System
WTP	Water Treatment Plant
WUA	Water User Association
WUC	Water User Committee

Part 1 General

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

In Tajikistan, a Water Sector Development Strategy (2006-2015) was established under the assistance of UNDP, aimed at attaining the Millennium Development Goals of the UN. The Strategy targets improving water supply coverage up to 80% in the rural area by the year 2015. A Presidential Decree related to the National Water Supply Plan (2007-2020) indicated to raise the water supply ratio to 90% in the rural area..

The rural water supply sector in Tajikistan presents many challenges from the viewpoints of social, organic and institutional aspects. The rural water supply service in Tajikistan started as a water supply to Sovkhozs (state farms) and Kolkhozs (collective farms). The Vakhsh pipeline which passes through the center part of the study area was constructed in 1977 as part of the water supply development. Construction of this pipeline largely contributed to improving water supply service coverage. Development of water supply facilities had been supported by budget subsidies from the Soviet Union. However, such system was stopped by the collapse of the USSR in 1991. Since then, the development of water supply services was retarded and most facilities were not properly maintained due to lack of funds. The Vakhsh pipeline has aged and part of the planned pipeline routes have not been constructed. Sovkhozs and Kolkhozs were divided into private farms by the agricultural revolution in 1992. Because of this, ownership of water supply facilities became unclear. Thus, maintenance of proper water supply facilities and most of other facilities were obliged to stop services due to aging and malfunctions. 83 facilities out of approximately 150 were listed by RWSA, 60% of the facilities have already stopped functioning. The reasons why most existing water supply systems are not functioning are the unclear situation of ownership by the systems, lack of ownership of community people, lack of affordability and willingness to pay the water tariff, etc.

The Study aims to formulate rehabilitation and extension plans of the existing water supply systems considering the Presidential Decision Directive which targets improving water supply coverage up to 90%. Therefore, it is necessary to rehabilitate the existing water supply systems taking into consideration the capacity of Vakhsh pipeline and groundwater potential and to study the operation and maintenance of a system that meets the socio-economical situation of the communities in the Study area.

In the Study area, water-borne diseases breakout every year, therefore, this is also an issue for improvement. Since the breakout of water-borne diseases is likely caused by the deterioration of the water source, it is important to study the improvement of people's behavior from the viewpoints of health and hygiene. Thus, improvement of personal hygiene and behavior, and the promotion of community participation are to be considered in the study.

Assistance to the rural water supply and, health and hygiene sectors are carried out by UNDP, UNICEF, ADB, ECHO (European Commission Humanitarian Aid Office) and NGOs. Exchange of information with these organizations and exploitation of such experience and knowledge are indispensable in the implementation of the Study.

1.2 OBJECTIVES OF THE STUDY

The objectives of the Study are:

(1) To establish rural water supply facility inventory in the study area.

(2) To formulate rehabilitation, reconstruction, and extension plans for the selected water supply systems

(3) To propose sustainable rural water supply management through a pilot project

(4) To pursue technology transfer to counterpart personnel in the course of the study

1.3 STUDY AREA

The Study will cover the following eight (8) Districts (Ryons) of Khatlon Oblast as shown in Figure 1.3.1.

(1) Vakhsh

(2) Kolkhozobod

(3) Dzhilikul

(4) Kumsangir

(5) Kabodiyon

(6) Shakhritus

(7) Nosiri-Khisrav

(8) Pyandzh

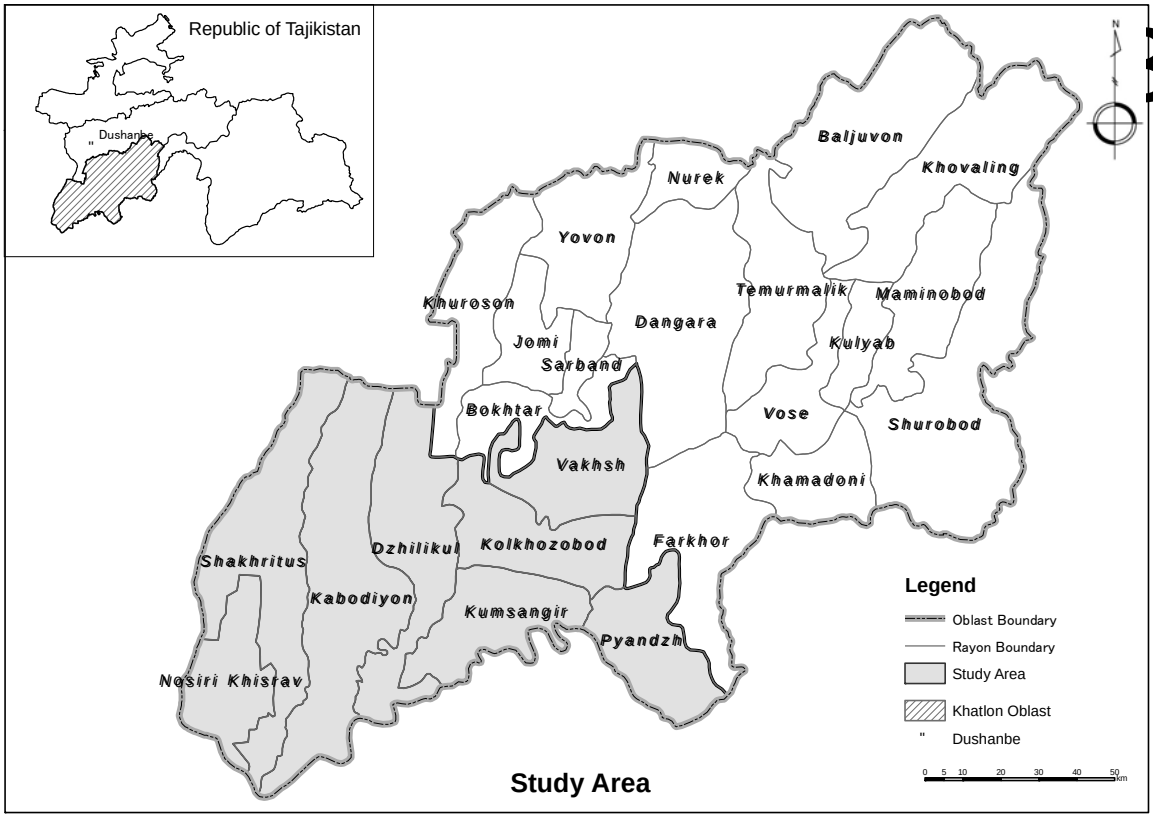


Figure 1.3.1 Study Area

1.4 IMPLEMENTATION OF THE STUDY

The Ministry of Melioration and Water Resources (MMWR), and the Tajik Rural Water Supply Authority (RWSA) were assigned as the counterpart organizations by the Government of Tajikistan, while the Japan International Cooperation Agency (JICA) was assigned as the official agency responsible for the implementation of the technical cooperation program of the Government of Japan.

The Study conducted by the Japanese study team, was comprised of members from Earth System Science Co., Ltd. and Japan Techno Co. Ltd, officially retained by JICA for the Study, and the counterpart staff provided by MMWR, RWSA and Hukmat of Khatlon Oblast.

The total schedule of the Study is shown in the Flow Chart (See, *Figure 1.4.1*).

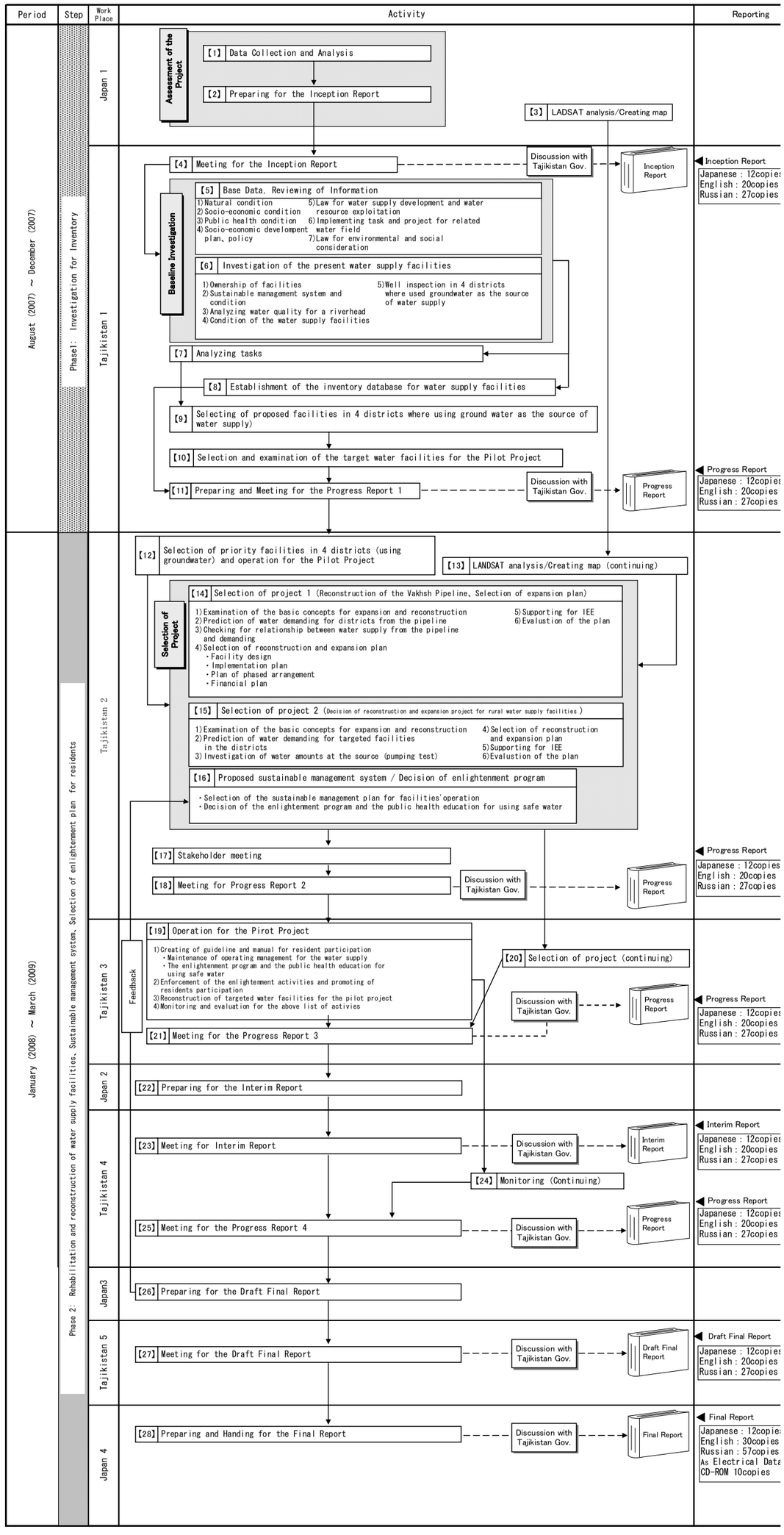


Figure 1.4.1 Flow Chart of the Study

1.5 COMPOSITION OF THE REPORT

This report consists of two (2) volumes: Main Report and Supporting Report. The Main Report presents the summarized results of all the studies. In Part 1, the basic information on the Study is described. Current situation and development issues on the Vakhsh conduits and the Rural Water Supply Systems, operation and maintenance system, and public health are described in from Chapter 3 to Chapter 7 in Part 2. Part 3 presents the rehabilitation and expansion plans for the Vakhsh conduits and the Rural Water Supply Systems, approximate implementation cost, economic and financial analyses, and social and environmental considerations as Chapter 8, Chapter 9, chapter 10 and Chapter 11, respectively. Conclusion and Recommendation on the development issues are presented in Part 4 based on the results of the pilot project.

The Supporting Report is composed of the following contents.

1. Appendix Tables for Chapter 3
2. Appendix Tables and Figures for Chapter 3
3. Appendix for Chapter 8
4. Appendix for Chapter 9
5. Manual for Operation and Maintenance of Rural Water Supply Systems

1.6 MEMBERS INVOLVED IN THE STUDY

Members involved in the Study are listed in *Table 1.6.1*.

Table 1.6.1 List of Members Involved in the Study

(1) The JICA Study Team

The Team is composed of the following 14 experts.

Name	Assignment
Mr. Yasumasa YAMASAKI	: Team leader/Rural Water Supply Planner
Mr. Toshihiro TSUCHIYA	: Water Supply Pipeline Planner
Mr. Naoki MORI	: Operation and Maintenance Planner/Community Organizing Specialist
Ms. Chiharu ABE	: Public Health and Hygiene Specialist
Mr. Kenji HIRAMATSU	: Organization and Institution Specialist /Socio-Economist
Mr. Tadao SUZUMURA	: Hydrogeologist (1)/Borehole Camera Specialist
Mr. Masatoshi IWAMOTO	: Electric and Mechanical Engineer
Mr. Hodaka IGO	: Environment and Social Consideration Specialist
Mr. Masao UEMATSU	: GIS Specialist
Mr. Shunichi HATANO	: Water Supply Facility Designer/Cost Estimator
Mr. Masakazu SAITO	: Rural Water Supply Facility Designer/Cost Estimator (2)
Mr. Tomu ASANO	: Interpreter
Ms. Etsuko KUROZUMI	: Interpreter
Mr. Hiroyuki NAKAYAMA	: Coordinator/Hydrogeologist (2)

(2) The Counterpart Team

The team is composed of following10 members.

Name	Organization
（Dushanbe）	
Mr. Isoev M.	: Head, RWSA
Mr. Davlatov S.	: Head, Department of Foreign Economic Relations, MMWR
Mr. Sharifov. G.	: Chief Engineer, RWSA
Mr. Sattorov	: Chief Specialist, Department of Water Resources, Science and Technology, MMWR
Mr. Abdulmuminov A.	: Head, Department of Land Reclamation and Water Resources of Hukmat of Khatlon Oblast
（Khatlon Oblast）	
Mr. Faizaliev R.	: Head, Oblast Department of RWSA
Mr. Zoirov J.	: Chief Engineer, Oblast Department, RWSA
Mr. Safarov S.	: Head, Kolkhozobod Rayon Section, RWSA
Mr. Rajabov R	: Head, Science and Investment Department, RWSA
Mr. Musoev A.	: Head, Vakhsh Rayon Section, RWSA

CHAPTER 2 GENERAL CONDITION OF THE STUDY AREA

2.1 METEOROLOGY

Annual precipitation in the Study is approximately 250mm. Monthly average precipitation is shown in *Figure 2.1.1*. Clear rainy seasons and dry seasons are recognized. The rainy season is from November to May.

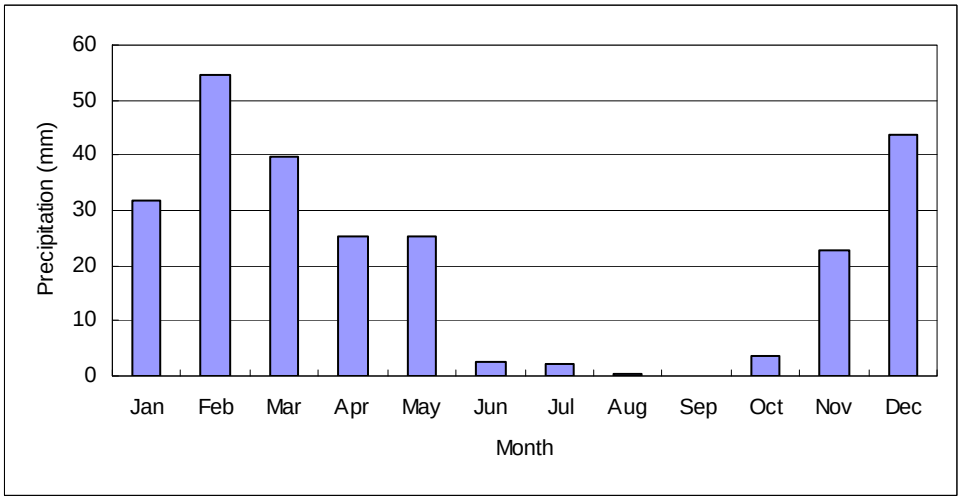


Figure 2.1.1 Monthly Average Precipitations (2001-2005)

Monthly average highest and lowest temperatures are shown in *Figure 2.1.2*.

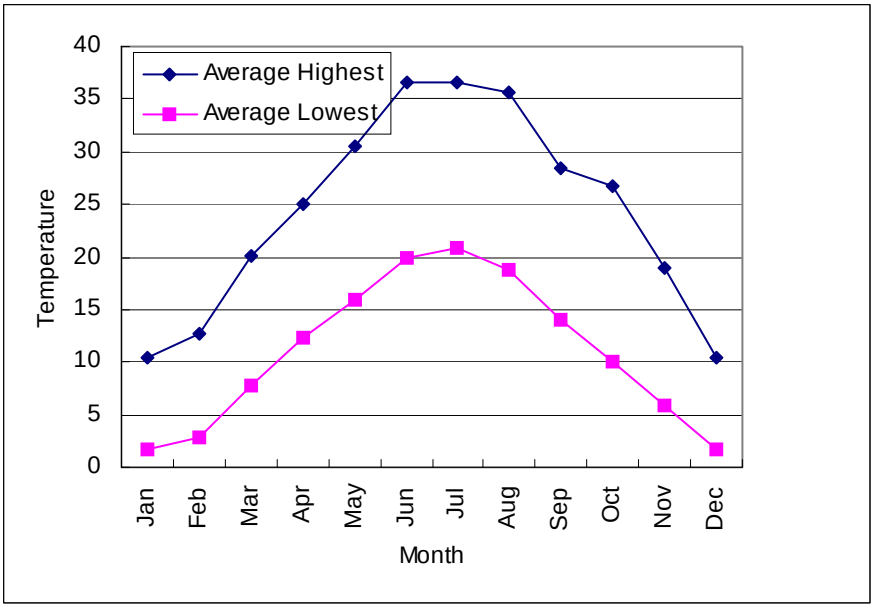


Figure 2.1.2 Monthly Averages Highest and Lowest Temperature

The Climate of Khatlon Oblast belongs to the typical continental climate. Daily temperature range and seasonal difference of temperature between summer and winter is large. Annual temperature range reaches 60°C. The monthly average highest temperature is extremely high in June, July and August. It is more than 35°C. The highest temperature, 40°C or more continues

for approximately 10 days in the summer season. In the winter season, the temperature falls below below 0°C for approximately 30 days.

2.2 TOPOGRAPHY AND GEOLOGY

2.2.1 TOPOGRAPHY

Mountain ranges and river networks are shown in *Figure 2.2.1*.

Mountains occupy 93% of the territory of Tajikistan and more than half of the country is located at an altitude of more than 3,000m and less than 7% is arable land.

Figure 2.2.1 Mountain Ranges and River Network in Tajikistan

Three rivers flow in the Study area: The Vakhsh, Pyandzh and Kofarnihan Rivers. Their features are shown in *Table 2.2.1*.

The Pyandzh River flows in the southern part of the Study area along the border with Afghanistan.

Table 2.2.1 Feature of the Rivers Flowing in the Study Area

River	Length (km)	River Basin (km^2)
Vakhsh	524	39,100
Pyandzh	921	114,000
Kofarnihan	387	11,600

The Vakhsh River flows between the Aktan and the Karatan Mountain Ranges, and flows into the Study area from Sarband. Both the Vakhsh and Kofarnihan Rivers merge with the Pyandzh in the south-western border of the Study area and becomes the Amudarya River.

2.2.2 GEOLOGY

The geological map of Tajikistan is shown in *Figure 2.2.2*.

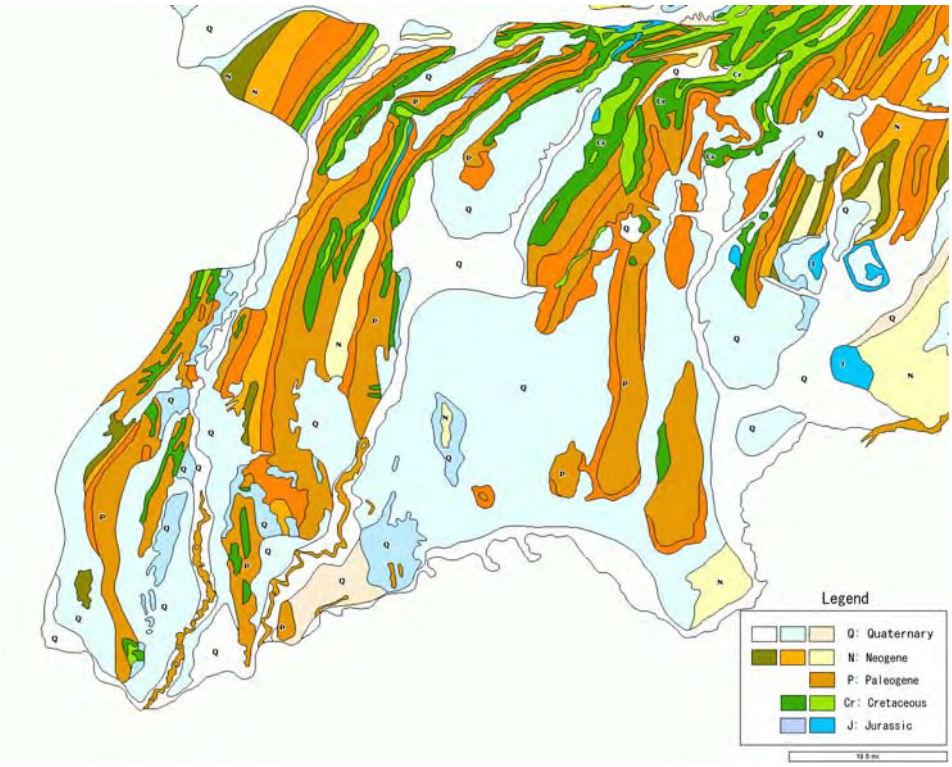


Figure 2.2.2 General Geology of Tajikistan

The Geology of Tajikistan is generally subdivided into two areas. The Pamir Plateau, in the eastern part of Tajikistan, is occupied by mainly Late Mesozoic to Early Neogene formations. The western side of Tajikistan, where the Study area is situated, is called “the Tajik Depression”. The Vakhsh, Pyandzh and Kofarnihan Rivers flow into this depression from the Pamir Plateau, forming a vast fluvial fan. The Study area is located in the fan formed by the Vakhsh River. Thick deposits composed mainly of sand and gravel were accumulated in the fan.

Groundwater is extracted from the fan deposits. Many boreholes were drilled by Tajik Geology in 1980s to research the geological and hydrogeological conditions including geological log, pumping test results and water quality.

2.2.3 HYDROGEOLOGY

Groundwater in the study area is classified into two (2) types, i.e. confined groundwater in the basement rock and phreatic (unconfined) groundwater in the alluvial deposits (overburden).

(1) Confined Groundwater in Basement Rock

“Forty-four (44) springs” erupt from the basement rock of limestone in Nosiri Khisrav Rayon, approximately one (1) km west of the Chashma pumping station. The groundwater might be infiltrating the upper stream of the Kofarnihan River and crop out at this site passing through caverns. The quality of spring water seems to be excellent.

In Kurgan-Tyube, one (1) deep borehole was drilled into the basement rock, where the basement rock. It is reported in the references prepared in the period Soviet Union shallowly underlies alluvial deposits that the groundwater contains extremely high Mg and NaCl contents more than the

drinking standards. The groundwater development of the basement rocks is limited due to this reason.

(2) Groundwater in Alluvial Deposits

The study area has less than 1,000mm of annual rainfall. However, the rivers originating from the Pamir recharge a considerably large amount of water to groundwater in alluvial aquifers through the year. Highly permeable alluvial sand and gravel layers occur in the fan deposits. Most of the study area is located in the tectonic valleys; therefore, high groundwater potential of shallow groundwater is expected.

2.3 SOCIO-ECONOMY

2.3.1 GENERAL ASPECTS

Tajikistan was the lowest income country among the member countries of the former Soviet Union. Tajikistan became an independent country due to the Soviet Union collapse in 1991. However, together with independence, the barter trade of aluminum, electric power, food, etc. with the countries of the former Soviet Union, and the subsidy (about 50% of the annual revenue) from Moscow were suspended. Also, a civil war break out in 1992 and lasted 5 years until 1997. These suspensions and the civil war caused severe economic and social stagnation in Tajikistan.

After the civil war, Tajikistan's social condition has become stable, and with increasing aluminum production and cotton production, the economy of the Tajikistan has been growing. Notwithstanding, GDP per capita is 364 USD (2005, IMF estimated) which is the lowest among the CIS countries. People who belong to the poverty group are mostly rural farmers, who present a serious problem to solve.

On the other hand, to conquer poverty and to seek high wages, nowadays, many have gone to foreign countries to work. The remittances from these people have been increasing every year, and have become a large financial source contributing to economy expansion. In 2005, 371 thousand peoples (among them, 132 thousand peoples from Khatlon Oblast) were employed in foreign countries, and the amount of remittance from them to their homes amounted to 550 million USD (about 26% of GDP) for 2004, and 735 million USD (about 31% of GDP) for 2005. (IOM research)

2.3.2 EXPORT AND IMPORT

Aluminum, cotton and electric power represent three of Tajikistan's exports. Although the export of aluminum stayed at 50 to 60% of the total for the years from 2001 to 2005, its export volume has increased remarkably from 2006. Since there has been little increase in exports of other products, the proportion of aluminum to the total export amount climbed to 75%.

The agriculture of Tajikistan is characterized by cotton growing. Cotton exports went up 24% of total exports value in 2003, however, its contribution to exports fell to 9% in 2006.

At present, in recent years, there has been no big change in terms of electric power export. The electric power and aluminum production export is surplus electricity of domestic consumption.

As for the imports, the volume of alumina for aluminum production, petroleum products, and wheat and flour have remarkably increased recently. For the year 2006, alumina has increased to double 2001 in US Dollar, petroleum 2.6 times, and wheat and flour 6.6 times. With import expansion, the trade deficit is expanding rapidly and amounted to 300 to 400 million USD yearly, in recent years (2004-2006).

2.3.3 INDUSTRY AND MINING SECTORS

There are 969 companies (as of 2006, 57.5% of those are of the state) in the industry and the mining sector.

The industrial sector of Tajikistan has branches of aluminum production, cement production, food processing, spinning, textiles, milling, chemical fertilizer production, electric apparatus (such as transformers) manufacturing, etc.. Among these branches, aluminum production is at the top of these branches and accounts for 43% of the total value of the industrial sector.

In Tajikistan, there is a state aluminum smelting company (operation started in 1975) with a production capacity of over 500 thousand ton/year, and it smelts aluminum from alumina (imported 100%) using abundant electrical power. The whole aluminum smelted by the company is mostly exported (about 400 thousand tons of aluminum was exported in 2006), and its export value accounted for 63% (2001 to 2006 average) of Tajikistan total exports.

Tajikistan, also, has various, but not such large amounts of mineral deposits within its territory, and 100 thousand tons of coal, 22 thousand tons of crude oil, and 20 million cubic meters of natural gas were produced in 2006.

2.3.4 AGRICULTURE

Agriculture produce 24.2% of the GDP for 2003, and 19.2% and 21.1% for 2004 and 2005 respectively, the production value of agriculture still accounts for approximately 20% of the GDP following the industrial sector. As of 2006, the total arable land of Tajikistan is 900 thousand hectares (66% of which is irrigated land), and of which 400 thousand hectares are used for growing grain and 300 thousand hectares are used to grow cotton.

A farm privatization policy was introduced after independence. A land reform law was enforced in 1992. By 2005, sovkhozs and kolkhoz had been divided and transformed into private farms, according to Defkan, except the state farms for seed-and-sapling production, livestock breeding and test growing. The lands of private farms are still properties of the state and dealings of those are forbidden. Presently, farmlands are separated into three groups, state farmland, Defkan farmland and individual farmer's land.

The agricultural sector accounts for 80% of the production sector's employment, and also accounts for 67% (as of November 2007) of all sectors of Tajikistan. From this figure, agriculture plays an important role not only in the economic sphere but also in the social sphere. However, employee's wages in the agriculture sector are the lowest. Monthly wage is only 43 Somoni, which is equivalent to 35% of the average wage (116 Somoni/month) of employees in all sectors. During four year from 2002 to 2006, the average wage of all sectors was increased 3.6 times (nominal base) but agriculture was 2.3 times. This is the lowest among all sectors.

2.3.5 ELECTRIC POWER

Tajikistan is abundant in water resources and 98% or more of electric power generation (about 15 billion kWh/year) is from the hydropower. There are 17 large-scale hydropower plants and 69 small-scale hydropower plants now. In electric power dealing with neighboring countries, from May to October there is an excess of exports from Tajikistan and from November to April there is an excess of imports to Tajikistan, so for the whole year Tajikistan is an importing country of electric power. In addition, during the electric power importing season, the people in rural areas are forced to bear with limited electric supply.

If the Sangtuda-2 hydropower plant (Sangtudsa-1 starts its operation in January 2008) and Rojon hydropower plant are built and those plants' power generation starts, not only required and

sufficient supply to the country but also the improvement of the export-and-import balance of electric power is expected. --- Sangutuda and Rojon are located upstream of the Vakhsh River running through Khatlon Oblast.

Only about 5% of Water-power generation has developed. The abundant water in the country, which will be able to be used in power generation, can be called important national resource.

2.3.6 GOVERNMENT AND ADMINISTRATION

Tajikistan is a constitutional and republican state. The present constitution was adopted in November 1994. The President is elected in a national direct election (the term-of-office seven years). The legislature is the Supreme Council (Majlisi Oli) with a two-chamber system, and consists of the National Assembly (Majlisi Namoyondagon) and people representation Parliament (Majlisi Milli). The terms of both chambers are five years. Administration of justice is by Supreme Court, the Highest Economy Court, the Constitutional Court, the Military Court, and District Courts.

Tajikistan's local administration consists of three tiers. As shown in *Figure 2.3.1*, Jamoats are of the first and the lowest local administrative bodies. Rayon and city are the second. And Oblasts are the third. Each administration of the second and the third has a government body called the Hukmat, and the president of Tajikistan appoints heads of these Hukmats. On the other hand, the chairperson belonging to Rayon or City names the head of Jamoats.

In addition, under the Jamoat, there are Mahalla/s, or village community/ies, and the Kishrak, which is a group of Mahallas. These Mahallas and Kishraks are not governmental bodies but traditional local communities, so that the project activities and works, such as field surveillance, plan development, etc. Are carried out in cooperation with these communities.

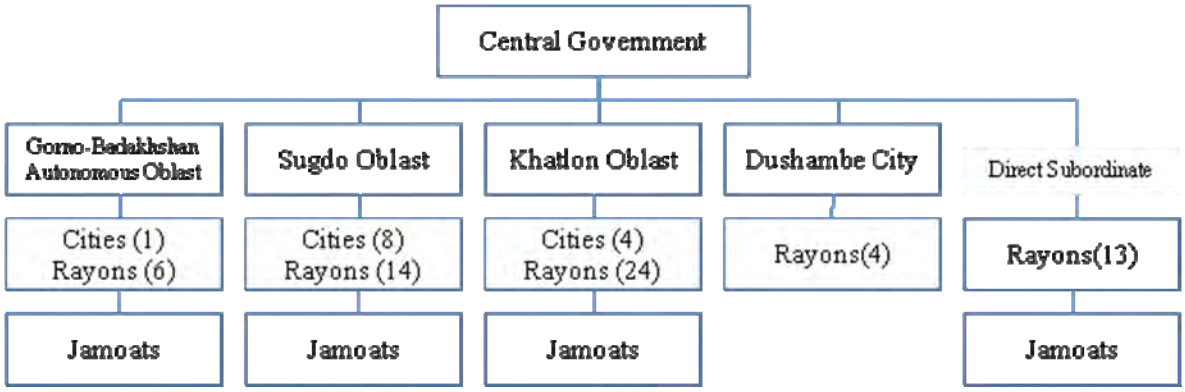


Figure 2.3.1 Local Administration Bodies of the Tajikistan

2.3.7 KHATLON

Khatlon Oblast is located in the southwest part of the country. The oblast's area (24.8 thousand km^2) is about 17% of the whole Tajik territory, while its population (2.52 million as of 2006) is about 36% of the total population of the country. In Khatlon Oblast, 82.6% of the population lives in rural areas and 17.3% in urban areas. The population density is 101.6 people/km^2 (as of 2006), and the rate of annual increase was 2.2% from 2001 to 2006 in the oblast, while that of whole Tajik population was about 2.0% in the same period.

Khatlon Oblast has been known as a good cotton producer since the former Soviet period. As of the end of 2006, the Khatlon Oblast has about 444 thousand hectares of arable land, which acounts for about 50% of the country's total. Besides growing potatoes, vegetables and other agriculture

products, grain and cotton are grown on 200 thousand hectares land and on 170 thousand hectares land respectively. As for industrial sectors of the Khatlon Oblast, there are many companies, producing processed food, such as dairy foods, meat, canned food, etc., producing chemical fertilizers of the whole-quantity fertilizers of Tajikistan, doing cotton ginning, manufacturing high voltage electricity transformers of whole units manufactured in Tajikistan, etc. In addition, the Nurek hydropower plant, which generates about 70% of total electric power of the Tajikistan, is also located in the Khatlon Oblast.

As for the employment of agriculture and industry sectors in the year 2006, 260 thousand workers, which accounts for 70% of the total employees (380 thousand workers) in Khatlon are working for state farms and Defkans. On the contrary, workers (employees) of the industry sector accounts for only 5%, which is 19 thousand workers.

According to the World Bank (2005), the poverty ratio of Tajikistan was 64% in 2003, and it differed by region. The ratio of Khatlon Oblast was 79%, being the second highest to that of GBAO (84%), while the ratio was 64% in Sogd Oblast which has agricultural characteristics similar to Khatlon. The average monthly wage of Khatlon is 79.71 Somoni (2006) the lowest in the country. It is about one third that at Dushanbe. Workplaces other than farms are few in the oblast, and many of Khatlon people seek jobs and high wages out of the oblast.

In a village in the southwestern area of Khatlon Oblast, the entire village is engaged in cultivation of cotton and vegetables at a state farm located in the village. The state farm, however, officially employs only one person from each family and the wages are low. Consequently, other family members, around 30% of the whole village, seek job to supplement family income out of the oblast and the country. It is not unvisual but a commonplace in the area, that around 10% of Jamoat's population, to which the said village belongs, is working out of the oblast or abroad.

Table 2.3.1 Socio-Economic Statistic Figures of Khatlon Oblast

Area	24,800 km^2 (17. 3% of the country total 143,100 km^2)	
Distance from Dushanbe	100 km, between Dushanbe and Kurgan-Tyube (Khatlon Oblast capital)	
Population, as of Jan. 1, 2007 (*1)		
2,519,600 (36% of the country total, 7,063,800)	Urban area	435,800 (17.3%)
	Rural area	2,083,700 (82.7%)
	Population density	101.6 capita/km^2
Economy (*1)		
Investment 520,937thds Somoni (42.9% of the country total), Business enterprises 238		
Industrial production(*1)		
Power generation 15,808mil.kWh, Electric transformer 22,500 thuds kW, Chemical fertilizer 32,300 ton, Cotton fiber 71,000 ton		
Agricultural production (tons)(*1)		
Grains 542,311 Potato 135,221 Cotton 258,073 Vegetables 259,182 Mellon 179,413 Fruit 58,751 Grape 46,268		
Livestock, number of heads (*1)		
Cattle 573,500 (Milk cow 314,592) Horse 50,346 Sheep, Goat 1,247,475		
Schools and students (*1)		
Preschools 105 (Children 10,425) Primary & Secondary schools 1,297 (Students 621,600) Vocational schools 12 (Students 7,500) Universities 5 (Students 18,900)		
Culture and amusement facilities (*1)		
Public libraries 496 (with 3,100 thud books) Culture circles 312 Cinemas 24 Theaters 2 Museums 13		
Medical institutes		
Medical institutions 150 Doctors 2,300 Nurses 7,500 79.9 people (out of 100,000) per day visit medical institutions.		
Malaria disease ratio: 471 per 100 thousand people		
Ethnic group		
Tajik 65% Uzbek 25% Kazakh/Kyrgyz/Russian 3.5% Tatar/Pamir 6.5%		
Religion		
Islamic (most of population) Christianity (mostly, Russian)		
Poorest group percentage(*2)		
91% (1991) 79% (2003)		
Salary, wages (monthly, Somoni) (*1)		
Average 79.71 Kumsangir 57.62 Kabodiyon 57.69 N.Khusrav 94.42		

Source: Tajik National Household Surveillance (2000) of State Statistical Committee
(*1) Statistical data of 2006 of State Statistical Committee (*2) WB (2005)

Jamoat-wise population is shown in *Table 2.3.2*.

Table 2.3.2 Jamoat-wise Population in the Study Area (as of Jan. 2007)

Vakhsh Rayon		**141,615**
1	ShahrakiVakhsh	12,425
2	Rohi Lenin	18,554
3	Ok Goza	27,162
4	Yangiobod	10,990
5	Kirov	31,197
6	Tojikobod	26,057
7	Mashal	14,780
Kolkhozobod Rayon		**137,491**
1	Navobod	17,628
2	Uzun	17,063
3	Madaniyat	13,589
4	S. Isoev	13,000
5	Frunze	17,650
6	Kalinin	12,066
7	Guliston	17,621
8	Tugalan	28,874
Kumsangir Rayon		**97,495**
1	Telman	17,868
2	Panj	27,385
3	Dusti	12,975
4	Kumsangir	21,361
5	Krupsky	10,875
6	Yakadin	7,031
Dzhilikul Rayon		**87,494**
1	Dzhilikul	20,774
2	Sverdlov	13,753
3	Dehkonobod	10,748
4	Nuri Vakhsh	13,769
5	Garauti	9,927
6	Navzamin	4,724
7	Gulmorod	13,799

Kabodiyon Rayon		**136,022**
1	Navobod	8,841
2	S. Khudoikulov	32,645
3	N. Khisrav	28,891
4	Yangi Yul	23,791
5	I. Niyozov	15,763
6	U. Nazarov	17,564
7	Kabodiyon	8,527
Shakhritus Rayon		**90,421**
1	Pakhtaobod	16,809
2	K. Kholmatov	25,183
3	Sayod	13,588
4	Jura Nazarov	14,515
5	Obshoron	6,871
6	Shahraki Shakhritus	13,445
N. Khisrav Rayon		**26,516**
1	Firuza	8,560
2	Istiklol	7,529
3	Komsomol	10,427
Pyandzh Rayon		**95,300**
1	Tugul	11,506
2	Arab	20,122
3	Namuna	18,868
4	Sarmantoy	18,906
5	Kuldimon	17,168
6	Shahraki Pyandzh	8,730

Part 2 Existing Condition of Rural Water Supply System and Development Issues

CHAPTER 3 CURRENT SITUATION AND DEVELOPMENT ISSUES ON THE VAKHSH CONDUITS

3.1 INTRODUCTION

The Vakhsh valley is famous for its intensive cotton plantation and much of the population has migrated to this area. However, there was a risk of contamination of the shallow groundwater, which is considered as a good water source of the population for domestic use, by agricultural chemicals, in particular cotton chemicals, in this area.

The Vakhsh Conduits was constructed in 1977 to supply water to the population in six (6) Rayons located in the Vakhsh valley and Kurgan-Tyube; the center of Khatlon Oblast in order to keep the population from using the shallow groundwater.

The formulation of initial plan of the Conduits was as follows:

Water source	: Stalin canal around 7km downstream from Sarband dam which is located around 15km to the east-north-east of Kurgan-Tyube
Service areas	: Sarband, Vakhsh, Bokhtar, Kumsangir, Kolkhozobod and Dzhilikul Rayons, and Kurgan Tyube
Number of WSSs to be distributed	: n/a[1]
The water distribution capacity	: 105,000m^3/day
Specific per capita consumption	: 130 liter/day[2]
The projected population served	: 800,000
Project period	: n/a

Figure 3.1.1 shows the conduits layout drawing of the initial plan which had doubled pipelines. It had intended to cover the above mentioned areas with three conduit systems.

The systems would in principle deliver water by gravity to the respective WSSs.

The Study aims to understand the current situation of the conduits from the Sarband settling basin (hereinafter referred to as Sarband SB) to Vakhsh, and Dzhilikul, Kolkhozobod and Dusti via Uzun[3] and to establish the rehabilitation plan of the Vakhsh Conduits (hereinafter referred to as "the Plan".

[1] n/a: not available
[2] It is not clear that the original plan considered the peak factor for the daily water demand or not.
[3] The conduit from Uzun to Kolkhozobod had been reportedly constructed in 1962 after then it was renovated. Uzun WSS which has well water sources was constructed in 1972.

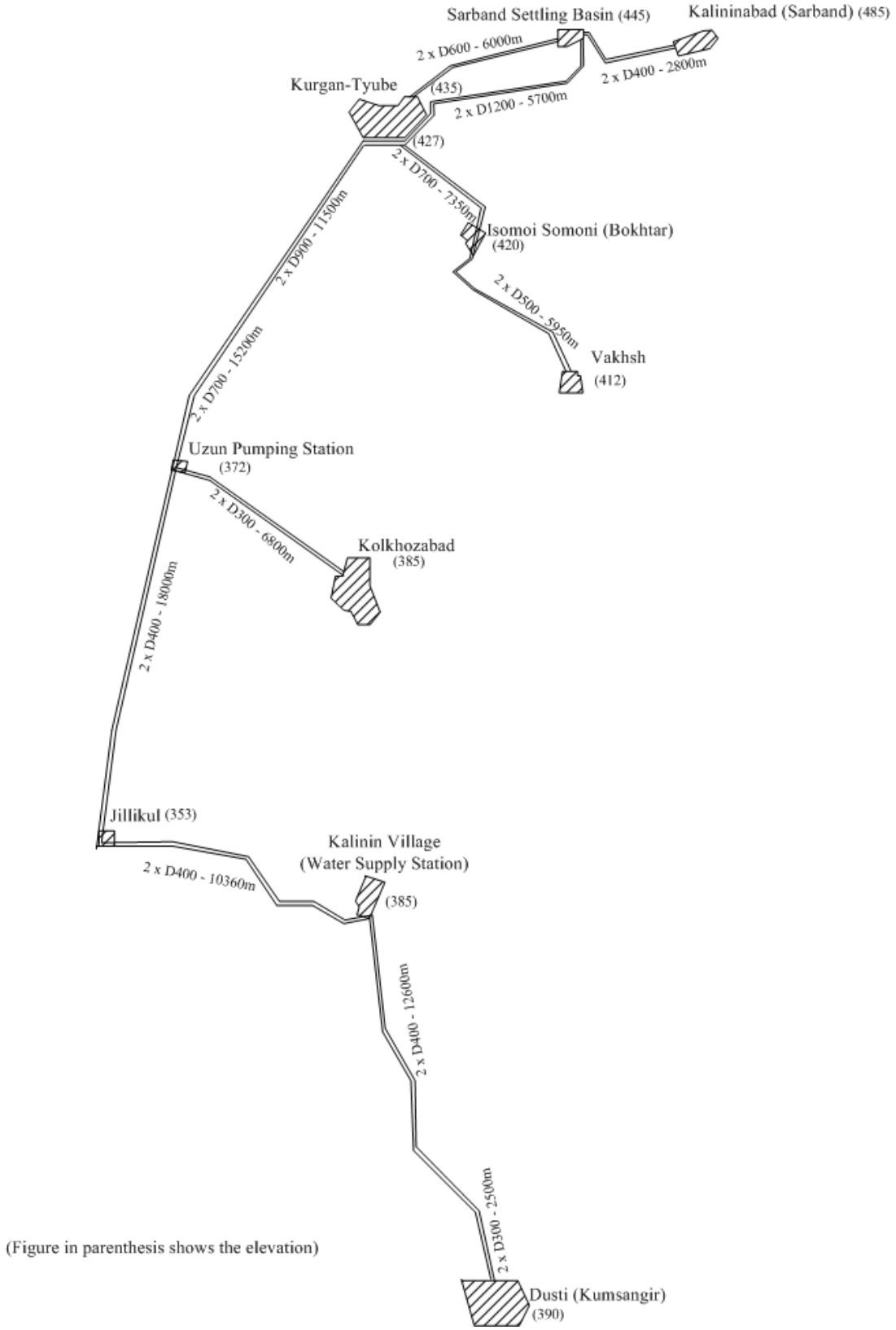


FIGURE 3.1.1 Initial Plan of Vakhsh Conduits

THE STUDY FOR SUSTAINABLE RURAL WATER SUPPLY SYSTEM IN THE SOUTHERN KHATLON OBLAST, THE REPUBLIC OF TAJIKISTAN	JICA

3.2 SOCIO-ECONOMIC SETTINGS

Table 3.2.1 shows the population from 2001 to 2006 of Rayons and Kurgan Tyube covered by the Vakhsh Conduits given by the National Statistic Committee. *Table 3.2.2* shows the population of the Rayons and their respective centers in 2007 provided by the division of statistics in Hukumat of the Rayons.

Table 3.2.1 Population from 2001 to 2006 of the Rayons and Kurgan-Tyube covered by the Vakhsh Conduits

	2001	2002	2003	2004	2005	2006
Sarband	19,500	20,300	21,200	21,800	22,900	23,400
Bokhtar	180,800	184,500	189,300	194,500	198,900	203,300
Vakhsh	130,800	133,100	135,800	138,600	141,300	144,400
Dzhilikul	77,200	79,000	81,100	83,100	85,200	87,300
Kolkhozobod	132,400	135,200	138,600	142,500	145,200	148,600
Kumsangir	87,700	89,800	92,000	94,500	96,800	99,300
Kurgan Tyube	63,000	64,500	65,700	67,200	68,800	69,900
Total						778,206

Source: Socio-economic Situation in Tajikistan 2007, National Statistic Committee

Table 3.2.2 Population of the Rayons and their Respective Centers in 2007

	Rayon Center	Total of Rayon	Number of households
Sarband	13,792	35,600	n/a
Bokhtar	7,354	191,784	24,620
Vakhsh	12,425	141,615	18,289
Dzhilikul	13,769	87,494	13,695
Kolkhozobod	13,000	137,491	20,868
Kumsangir	12,975	97,495	16,652
Total	73,315	691,479	

Source: the division of statistics in Hukumat of the Rayons.

3.3 CURRENT CONDITIONS OF THE VAKHSH CONDUITS

The realization of the initial plan has been the double pipelines for Kurgan-Tyube and the conduits not yet connected with Kalininabad, the center of Sarband Rayon. The conveyance system for other areas is a single pipeline and the double lines might be the second phase of the project.

However, social conditions during 30 years considerably altered the Conduit system and consequently there are several facilities which are not shown in the initial plan, such as Pump Stations (PSs), conduits, water source wells, etc. with the Conduits.

Figure 3.3.1 shows the outline layout of the Vakhsh Conduits with the WSSs in the Bokhtar, Dzhilikul, Kolkhozobod, Kumsangir and Vakhsh Rayons which the Vakhsh Conduits intends to cover. *Table 3.3.1* shows the list of the above-mentioned WSSs which includes the code of WSS shown in *Figure 3.3.1*. Hereinafter, this code will indicate the WSS mentioned in this text.

The Conduits cover the rural WSSs as well as the WSSs operated by the Vodokanals mainly located in the Rayon Centers and Kurgan Tyube.

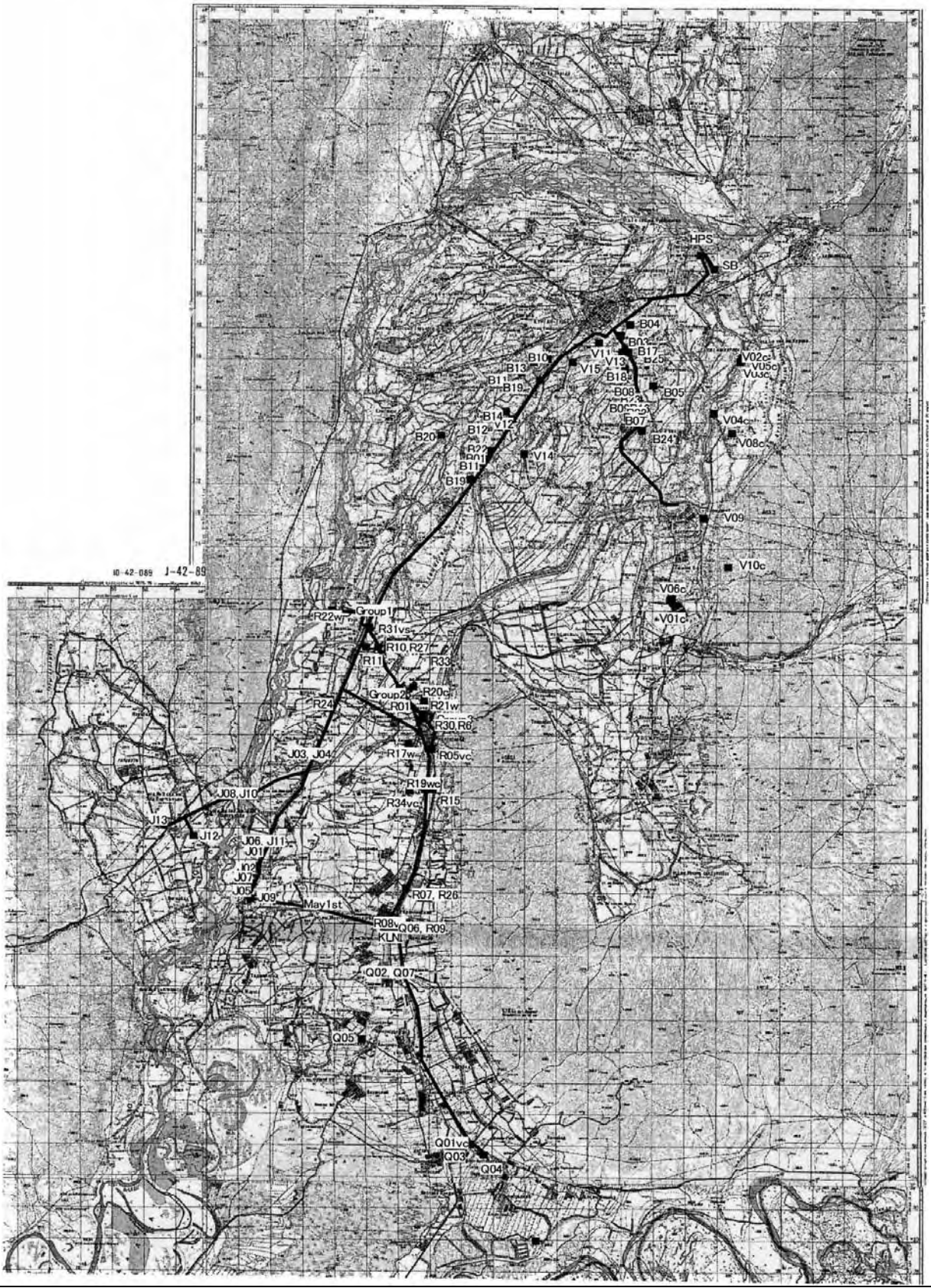


FIGURE 3.3.1 Outline Layout of the Vakhsh Conduits

THE STUDY FOR SUSTAINABLE RURAL WATER SUPPLY SYSTEM IN THE SOUTHERN KHATLON OBLAST, THE REPUBLIC OF TAJIKISTAN	JICA

3.3.1 ALTERNATION OF THE CONDUITS FROM THE INITIAL PLAN

Comparing the initial plan and the current conditions, the Team noticed the following differences:

(1) Bokhtar Head PS, Uzun and Kalinin PSs exist.
(2) The diameter of several pipelines is different.
(3) Steel pipes were supposed to be used for the Conduits but Cast Iron Pipe4 (CIP) and concrete pipe are used in the Conduits owing to the contribution by Kolkhoz and Sovkhoz who requested more water.
(4) The conduit connecting Uzun PS and Kalinin WSS has been constructed.
(5) The conduit to Vakhsh has not been completed. It was suspended about 3.5km before Vakhsh.
(6) The initial plan seemed to be to deliver water to the Kalinin WSS by gravity via Dzhilikul, however, the Kalinin WSS sends water to Dzhilikul by pumping.
(7) The Uzun PS is supplied with water from the Uzun Well PS which is located around two (2) km to the west of the Uzun PS.

3.3.2 WATER SOURCE

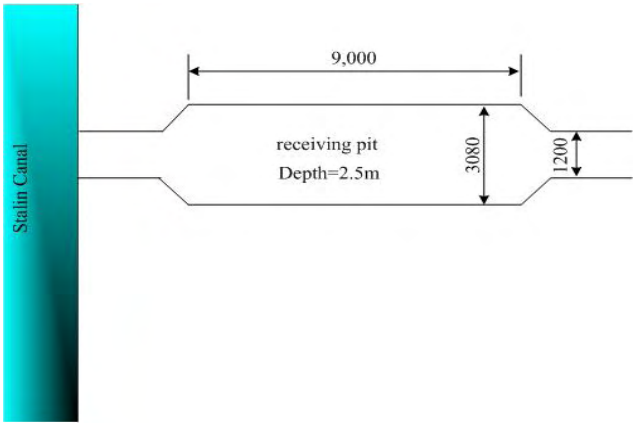
The water source is the Stalin canal which beside runs just aside the facilities of Sarband SB, however, the information on the canal such as cross sections, high and low water level corresponded with discharges. However, the Canal has enough discharge for the Conduits system considering the fact that the water level of the canal does not change after intake even in August.

Regarding the water right to be set for the water supply related to Vakhsh Conduits, etc., the RWSA explained that 105,000 m^3/day was authorized at the start of the Vakhsh Conduits project, however it does not reportedly exist in writing.

3.3.3 INTAKE AND SETTLING BASIN

Figure 3.3.2 shows the rough sketch of the receiving pit[5] at the intake from the Stalin canal. Considering the size of the cross section (around 2.6m^2) of the entrance channel to the pit, it seems to have over 105,000 m^3/day (1.2m^3/s) that the RWSA considers as the capacity of the Vakhsh Conduits.

[4] It is reportedly the Gray Cast Iron Pipe which does not have inside coating. The Gray Cast Iron Pipe is known as fragile against shock powers.
[5] It regulates the flow before entering the setting basin in order not to disturb the basin and remove rather big size suspended substances.



Source: own study

Figure 3.3.2 Outline of Receiving Pit at Intake

Figure 3.3.3 shows the Sarband Intake and Settling Basin. The capacity of the Basin is reportedly 240,000 m^3.

One of the difficulties is this facility is the lowering of the water level[6] of the Stalin canal in winter, which is the water source of the Vakhsh Conduits system, and it makes water delivery to the settling basin fill with sediment.

The system has the facilities for air lifting and scouring in order to make the water level in the conduits between respective facilities and to make the cross-section area of the flow of the conduits as clear as possible.

There is a perforated concrete pipe with a 1.2m diameter in the Settling Basin. The RWSA explains that this pipe has a filtration effect and the water quality in terms of turbidity is consequently better than that of the water surface.

The Study Team analyzed the turbidity[7] at the Sarband dam and the water of the Settling Basin surface in the downstream area. The result is as follows:

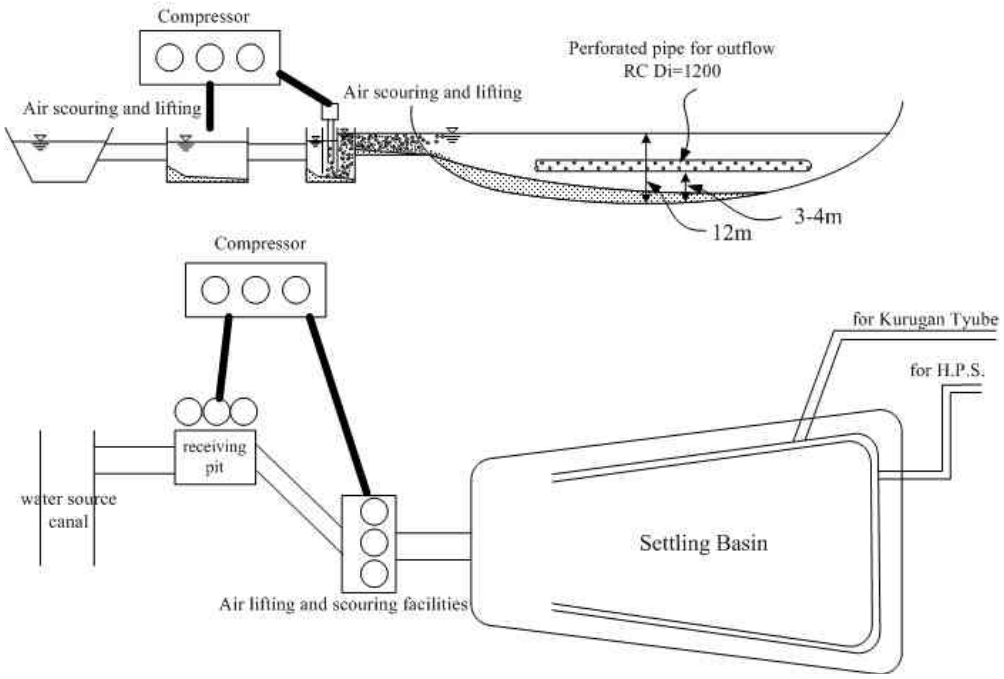
Sarband dam : 57.0 FTU[8]
Sarband Intake : 4.16 FTU

It shows that the Settling Basin is effective still now.

Another difficulty of this facility is the lining of the side slope of the Basin. A masonry lining retains the slope, however, it is high permeable. If there is not clayish impermeable sediment layer

[6] The Study Team confirmed in February 2008 that the water level of Sterlin Canal at the intake is a little bit lower than that in summer since the near-by downstream gate controlled the water level.
[7] HANNA portable turbidity meter; model HI93703 under the condition of calibration at factory delivery.
[8] Formazin Turbidity Unit can be considered as NTU: Nephelometric Turbidity Unit, according to the manual of the Portable Turbidity Meter manufactured by HANNA.

on the side slope, the water in the Basin will run away to neighboring low-lying areas.



Source: own study

Figure 3.3.3 Sarband Intake and Settling Basin

3.3.4 CONDUITS

Figure 3.3.4 shows the layout of the Vakhsh mains and the diameter, length and material of each pipeline in *Table 3.3.2*. Following *Table 3.3.3* presents the pipe composition of the Conduits.

Table 3.3.2 Pipe Composition of Vakhsh Conduits

Pipe	Inside Diameter (mm)	Length (km)
Steel Pipe	313	17.8
Steel Pipe	414	3.2
Cast Iron Pipe	500	9.0
Steel Pipe	514	54.0
Cast Iron Pipe	600	7.5
Steel Pipe	614	6.2
Steel Pipe	700	16.3
Steel Pipe	900	8.0
Steel Pipe	996	4.0
Steel Pipe	1192	5.2
Concrete Pipe	1200	1.2
Total		132.4

Source: own study

The defects of the Conduits the Study Team could observe are in the following two areas:

1) There is a sound like pouring out of water from the roadside gully where the pipe seems to be exposed at a point around 10km from Kurgan Tyube to Uzun.
2) There is a place just after the bridge crossing the Vakhsh river from Uzun to Satarrov where pipe is missing in the Vakhsh sub-mains

Besides, the chief engineer of RWSA Khatlon Branch reported the necessity of replacement of around 350m concrete pipe in the section between the Sarband SB and the Bokhtar Head PS due to deterioration.

30 years have passed since the Vakhsh Conduits was constructed and it is said that the conduits are heavily deteriorated in terms of hydraulic performance, stable water convey, etc. However, there is no data, and information which proves this deterioration.

As mentioned above, most of the pipes used in the Vakhsh Conduits are steel tubes of which the outside has asphalt coating and the no inside coating. Considering the fact that the water quality, which is fed mostly by melting glaciers, can be considered well, the conduits scarcely drain empty and the outside wall surface is protected by the asphalt coating, there has not been a high risk of pipe corrosion either on the inside or outside surfaces.

However, it is quite difficult to estimate the influence of pipe (sub-main) connecting works to the Vakhsh Conduits Main.

According to the material provided by the RWSA, a considerable number of pipes of diameter from 20 to 325mm connect the Conduits. Total number of connections shown in the said material is 60 and 13 of them have respective tanks. Conduits for other connections seem to directly supply water to the population. However, the Study Team could not identify all the facilities such as valves for connections, tanks, etc.

Regarding hydraulic characteristics of the Vakhsh Conduits, it is quite difficult to prepare a hydraulic model to analyze the performance due to lack of data and information on the Conduits, especially the longitudinal profile of the Conduits.

The Study Team will try hydraulic analysis of the Conduits using available data which is acceptable for the concerned parties. However, the result will not be reliable under the current situation of data and information availability. Because, the Vakhsh Conduits were initially planned as water delivery by gravity and the data on elevation are essential for hydraulic modeling, especially in a gravity delivery system.

Because, the Vakhsh conduits pass through lower area of the Vakhsh valley to convey water to higher places as a reverse siphon, the judgment to take into account booster PS depends on the data on elevation. The conditions of respective branch pipe connections such as a flow control to tanks, leakage, etc. also affect the hydraulic analysis.

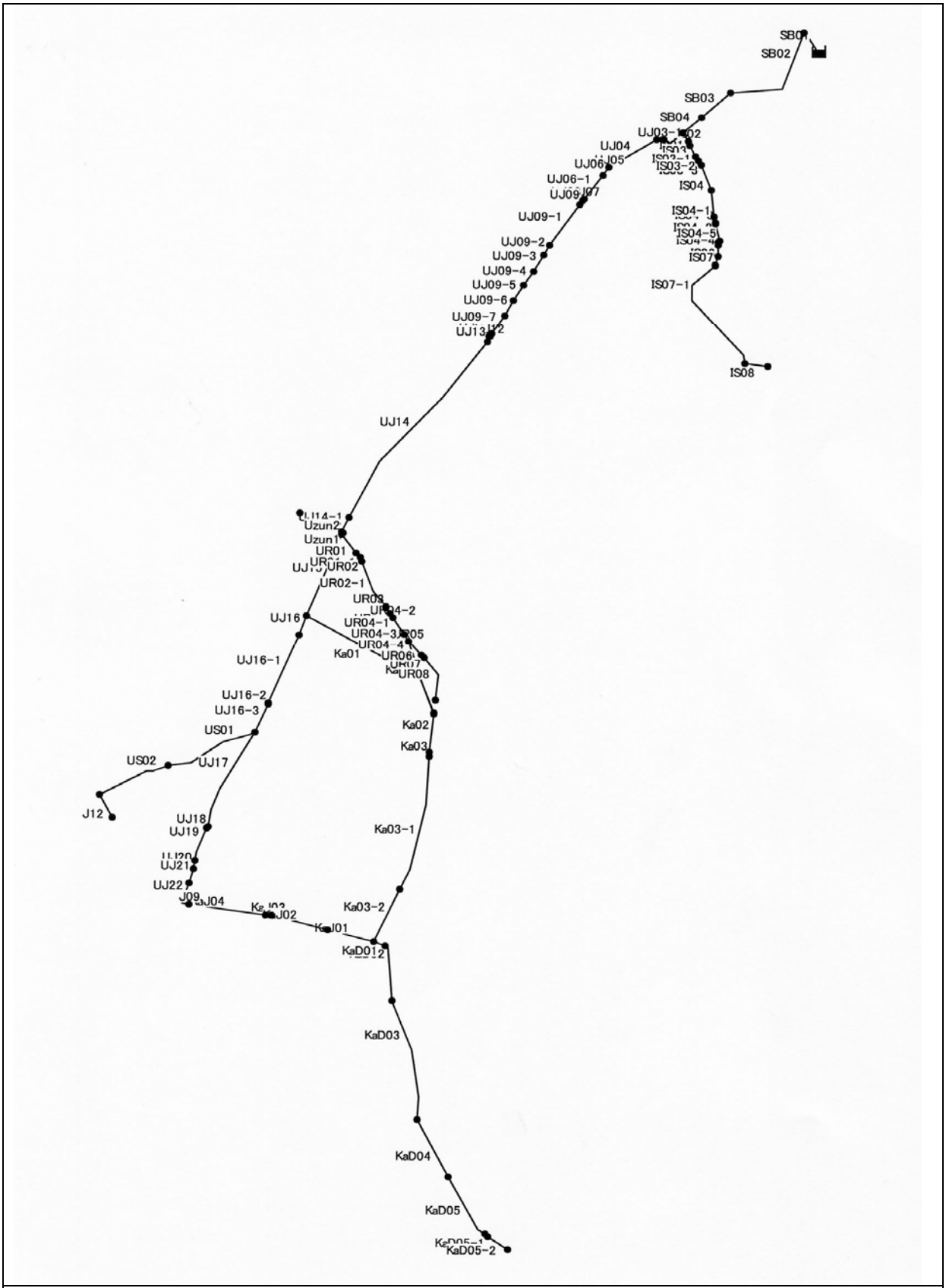


FIGURE 3.3.4 Outline Layout of the Vakhsh Mains (Pipelines)

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3.3.5 PUMPING STATIONS

There are three PSs in the Conduits system, they are the Bokhtar, the Uzun and Kalinin PS. The Bokhtar and Uzun PSs are not functioning now due to deterioration of the facilities. The RWSA gives priority to renew the pumping facilities of H.P.S., however, it explains that pump facilities can not be renewed solely because there is a risk to rupturing some parts of the Conduits due to pressure increase.

(1) Bokhtar Head PS

Bokhtar Head Pumping Station is located about two kilometer of distance from the sand settling basin mentioned above. This pumping station was formulated and constructed for transmitting water to Vakhsh Conduits but now this station isn't used. The roof of this station is still remained and six pumps bases are also remained. It was estimated that there were six branches of pipe in this station. In these branches, there are not pumps, pipes and valves in three branches, there are only pump and valves in two branches, and in only one branch there's one old pump, valves and pips. But the pipes (made of steel) of Vakhsh Conduit after here are so weak, so these pipes may be broken by the pressure of water if the water is pumped. In this reason, this pumping station isn't used. Transformer, incoming panel and control panel also become too old to work this only one pump as shown following four pictures.

Bokhtar Head Pumping Station

Electric Motor

Incoming Panel and Transformer

Control Panel for Pump

(2) Uzun PS

Uzun Pumping Station is located about 30 kilometers of distance from Bokhtar Head Pumping Station. We don't know the purpose of construction of this station, but we estimate that it is for discharging water to Kolkhozobod and Kalinin.

This pumping station has the condition to work now, but there is not enough water to come, it is not used now. There are four branches to distribute water installed four pumps now. Two pump's capacities are 630m^3/h-90m and for the electric motors 200, 250kW. These electric motors were used for a long time by repairing many times, one was made in 1992, and other electric motors were made in 1972. The other side, electric incoming facilities have two line of changing voltage, capacity of transformer is 1,000kVA. But there's only one transformer, there isn't transformer on another line. Electric Incoming facilities with cables are very old especially distribution panels were made in 1967 without this transformer. And also control panels of pumps are too old made in 1967, these pumps can barely work.

Uzun Pumping Station

Control Panel for Pump

(3) Kalinin PS

This pumping station is used for distribution of water to Dzhilikul and Kumsangir area by taking water from near the canal. There're four pumping houses; old pumping house, new pumping house and two intake pumping houses. These pumps are shown below in *Table 3.3.4*.

Table 3.3.4 Specifications of Pumps at Kalinin Pumping Stations

Installation Place	Manufactuaring year	Flow rate/H.M.T	Capacity	Voltage	Manufacturaing Country
New Pomping House	2004	320m^3/h / 50m	45kW	380V	USSR
	2004	320m^3/h / 50m	45kW	380V	USSR
	(unknown)	200m^3/h / 36m	37kW	380V	UKRAINE
	(unknown)	200m^3/h / 36m	37kW	380V	UKRAINE
Old Pomping House	(unknown)	(unknown)	75kW	(unknown)	(unknown)
	(unknown)				
Intake Water Pomping House 1	(unknown)	320m^3/h / 50m	45kW	380V	(unknown)
	(unknown)	320m^3/h / 50m	45kW	380V	(unknown)
Intake Water Pomping House 2	(unknown)				

Pumps in the new pumping house are not old, because this house was rehabilitated in 2005. But the pumps with control panels are not rehabilitated, so it is too old.

Kalinin New Pumping Station

A Pump at New pumping station

Intake water pumping station 1

Incoming Panel and Transformer

3.3.6 ANCILLARY FACILITIES OF THE CONDUITS (VALVES, WASH OUTS, INSTRUMENTATION EQUIPMENT, WATER PIPE BRIDGE)

(1) Valves

There're many water supply systems (WSS) connected to Vakhsh Conduits, but study team couldn't find any valve box for distribution to WSS. For Vakhsh Branch, there's some valve box. But many valves can't be operational because in the valve box there is much rain water, sand and mud. These valves box isn't maintained for a long time. These valves are type of gate valves or stopping valves. Some valves are visible from outside, but appearance is so much rust that handle doesn't work. So these valves are too old.

Inside of Vakhsh - Uzun Junction Valve Box

Inside of Dzhilikul - Grauti Junction Valve Box

(2) Wash Outs

Study team found only one wash out valve inside of the Vakhsh - Uzun junction valve box for Vakhsh Conduits. Another wash outs couldn't be found.

Wash Out Valve inside of Valve Box

(3) Instrumentation Equipments

The instrument found is one flow rate meter on pipe of the branch of Kolkhozobod. But appearance is also so much rust that it is not clear to work or not.

(4) Water Pipe Bridge

On the bridge crossing the Vakhsh River going to Garauti WSS, the two pipes which are steel and diameter 325mm are installed. But there aren't water pipe brides using some pipe beams or supporting steel, only pipes are crossing the canal. So there is a pipe broken on the canal.

3.3.7 WATER TREATMENT FACILITIES

The Vakhsh Conduits System does not have any water treatment plants except disinfection facilities[9] at the Sarband intake and PSs though they are not functioning now due to troubles of devices, apparatuses, etc.

[9] Bleaching powder (calcium hypochlorite) was used as disinfectant though the chlorine concentration

As already mentioned, the water source of the Vakhsh Conduits is the surface water, the Stalin Canal, which generally contains particulate matters carried by the Vakhsh River[10,] microbes generated by animals who live in and around the water, and so on.

The Study Team confirmed that the turbidity of the water at the Sarband SB is rather low as surface water, however, there are fish and maybe other animals in the basin and birds come there.

It is accordingly appropriate to consider that the water flow in the Vakhsh Conduits is contaminated with microbes (pathogens), etc. though no water analysis data is available.

The Government of Tajikistan constructed the Vakhsh Conduits to supply the population in the Vakhsh Valley area with drinking water. It is therefore necessary to construct proper water treatment facilities in order to realize a drinking water supply which will bring the low level of health concern to the population though analysis data on the raw water of the Sarband SB to have the idea on the water treatment process.

3.3.8 WSSs CONNECTED TO THE CONDUITS

An inventory survey treated 98 WSSs and two (2), Uzun and Kalinin, PSs distributed in Bokhtar, Vakhsh, Dzhilikul, Kolkhozobod and Kumsangir Rayons. *Attached Table 3.3.1 (Appendix 1)* presents the summary survey output of the 100 WSSs. Following *Table 3.3.5* is a tabulation of the WSSs from the *Attached Table 3.3.1 (Appendix 1)* sorted by Rayon and type of water source.

Table 3.3.5 WSSs Connected to the Conduits

	Irrigation Canal	Vakhsh Conduits	Vakhsh Conduits / Irrigation Canal	Well	Total
Bokhtar	0	25	0	0	25
Dzhilikul	0	13	0	0	13
Kolkhozobod	1	28	5	3	37
Kumsangir	1	6	1	0	8
Vakhsh	10	5	0	0	15
Total	12	77	6	3	98

Source: own study

Table 3.3.6 shows the projected population to be supplied with water through the WSSs

Table 3.3.6 Population supposed to be Supplied with Water through the WSSs

	Irrigation Canal	Vakhsh Conduits	Vakhsh Conduits / Irrigation Canal	Well	Total
Bokhtar		40,752			40,752
Dzhilikul		32,410			32,410
Kolkhozobod	2,791	62,159	15,966	13,986	94,902
Kumsangir	6,600	26,125	6,601		39,326

of it is not clear

[10] The Sarband Dam, the source of Stalin canal, retains the water of Vakhsh river.

Vakhsh	71,566	18,917			90,483
Total	80,957	180,363	22,567	13,986	297,873

Source: own study

This section describes the character of the 55 Rural WSSs (77 WSSs from the Conduits only and remaining six (6) take water from the Conduits and an irrigation canal and 25 WSSs in Bokhtar and 3 Rayon Centers are excluded) supplied with water from the Vakhsh Conduits in the target Rayons; Vakhsh, Dzhilikul, Kolkhozobod and Kumsangir.

(1) Operation Conditions

25 WSSs out of the 55 Rural WSSs are now not operating and a number of operational WSSs can not supply the population with water in full capacity. Their average life time is around 13 years. The water supply system consists of pipes, valves, concrete structures, pumps and their life time is considered around 30 to 40 years except the pumps providing good performance of the maintenance work. The lifetime of the WSSs in the Study Area is accordingly rather short.

It is said that the shortage of the budget to repair or to maintain the WSSs is the principal reason of such low operation state.

(2) Owner and Operator

Following *Table 3.3.7* shows the number of owners and operators sorted by organization category.

Table 3.3.7 Number of Operators and Owners

Operator and Owner	Number of WSSs
Kolkhoz	15 (5)
Village	1 (1)
Jamoat	19 (10)
Kolkhoz & Jamoat	1 (0)
Sovkhoz & Jamoat	2 (0)
Community	1 (0)
Ministry	1 (0)
RWSA	7 (6)
Vodokanal	8 (3)
Total	55 (25)

Note: Figures in parenthesis show the number of WSSs which are shutdown
Source: own study

Since nine (9) different organizations operate the Rural WSS, it seems to be very difficult to make the service level equal among WSSs. Service level means the water quantity can be delivered: the water quality, water rate to be applied, accessibility, continuity of the water supply consumer relations, and so forth.

The table shows that Kolkhoz and Vodokanal had good performance of the WSS operation, however, RWSA, rural water supply undertaking, does not seem to function well. Though Kolkhoz seems to have sufficient capability to do the OM/M of a WSS, it necessitates confirming it's suitability for the water supply undertaken in terms of the charter relative to the water supply

and whether it will be able to maintain the same service level with RWSA or other authorized organizations when the government policy on the water supply service level[11] will become clear. Furthermore, the permanence of the kolkhoz should be studied.

(3) Indicators regarding Service Level

The Study Team looked at following indicators to grasp the service level of the Rural WSSs.

1) Distribution pipe length per tap

This indicator implies a mean distance between neighboring taps, i.e. the shorter length, the more for consumers.

The average, longest and shortest distribution pipe length per tap is 112m, 420m and 20m respectively. Roughly speaking, around half of the population has a communal tap within 60m from its house. This means people can carry two (2) vessels of 20 liters within 10 minutes.

The short distance up to a communal tap is convenient for consumers instead the cost of water supply increases because high accessibility induces consumers to take more water. It necessitates increasing the capacity of WSS to meet the demand and to raise the renewal cost as well as the maintenance cost. As a result, the water rate to be applied should be high.

2) Population per tap

The average, biggest and smallest population per tap is 260, 69 and 11 respectively. If the population per tap is large, people often have to make a row while waiting to take water. If it is small, though it is convenient for consumers, the efficiency of the WSS is not good, i.e. the capacity of the WSS is rather bigger than the water demand and the consumers shall pay a higher rate for water.

The capacity of a communal tap, the operation hours of WSS and mean per capita consumption will determine the appropriate number of a communal tap.

(4) Alternative Water Sources

There is alternative water sources in all the surveyed WSSs connected to the Vakhsh Conduits. They are mainly irrigation canals. The average, longest, and shortest distance to an alternative water source is 659m, 3,000m and 200m respectively. However, there are only two (2) WSSs which have the alternative water source with a 3,000m distance and the others are less then 1,200m.

Most of the population seems to be able to take water free of charge from the alternative water source within 20 minutes. In case of an irrigation canal, even if the traveling time is long, the time to put water into vessels is quite short.

Comparing the conditions to get water between a communal tap and irrigation canal, the population should pay for the former and should take a little bit longer to fetch free water for the latter. It seems to be difficult to change the population's mind to use communal taps without raising the awareness on health concerns about the water. However, no analysis data on the irrigation canal water the appearance of which is rather good and the feel of the water is cold even in the hot summer.

3.3.9 CAPACITY OF THE VAKHSH CONDUITS UNDER THE CURRENT SITUATION

The Study Team prepared the hydraulic model of the Vakhsh Conduits based on the coordinates of the valves and other exposed points of the Conduits by a GPS receiver for trekking and the data of inventory survey and existing materials. This hydraulic model has following assumptions and problems.

[11] NDS refers the necessity to determine the appropriate per capita consumption of the water supply.

- The conduits are laid parallel to the ground surface
- The coordinates of the points mentioned above are applied to the nodes (junction of conduits) used in the hydraulic model (the data has ± (plus minus) 10m errors at the maximum)
- The Study Team altered the route of the Conduits referring the existing topographic map through the assumption that the conduits were laid along the existing road. This alternation inserted a number of nodes in the hydraulic model and the Team calculated their coordinates by using the data of surveyed points.
- There 83 WSSs and two (2) PSs which connect to the Vakhsh Conduits
- Outflow form the Conduits takes place at 83 WSSs
- A WSS connects to the Conduits with the shortest distance.
- Water flows into the tank without regulating the flow rate
- The flow rate equivalent to the MDWD is the inflow to WSSs which do not have a tank.
- "C" value of the Hazen-Williams' formula, which applies to the hydraulic analysis, reflects the leakage of Conduits. "C" is the hydraulic factor related to the roughness of pipe inner surface. The Appendix shows the "C" value applied to the model
- Though the conduit between the Vakhsh River and the Sattarov WSS lacks some hundred meters of pipe, this fact is neglected in the model.

The Team estimated the capacity of Vakhsh Conduits under the current situations in the following two (2) cases. "The capacity in the estimation" is the out-flow rate of the Sarband SB when all the WSSs connect to the Conduits can be able to have with minimum necessary dynamic pressure. *Appendix* explains the mathematical expression of the hydraulic analysis.

(1) Inflow rate to the tank of WSS is not regulated

Tanks in 18 WSSs including two (2) PSs connects to the Vakhsh Conduits according to the inventory survey. Inflow to the tank is made that tank inlet discharges water above the water surface by dynamic pressure of the sub-main of the Conduits. It is said that there is no valve which regulate on the sub-main.

The high water level set to respective tank is three (3) to five (5) meters except ones of Uzun PS which are reportedly now broken.

Accordingly, the inflow to WSSs in this hydraulic model is taken place as follows:

1) WSSs which have tanks: inflow is taken place at the tank inlet of which elevation is ground elevation plus five (5) meters and flow rate depends on the dynamic pressure at the connection to the Vakhsh main.
2) WSSs which do not have tanks: inflow, which is regulated as the maximum hourly water demand in 2007, is take place at entrance of the distribution main of the WSS. The flow rate is assumed as the maximum hurly water demand in 2007 multiply the operation rate of the WSS.

The Study Team made the hydraulic analysis making use of the hydraulic model established according to above mentioned assumption.

Table 3.3.8 presents the WSSs with tank, the maximum hourly water demand of respective WSSs and their operation rates.

Figure 3.3.5 and *Attached Table 3.1 and 3.2* show the output of the analysis. Though, the outflow of Sarband SB is 610 liter/second (52,700m^3/day), 542iter/second out of total outflow flows into tanks and remaining 68 liter/second is for the WSSs which do not have tanks. Since the total of maximum hourly water demand of the WSSs without tank is 85 liter/second, water for said WSSs is apparently insufficient. On the other hand, water does not reach the WSSs of Kolkhozobod, Dusti which have the tanks. However, the outflow of Sarband SB is far bigger than the total water demand, 157 liter/second.

The dynamic pressure difference between at the connection point of the Vakhsh main and sub-main and the tank inlet determines the flow rate to the tank and the assumption that the flow rate never exceeds the maximum hourly demand can not consequently work out.

(2) The flow rate to the WSSs is regulated

The following assumptions are applied to the model:

- The flow rate to WSSs does not exceed their water demand by regulating through a valve
- All the WSSs have the capacity to meet the water demand
- The minimum dynamic pressure at the WSSs is 5m[12] water head.

The team got the capacity of the Vakhsh Conduits as how many times bigger than the maximum hourly water supply in 2007.

The output of analysis shows that the outflow rate of 272 liter/second (23,500m^3/day) of Sarband SB makes the dynamic pressure of Kolkhoz Lenin WSS 5.02m water head. Kolkhoz Lenin is located around 1 km to the south-west of Dusti and it is the farthest WSSs from the Sarband SB.

Attached Table 3.3 shows the base demand of each WSS and the possible water supply by the Vakhsh Conduits with the head and pressure.

The dynamic pressures of case 1) and case 2) at the meeting point of the conduits to Dzhilikul and to Kolkhozobod are 16.20m (case 1) and 51.83m (case 2) respectively. Unnecessary big flow rate into tanks which locate upstream area of the Uzun PS generates bigger friction loss head than that of the case 2) and it makes the dynamic pressure difference mentioned above.

Appropriate regulation of inflow rate to the WSS is essential to operate the Vakhsh Conduits effectively and efficiently.

[12] This pressure seems to be possible to convey water into the tanks by gravity.

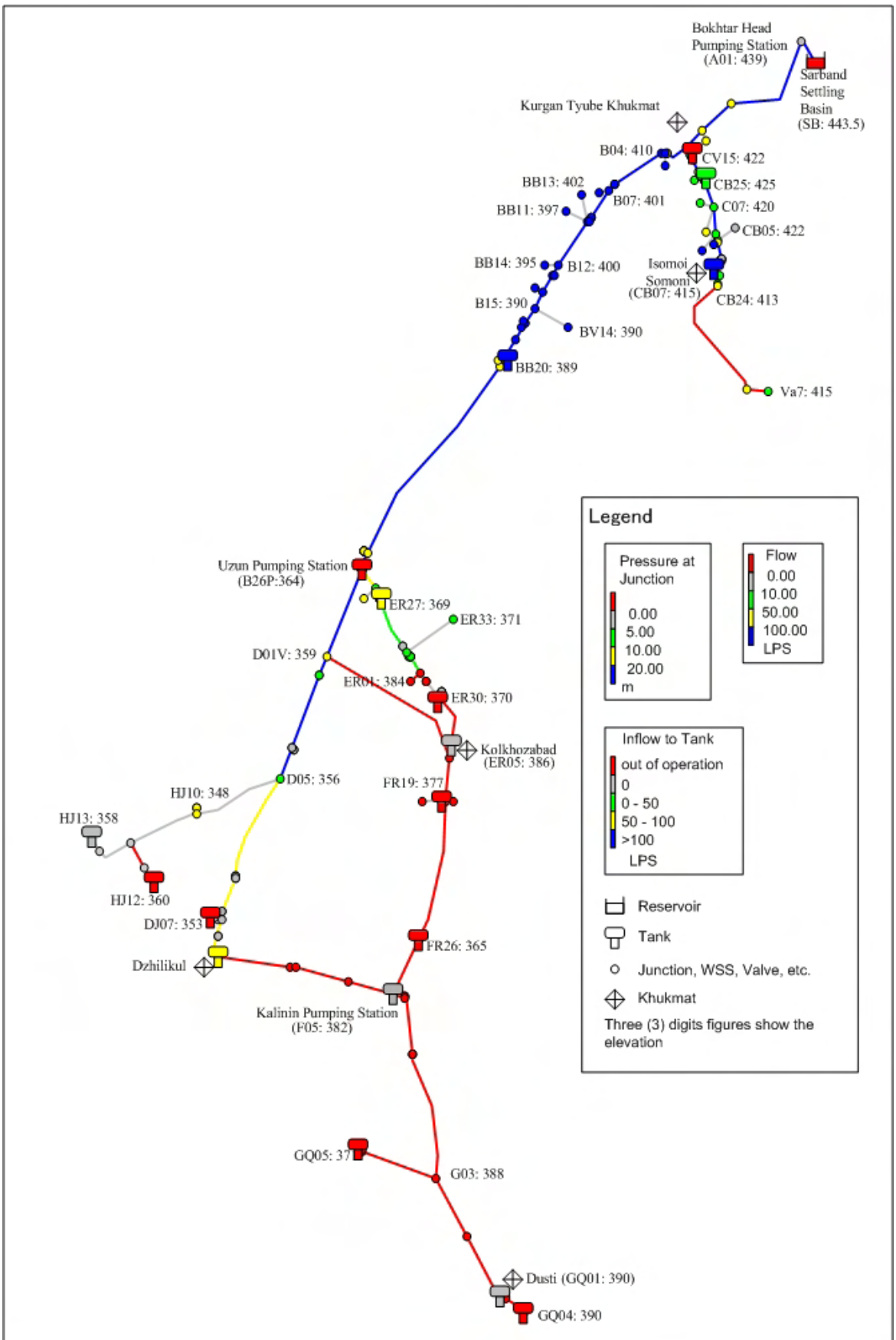

Figure 3.3.5 Hydraulic Performance by Connected Tanks of which Inflow is not Regulated

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3.4 UNDERLYING DIFFICULTIES IN THE REHABILITATION OF THE VAKHSH CONDUITS

The Study Team confronted several difficulties and some of them seem to be tasks for effective OM/M of the future renewed Vakhsh Conduits. Following are such difficulties.

(1) Collection of Data and Information Necessary the OM/M

It is necessary to have the records of leakage, rupture, pipe repair and their location of each section which is reasonably divided in the Conduits with respect to O/M. The RWSA can prepare a yearly repair plan by analyzing such data, if available. It is difficult to prepare a rational rehabilitation plan based on the priority order according to the analysis result.

Furthermore, a large scale map which incorporates all the facilities related to the Vakhsh Conduits to give an idea about the current conditions. For the effective OM/M, it should be revised whenever the system is modified and the social settings change.

It urgently necessitates making a precise longitudinal profile of the Conduits. It is essential for the hydraulic modeling for effective operation.

Furthermore, in addition to above-mentioned leakage, it is necessary to have the information on supplied water with non-revenue. The Unaccounted For Water to be defined as the sum of leakage and supplied water with non-revenue is also one of the targets of the Plan.

(2) Establishment of Quantitative Service Level Indicator

Existence of quantitative indicators such as quality, quantity, accessibility, affordability, coverage and continuity explained below which can be applied to the rural water supply in Tajikistan is not clear. These indicators are necessary for the preparation of the rehabilitation plan as well as OM/M of the Vakhsh Conduits System.

1) Quality: critical parameters for drinking water e.g. Faecal coliform, Turbidity, Residual Chlorine, pH

The Study Team recommends applying following values recommended by WHO as the ad hoc guideline value of drinking water quality until the government of Tajikistan stipulates its national standard value of drinking water quality and establish the surveillance system of the drinking water quality.

Faecal coliform:	must not be detectable in any 100ml samples
Turbidity:	<5NTU
Residual Chlorine:	0.2 – 0.5 mg/L
pH:	6.5 – 8.5

Regarding other parameters, RWSA should make surveillance of them referring the third edition of Guideline of Drinking Water Quality issued by WHO, etc.

2) Quantity: following three indicators

- unit per capita consumption per day (liter)
- peak factor for daily water demand to determine the capacity of a WSS, the following formula gives the value of this indicator:

$$\text{the peak factor for daily water demand} = \frac{\text{the maximum daily water supply (usually in summer)}}{\text{the average daily water supply (yearly water supply/365)}}$$

- peak factor for hourly water demand to determine the diameter of distribution pipe, etc., the following formula gives the value of this indicator:

$$\text{peak factor for the hourly water demand} = \frac{\text{the maximum hourly water supply in the maximum day}}{\text{the average hourly water supply in the maximum day}}$$

3) Accessibility: disposition of communal taps i.e. mean distance from respective households to a communal tap or mean time of one return trip to fetch water from a communal tap

4) Affordability: the capacity of the population to pay for the water supplied

5) Coverage: how much population can be covered by a WSS convenient for consumers with affordable cost

6) Continuity: how many hours does a WSS supply water to population with affordable cost

(3) Necessity of Water Quality Control

There is not sufficient data on the quality of water delivered by the Vakhsh Conduits and raw water in the Sarband SB.

The water analysis to have the values of parameters listed in the WHO guidelines for drinking water quality (third edition)[13] should be made in order to understand the necessity of a water treatment for the drinking water supply. The samples for analysis should be taken at the Saruband Settling Basin and several points on the Vakhsh Conduits including the farthest point from the Sarband SB.

In addition, corrosive characteristics of raw water should be analyzed because inside unlined steel pipes compose the Vakhsh Conduits.

(4) Raising Population's Awareness of the Benefits of Water Supply and the Principle of "Beneficiary Payment"

Since the population has an alternative water source not far from its house and the water of the alternative source looks clean and its touch is cold in the hot summer, the population will pay for expensive piped water supply. It is a primary observation of the Study Team on the rural water supply environment.

Though the water rate currently applied to the rural water supply is reportedly controlled low, in principle, it shall reflect the cost of water supply.

Without having a positive answer to this question, even if the Study Team could propose a physical Plan system, it is apparently difficult to make the WSSs through the Conduits sustainable.

In fact, the Study Team confirmed that a WSS in Vakhsh Rayon stopped its operation in the irrigation season due to the request of the population saying that the water in the canal was available.

One of the possible but difficult solutions to this issue is to start a discussion with the target population on how to maximize the benefit of the piped water supply such as heath gains, increased time and on why consumers will pay for water.

(5) Establishment of Organization for OM/M of the WSS

Establishment of an autonomous organization for the OM/M of the WSS is indispensable to assure the sustainability of the drinking water supply regardless of whether it is subordinate body of an existing organization or an independent one. However, it shall be a legal entity as long as it shall assure the water quality suitable for drinking complies with forthcoming national guidelines for drinking water

[13] It is said that the Government of Tajikistan applied the values specified in the GOST 2874-82 as the drinking water quality guideline ones. However, the Study Team recommends applying the WHO guidelines for drinking water quality (GDWQ) to the assessment of the water because in 1983–1984 and in 1993–1997, the WHO published the first and second editions of the GDWQ in three volumes and in 2004 it has published the third edition of GDWQ for further development of the guidelines.

quality, and shall be accountable to handle the money paid by the consumers for water supply auditing. The organization to govern such OM/M respective of WSSs shall be reinforced to assist and supervise it. The water rate shall assure the autonomous management of the OM/M organization.

The Water Code promulgated by the Government of Tajikistan prohibit the privatization of WSS Accordingly, the eligible organizations to operate the WSS might be RWSA, Vodokanal and Khukmat of Jamoat or Rayon, etc.

However, the WSSs who have water from the Vakhsh Conduits include small scale WSSs which necessitates the OM/M by beneficiaries themselves to reduce financial overburden. It is expected to expedite the legislation on the drinking water users association.

(6) Necessity of Drainage Facilities

Improvement of water supply brings the increase of water quantity available and therefore the volume of waste water increases. If the disposal of waste water is appropriately treated, it will have an adverse effect on the environment, especially sanitary conditions which are supposed to be improved by the water supply. It will accordingly necessitate drainage facilities in order to maximize the benefits of the water supply.

APPENDIX HYDRAULIC ANALYSIS

Assuming a pipe network with "N" junction nodes and the flow-headloss relation in a pipe between nodes "i" and "j" given as:

$$H_i - H_j = h_{ij} = 10.666 \cdot C^{-1.85} \cdot D_{ij}^{-4.87} \cdot L_{ij} \cdot Q_{ij}^{1.85} \qquad (1)$$

where

H: nodal head (m)

h: headloss (m)

C: hydraulic factor related to the roughness of pipe inner wall shown in the following page

D_{ij}: diameter of pipe between nodes "i" and "j" (m)

L_{ij}: lenght of pipe between nodes "i" and "j" (m)

The continuity around all nodes must be satisfied:

$$\Sigma (Q_{ij} - F^i) = 0 \qquad \text{for } i=1 \text{ ..... } N \qquad (2)$$

where

Fi: flow demand at node "i"

All heads Hi and flow rates Qij that satisfy the equations (1) and (2) are the solution.

Following table shows the value of "C" applied to the analysis. The minor headloss taken place at valves, fittings, etc. is considered through the determination of "C" value to be applied.

Pipe Material	Age (Year)	Diameter	C	Modified C considering minor loss, leakage, etc.
Steel and Cast Iron (unlined)	New	All sizes	130	110
	5	>380mm	120	100
		<380mm	118	98
	10	>600mm	113	93
		>300mm	111	91
		<300mm	107	87
	20	>600mm	100	80
		>300mm	96	76
		<300mm	89	69
	30	>760mm	90	70
		>400mm	87	67
		<400mm	75	55
	40	>760mm	83	63
		>400mm	80	60
		<400mm	64	44
	50	>760mm	77	57
		>400mm	74	54
		<400mm	57	37
PVC, HDPE	Average	All sizes	130	110
Concrete (steel forms)			120	100

PVC: Polyvinyl chloride, HDPE: High Density Polyethylene

Source: Larry W. Mays, Water Distribution Systems Handbook, McGraw Hill, and other literatures

Table 3.3.1 List of Water Supply Systems in Rayons coverd by Vakhsh Conduits (1/5)

Code	Water Supply System	Jamoat	Owner	Operator	Population in the service	Year of Construction	Operation Status	Operation Years	Total Distribution	Number of	Aleternative Water Source	Distance to AWS	Population per Tap	Distribution Pipe Length per Tap
B-01	Kojzavod	Sarvaty	Ministry of	Ministry of	100	1989	shutdow	19	350	2	irrigation canal	400	50	175
B-02	5-floor building	PGT I Somony	Bokhtar Raipo	Bokhtar Raipo	320	1997	operatio	11	178	32	irrigation canal	5000	10	6
B-03	Vodnykov village	Orion	Vodnykov village	Vodnykov village	50	1990	operatio	18	149	5	irrigation canal	500	10	30
B-04	Zarbador	Orion	c/f Murod Boqy	c/f Murod Boqy	380	1987	operatio	21	1050	4	irrigation canal	4600	95	263
B-05	Shmit village	Mehnatobod	c/f "Mehvar" (Dehkan farm)	c/f "Mehvar" (Dehkan farm)	400	1987	operation	21	1850	30	irrigation canal	4800	13	62
B-06	New decontaminate building	Sarvaty Istiqlol	GDMPVK Kurgan Tyube	GDMPVK Kurgan Tyube	15	1990	operation	18	900	2	irrigation canal	5000	8	450
B-07	PGT I. Somoni	PGT I. Somoni	UVK Bokhtar region GDMPVK Kurgan Tyube	UVK Bokhtar region	7354	1997	operation	11	24500	24	ground water	5000	306	1021
B-08	Khursandy No.1	Mehnatobod	c/f "Mehvar" (Dehkan farm)	c/f "Mehvar" (Dehkan farm)	500	1987	operation	21	1550	40	irrigation canal	300	13	39
B-09	Khursandy, Qizil-Bairak, Kosygin	Mehnatobod	c/f "Mehvar" (Dehkan farm)	c/f "Mehvar" (Dehkan farm)	580	1987	operation	21	3020	53	irrigation canal	400	11	57
B-10	Marxism village	Sarvati istiqlol	c/f Saido (Dehkan farm)	c/f Saido (Dehkan farm)	750	2005	operation	3	1480	42	irrigation canal	4000	18	35
B-11	1-May village	Sarvaty Istiqlol	c/f "Sakhovat" (Dehkan farm)	c/f "Sakhovat" (Dehkan farm)	400	1988	operation	20	2680	15	irrigation canal	500	27	179
B-12	Lenin 2 village	Sarvaty Istiqlol	c/f "Nazary Mirozokarim" (Dehkan farm)	c/f "Nazary Mirozokarim" (Dehkan farm)	1050	2001	operation	7	1310	30	irrigation canal	400	35	44
B-13	Bofanda village	Sarvaty Istiqlol	c/f "Sakhovat" (Dehkan farm)	c/f "Sakhovat" (Dehkan farm)	600	1988	operation	20	5060	31	irrigation canal	300	19	163
B-14	Lenin-1 village	Sarvaty Istiqlol	c/f "Nazary Mirzokarim" (Dehkan farm)	c/f "Nazary Mirzokarim" (Dehkan farm)	1500	1988	operation	20	3420	64	irrigation canal	600	23	53
B-15	AZS Salimov Kh	Mehnatobod	Salimov Kh	Salimov Kh	30	2005	operatio	3	250	1	irrigation canal	4400	30	250
B-16	AZC Rahmatov A	Mehnatobod	Rahmatov A (Private)	AZC Rahmatov A (Private)	16	2000	operation	8	20	1	irrigation canal	5000	16	20
B-17	Vorojil village	Mehnatobod	c/f "Mehvar" (Dehkan farm)	c/f "Mehvar" (Dehkan farm)	10	2002	operation	6	50	1	irrigation canal	5000	10	50
B-18	Khursandy No.2 village	Mehnatobod	c/f "Mehvar"	c/f "Mehvar"	400	1987	operation	21	1450	33	irrigation canal	3700	12	44
B-19	Qizil-Sharq village	Sarvaty Istiqlol	c/f "Firuz-2004" (Dehkan farm)	c/f "Firuz-2004" (Dehkan farm)	800	1989	operation	19	910	50	irrigation canal	500	16	18

note:
1. WSS: Water Suppy System
2. The first letter of code indicate the Rayon where the WSS locates: B; Bokhtar, J; Jillikul, Q; Kumsangir, R; Kolkhozabad, V; Vakhsh
3. Suffix of the Code shows the water sources of the WSS: v; Vakhsh Conduits, w; ground water, c; canal. In case the code does not have suffix, the WSS is supplied with water from the only Vakhsh Conduits
4. Operation years are from the construction year to the year of shutdown or 2008.

Table 3.3.1 List of Water Supply Systems in Rayons coverd by Vakhsh Conduits (2/5)

Code	Water Supply System	Jamoat	Owner	Operator	Population in the service	Year of Construction	Operation Status	Operation Years	Total Distribution	Number of	Aleternative Water Source	Distance to AWS	Population per Tap	Distribution Pipe Length per Tap
B-20	Water fence Zargar	Zargar	c/f "Davronb Nuriddin" (Dehkan farm)	c/f "Davronb Nuriddin" (Dehkan farm)	9677	1989	operation	19	21710	150	irrigation canal	400	65	145
B-21	Vyon village	Sarvaty	Vyon village	Vyon village	200	1986	operatio	22	1470	10	irrigation canal	3600	20	147
B-22	PMK ZAO "TDES"	Sarvaty Istiqlol	ZAO (closed joint stocks company) "TDES"	ZAO (closed joint stocks company) "TDES"	80	1980	operation	28	100	2	irrigation canal	1500	40	50
B-23	Boarding school	Mehnatobod	Rayon Bokhtar	Rayon Bokhtar	300	1991	operatio	17	230	6	irrigation canal	500	50	38
B-24	Mehnatobod village	Mehnatobod	Jamoat	Jamoat	6052	1965	operatio	43	3700	28	irrigation canal	400	216	132
B-25	Voroshilova village	Mehnatobod	Jamoat	Jamoat	9188	1985	operatio	23	31000	220	irrigation canal	700	42	141
J-01	Agronomy village of Dehkanabad	Dehkanabad	Fayzaly Said kolkhoz	Fayzaly Said kolkhoz	1138	1990	operation	10	3400	16	irrigation canal	600	71	213
J-02	Vodokanal	Jillikul	Vodokanal	Vodokanal	450	1986	shutdow	8	1000	14	irrigation canal	400	32	71
J-03	Kirov village of Dehkanabad	Dehkanabad	Moskva Sovkhoz, Dehkanabad	Moskva Sovkhoz, Dehkanabad	566	1990	operation	10	1600	15	irrigation canal	600	38	107
J-04	Moskva village of Dehkanabad	Dehkanabad	Moskva Sovkhoz of Dehkanabad	Moskva Sovkhoz of Dehkanabad	672	1991	operation	10	1900	15	irrigation canal	400	45	127
J-05	Kuibeshev village, Dehkanabad	Dehkanabad	Fayzaly Said kolkhoz	Fayzaly Said kolkhoz	1837	1990	operation	14	5600	30	irrigation canal	400	61	187
J-06	Surh Ribhoz village	Dehkanabad	Community of Dehkanabad	Community of Dehkanabad	670	1976	operation	22	1400	10	Vakhsh river	1200	67	140
J-07	Mirovoy village	Dehkanabad	Fayzaly Said	Fayzaly Said	1897	1988	shutdow	6	2800	25	irrigation canal	600	76	112
J-08	area Kabadiyon	Kabadiyon	Jamoat Kabadiyon Jilikul district	Jamoat Kabadiyon Jilikul district	4200	1989	shutdown	3	1200	26	irrigation canal	600	162	46
J-09	Water channel	Jillikul	Water channel	Water channel	4820	1986	operatio	7	10600	269	irrigation canal	500	18	39
J-10	Galaba village and Jillikul Jamoat	Jilikul	water channel	water channel	860	1964	shutdown	23	1600	6	irrigation canal	700	143	267
J-11	Leninabad area	Jilikul	Water channel	Water channel	1700	1986	shutdow	20	2200	26	irrigation canal	600	65	85
J-12	Ergash Sattarov Kolhoz	Nuri Vakhsh	Eshbek Sattarov Kolhoz	Eshbek Sattarov Kolhoz	3800	1987	shutdown	5	16800	40	irrigation canal	800	95	420
J-13	s/z Moskva k/z E. Satorov	Nuri Vakhsh	Rural Water Works Supply	Rural Water Works Supply	9800	1987	operation	12		75	irrigation canal	1200	131	
Q-01vc	Vodokanal Dusty	Dusty	GUP HMK, Vodokanal Dusty	Vodokanal Dusty	6601	1973	operation	22	20500	80	irrigation canal	100	83	256

note:
1. WSS: Water Suppy System
2. The first letter of code indicate the Rayon where the WSS locates: B; Bokhtar, J; Jillikul, Q; Kumsangir, R; Kolkhozabad, V; Vakhsh
3. Suffix of the Code shows the water sources of the WSS: v; Vakhsh Conduits, w; ground water, c; canal. In case the code does not have suffix, the WSS is supplied with water from the only Vakhsh Conduits
4. Operation years are from the construction year to the year of shutdown or 2008.

Table 3.3.1 List of Water Supply Systems in Rayons coverd by Vakhsh Conduits (3/5)

Code	Water Supply System	Jamoat	Owner	Operator	Population in the service	Year of Construction	Operation Status	Operation Years	Total Distribution	Number of	Aleternative Water Source	Distance to AWS	Population per Tap	Distribution Pipe Length per Tap
Q-02	Drinkable	Krupskaya	Qumsangir	Qumsangir	1112	1985	shutdow	0	2600	26	irrigation canal	500	43	100
Q-03	Drinkable	Krupskaya	Qumsangir	Qumsangir	1255	1986	shutdow	12	5200	30	irrigation canal	700	42	173
Q-04	Lenin kolkhoz of Qumsangir village	Pyanj	Lenin Jamoat	Lenin Jamoat	11979	1987	shutdow n	5	35000	88	irrigation canal	700	136	398
Q-05 (Group3)	drinkable	Telman	Qumsangir RWWS	Qumsangir RWWS	8496	1988	shutdow n	4	7000	35	irrigation canal	800	243	200
Q-06	village Udarnik	Krupskaya	Qumsangir	Qumsangir	1534	1987	shutdow	21	6200	40	irrigation canal	800	38	155
Q-07	Drinkable	Krupskaya	Qumsangir	Qumsangir	1749	1985	shutdow	0	2400	24	irrigation canal	700	73	100
Q-08c	5-th village	Pyanj	Qumsangirs Vodokanal	Qumsangirs Vodokanal	6600	1972	shutdow n	19	18500	80	irrigation canal	800	83	231
R-01	Jomi jamoat	Tugalang	Tugalang	Tugalang	2497	1987	shutdow	12	4200	25	irrigation canal	700	100	168
R-02 (Group1)	Ittifoq-1	Uzun	Kolkhoz S. Jumaev	Kolkhoz S. Jumaev	1300	1974	operatio n	34	2800	20	irrigation canal	700	65	140
R-03 (Group1)	Pakhtaaral Street	Uzun	S. Jumaev collective farm	S. Jumaev collective farm	1800	1978	operatio n	17	2000	12	irrigation canal / Vakhsh river	800	150	167
R-04 (Group3)	Kazakhs Village	S. Isaeva	GUP "KhMK"	Vodokanal GUP "KhMK"	2800	1974	operatio n	25	5200	85	irrigation canal	700	33	61
R-05vc (Group3)	PGT Isaeva	PGT Isaeva	GUP "KHMK"	GUP "KHMK"	8000	1974	operatio n	28	17500	250	irrigation canal / Vakhsh	600	32	70
R-06	Central district hospital	S. Isaeva	Central district hospital of Jamoat S. Isaeva	Central district hospital of Jamoat S. Isaeva	1800	1978	operatio n	30	1700	12	irrigation canal	300	150	142
R-07	40 year Oktyabr	Kalinin	Collective farm 40 year Oktyabr	Collective farm 40 year Oktyabr	3200	1974	shutdow n	25	2500	20	irrigation canal	400	160	125
R-08vc	Pump station Kalinin area	Kalinin	RWSA and KhREY	RWSA and KhREY		1984	operatio n	14	15800		irrigation canal	400		
R-09	Uzbekobod Street	Kalinin	Qumsangir	Qumsangir	2854	1984	shutdow	14	4600	35	irrigation canal	600	82	131
R-10	Qizil-bairak kolkhoz T.	Madaniyat	kolkhoz T. Esanqulov	kolkhoz T. Esanqulov	1202	1985	operatio n	8	4200	30	irrigation canal	700	40	140
R-11	kolkhoz T. Esanqulov	Madaniyat	Kolkhoz T. Esanqulov	Kolkhoz T. Esanqulov	4120	1978	operatio n	15	4800	30	irrigation canal	800	137	160
R-12 (Group1)	Urtabuz	Navobod	S. Jumaev collective farm	S. Jumaev collective farm	1300	1987	operatio n	0	1400	15	irrigation canal	900	87	93
R-13 (Group1)	Qizil Namuna c/farm N. Begova	Navobod	Jamoat Navobod	Jamoat Navobod	714	1962	shutdow n	30	6200		Vakhsh river	300		

note: 1. WSS: Water Suppy System
2. The first letter of code indicate the Rayon where the WSS locates: B; Bokhtar, J; Jillikul, Q; Kumsangir, R; Kolkhozabad, V; Vakhsh
3. Suffix of the Code shows the water sources of the WSS: v; Vakhsh Conduits, w; ground water, c; canal. In case the code does not have suffix, the WSS is supplied with water from the only Vakhsh Conduits
4. Operation years are from the construction year to the year of shutdown or 2008.

Таблица 3.3.1 Перечень систем водоснабжения районов, обслуживаемых Вахшским Трубопроводом (4/5)

Код	СВС	Джамоат	Владелец	Оператор	Население в зоне действия	Год конструкции	Статус режим работы	Период работы	Общая длина распределения (м)	Кол-во кранов (водопроводов)	Альтернативный Источник Воды (АИВ)	Дистанция от АИВ (м)	Число жителей на один кран	Длина распределительной трубы на один кран (м)
R-14 (1 Группа)	Колхоз Андреев Н.Бегов	Навабад	Джамоат Навабад	Джамоат Навабад	2274	1964	закрыто	34	5200	30	Вахшский трубопровод ирригационный кана	3000	76	173
R-15	Енгелс Джамоата Тугаланг	Тугаланг	Джамоат Тугалант	Джамоат Тугалант	2500	1987	закрыто	11	2800	25	Ирригационный канал	500	100	112
R-16 (2 Группа)	Улица Хлопкоров	Тугаланг	Джамоат	Джамоат	590	1978	рабочий	19	1400	18	Ирригационный канал	200	33	78
R-17в	Водаснабжения уч. Киров от скважины № 5 к магистральному водоводу.	Тугаланг	ММ и ВР РТ (Министерство Мелиорации и Водных Ресурсов)	КУМО (Отдел Ирригации канала в Калхазабадском Районе)	5000	1978	рабочий	30	500		Ирригационный канал	400		
R-18 (2 Группа)	Джамоат Ленин Тугаланг	Тугаланг	Джамоат	Джамоат	1670	1978	рабочий	30	1800	25	Ирригационный канал	3000	67	72
R-19vc	Джамоат Ленинград Тугаланг	Тугаланг	Джамоат Тугалант	Джамоат Тугалант	3493	1987	рабочий	15	4000	28	Ирригационный канал	300	125	143
R-20c	Пятилетка Джамоата Тугаланг	Тугаланг	Джамоат Тугалант	Джамоат Тугалант	2791	1987	рабочий	13	2800	30	Ирригационный канал	50	93	93
R-21w	Йаш Лминчи (От 4 го скважина до центра)	Тугаланг	ХРЕУ	ХРЕУ	5000	1978	рабочий	30	3000	40	Ирригационный канал	1000	125	75
R-22w	Строительство Воды в 1Узуне	Узун	ТСХВС	ТСХВС	3986	1962	рабочий	40	9700	165	Вахшская река	600	24	59
R-23 (1 группа)	Иттифок Джумаев, Колхоз	Узун	Иттифок Джумаев, Колхоз	Иттифок Джумаев, Колхоз	850	2001	закрыто	4	3000	32	Ирригационный канал	700	27	94
R-24	К. Маркс	Узун	Джамоат	Джамоат	1300	1987	рабочий	21	1600	5	Ирригационный канал	600	260	320
R-25 (1 группа)	Правда С. Джумаев Колхоз	Узун	Джумаев Колхоз	Джумаев Колхоз	1593	1978	рабочий	30	4500	30	Ирригационный канал	400	53	150
R-26	Конструкция селения Калинин	Калинин	Селение 40 летие Октября	Кишлак 40 летие Октября	3142	1986	закрыто	7	3000	45	Ирригационный канал	800	70	67
R-27	Есанкулов Колхоз	Маданият	Есанкулов Колхоз	Есанкулов Колхоз	1200	1985	рабочий	13	4900	12	Вахшский трубопровод ирригационный кана	600	100	408
R-28 (1 Группа)	Чапаев	Навабад	Джамоат Навабад	Джамоат Навабад	5510	1980	рабочий	28	5800	85	Вахшская река	500	65	68
R-29 (2 Группа)	Джамоат Коммунист Тугаланг	Тугаланг	Джамоат Тугалант	Джамоат Тугалант	4862	1987	рабочий	21	5500	25	Ирригационный канал	300	194	220
R-30	Джамоат Галаба Тугаланг	Тугаланг	Джамоат Тугалант	Джамоат Тугалант	1101	1987	закрыто	17	1400	26	Ирригационный канал	400	42	54
R-31в	Конструкция СВ Узун 2	Узун	ТСХВС	ТСХВС	0	1974	рабочий	26						
R-32 (3 Группа)	Хлопзавод Пивзавод ПГТ Исаев	ПГТ Исаев	Водоканао ГУП "ХМК"	Водоканао ГУП "ХМК"	1800	1973	рабочий	35	1500	20	Ирригационный канал	400	90	75
R-33	Селение Исаев	Тугаланг	Водоканал	Водоканал	1100	1987	рабочий	12	2100	15	Ирригационный канал	300	73	140

Примечания: 1. СВС: Система Водоснабжения
2. Первая буква кода указывает на местоположение СВС в Районе: Б; Бохтар, Д; Джиликул, К; Кумсангир, Р; Калхазабад, В; Вахш
3. Суффикс кодов означает источник воды СВС: В; Вахшский трубопровод, П; подземная вода, К; канал. В случае если коды без суффиксов, то СВС снабжается водой от Вахшского трубопровода

Таблица 3.3.1 Перечень систем водоснабжения районов, обслуживаемых Вахшским Трубопроводом (5/5)

Код	СВС	Джамоат	Владелец	Оператор	Население в зоне действия	Год конструкции	Статус режим работы	Период работы	Общая длина распределения (м)	Кол-во кранов (водопроводов)	Альтернативный Источник Воды (АИВ)	Дистанция от АИВ (м)	Число жителей на один кран	Длина распределительной трубы на один кран (м)
R-34vc	Ул. Шахтиёр Тугалангского местности	Тугаланг	Джамоат Тугалан г	Джамоат Тугалан нг	1673	1987	закрыто	6	1600	38	Ирригационный канал	600	44	42
R-35 (1 группа)	Саноат	Узун	Джумаев С Колхоз	Джумаев С Колхоз	1832	1988	рабочий	20	3600	75	Вахшский трубопровод	500	24	48
R-36 (1 группа)	Пахтаабад Джамоат Узун	Узун	Джамоат Узун К олхоз Джумаев	Джамоат Узун К олхоз Джумаев	3700	1986	рабочий	22	5500	120	Вахшский трубопровод	400	31	46
R-37 (3 группа)	Местность Мира	С. Исаев	Водоканал	Водоканал	2800	1974	рабочий	34	3200	75	Ирригационный канал	200	37	43
R-38vc (3 группа)	Советская местность ПГТ Исаев	С. Исаев	Водоканал	Водоканал	2800	1974	рабочий	34	1100	15	Ирригационный канал	400	187	73
R-39 (1 группа)	Мехнатабад Джпмоат Узун от С. Колхлз Джум	Узун	С.Джумаев Колхоз	С.Джумаев Колхоз	748	1988	закрыто	11	3800	62	Ирригационный канал	700	12	61
V-01c	Вахш. Экономика Джамоата Ак	Акгаза	Джпмоат	Джамоат	2685	1986	закрыто	14	2500	32	Ирригационный канал	200	84	78
V-02c	Джамоат Киров	Киров	Джамоат Киров	Совхоз С. Турдиев	7705	1987	закрыто	10	10300	35	Ирригационный канал	500	220	294
V-03c	Джамоат Киров 1-отрасль	Киров	Джамоат Киров	Колхоз С. Турдиев	6723	1987	закрыто	7	2500	28	Ирригационный канал	300	240	89
V-04c	Джамоат Кировov Кишлак Ленин, Руз обода и Мардотсояа	Киров	ТСХВС	ТСХВС	3644	1991	закрыто	7	4150	65	Ирригационный канал	600	56	64
V-05c	Гос колхоз Турдаев 3 отдель	Киров	Джамоат Киров и ТСХВС	Джамоат Киров и ТСХВС	8907	1991	закрыто	17	7500	80	Ирригационный канал	500	111	94
V-06c	Джамоат Окгаза	Окгаза	Джамоат Окгаза	Джамоат Окгаза	3317	1986	закрыто	22	3500	48	Ирригационный канал	300	69	73
V-07c	Джпамоат Окгаза	Окгаза	ТСХВС	ТСХВС	12085	1986	закрыто	19	6500	62	Ирригационный канал	300	195	105
V-08c	Джамоат Рохи Ленин	Рохи Ленин	ТСХВС	ТСХВС	17400	1986	закрыто	19	3800	50	Ирригационный канал	400	348	76
V-09	ПГТ Вахш	Вахш	ТСХВС	ТСХВС	4200	1979	закрыто	0			Ирригационный канал	600		
V-10c	Гос колхоз Вахшского района	Яангуобод	ТСХВС	ТСХВС	4900	1986	закрыто	12	3200	30	Ирригационный канал	200	163	107
V-11	Селение Зархез	Таджикабад	Джамоат	Джамоат	700	1987	рабочий	21	1200	60	Ирригационный канал	600	12	20
V-12	МЧС	Таджикабад	Министерство внутренних Дел М	Министерство внутренних Дел М	200	2000	рабочий	8	100	4	Ирригационный канал	1200	50	25
V-13	Селение Пахтаабад	Таджикабад	Джамоат	Джамоат	100	1987	рабочий	21	800	4	Ирригационный канал	600	25	200
V-14	Селение Навабад	Таджикабад	Джамоат Таджикабад	Джамоат Таджикабад	250	1980	рабочий	28	3300	22	Ирригационный канал	800	11	150
V-15	л/х Джумаев С	Таджикабад	Джамоат Таджикабад	Джамоат Таджикабад	17667	1980	закрыто	10	17620	340	Ирригационный канал	300	52	52

Примечания: 1. СВС: Система Водоснабжения
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3. Суффикс кодов означает источник воды СВС: В; Вахшский трубопровод, П; подземная вода, К; канал. В случае если коды без суффиксов, то СВС снабжается водой из Вахшского трубопровода

Table 3.3.3 List of Pipes Compose the Vakhsh Conduits

Pipe ID	Length	Diameter (I.D.)	Pipe	Pipe ID	Length	Diameter (I.D.)	Pipe
	m	mm	Material		m	mm	Material
Pipe SB01	1229	1200	concrete	Pipe IS04-2	224	614	steel
Pipe SB02	5223	1172	steel	Pipe IS04-3	116	614	steel
Pipe SB03	1776	996	steel	Pipe IS04-4	765	614	steel
Pipe SB04	1116	996	steel	Pipe IS04-5	86	614	steel
Pipe UJ01	1083	996	steel	Pipe IS04-6	120	614	steel
Pipe UJ02	32	900	steel	Pipe IS05	584	614	steel
Pipe UJ03	94	900	steel	Pipe IS06	384	600	cast iron
Pipe UJ03-1	238	900	steel	Pipe IS07	40	600	cast iron
Pipe UJ04	2545	900	steel	Pipe IS07-1	6058	600	cast iron
Pipe UJ05	14	900	steel	Pipe IS08	1044	600	cast iron
Pipe UJ06	455	900	steel	Pipe UR01	1079	514	steel
Pipe UJ06-1	1417	900	steel	Pipe UR01-1	274	514	steel
Pipe UJ07	28	900	steel	Pipe UR02	246	514	steel
Pipe UJ08	54	900	steel	Pipe UR02-1	2393	514	steel
Pipe UJ09	225	900	steel	Pipe UR03	23	514	steel
Pipe UJ09-1	2388	900	steel	Pipe UR04	382	514	steel
Pipe UJ09-2	540	900	steel	Pipe UR04-1	180	514	steel
Pipe UJ09-3	905	700	steel	Pipe UR04-2	16	514	steel
Pipe UJ09-4	810	700	steel	Pipe UR04-3	945	514	steel
Pipe UJ09-5	852	700	steel	Pipe UR04-4	403	514	steel
Pipe UJ09-6	825	700	steel	Pipe UR05	5	514	steel
Pipe UJ09-7	1030	700	steel	Pipe UR06	882	514	steel
Pipe UJ10	156	700	steel	Pipe UR07	167	514	steel
Pipe UJ11	36	700	steel	Pipe UR08	2237	514	steel
Pipe UJ12	22	700	steel	Pipe Ka01	7740	514	steel
Pipe UJ13	230	700	steel	Pipe Ka02	1792	514	steel
Pipe UJ14	10574	700	steel	Pipe Ka03	1000	514	steel
Pipe UJ14-1	758	700	steel	Pipe Ka03-1	6448	514	steel
Pipe UJ15	4212	514	steel	Pipe Ka03-2	2755	514	steel
Pipe Uzun1	102	700	steel	Pipe KaD01	543	500	cast iron
Pipe Uzun2	8	700	steel	Pipe KaD02	2660	500	cast iron
Pipe Uzun3	22	700	steel	Pipe KaD03	5781	500	cast iron
Pipe UJ16	978	514	steel	Pipe KaD04	3000	514	steel
Pipe UJ16-1	3528	514	steel	Pipe KaD05	3215	414	steel
Pipe UJ16-2	3	514	steel	Pipe KaD05-1	188	313	steel
Pipe UJ16-3	1493	514	steel	Pipe KaD05-2	1113	313	steel
Pipe UJ17	4926	514	steel	Pipe US01	4348	313	steel
Pipe UJ18	87	514	steel	Pipe US02	3492	313	steel
Pipe UJ19	1655	514	steel	Pipe J12	1257	208	steel
Pipe UJ20	355	514	steel	Pipe KaJ01	2193	313	steel
Pipe UJ21	728	514	steel	Pipe KaJ02	2626	313	steel
Pipe UJ22	1293	514	steel	Pipe KaJ03	299	313	steel
Pipe IS01	440	614	steel	Pipe KaJ04	3514	313	steel
Pipe IS02	21	614	steel	Pipe UzunP	2669	313	steel
Pipe IS03	180	614	steel	Pipe KaDE	3628	514	steel
Pipe IS03-1	646	614	steel				
Pipe IS03-2	198	646	steel				
Pipe IS04	1269	614	steel				
Pipe IS03-3	254	614	steel				
Pipe IS04-1	1291	614	steel				

Table 3.3.8 Maximum Daily Water Demand and Operation Rate of WSSs in 2007

(1/2)

ID No	Maximum hourly demand (L/s)	Status	Operation rate (%)	Modified Maximum Hourly Demand (L/s)	Tank
R-08		operation	30	0	
R-31		operation	50	0	
B-07	**21.66**	**operation**	**100**	**21.66**	**2000m^3 x 2**
J-09	**15.37**	**operation**	**50**	**7.69**	**1000m^3 x 2**
Q-01	**19.46**	**operation**	**40**	**7.78**	**2000m^3 x 1, 500m^3 x 2**
R-05	**23.57**	**operation**	**30**	**7.07**	**2000m^3 x 2**
B-01	0.18	shutdown	0	0	
B-02	0.57	operation	100	0.57	
B-03	0.09	operation	100	0.09	
B-04	0.66	operation	100	0.66	
B-05	0.69	operation	100	0.69	
B-06	0.03	operation	100	0.03	
B-08	0.87	operation	100	0.87	
B-09	0.91	operation	100	0.91	
B-10	1.17	operation	100	1.17	
B-11	0.69	operation	100	0.69	
B-12	1.62	operation	100	1.62	
B-13	0.93	operation	100	0.93	
B-14	2.32	operation	100	2.32	
B-15	0.06	operation	100	0.06	
B-16	0.03	operation	100	0.03	
B-17	0.03	operation	100	0.03	
B-18	0.69	operation	100	0.69	
B-19	1.22	operation	100	1.22	
B-20	**12.01**	**operation**	**50**	**6.01**	**2000m^3 x 2**
B-21	0.36	operation	100	0.36	
B-22	0.15	operation	50	0.08	
B-23	0.51	operation	100	0.51	
B-24	7.88	operation	100	7.88	
B-25	**11.39**	**operation**	**100**	**11.39**	**1000m^3 x 1**
J-01	1.76	operation	50	0.88	
J-02	0.78	shutdown	0	0	
J-03	0.88	operation	50	0.44	
J-04	1.04	operation	50	0.52	
J-05	2.85	operation	50	1.43	
J-06	1.04	operation	50	0.52	
J-07	**2.93**	**shutdown**	**0**	**0**	**500m^3 x 1**
J-08	5.93	shutdown	0	0	
J-10	1.33	shutdown	0	0	
J-11	2.64	shutdown	0	0	
J-12	**5.35**	**shutdown**	**0**	**0**	**500m^3 x 2**
J-13	**12.15**	**operation**	**50**	**6.08**	**500m^3 x 1**
Q-02	1.7	shutdown	0	0	
Q-03	1.94	shutdown	0	0	
Q-04	**14.1**	**shutdown**	**0**	**0**	**500m^3 x 3**
Q-05	**10.53**	**shutdown**	**0**	**0**	**500m^3 x 2**
Q-06	2.37	shutdown	0	0	
Q-07	2.69	shutdown	0	0	
R-01	3.86	shutdown	0	0	
R-02	2	operation	100	2	
R-03	2.77	operation	100	2.77	
R-07	4.52	shutdown	0	0	
R-09	4.42	shutdown	0	0	
R-10	1.86	operation	100	1.86	
R-11	5.81	operation	100	5.81	
R-12	2	operation	100	2	

Table 3.3.8 Maximum Daily Water Demand and Operation Rate of WSSs in 2007

(2/2)

R-13	1.09	shutdown	0	0	
R-14	3.51	shutdown	0	0	
R-15	3.86	shutdown	0	0	
R-16	0.91	operation	50	0.46	
R-18	2.58	operation	100	2.58	
R-19	**4.93**	**shutdown**	**0**	**0**	**500m^3 x 2**
R-23	1.3	shutdown	0	0	
R-24	2	operation	100	2	
R-25	2.45	operation	100	2.45	
R-26	**4.42**	**shutdown**	**0**	**0**	**500m^3 x 2**
R-27	**1.86**	**operation**	**100**	**1.86**	**500m^3 x 2**
R-28	7.17	operation	100	7.17	
R-29	6.85	operation	100	6.85	
R-33	1.7	operation	70	1.19	
R-34	2.58	shutdown	0	0	
R-35	2.82	operation	100	2.82	
R-36	5.23	operation	100	5.23	
R-39	1.14	shutdown	0	0	
V-11	1.09	operation	100	1.09	
V-12	0.36	operation	100	0.36	
V-13	0.18	operation	100	0.18	
V-14	0.45	shutdown	0	0	
V-15	**19.73**	**shutdown**	**0**	**0**	**1000m^3 x 1**
R-04	4.31	operation	50	2.16	
R-06	**2.77**	**operation**	**100**	**2.77**	**60m^3 x 1**
R-30	1.7	shutdown	0	0	
R-32	2.77	operation	50	1.39	
R-37	4.31	operation	100	4.31	
R-38	4.31	operation	100	4.31	
			Total	156.5	

CHAPTER 4 EXISTING CONDITION AND DEVELOPMENT ISSUES OF RURAL WATER SUPPLY SYSTEM

4.1 INVENTORY SURVEY OF EXISTING RURAL WATER SUPPLY SYSTEMS

4.1.1 BACKGROUND

It is said that more than 100 rural water supply systems in the Study Area and the water supply coverage is approximately 40.1%. However, an accurate number of the existing water supply system and their ownership, accurate water supply coverage have not been confirmed yet. Such information is indispensable to formulate a rehabilitation plan of the Vakhsh Conduits and rural water supply systems. In order to grasp the existing condition of rural water supply and to construct a GIS database system, an inventory survey was carried out.

4.1.2 OBJECTIVES AND METHODOLOGY

The Inventory Survey was conducted to collect basic information and to understand the supply situation of the villages in the Study area. Primarily, the output of the survey is utilized in understanding the current situation of the water supply systems, and secondarily to be incorporated into the rehabilitation and extension plan and selection of priority water supply systems.
The survey was carried out by structured village interviews. In the interviews, a form questionnaire was utilized, of which the survey items include: 1) population and location (by GPS coordinates) of village, 2) service population and 3) current situation of water supply facilities. A total number of 103 existing water supply systems were surveyed.
The survey was conducted by a local consultant contracted by the Study team.

4.1.3 SURVEY ITEMS

Items of the inventory survey include following data. Detailed items are shown as *Appendix 1: Inventory Survey Sheet* in Supporting Report.

- Basic information on water supply system
- Water source
- Water supply facilities
- Operation and maintenance systems
- Necessary rehabilitation
- Others

4.2 SURVEY RESULT

4.2.1 NUMBER OF EXISTING WATER SUPPLY SYSTEMS

The inventory survey revealed that there exist 103 rural water supply systems in the Study Area and those systems supply water to 182 villages. There are two (2) areas: the area where the water source is mainly Vakhsh Conduits and the other where the water source is mainly groundwater. In this Chapter, the former is expediently called “area A” and the latter “area B”. Each area includes the following Rayons.
Area A: Vakhsh, Kolkhozobod, Dzhilikul and Kumsangir Rayons (Total population: 464 thousand)
Area B: Kabodiyon, Shakhritus, Nosiri-Khisrav and Pyandzh Rayons (Total population: 348 thousand).

The number of water supply systems is summarized as *Table 4.2.1*.

Table 4.2.1 Number and Condition of Water Supply Systems in the Study Area

	Rayon	Total No. of Facilities	No. of Village (Service Area)	No. of Facility		
				Working	Partly Working	Deteriorated
Area A	Vakhsh	14	32	5	0	9
	Kolkhozobod	31	38	10	9	12
	Dzhilikul	9	10	0	6	3
	Kumsangir	7	15	0	0	7
	Total	61	95	15	15	31
Area B	Kabodiyon	14	36	3	2	9
	Nosiri Khisrav	3	7	0	1	2
	Shakhritus	10	17	6	1	3
	Pyandzh	15	27	2	2	11
	Total	41	87	11	6	25
Grand Total		103	182	26	21	56

Source: Inventory survey by the Study team

In area A, there are 61 systems in total. Their service area is 95 villages. 15 systems (25%) out of 61 are working, while 31 systems (51%) have deteriorated and are not in working order. The remaining 15 systems (25%) are partly working. The number of working systems is concentrated in the Kolkhozobod Rayon. A few systems are working in the Vakhsh and Kumsangir Rayons. No system is working in the Dzhilikul and Kumsangir Rayons. In Area A, 47 systems are connected to the Vakhsh Conduits, while three (3) systems are tapping water from groundwater and 11 systems are getting it from irrigation canals.

In Area B, the total number of systems is 41. Their service area is 87 villages. Among them, 11 systems (27%) are working. Six (6) systems (15%) are partly working. Remaining 25 systems (61%) have deteriorated and are not working.

Many development issues on the existing rural water supply systems in terms of both facilities, and operation and maintenance system were observed through the inventory survey and the field survey by the Study Team. Those are described in Chapter 6.

4.2.2 COVERAGE OF RURAL WATER SUPPLY

The total population in the Study area is approximately 812 thousand persons (as of Jan. 2007): 464 thousand persons in Area A and 348 thousand persons in Area B.

The center area of each Rayon is supplied water by Vodokanal except the Nosiri-Khisrav Rayon where Vodokanal does not exist. Vodokanal supplies 76.4 thousand persons in seven (7) Rayons, therefore, the population covered by the rural water supply systems is 736 thousand persons: 412 thousand in the area A and .324 thousand in area B. The Water supply situation in the Study area is summarized in *Table 4.2.2*.

The population served by rural water supply systems is 15 % of the total population: 10% in area A and 23 % in area B. In area A, Kolkhozobod shows relatively high coverage, it is 24%.

In area B, the coverage of service by the rural water supply system is 50 % in Shakhritus, while that of Kabodiyon is extremely low, it is only 7 %.

Table 4.2.2 Coverage of Water Supply

	Rayon	Total Population (Jan. 2007)	Population served by Vodokanal	Population to be served by Rural Water Supply Systems (2007)	Population Served by Rural Water Supply System		Population Unserved	
Area A	Vakhsh	141,615	12,425	129,190	10,157	8%	119,033	84%
	Kolkhozobod	137,491	13,000	124,491	29,292	24%	95,199	69%
	Dzhilikul	87,494	13,769	73,725	0	0%	73,725	84%
	Kumsangir	97,495	12,975	84,520	0	0%	84,520	87%
	Total	464,095	52,169	411,926	39,449	10%	372,477	80%
Area B	Kabodiyon	136,022	7,000	129,022	9,117	7%	119,905	88%
	Nosiri Khisrav	26,516	0	26,516	8,500	32%	18,016	68%
	Shakhritus	90,421	8,200	82,221	41,442	50%	40,779	45%
	Pyandzh	95,300	9,000	86,300	14,200	16%	72,100	76%
	Total	348,259	24,200	324,059	73,259	23%	250,800	72%
Grand Total		812,354	76,369	735,985	112,708	15%	623,277	77%

Source: the division of statistics in Hukmat of the Rayons.

4.3 DATABASE SYSTEM CREATED IN THE STUDY

4.3.1 INTRODUCTION

In order to formulate the water supply improvement plan for the existing water supply system, detailed information of each water supply system located in the targeted area is essential.
However, due to lack of a database of the water supply system in the target area, an inventory survey has been carried out in this Study, as mentioned in Chapter 4. And all information collected in this inventory survey was compiled in the database created in this Study.
In addition, a Geographical Information System (hereinafter referred to as GIS) was introduced to the study. The GIS technology is possible to perform spatial analysis by using various data, which is one of the advantages of utilizing GIS.
In this chapter, the design of the database created considering the actual utilization of the databases and outputs created by GIS is described.

4.3.2 DATABASE SYSTEM CREATED IN THE STUDY

(1) Design of the Database System

The results of the inventory survey were compiled using MS-Excel and then the data was divided in to 7 tables, in accordance with their characteristics listed in *Table 4.3.1* and *Table 4.3.2*, that compose the "Khatlon_WSS.mdb", a database created using MS-Access.
The method of viewing the database is as follows. Opening the file of "Khatlon_WSS.mdb" to view the database, the "Start" form pops up to choose each facility. Select the name of the facility, records and six (6) sheets are opened up. Each sheet shows the data of the inventory survey. It is a set shown in *Appendix* of *Chapter 2 in* Supporting Report.

Table 4.3.1 List of Information in the Database (1)

Database table	Items		Remarks
A_Water_Supply	-Date inventoried -Name of Rayon, -Name of Jamoat -Name of Village -Coordinates -Name of the WSS -Year of Construction -Owner of the WSS -Operator of the WSS -Type of source of water -Source of water	-Operating condition -Average quantity of water supplied -Maximum quantity of water supplied -Service hours -Reason of stopping the operation -Date of stopping the operation -History of rehabilitation made in the system	Basic information about the water supply system (English and Russian).
B_Water_Source	-Quantity of well -Depth of well -Capacity (yield) of well -Static and dynamic water level of the well -Casing diameter -Casing material -Screen position -Pump model and type -Pump setting position	-Pump motor output -Pump head -Pump discharge capacity -Diameter of the riser pipe -Material of the riser pipe -Pump starting up method -Location of control panel -Alternative water source -Distance to fetching water -Fetching times per day	Information about the source of water for the water supply system (English and Russian).

Table 4.3.2 List of Information in the Database (2)

Database table	Items	Remarks
C_Network	-Diameter and material of the aqueduct -Total length of the aqueduct -Condition and problems of the aqueduct -Quantity of valves in the aqueduct -Coordinates of the reservoir -Capacity and material of the reservoir -High and low water level of the reservoir -Condition and problems of the reservoir -Existence of chlorination facility and the agent utilized -Diameter and material of the transmission line -Length of the transmission line -Condition and problems of the transmission line -Quantity of valves in the transmission line -Coordinates of the Distribution tank -Type and capacity of the distribution tank -Material of the distribution tank -Condition and problems of the distribution tank -Diameter and material of the distribution main -Length of the distribution main -Condition and problems of the distribution main -Quantity of valves in the distribution main -Quantity of public taps -Diameter and material of the public tap -Total length of the service line	Information about the water supply system network (English and Russian)
E_Rehabilitation	-Name and quantity of facilities to be rehabilitated or replaced	(English and Russian)
F_Figure	Schematic layout of the water supply system	(English and Russian)
Pop_Serv	-Villages served by the water supply system -Population served by the water supply system	(English and Russian)
WaterQuality	-Results of the water quality analysis	(English and Russian)
Well	-Coordinates of each well existent as a water source	(English and Russian)

The structure of the Khatlon WSS Database is shown in *Figure 4.3.1*. Two sub folders are under the Khatlon WSS folder; “Db” folder and “GIS” folder. In the “Db” data folder, “Khalon_WSS.mdb”, a MS-Access database file and two subfolders “Tables (excel)” and “Figures” are filed. “Khatlon_WSS.mdb” file is composed of seven (7) tables where the results of the inventory survey are organized. The “Tables (excel)” folder contains MS-Excel files where the results of the inventory survey are organized and in the "Figures” folder, the schematic layout of all water supply systems inventoried is filed as raster data.

In the “GIS” data folder, the data files for creating maps and results of analysis such as table, polygons, polylines and point data are filed as a shape file and a dbf file. Under the “GIS” folder, four (4) sub folders were created (“01_MapFileGIS”, “Raster”, “Study Area” and “Figures”). First of all, in the “01_MapFilesGIS” the output of GIS analysis such as distribution of water supply system, operational condition of the water supply system, population served, etc., are filed as a map file (“mxd” format which can be opened by Arc GIS).

Second, in the “Raster” folder, 28 maps which cover the whole Khatlon Oblast are filed as raster

data. Those maps were utilized as a background of the map files. Third, in the “Study Area” folder, shapefile of the administrative boundaries of the Study Area are filed and two subfolders were also created (“Inventory” and “Priority System”). Those subfolders contain the shapefiles and dbf files of the analyzed data by GIS. Finally, in the “Figure” folder, the output of the analysis by GIS are filed as raster data.

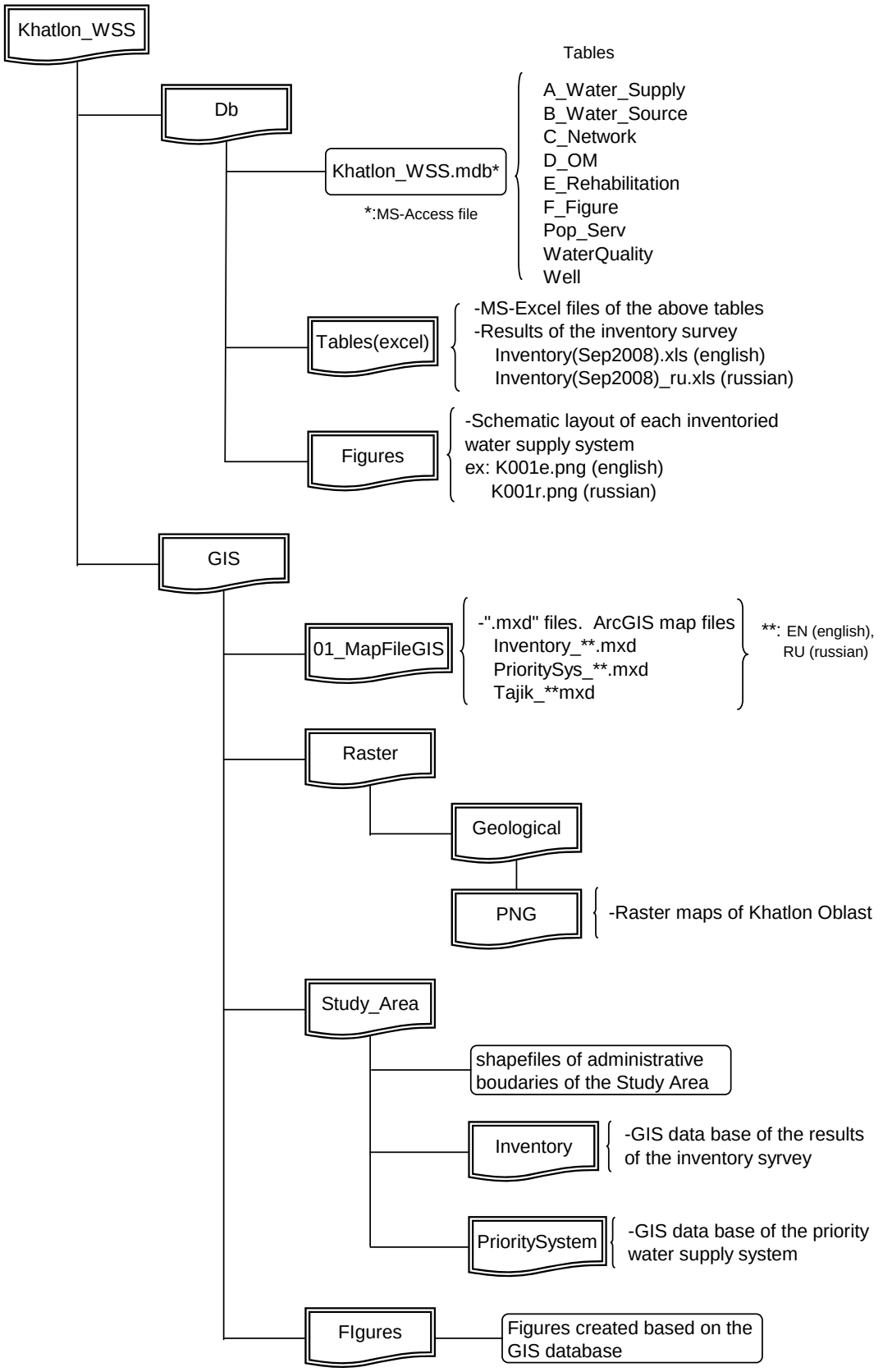


Figure 4.3.1 Structure of Database System

4.3.3 DATABASE SYSTEM CREATED WITH GEOGRAPHIC INFORMATION SYSTEM (GIS)

(1) General

In order to take advantage of the GIS, it should be mentioned that accurate data input and proper technical consideration to the results obtained by GIS analysis are required to prevent the misunderstanding of the results. Considering the characteristics of the advantages of GIS technology, the preparation of maps and analysis were carried out using GIS.

(2) Maps Created by Geographic Information System (GIS)

1) Base Map

Administrative boundaries such as Oblast boundary and Rayon boundary are fundamental information; however, the digital format of those boundaries data was not available before starting the Study. Therefore, the Study Team prepared and created the digital format of the boundaries through three (3) steps, which are:

1) The collection of the boundary data on the prints, 2) the scanning of collected maps and

3) the digitizing of the scanned maps.

The base maps provided in the Study are listed in *Table 4.3.3*.

Table 4.3.3 List of Base Maps Created

Data		Source	Format
1	Study area boundary	Existing Topographic map	Shape
2	Rayon boundary	Existing Topographic map	Shape
3	Oblast boundary	Existing Topographic map	Shape

2) Analysis Map

In order to understand the actual situation of the water supply system of the Study Area, analysis maps of the actual situation of the water supply system were created in the Study. An inventory survey was accomplished due to lack of any information about the water supply system of the covered target area.

The development of a location map of the water supply systems, in digital format, is one of the important results achieved by the Study.

Analysis maps were created by overlaying the information of the inventory survey such as operation conditions, served population, etc., to the correspondent water supply system.

Table 4.3.4 shows the list of maps created in this Study.

Table 4.3.4 List of Maps Created

	Maps
1	Distribution map of the water supply system
2	Distribution map of the water supply facility by operating condition
3	Distribution map of the water supply system by number of population served
4	Distribution map of the water supply system by type of water source
5	Distribution map of the priority facilities

4.3.4 RECOMMENDATIONS

The database system was created as the result of the analysis and of the field investigations performed by the Study Team, i.e. the inventory survey of the water supply system and a site survey. In order to facilitate continued effective utilization of the database, the following items are absolutely recommended.

(1) Improvement of the Accuracy of Locality Information

For the effective application of the database, the locality information is fundamental, especially for the analysis by the GIS. Therefore, it is strongly recommended to determine the coordinates by the Global Positioning System (GPS) when any new data is added to the database. Besides, it is desirable to determine the coordinates even for the existing data.

(2) Periodical Update of the Database

In order to reflect the latest conditions of the water supply system, it is recommended to do a periodical update of the database.

4.4 WATER QUALITY OF EXISTING WATER SOURCE

4.4.1 WATER QUALITY ITEMS ANALYZED

The water quality of each system is measured from the following items if the system is working. Water quality of existing water supply systems were surveyed during following two seasons as mentioned above.

- Winter season (55 water supply systems): from November to December 2007
- Summer season (46 water supply systems): June 2008

Water quality items analyzed are shown in *Table 4.4.1*.

Table 4.4.1 Water Quality Items Analyzed

Facility	Water Quality Items
Existing water supply systems	Total Coliform, Escherichia Coli, pH, Temperature (T), Electric Conductivity (EC), Total Dissolved Solid (TDS), Iron (Fe), Fluoride (F), Arsenic (As), Chloride (Cl), Nitrate (NO_3)

4.4.2 DRINKING WATER STANDARD

In Tajikistan, "GOST 2874-82" is applied as the drinking water quality standard. They are shown in *Table 4.4.2*.

Table 4.4.2 Drinking Water Standard (GOST 2874-82)

Item	Unit	with treatment facility	without authorized treatment facility
E. Coli	count/ml	100	100
Total Coli.	count/l	3	3
pH		6.0 – 9.0	6.0 – 9.0
Temperature (T)		-	-
Electric Conductivity (EC)	mS/m	-	-
Total Dissolved Solid (TDS)	mg/l	1,000	1,500
Iron (Fe)	mg/l	0.3	1
Fluoride (F)	mg/l	0.7	0.7
Arsenic (As)	mg/l	0.05	0.05
Residual Chlorine (Cl)	mg/l	-	-
Nitrate ($NO_{3)}$	mg/l	45	45

4.4.3 RESULTS OF WATER QUALITY ANALYSES

The total number of water supply systems surveyed are 55 in winter season and 46 in summer season. List of water supply system surveyed is shown in *Table 4.4.3*. Results of the analyses are shown in *Table 4.4.4 and Table 4.4.5*.

(1) pH

In winter season, the pH values show a relatively wide distribution from 5.1 to 9.0. A total of 32 samples show less than 6, against the GOST standard from 6 to 9.
In contrary, all the samples (46 samples) showed the value within the standard in summer season, from 6.35 and 8.34.

(2) Escherichia Coli. And Total Coliform

In winter season, number of Escherichia Coli, (E. Coli) was detected in 31 systems (54%). However, it is lower than the standard: It is in a range from o to 6. Total Coliform was detected in 41 systems (72%): It is in a range from 1 to 4. Only one (1) system in the Dzhilikul Rayon shows the value, 4 which is more than the standard.
In summer season, it is in arrange from 0 to 62, it is relatively higher than that of winter season. However, it is still less than the standard. Total Coliform is higher than that of winter season, it is in a range from 0 to 59. 24 samples, out of 46 samples exceed the standard value.

(3) Electric Conductivity (EC) and Total Dissolved Solid (TDS)

In winter season, Electric Conductivity (EC) is generally low, it is between 31.7 and 92.2 mS/m. Total Dissolved Solid (TDS) value is also low, in a range from 152 to 628 mg/l. TDS value is less than the standard. EC value and TDS value has a close relationship. When the EC value is low, the TDS value is low.
EC value is in a range from 30.2 to 204 mS/m in summer season. TDS are in a range between 177 and 960 mg/L. Same close relationship as winter season was recognized between EC value and TDS value in summer season.

(4) Temperature (T)

Temperature is relatively low, in a range from 12 to 20 degree Celsius in winter season. In summer season, temperature is high, from 27.1 to 31.8 degree Celsius.

(5) Iron (Fe)

Irion contents in both winter season and summer season are less than the standard in all the village. The Iron contents are from 0.05 mg/L to less than 4 mg/L in winter season and less than 0.05 mg/L against the standard value 1 mg/L.

(6) Fluoride (F)

In winter season, Fluoride contents are less than 0.4 mg/L, it is less than the standard 0.7 mg/L.
Fluoride contents are 0 or 1.5 mg/L in summer season: The contents higher than the standard (0.7 mg/L) appeared at two (2) systems, Kizil-Ittifoq village in Kabodiyon and Navruz of Sovkhoz No.5 in Nosiri-Khisrav.

(7) Arsenic (As)

The Arsenic content of all the samples shows less than 0.2 mg/L, it is due to the detected limit of the test paper. Therefore, it does not mean that no deterioration by Arsenic is recognized. Arsenic contents were analyzed by UNICEF. According to “Rapid Assessment of Drinking-Water Quality in The Republic of Tajikistan (RADWQ) (UNICEF 2006)”, deterioration by Arsenic was not identified.

(8) Residual Chlorines

Content of Residual Chlorine is in a range from less than 0.1 mg/l to 2 mg/l in winter season. In summer season, it is between 0.1 and 0.4 mg/L/

(9) Nitrate (NO3)

In winter season, Nitrate content is less than 2 mg/l against the GOST standard 45 mg/l. In summer season, most of Nitrate contents are less than 5 mg/L.
However, relatively high contents were confirmed at three (3) water supply systems. They are 20 mg/L in Jamoat Nosiri Khisrav Water Supply system in Kabodiyon, 10 mg/L in Navruz of Kolkhoz No.5 in Kabodiyon and Kolkhoz Vatan Water Supply system in Shakhritus.

4.4.4 INFLUENCE OF ORGANOCHLORINE INSECTICIDES ON WATER QUALITY

Regarding the possibility of deterioration by organochlorine pesticides, a survey was carried out in 2001 including Khatlon Oblast by WHO as the collaborating work with the Federal Environmental Agency of Germany (FEA) and the Tajik Ministry of Health. The results were published as a technical report titled "Survey for an initial assessment of current pollution by organochlorine pesticides in drinking-water sources of the Republic of Tajikistan". The following 12 organochlorine insecticides were analyzed in the survey.

- α-, β- and ?- HCH (Lindane)
- p,p'-DDE, p,p'-DDD and p,p'-DDT
- Methoxychlor
- Aldrin and Dieldrin
- Heptachlor-Epoxide
- α- and β-Endsulfan

Table 4.4.6 shows the group and amount of pesticides used in agriculture in Tajikistan. The amount of pesticides used in agriculture underwent a sharp decline by more than 90% between the early seventies and the late nineties (Schmoll 2002).

Table 4.4.6 Group and Amount of Pesticides Used in Agriculture in Tajikistan

Pesticide Group	Year			
	1972-1976	1980-1985	1990-1995	1996-2000
Total amount used	75,441	43,534	4,488	4,574
Organochlorine	86.1%	57.3%	31.4%	29.2%
Organophosphorus	6.9%	21.5%	45.4%	47.0%
Carbamates	1.5%	2.6%	7.5%	9.0%
Pyrethroids	0.0%	2.2%	9.9%	10.3%
Nitrophenyls	5.4%	14.8%	4.7%	3.2%
Trianines	0.2%	1.6%	1.1%	1.3%

Source: MoH, 2002

As a result of analyses, the following conclusions were obtained (Schmoll 2002).

(1) Pollution of drinking-water sources with organochlorine insecticides is widespread. At 86% of the investigated sites, one or more substances could be detected at concentrations above the detection limit.

(2) Concentration levels in tested water sources are generally low if compared with the WHO guideline values for drinking water quality (WHO 2004).

These conclusions show that concentration level of organochlorine is lower than the WHO guideline value (WHO 2004) although some insecticides were detected.

Table 4.4.3 List of Existing Water Supply System Surveyed (1/2)

Facility Code	Ryon	Jamoat	Village	Name of Water Supply System	Owner of Water Supply System	Name of Operator	Water Source	
K-05	Kabodiyon	Navobod	Navruz	Water Supply Navruz	RWSA	RWSA	2: Groundwater	
K-01	Kabodiyon	Nosiri Khisrav	Lenin, Jura Azizov,Sino, Tursunzoda	Water Supply Jamoat Nosiri Khisrav	GUP "KHMK" Kabodiyon region	KDFO Kabodiyon	2: Groundwater	
K-08	Kabodiyon	S. Khudoikulov	Chkalov	Water Supply Chkalov	Jamoat Chkalov	Jamoat Chkalov	2: Groundwater	
K-03	Kabodiyon	S. Khudoikulov	Kizil-Ittifoq	Water Supply Qizil-Ittifoq	Jamoat Qizil-Ittifoq	Jamoat Qizil-Ittifoq	2: Groundwater	
N-01	Nosiri-Khisrav	Istiklol	44-Chashma "Oltinsoy"	Water Supply Nosiri-Khusrav ryon	RWSA	RWSA	2: Groundwater	
N-03	Nosiri-Khisrav	Firuza	Navruz of Sovkhoz No.5	Water Supply Navruz and Jamoat Muhammadiev	RWSA	RWSA	2: Groundwater	
P-04	Pyandzh	city Pyandzh	Pyandzh	Water Supply PGT Pyandzh	Water-supply Pyanjkogo region	Water-supply Pyanjkogo region	2: Groundwater	
P-03	Pyandzh	Namuna	Peshqadam 1 and 2	Water Supply Jamoat Namuna	Jamoat Namuna	Jamoat Namuna	2: Groundwater	
P-08	Pyandzh	Sarmantoy	Dzerjinsky-1	Water Supply population Dzerjinsky-1	RWSA	RWSA	2: Groundwater	3: Irrigation canal
P-10	Pyandzh	Sarmantoy	Dzerjinsky-2	Water Supply population Dzerjinsky-2	RWSA	RWSA	2: Groundwater	3: Irrigation canal
P-07	Pyandzh	Tugul	Territory School No.5	Water Supply Jamoat Tugul and School No.5	Jamoat Tugul	Jamoat Tugul	2: Groundwater	
S-03	Shakhritus	Jura Nazarov	Aivoj	Water Supply Aivoj	Jamoat Jura Nazarov	Jamoat Jura Nazarov	2: Groundwater	
S-09	Shakhritus	Obshoron	Binokor	Water Supply Binokor	Jamoat Obshoron	Jamoat Obshoron	2: Groundwater	
S-04	Shakhritus	Obshoron	Vatan	Water Supply Kolkhoz Vatan	Jamoat Obshoron	Jamoat Obshoron	2: Groundwater	
S-07	Shakhritus	Obshoron and Kholmatov	Stroiteley	Water Supply Stroiteley	UVK Shakhritus	UVK Shakhritus	2: Groundwater	
S-05	Shakhritus	Pakhtaobod	Sultanabod	Water Supply Sultanabod	Jamoat Pakhtaobod	Jamoat Pakhtaobod	2: Groundwater	
S-08	Shakhritus	Sayod	Kizil Askar	Water Supply Kizil Askar	Jamoat Sayod	Jamoat Sayod	2: Groundwater	
S-10	Shakhritus	Sayod	Sayod	Water Supply Sayod	Jamoat Sayod	Jamoat Sayod	2: Groundwater	
S-01	Shakhritus	Shakhritus	Karl Marks	Water Supply Karl Marks	Jamoat Shakhritus	Jamoat Shakhritus	2: Groundwater	
J-01	Dzhilikul	Dehkanabad	Agronomy	Water Supply Agronomy village of Jamoat Dehkanabad	Kolkhoz Fayzaly Said	Kolkhoz Fayzaly Said	1: Vakhsh Conduit	
J-03	Dzhilikul	Dehkanabad	Kirov	Water Supply Kirov village ofJamoat Dehkanabad	Moskva Sovkhoz, Dehkanabad Jamoat	Moskva Sovkhoz, Dehkanabad Jamoat	1: Vakhsh Conduit	
J-05	Dzhilikul	Dehkanabad	Kuybeshev	Water Supply of Kuybeshev village, Jamoat Dehkanabad	Fayzaly Said kolkhoz	Fayzaly Said kolkhoz	1: Vakhsh Conduit	
J-04	Dzhilikul	Dehkanabad	Moskva	Water Supply of Moskva village of Dehkanabad Jamoat	Moskva Sovkhoz of Dehkanabad Jamoat	Moskva Sovkhoz of Dehkanabad Jamoat	1: Vakhsh Conduit	
J-06	Dzhilikul	Dehkanabad	Ribhoz Surh	Water Supply of Surh Ribhoz village	Community of Dehkanabad	Community of Dehkanabad Jamoat	1: Vakhsh Conduit	
J-9	Dzhilikul	Dzhilikul	Dzhilikul	Vodokanal	Vodokanal	Vodokanal	1: Vakhsh Conduit	
J-13	Dzhilikul	Nuri Vakhsh	s/z Moskva к/z E. Sattorov	Water Supply of s/z Moskva of к/z E. Sattorov	RWSA	RWSA	1: Vakhsh Conduit	

Table 4.4.3 List of Existing Water Supply System Surveyed (2/2)

Facility Code	Ryon	Jamoat	Village	Name of Water Supply System	Owner of Water Supply System	Name of Operator	Water Source	
R-08	Kolkhozobod	Kalinin	Kalinin	Pump station Kalinin	RWSA and KhREY Qumsangir	RWSA and KhREY Qumsangir	1: Vakhsh Conduit	3: Irrigation canal
R-27	Kolkhozobod	Madaniyat	Esanqulov	Water Supply Kolkhoz Esanqulov	Esanqulov Kolkhoz	Esanqulov Kolkhoz	1: Vakhsh Conduit	
R-11	Kolkhozobod	Madaniyat	JD Station	Water Supply Kolkhoz T. Esanqulov	Kolkhoz T. Esanqulov	Kolkhoz T. Esanqulov	1: Vakhsh Conduit	
R-10	Kolkhozobod	Madaniyat	Kizil-Baurak	Water Supply Kizil-Baurak Kolkhoz T. Esanqulov	Kolkhoz T. Esanqulov	Kolkhoz T. Esanqulov	1: Vakhsh Conduit	
R-28	Kolkhozobod	Navobod	Chapaev	Water Supply Chapaev	Jamoat Navobod	Jamoat Navobod	1: Vakhsh Conduit	
R-12	Kolkhozobod	Navobod	Urtabuz	Water Supply Urtabuz	Kolkhoz S. Jumaev	Kolkhoz S. Jumaev	1: Vakhsh Conduit	
R-32	Kolkhozobod	PGT Isoev	Khlopzavod-Pivzavod	Water Supply Khlopzavod-Pivzavod of PGT Isaeva	Vodokanal GUP “KhMK”	Vodokanal GUP “KhMK”	1: Vakhsh Conduit	
R-05	Kolkhozobod	PGT Isoev	Lenin	Water Supply Vodokanal PGT Isaeva	GUP “KHMK”	GUP “KHMK”	1: Vakhsh Conduit	3: Irrigation canal
R-06	Kolkhozobod	S. Isoev	Central district hospital	Water Supply Central district hospital	Central district hospital of Jamoat S. Isaeva	Central district hospital of Jamoat S. Isaeva	1: Vakhsh Conduit	
R-04	Kolkhozobod	S. Isoev	Kazakhs	Water Supply Kazakhs Village	GUP “KhMK”	Vodokanal GUP “KhMK”	1: Vakhsh Conduit	
R-37	Kolkhozobod	S. Isoev	Mira	Water Supply Mira	Vodokanal	Vodokanal	1: Vakhsh Conduit	
R-38	Kolkhozobod	S. Isoev	Sovet	Water Supply Sovet PGT Isaeva	Vodokanal GUP “KhMK” (Sate Unitary Enterprise)	Vodokanal GUP “KhMK”	1: Vakhsh Conduit	3: Irrigation canal
R-29	Kolkhozobod	Tugalan	Communist	Water Supply Communist, Jamoat Tugalang	Jamoat Tugalang	Jamoat Tugalang	1: Vakhsh Conduit	
R-33	Kolkhozobod	Tugalan	Jomi	Water Supply Jomi, Jamoat Tugalang	Jamoat Tugalang	Jamoat Tugalang	1: Vakhsh Conduit	
R-16	Kolkhozobod	Tugalan	Khlopkorob	Water Supply Khlopkorob	Jamoat Tugalang	Jamoat Tugalang	1: Vakhsh Conduit	
R-17	Kolkhozobod	Tugalan	Kirov	Water Supply Kirov from the bore hole 5 to Main pipe line	MM and VR TR	KUMO	2: Groundwater	
R-18	Kolkhozobod	Tugalan	Lenin	Water Supply Lenin, Jamoat Tugalang	Jamoat Tugalang	Jamoat Tugalang	1: Vakhsh Conduit	
R-02	Kolkhozobod	Uzun	Ittifoq-1	Water Supply Ittifoq-1	Kolkhoz S. Jumaev	Kolkhoz S. Jumaev	1: Vakhsh Conduit	
R-22	Kolkhozobod	Uzun	Ittifoq-3	Water intake installation Uzun 1	RWSA	RWSA	2: Groundwater	
R-24	Kolkhozobod	Uzun	K. Marks	Water Supply K. Marks	Jamoat Uzum	Jamoat Uzum	1: Vakhsh Conduit	
R-39	Kolkhozobod	Uzun	Mehnatobod	Water Supply Mehnatobod Jamoat Uzun from Kolkhoz S. Jumaev	Kolkhoz S. Jumaev	Kolkhoz S. Jumaev	1: Vakhsh Conduit	
R-03	Kolkhozobod	Uzun	Pakhtaaral	Water Supply Pakhtaaral	Kolkhoz S. Jumaev	Kolkhoz S. Jumaev	1: Vakhsh Conduit	
R-36	Kolkhozobod	Uzun	Pakhtaobod	Water Supply Pakhtaobod Jamoat	Jamoat Uzun kolkhoz Jumaev	Jamoat Uzun kolkhoz Jumaev	1: Vakhsh Conduit	
R-25	Kolkhozobod	Uzun	Pravda	Water Supply Pravda Kolkhoz S.	Kolkhoz S. Jumaev	Kolkhoz S. Jumaev	1: Vakhsh Conduit	
R-35	Kolkhozobod	Uzun	Sanoat	Water Supply Sanoat	Kolkhoz S. Jumaev	Kolkhoz S. Jumaev	1: Vakhsh Conduit	
R-31	Kolkhozobod	Uzun	Uzun	Water Supply constructions Uzun 2	RSWA	RSWA	1: Vakhsh Conduit	2: Groundwater
R-21	Kolkhozobod	Tugalan	Yosh-Leninchi	Water Supply Yosh-Lrninchi (From bore hole 4 to main pipe-line)	KhREY	KhREY	2: Groundwater	
Q-1	Kumsangir	Dusti	1-Area	Vodokanal Dusti	GUP HMK Vodokanal Dusti	Vodokanal Dusti	1: Vakhsh Conduit	3: Irrigation canal
V-05	Vakhsh	Kirov	Oq-Gaza, Yangi-Ariq, Kizil-Soy, Yangi-Hayot, Yangi-Yor, Shar-shara	Water Supply Sovkhoz Turdiav the 3rd branches	Jamoat Kirov and RWSA	Jamoat Kirov and RWSA	3: Irrigation canal	
V-12	Vakhsh	Tojikobod	MChS (Military base of Ministry on exceeding	Water Supply Military base of Ministry on exceeding event	Ministry on exceeding event	Ministry on exceeding event	1: Vakhsh Conduit	
V-14	Vakhsh	Tojikobod	Navobod	Water Supply Navobod	Jamoat Tojikobod	Jamoat Tojikobod	1: Vakhsh Conduit	
V-13	Vakhsh	Tojikobod	Pakhtakor	Water Supply Pakhtakor	Jamoat Tojikobod	Jamoat Tojikobod	1: Vakhsh Conduit	
V-11	Vakhsh	Tojikobod	Zarkhez	Water Supply Zarkhez	Jamoat Tojikobod	Jamoat Tojikobod	1: Vakhsh Conduit	

Table 4.4.4 Results of Water Quality Survey (Winter, November - December 2007)

Item	Unit	GOST 2874-82		Kabodiyon				Nosiri-Khisrav		Pyandzh					Shakhritus							
		with treatment facility	without authorized treatment facility	K-05	K-01	K-08	K-03	N-01	N-03	P-04	P-03	P-08	P-10	P-07	S-03	S-09	S-04	S-07	S-05	S-08	S-10	S-01
pH	-	6.0-9.0	6.0-9.0	6.2	5.1	6.3	6.6	9.0	6.3	9.0	9.0	9.0	5.8	9.0	5.9	7.3	7.4	5.9	5.9	5.9	7.4	5.9
Temperature	oC			16	16	16	16	16	16	16	16	16	17	16	18	18	18	18	18	18	18	18
EC	mS/m			33.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4	37.4	33.4	33.7	120.2	92.2	33.7	33.7	33.7	33.7	33.7
TDS	mg/l	1,000	1,500	156	166	166	154	166	166	166	166	166	177	166	156	628	470	156	156	156	456	156
E. Coli	count/ml	100	100	0	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	0
Total Coli.	count/l	3	3	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	0	1	0	1
Fe	mg/l	0.3	1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	< 0.4	0.05	0.05	0.05	0.05	0.05	0.05	0.05	< 0.05	0.05
F	mg/l	0.7	0.7	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.2	0.2	0.0	0.2	0.2	0.2	0.2	0.2
As	mg/l	0.05	0.05	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Residual Chlorine	mg/l			2.0	0.2	0.2	0.2	0.2	0.2	< 0.2	0.2	0.2	< 0.2	0.2	< 0.4	< 0.1	< 0.1	<0.2	0.2	0.4	< 0.1	< 0.4
NO_3	mg/l	45	45	1	1	1	1	1	1	< 1	1	1	< 2	1	< 2	< 1	2	< 2	2	2	< 2	< 2

Item	Unit	GOST 2874-82		Dzhilikul							Kolkhozobod										
		with treatment facility	without authorized treatment facility	J-01	J-03	J-05	J-04	J-06	J-09	J-13	R-08	R-27	R-11	R-10	R-28	R-12	R-32	R-05	R-06	R-04	R-37
pH	-	6.0-9.0	6.0-9.0	5.6	5.5	5.9	6.2	5.1	5.2	5.1	5.4	5.6	5.8	5.2	5.1	5.9	5.7	5.2	6.1	5.8	6.8
Temperature	oC			16	16	15	17	16	12	16	16	17	12	19	16	17	15	16	16	18	18
EC	mS/m			33.3	32.3	32.7	33.2	33.4	31.7	33.4	33.4	32.5	33.3	66.5	33.4	32.5	33.6	63.5	33.4	64.9	64.9
TDS	mg/l	1,000	1,500	164	165	162	165	166	161	136	166	165	164	170	166	165	154	175	162	166	165
E. Coli		100	100	1	1	1	1	1	1	6	1	1	0	1	0	1	0	0	0	0	1
Total Coli.		3	3	1	1	1	1	1	1	4	1	1	0	1	1	1	0	1	1	0	1
Fe	mg/l	0.3	1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.40	0.05	0.05	0.50	0.05	0.05	0.05	0.50	0.05	0.05	0.05
F	mg/l	0.7	0.7	0.4	<0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	< 0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
As	mg/l	0.05	0.05	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Residual Chlorine	mg/l			< 0.2	<0.2	0.2	0.1	0.2	0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	<0.2	0.2	0.2	< 0.2	< 0.2
NO_3	mg/l	45	45	< 1	< 1	1	2	1	1	2	< 1	1	< 1	< 1	< 1	1	<1	1	1	< 1	< 1

Item	Unit	GOST 2874-82		Kolkhozobod															Kumsangir	Vakhsh
		with treatment facility	without authorized treatment facility	R-38	R-29	R-33	R-16	R-17	R-18	R-02	R-22	R-24	R-39	R-03	R-36	R-25	R-35	R-31	R-21	Q-01	V-05
pH	-	6.0-9.0	6.0-9.0	5.3	6.7	5.9	5.7	6.2	6.5	5.9	6.2	6.1	5.9	5.2	5.3	6.0	8.7	5.5	5.9	6.4	5.4
Temperature	oC			15	15	16	15	17	17	13	17	16	12	16	15	19	16	17	17	16	20
EC	mS/m			64.5	66.4	33.4	33.9	33.3	36.6	33.4	32.5	33.4	33.5	32.4	32.3	32.8	33.4	32.5	34.0	33.4	66.5
TDS	mg/l	1,000	1,500	170	337	172	165	165	174	168	165	166	152	161	162	162	166	168	166	154	164
E. Coli		100	100	0	0	0	1	0	1	0	1	0	0	0	0	1	1	0	1	1	0
Total Coli.		3	3	0	1	1	1	1	1	1	1	0	1	1	0	1	1	0	1	1	0
Fe	mg/l	0.3	1	0.05	0.50	0.05	0.05	0.05	0.50	0.05	0.05	0.05	0.05	0.40	0.05	0.05	0.05	0.04	0.05	0.50	0.05
F	mg/l	0.7	0.7	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.2	0.4	0.4	< 0.4	0.4	0.4	0.4	0.4	0.4	0.4	< 0.4
As	mg/l	0.05	0.05	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Residual Chlorine	mg/l			< 0.2	< 0.2	< 0.1	0.2	< 0.2	< 0.2	< 0.2	0.2	0.2	< 0.2	< 0.2	< 1	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2
NO_3	mg/l	45	45	< 1	< 1	< 2	1	< 1	< 1	< 1	1	< 1	< 1	< 1	< 2	< 2	< 1	< 1	1	< 1	2

Table 4.4.5 Results of Water Quality Survey (Summer, June 2008)

Item	Unit	GOST 2874-82		Kabodiyon			Nosiri-Khisruv		Pyandzh				Shakhritus						
		with treatment facility	without authorized treatment facility	K-01	K-08	K-03	N-01	N-03	P-03	P-08	P-10	P-07	S-03	S-09	S-04	S-07	S-08	S-10	S-01
pH	-	6.0-9.0	6.0-9.0	6.72	6.86	6.82	6.43	7.11	8.34	7.96	7.96	8.20	6.85	7.08	6.92	7.08	6.35	6.81	6.56
Temperature	^{o}C			31.2	30.5	30.8	30.5	31.6	27.7	27.5	27.5	27.8	30.5	30.4	31.0	30.4	29.9	30.3	30.7
EC	mS/m			113	63.5	0.204	114.3	170.7	77.2	72.0	72.0	64.3	63	117.6	85.8	117.6	46.9	118.8	30.2
TDS	mg/l	1,000	1,500	524	316	960	956	775	418	366	366	330	340	557	444	557	216	585	177
E. Coli	count/ml	100	100	10	14	62	46	4	0	5	5	14	25	20	6	20	6	8	31
Total Coli.	count/l	3	3	4	11	59	32	1	10	17	17	7	0	2	4	2	2	5	22
Fe	mg/l	0.3	1	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>
F	mg/l	0.7	0.7	0	0	1.5	0	1.5	0	0	0	0	0	0	0	0	0	0	0
As	mg/l	0.05	0.05	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>
Residual Chlorine	mg/l			0.2	0.1	0.4	1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
NO_3	mg/l	45	45	20	1>	45<	1>	10	1>	2	2	1>	1>	2	10	2	1>	5	1>

Item	Unit	GOST 2874-82		Dzhilikul						Kolkhozobod								
		with treatment facility	without authorized treatment facility	J-01	J-03	J-05	J-04	J-06	J-13	R-08	R-27	R-11	R-10	R-28	R-12	R-06	R-29	R-16
pH	-	6.0-9.0	6.0-9.0	7.70	7.85	7.73	7.98	7.62	7.73	8.18	7.82	7.69	7.82	7.86	7.83	7.94	7.72	7.72
Temperature	^{o}C			27.3	27.4	27.3	27.9	27.3	27.5	27.4	27.4	27.5	27.4	27.7	27.3	27.8	27.1	27.1
EC				68.7	67.7	67.2	65.2	69.3	72.7	83.8	65.4	67.3	65.4	69.4	64.7	84.1	66.8	66.8
TDS	mg/l	1,000	1,500	357	345	376	338	328	376	424	344	398	344	409	349	430	395	395
E. Coli	count/ml	100	100	34	14	2	0	5	31	19	23	14	23	16	21	8	17	17
Total Coli.	count/l	3	3	3	2	1	0	1	2	19	2	6	2	5	3	22	2	2
Fe	mg/l	0.3	1	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>
F	mg/l	0.7	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
As	mg/l	0.05	0.05	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>
Residual Chlorine	mg/l			0.1	0.1	0.1	0.1	0.1	0.1	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>
NO_3	mg/l	45	45	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Item	Unit	GOST 2874-82		Kolkhozobod									Vakhsh				
		with treatment facility	without authorized treatment facility	R-18	R-02	R-22	R-24	R-39	R-03	R-36	R-25	R-35	R-31	V-05	V-12	V-14	V-13	V-11
pH	-	6.0-9.0	6.0-9.0	7.72	7.69	7.53	7.67	7.86	7.86	7.86	7.86	7.86	7.86	7.76	7.91	7.30	7.40	7.41
Temperature	^{o}C			27.1	27.1	27.7	27.3	27.7	27.7	27.7	27.7	27.7	27.7	28.7	30.9	30.5	31.8	31.5
EC				66.8	61.9	69.2	65.4	66.6	64.8	64.8	64.8	64.8	64.8	89.6	96.1	89.1	80.1	91.6
TDS	mg/l	1,000	1,500	395	391	365	345	346	336	336	336	336	336	458	411	408	405	415
E. Coli	count/ml	100	100	17	4	11	15	4	40	40	40	40	40	3	1	1	2	1
Total Coli.	count/l	3	3	2	2	4	5	3	11	11	11	11	11	0	0	12	28	0
Fe	mg/l	0.3	1	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>	0.05>
F	mg/l	0.7	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
As	mg/l	0.05	0.05	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>	0.2>
Residual Chlorine	mg/l			0.2>	0.2>	0.2>	0.2>	0.1	0.2>	0.1	0.2>	0.1	0.1	0.1	0.4	0.4	0.4	0.4
NO_3	mg/l	45	45	1	1	1	1	1	1	1	1	1	1	1	1>	1>	1>	1>

4.5 DEVELOPMENT ISSUES IN FORMULATING THE REHABILITATION AND EXPANSION PLAN

The Inventory survey and the field survey revealed that there are various problems on the existing rural water supply systems. Among the issues on the formulation of rehabilitation and expansion plan for the existing rural water supply systems, issues on the facilities are described in this Clause. Issues on the operation and maintenance are presented in Chapter 6.

(1) Electric sub-station

Transformers in the villages are not used for only water supply but various purposes. It causes both lack and lowering of voltage of electricity in many villages. In order to keep sufficient and proper voltage electric supply to the rural water supply systems, it is required to prepare independent and sufficient capacity of transformers.

(2) Water Well and Ancillary Facilities

1) Improper well structure

It was confirmed that sands in aquifers had been intruded into the water wells and deposited in the wells due to improper well structure. Shape of screen is holes with about 13mm of diameters. Diameter of gravels packed in the annular space between wall of well and casing/screen pipes is about 15mm. The intruded sands will cause following trouble in the water wells.

- attribution of submersible pump and burning of mortar
- clogging of screen by deposited sand and depreciation of well capacity
- attribution and clogging of pipes
- collapse of gravel filter, clogging of filter and ground subsidence around the well

It is indispensable to construct wells with proper structure. Specification of such structure is as follows:

The material of screen pipes shall be PVC, which allows processing of small-slot screen (less than 1 mm), and is of anti-corrosion. Size of the well gravel shall be 3 to 5 mm. The above specifications of wells will realize the prevention of sand intrusion into the wells.

2) Lack of check-valve on the well outlet pipe

For many water supply facilities, no check-valve is equipped on the well outlet piping. Damage to the submersible pump may be happened due to water hammer which is generates the reverse water flow upon the switching-off the pump. Therefore, installation of check-valves should be included in the rehabilitation plan.

3) Improper structure of submersible pump

Russian made ECV submersible pumps are generally used. The motor of this ECV pomp is not water-tight type and the motor is directly cooled by the well water. This cooling method has the high effectiveness. However, the cylinder and the cable of the motor are apt to be damaged in this system. Therefore, the water-tight type submersible pump is desirable to be applied in the rehabilitation and expansion plan.

4) Inappropriate material of riser pipes

Uncoated steel pipes are generally used as the riser pipe at which both sides the flanges are welded by the pump installation company. Therefore, corrosion by oxidation and/or leakage of the pipe due to mal-workmanship of welding may be easily occurred. Because of these reasons, it may be occurred the cutting of the pipes and decline of the pump discharge rate. In the rehabilitation and expansion plan, stainless riser pipes, of which the quality is anti-corrosive, with the flanges manufactured in the factory under the proper quality control should be applied.

5) Lack of the protection circuit in the control panel of the submersible pump

In Tajikistan, the breakdown of electrical appurtenances are often occurred due to significant change and lost phase of voltage power supply.

Many submersible pumps were broken down within several months after new installation. Such breakdowns can be prevented by means of installation of the protection circuit in the control panel of the submersible pump.

6) Necessity of the improvement of the skills of the electrical works

There is no professional manufacturer, which can produce the control panel of the submersible pump in Tajikistan. In many cases, the control panels are made by the private electricians by using used electrical parts and cables. Therefore, its quality control is very poor and this may cause breakdown of the submersible pumps. In the rehabilitation and expansion plan, it should be considered to select the products which are manufactured under the proper quality control, and it is also necessary to include the technical transfer component to improve the skills of the electrical works by the pump operators.

7) Lack of the basic data such as facility drawings, operation records, maintenance records etc.

All the existing water supply facilities were constructed in the former Soviet Union's era. Because of the civil war after the independence, layout and other drawings of each water supply facility were lost. In addition, the operation record and maintenance record of the water supply facilities are not found. These data is indispensable for the proper operation and maintenance of the water supply systems and should be properly kept after the rehabilitation.

8) Inappropriate water quality management

Periodical analysis data of water quality of the water supply systems is not found. The water quality analysis should be carried out referring the WHO Guideline (Version 3 2004).

CHAPTER 5 INSTITUTIONAL CONSIDERATION

5.1 ADMINISTRATIVE ORGANIZATIONS FOR WATER SECTORS

There are many administrative agencies and public enterprises concerning water sectors in Tajikistan. The list below shows such government offices and public enterprises which have some direct concern, responsibility, authority and business with the water sector.

- Ministry of Melioration and Water Resources (MMWR) --- administrating farm irrigation, rural water supply and pasture water supply.
- Rural Water Supply Authority (RWSA, Tajikselkhozvodoprovodstroy) ---- carrying out design, construction and operation of rural the water supply system and pasture watering system. Its upper administrative organ is the MMWR.
- Housing and Communal Service Enterprise (HCSE, Khojagee Manziki va Kommunali) --- carrying out design, construction and operation of water supply and sewage system of cities and the towns. The Presidential Office is the upper administrative organ.
- State Sanitary and Epidemiology Service ---- conducting water quality examinations. It falls under the Ministry of Health.
- State Geological Survey --- carrying out development, survey and monitoring of underground resources, including groundwater. This belongs to the Presidential Office.
- Committee of Anti-Monopoly Control and Entrepreneurship Support --- controlling public utility tariff, including water tariff.
- State Committee on Environment Protection and Forestry --- administrating natural resources, including water resource development and protection.
- Ministry of Energy ---- administrating energy sector, including water-power generation.
- State Committee for Emergency Situation and Civil Defense ---- administrating prevention and measures against disasters, such as river disasters.
- Tajik Standard Authority (Tajikstandart) ---- administrating design standards, including designs of water supply facilities, water ways, canals, etc.
- Hydro-Meteorological Service ---observation, collection and analyzing of weather data.
- Ministry of Economy and Trade ---- water resource development and protection plan.
- Ministry of Agriculture / Association of Dehkan Farms and Agricultural Cooperatives / Water Users Associations ---- administrating or managing water usage. within their administrative areas.

Among these entities, the following administrative authorities and public enterprises have close concerns with the rural water supply.

5.1.1 MINISTRY OF MELIORATION AND WATER RESOURCES (MMWR)

As implied in the name of the Ministry, it is mainly responsible for land melioration and water resources in Tajikistan. MMWR's power and responsibility were stated in resolution No.595. In the general provision it is the central enforcement authority in the field of water resources and land reclamation. The MMWR carries out functions on development of a uniform state policy and

normative legal regulation in the sphere of improvement of irrigated land, operation and maintenance of water facilities and protection of water resources, as well as construction of rural water supply and pastures watering.

Among subordinate organizations, it has a rural water supply operational enterprise, the Rural Water Supply Authority (RWSA). There is, however, no department and division in MMWR which is solely responsible to administrate the RWSA, while departments and divisions of the MMWR conduct its administrative power within their competence in the RWSA.

Besides administrative units in the main office in Dushanbe, the MMWR has branch offices for specific works mainly related to the irrigation and other enterprises including construction material production factories in Dushanbe and Oblasts.

The organizational structure of the main office, branches and enterprises are shown in *Figure 5.1.1* and *Figure 5.1.2*, respectively.

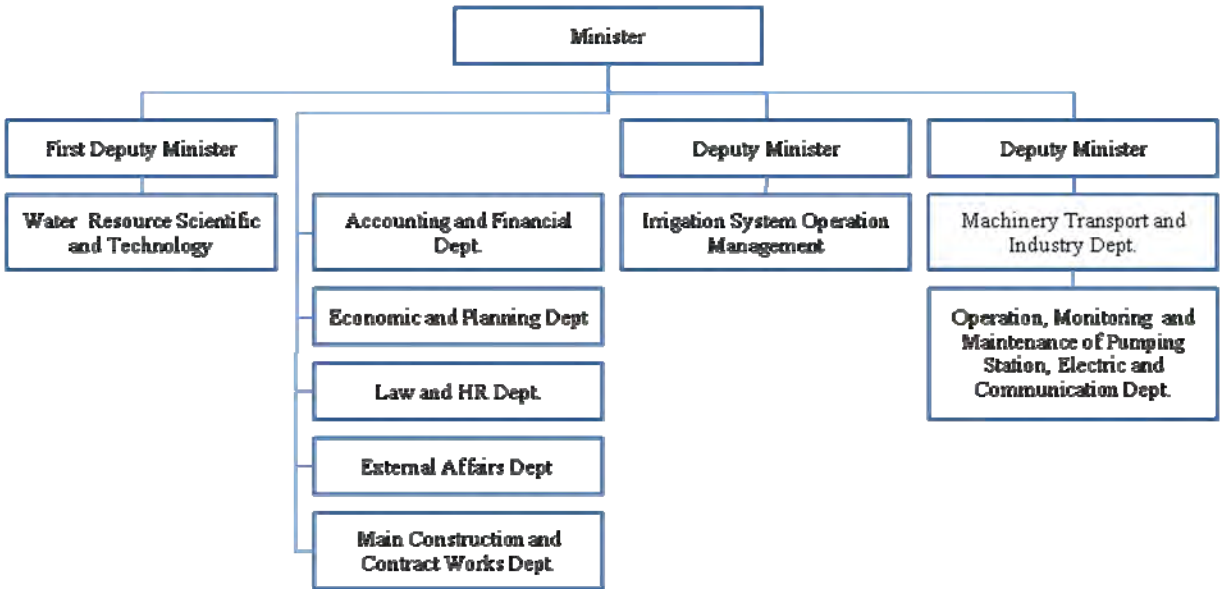


Figure 5.1.1 Ministry of Melioration and Water Resources

Function of each unit in the MMWR is as follows.

- Accounting and Financial Dept.
- Economic and Planning Dept. (5)
- Legal and Personnel Dept.
- External Affairs Division. (4): This is a division for international affairs including aid cooperation.
- Main Construction and Construct Works Division. (5): This division administrates rather large constructions water facilities that the MMWR initiates.
- Water Resource Science and Technology Dept. (5): This department is functioning as the Tajikistan representative in international meetings on water resources, such as the meeting of four countries Kazakhstan, Uzbekistan, Kirgizstan and Tajikistan on water resources.

- Irrigation System Operation Dept. (11): This is the general department to administrate MMWR's local water management departments in Oblasts and Rayons. These local departments are assigned and responsible for monitoring, analyzing, recording and conducting other management functions of the irrigation system and facilities.
- Machinery Transport and Industry Division. (4): It conducts the arrangement of deploying construction machines, such as trucks, bulldozers, tractors, etc. owned by various public enterprises for water supply system and irrigation system construction. It also supervises construction material production enterprises that come under the MMWR.
- Operation, Monitoring and Maintenance of Pump-Stations, Electricity and Tele-Communication Division (4): This division is responsible for monitoring the capacity and operating condition of water pump stations of irrigation system and water supply systems. The Pumps of the RWSA are also included in their monitoring list.

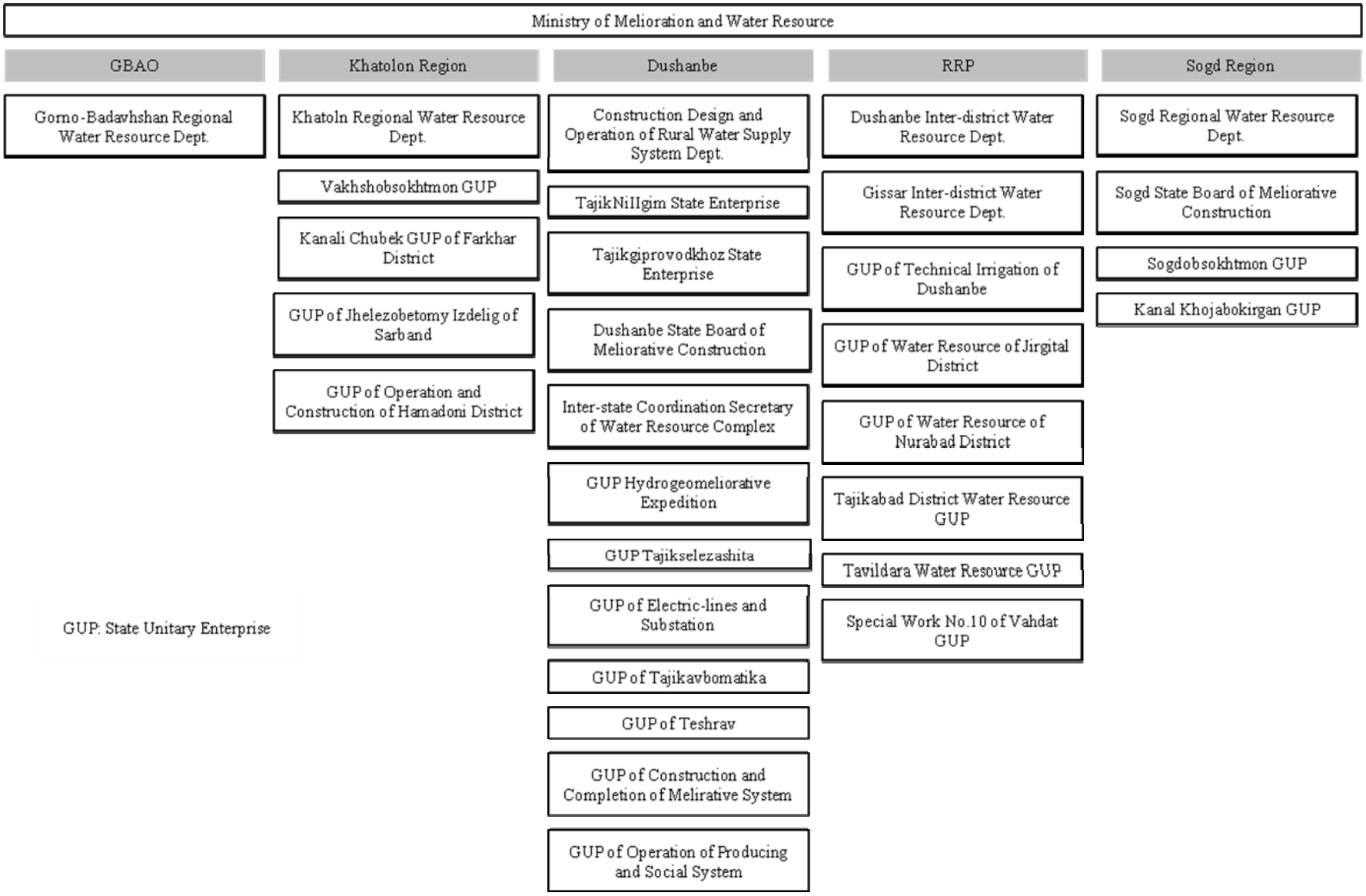


Figure 5.1.2 Local Departments and Enterprises of Ministry of Melioration and Water Resources

5.1.2 RURAL WATER SUPPLY AUTHORITY (RWSA)

Until 1983 when the RWSA came under the the MMWR, the RWSA was one of the Government ministries. Its obligatory works are now administered by the MMWR and specialize in providing rural water supply for the people in rural area and pasture watering, and the construction of water supply facilities. The president of the RWSA is assigned by the Minister of the MMWR with the approval of the Government.

As for the organizational structure of the RWSA, it is structured with the headquarters and branches in Oblasts. The headquarters, which is the general management and administrative unit structured with 55 staff, is located in Dushanbe. Branches are running rural water supply services for rural people in Oblasts, and the staff number is 980 in total.

The RWSA organizational units can be functionally grouped into four. The first is technical and engineering, the second is water supply operation administration, the third is construction works, and the fourth is general administration. The headquarters and Kurugan-Tyube branch office are structured on this formation.

Organization structure charts of the headquarters, branches and Khatlon branch are shown in *Figures 5.1.3*, *Figure 5.1.4* and *Figure 5.1.5*, respectively.

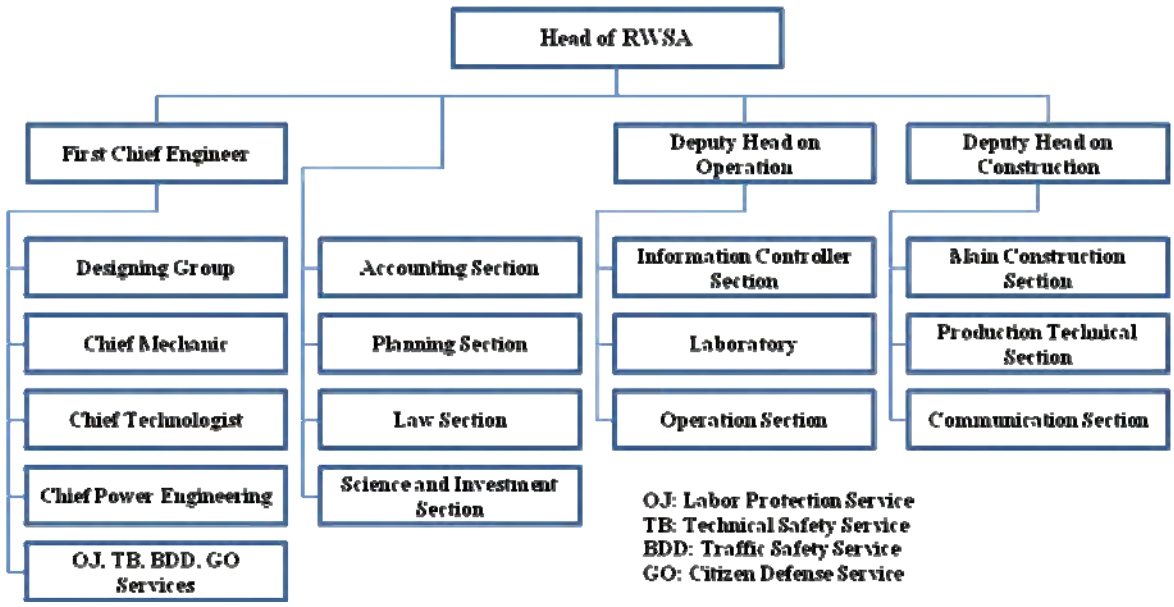


Figure 5.1.3 RWSA Headquarter Organizational Structure

Functions of the RWSA's headquarter are as follows:

Division and Sections

- Design group --- Designing water supply facilities, including wells (3).
- Chief mechanic --- Administering construction machines, such as boring machines (1).
- Chief technologist --- Selecting equipment and devices of water supply (1).
- Chief electric power engineer --- Administering electric works of the facility (1).
- Labor protection, safety, etc. --- Labor protection, Safety on Technical and traffic, Civil defense, etc. (1).

- Accounting section --- Internal accounting works. (6).
- Planning section --- Water tariff setting, Financial planning, Water supply contracts administration. (3).
- Law section: Legal actions for non-paid water charges, etc. (1).
- Science and investment section --- Coordinating foreign donor's assistance. (3).
- Information control section --- Sending/receiving data, notifications, etc., between the head office and branches. (2).
- Laboratory --- Testing water quality. (Requests come from branches and the Vodokanal new office. Branches far from the RWSA main office ask SES to test water quality.) (5)
- Operation section --- Water supply standard volume setting, assisting water supply plan development, monitoring water supply. (3).
- Main construction section --- Administrating construction new water supply facility and expansion of existing ones. (3).
- Production technical section --- Administering water supply facility repairs. (3).
- Communication section --- Maintaining tele-communication equipment. (1).
- ( ) shows number of staff.

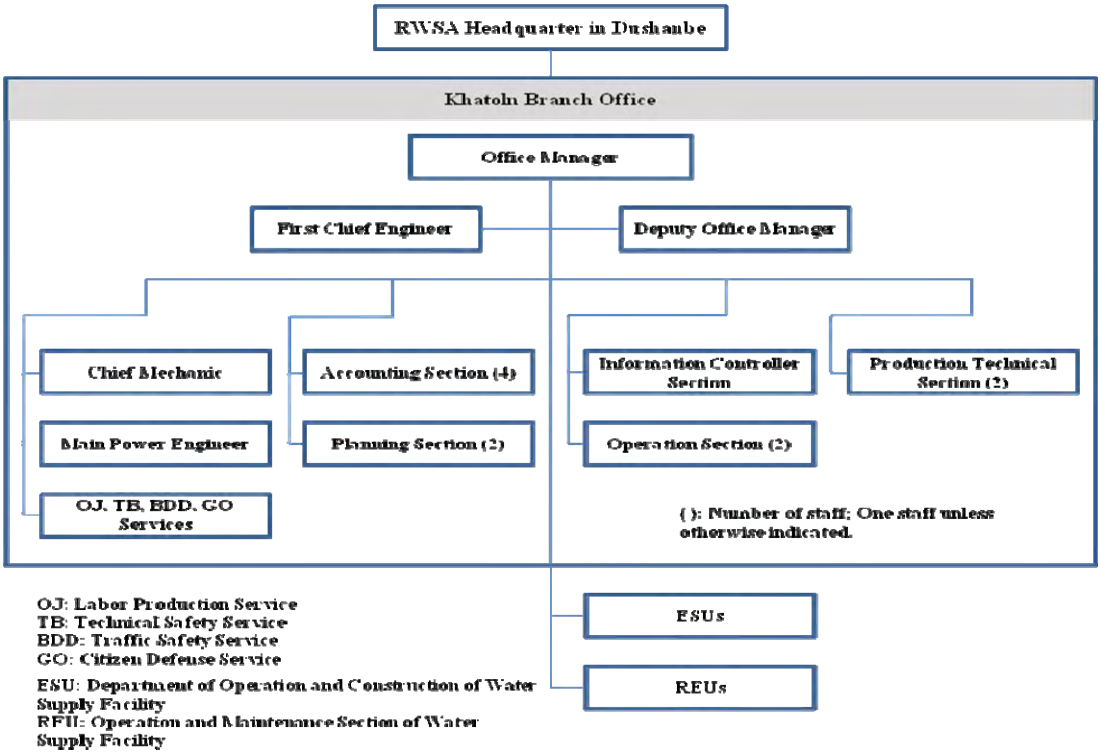


Figure 5.1.4 Khatlon Branch Organization Structure of RWSA

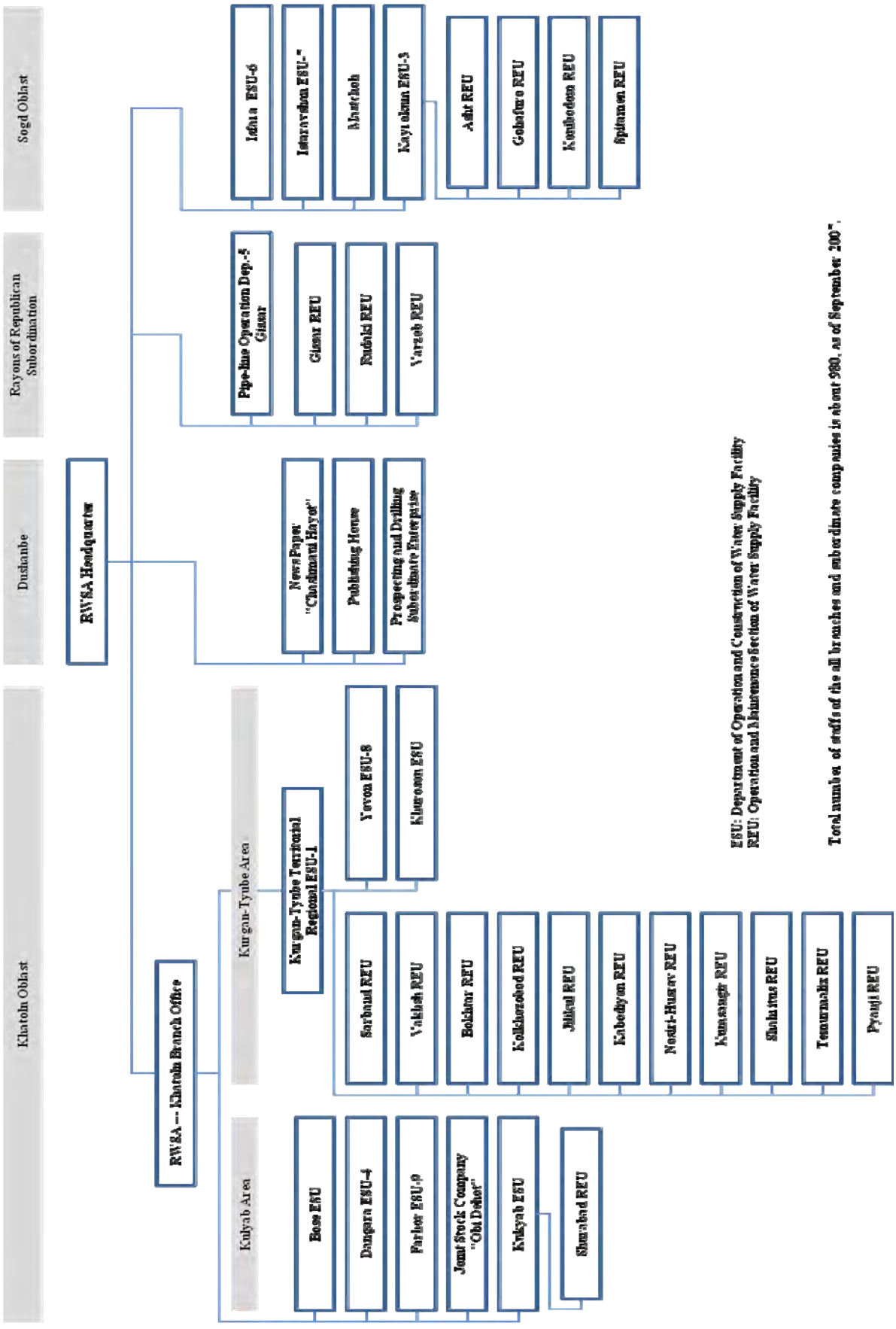


Figure 5.1.5 Overall Organization Structure of RWSA

5.1.3 HOUSING AND COMMUNAL SERVICE ENTERPRISE

The Housing and Communal Service Enterprise (HCSE) is a state enterprise that comes directly under the Presidential Office, and has subsidiary operational units, like Vodokanals running water supply and sewage services in almost every city and town in Tajikistan. Like the RWSA and HCSE, it is a self-financed enterprise, and is to carry out all tasks related to urban water supply including construction, operation and maintenance of facilities only by revenue from water users.

In the study target area, Vodokanals are now providing water supply services in seven cities/towns (Rayon regional centers), other than Nosiri Khisrav. RWSA supplies water with charges to Vodokanals in the study area from Vakhsh Conduits.

5.1.4 STATE GEOLOGICAL SURVEY AUTHORITY

This is an authority for examining use of groundwater and sewage facilities. For examination, the following legal power has been given this authority by the State Resolution No.39 (in year 2002).

- Permission of groundwater extraction
- Agreement on design of well drilling
- Agreement on survey and study of new water intake
- Agreement on design of water reservoir, water purification plant and sewage disposal plant

Practically, any entity needs to get a permission/license, which is to be renewed every three years from this authority for extraction of groundwater (surface water intake licenses are given by the MMWR).

5.1.5 STATE SANITARY AND EPIDEMIOLOGY SERVICE

State Sanitary and Epidemiology Service (known as SES) is a state organ, and comes under the Ministry of Health, responsible for examining quality of drinking water. It has laboratories to analyze water quality in all eight Rayons in the study area. Some RWSA branch offices neighboring Dushanbe bring water to examine to the laboratory of the RWSA headquarters, but other RWSA branches bring the water to the SES to be examined instead.

5.1.6 COMMITTEE ON ANTI-MONOPOLY AND CONTROL AND ENTREPRENEURSHIP SUPPORT

This is a committee and it has the power of controlling public utility service tariff in Tajikistan. The RWSA has, therefore, to ask this committee every year to examine the water tariff before charging water users including the tariff for Vodokanals.

5.2 DEVELOPMENT STRATEGY OF WATER SUPPLY

As the thrusts of water supply sector development in Tajikistan, program and strategy have been compiled. These is a "Water Sector Development Strategy (WSDS)" and "National Water Supply Program (NWSP)" and "Expansion of Access to Water Supply" in "The National Development Strategy (NDS)".

"The Water Sector Development Strategy" was developed in June 2006 with the assistance of the UNDP for the purpose of realization of the targets of the International Decade for Action "Water for Life" (2005-2015) and achievement of the Millennium Development Goals (MDGs).

On the other hand, "NWSP (2008-2020)" was established in December 2006 by Presidential Decree No.514 in accordance with Article 6 Water Code with the purpose of providing the population with clean drinking water.

And "NDS" which includes "Expansion of Access to Water Supply" has been approved by the Parliament 28 June 2007. This "NDS, the draft of which was initiated by the President in 2005,

intends to provide for an orderly long-term development process in accordance with the MDGs. "NDS" can be read as a renewal of "The Water Sector Development Strategy".

The following are some details of these program and strategies. "WSDS" shows the estimation of water sector development cost of 636,309 thousand USD for the year 2006 - 2015 (*Table 5.2.1*). "NWSP" gives, also, the cost of 3,324,843 thousand Somoni in total (equivalent to 966,500 thousand USD) for 2008 - 2020 (*Table 5.2.2*). On the other hand, NDS does not state the development cost estimation, though it gives the water access ratio in cities and in rural areas to attain 97% (93% in 2004) and 74% (47% in 2004) respectively by the year 2015 (*Table 5.2.3*).

Table 5.2.1 Estimated Required Fund of Water Sector Development Strategy

	2006	2006-2008	2006-2010	2006-2015
Water sector total	43,605	159,084	352,376	636,309
Urban	36,810	134,484	297,699	511,309
Rural	6,795	24,600	54,677	125,000

Unit: thousands USD

Table 5.2.2 Estimated Fund Required in National Water Supply Program

Oblasts	as of Jan. 2006		Plan (2007 – 2020)					
	Total population	Water access population	Water access population	Required fund, estimated (thousands Somoni)				
					Central Gov	Local Gov	DA	Water supplier
Khatlon	2,467	1,158	2,588	973,910	15%	10%	70%	5%
Sogd	2,058	1,035	2,549	935,345				
DRD	93,534	707	1,040	258,900				
GBAO	707	78	214	68,687				
Dushanbe	646	641	1,290	1,088,000				
Total	6,919	3,621	7,683	3,324,843				

Note: DA represents development assistances from foreign countries.

Table 5.2.3 Water Access Ratios in Key Target Socio-Economic Indicators of the NDS

	2003	2015
Access of the urban population to safe water (%)	93	97
Access of the rural population to safe water (%)	47	74

5.2.1 MAIN PRIORITIES, AREAS OF ACTIVITY, ANTICIPATED RESULTS OF WATER SECTORS IN NDS

In connection with the water sectors, the following are emphasized in the NDS.

Main Priorities, areas of activity

(1) Reform the system as a whole through the improvement of sectoral policy and the creation of new ownership entities --- improving the legislation and mechanisms for the collection of payments from consumers, creation and operation of consumers' associations.

(2) Make the sector more attractive from an investment standpoint -- focusing the efforts of all development partners, making construction of local water collection systems and other facilities sound and economical.

(3) Make effective use of the sector's existing potential --- increasing the efficiency of the existing water supply.

Expected by 2015:

- Reducing half the number of people who do not have reliable access to drinking water
- Fostering reasonable water consumption standards, including a rational tariff mechanism to cover at least 90% of the cost of the services by collecting water tariffs from consumers
- Implementing effective public-private partnership mechanisms
- Creating new ownership entities for the water supply

Plural programs and strategies might cause some confusion in development, however, NDS is the latest strategy approved by the State, so that it comes a head of other strategies, plans and programs, and it should be followed by all concerned. However, this strategy is rather conceptual, therefore, phased concrete arrangements by sector are necessary when it is implemented.

5.2.2 Foreign Aid for National Water Supply Program

Water supply development largely depends on foreign aid as the National Water Supply Program states that distribution of funds necessary to implementation of the plan is 15% by central government, 10% by local government, 70% from aid investment and 5% by enterprisers. As for water supply improvement, there is some discussion about the assistance by World Bank for Dushanbe and by EBRD for Sogd. On the other hand, there has been no offer of fund assistance from anywhere for rural water supply development. In addition, ECHO, which has provided 90% of funds for the UNDP activities including rural water supply rehabilitation, has stopped that financial support from July 2007.

5.2.3 Water Supply Development Movement

In order No. 514, the following organizations are named: MMWR; Housing and Communal Service Enterprise (Vodokanal parent enterprise); Oblast Hukmat; GBAO; Dushanbe city; cities and Rayon Hukmat. To discuss the concrete arrangement of the program development, as the initial steps, workshops with participation of these entities have been held since February 2007. These workshops are chaired by the Minister of MMWR and are to be held continuously. (One was scheduled to be held in Khatlon Oblast in October, 2007.)

5.3 Laws related to Rural Water Supply

Up to now, two laws which are directly related to rural water supply have been established. These are the Water Code and the Water Users Association Law. The second one, established in 2006, is with the purpose of forming water users association for irrigation. And the Water Code was established in 2000, and it is the basis of laws and regulations concerning water relations and almost all water relations are covered by it.

5.3.1 Water Code

In particular, regulations on the institutional matter of water relations are stipulated in Articles 6 to 8 of the Code. In Article 6, the competence of the state in the field of regulation on water relations is stated. The competence of local executive authorities in the field of regulation of water relations, and the state regulation and support in the field of water relations are prescribed in Article 7 and 8 respectively. In addition, regarding water supply, the following articles are prescribed in Article 53 to Article 60 of the Code: water and water bodies allocated for drinking, social and other needs of the population; centralized and decentralized water supply for the population; use of groundwater of drinking quality for needs not related to drinking and the social

water supply; right of property for systems of drinking water supply; financing sources in the field of drinking water supply; certification in the field of drinking water supply; guarantee on provision of drinking water in case of disturbance in the operation of centralized and decentralized systems of drinking water supply.

5.3.2 WATER QUALITY STANDARD

In Tajikistan, the law on drinking water quality standards has not been established yet. And GOST 2874-82 which was established in 1982 as the standard of Soviet Socialist Republics is presently applied to water quality examination as the state guideline.

5.3.3 PROPRIETORSHIP OF RURAL WATER SUPPLY SYSTEMS

There are many non-functioning rural water supply systems among Dehkans. These systems were constructed during the Soviet era for former Sovkhoz and Kolkhoz. Through the Agrarian Land Reform Sovkhoz and Kolkhoz have been divided and transferred into privately owned farms, said Dehkans. However, water supply systems in Sovkhoz and Kolkhoz were left as they ware not transferring the proprietorship to any private or public entities. Consequently, most of them have fallen into poor condition.

Any laws and regulations on transfer of proprietorship of water supply systems in former Sovkhoz s and Kolkhozs have not been established yet. Since most of them need large rehabilitations to start operation that will require a large amount of funds, thus, the RWSA does not have any intention, presently, to take over these systems. But, some measure should be taken soon to restore and to start operation of these water supply systems for the people in the rural area.

Agrarian Land Reform: At the end of the Soviet era, 1991, there were about 600 Sovkhozs and Kolkhozs in Tajikistan. Since the land reform law was established in 1992, about 400 Sovkhoz and Kolkhoz have been divided into 23 thousand private Dehkans. Since, the land in Tajikistan is in exclusive ownership of the State (stated in the Land Code), ownership of Dehkan means lifetime usufruct of the farmland, and it is not transferable to others and not able to be inherited to the successor.

5.3.4 RESPONSIBLE ENTITY FOR RURAL WATER SUPPLY

According to the Water Code, both the national government and local executive authorities are institutionally responsible for providing water supply for the people in Tajikistan. And the actual scheme arranged now seems to be following the laws without large variance. For the people living in rural areas, the RWSA under the MMWR provides water supply services, and Vodokanal of the HCSE which comes under the Presidential Office provides water supply services for people in cities and towns. *Figure 5.3.1* shows organizations supplying water to the people.

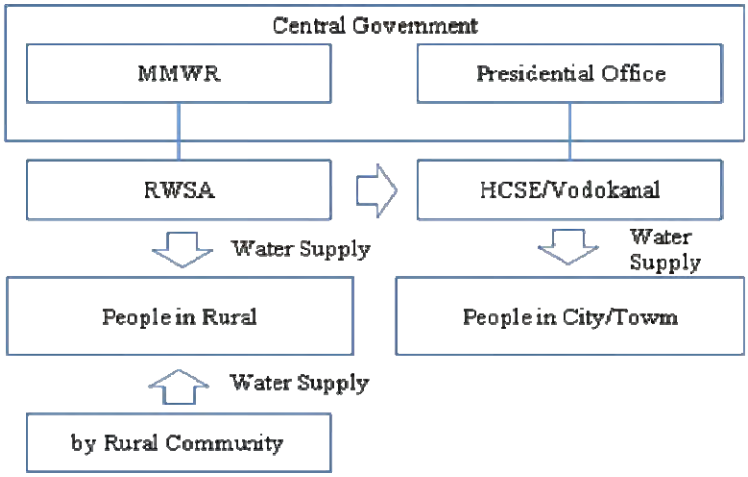


Figure 5.3.1 Organizations Supplying Water to People

No specific law on the water supply system has been established in Tajikistan, however, the Water Code, in which water resources protection and usage are mainly stated, stipulates the responsibilities of the central government and local governments, and water user obligation. Though, there are some water supply facilities being operated by rural communities, and water users are paying the water tariff. The government is providing subsidies to those water supply facilities through the MMWR and RWSA, however, those subsidies are not sufficient. The present scheme of the water supply, in general, follows the "Water Code", expect for the fact that there is no involvement of the local government.

ts.

In general, the water supply systems are being carried out along with the law, however, especially the rural water supply for rural people, there is more than one organization carrying out the water supply systems now. Some water supply systems are operated by rural committees, such as JRCs (Jamoat Resource Centers, former JDCs (Jamoat Development Committees)) whose water supply systems had been rehabilitated with the assistance of the UNDP, water supply systems by RWSA, and by Defkan farms operate water supply systems. The state policy is not clear in terms of organization what should take care and carry out the water supply systems for the people.

5.3.5 RESOLUTION OF MMWR FOR WATER RELATIONS

Regarding the rural water supply system, the MMWR, among ministries of Tajikistan, seems to have a general responsibility for water supply developing and maintaining by taking over the role stated in Water Code Article 6 (Competence of the Government of the Republic of Tajikistan in the field of regulation of water relations). Its responsibility is stated in resolution (No.595, 28 Dec. 2006). The following are extracts, clearly stipulating the MMWR's power over the rural water supply.

The MMWR is the central enforcement authority in the field of water resources and land reclamation carrying out functions on development of a uniform state policy and normative legal regulation in the sphere of improvement of the irrigated lands, operation and maintenances of water supply facilities, formation, use and protection of water resources, construction, rural water supply and pasture watering.

The MMWR has the following powers: --- Running the uniform state policy in the field of land improvement of the irrigated ground independently making decisions on use and protection of water resources, construction of water facilities, water supply of rural population and pasture

watering; --- Developing implementation of long-term and short-term state programs of an effective use and protection of water resources, development of land reclamation, rural water supply and pasture watering, protection of territory from harmful influence of waters; --- Carrying out effective investment policy and optimization of a combination of the state centralized capital investments and means of the enterprises and organizations with the purpose of development of land reclamation, maintenance and operation of the state water facilities, water supply of rural population and pasture watering; --- Coordinating activities of enterprises and organizations of the corresponding ministries and departments, executive bodies of the government and international organizations irrespective of the patterns of ownership, dealing with water supply issues; --- Coordinating activities on development of the centralized and non centralized water supply systems for rural areas and pastures;

5.3.6 COMPETENCE OF LOCAL EXECUTIVE AUTHORITIES FOR WATER RELATIONS

It seems that local governments now provide no financial and institutional support in rural water supply system development, maintenance and operation. Though, Water Code Article 7 states "The Local government shall provide drinking water, protection and development of centralized, decentralized systems of water drinking distribution for consumers within its competence, determined by the law of the Republic of Tajikistan". Substantially, water supply in the rural area is provided by the RWSA and communal parties. In another words, it is difficult to say what is local government competence and responsibility, for water relations.

Water Code, Article 7. Competence of Local Executive Authorities in the field of Regulation of Water Relations --- Among the duties and powers of the bodies of the local executive authorities in the field of water relations are the following:

(1) Determination of main directions of use and protection of water in their territories; providing law and order in the field of regulation,

(2) Use and protection of water resources;

(3) Accounting and evaluation of the water condition and water bodies,

(4) Control over use and protection of water,

(5) Observing the established limits on water consumption actions on preservation and improvement of water body conditions,

(6) Prevention and liquidation of adverse influences, as well as pollution of water, rehabilitation of objects, damaged as a result of accidents, floods, mountain torrents and other natural disasters;

(7) Providing drinking water, protection and development of centralized, decentralized systems of drinking water distribution for consumers within its competence, determined by the law of the Republic if Tajikistan;

(8) Coordination of allocation and putting into operation of enterprises, buildings and fulfillment of works on water bodies and coastal water protection zones;

(9) Regulation of other issues envisaged by the law.

5.3.7 WATER SUPPLY SERVICE BY THE LOCAL GOVERNMENT

According to the Water Code, the local government has an obligation to provide water supply services to the community people. However, neither Hukmat of Khatlon Oblast nor local government in the Oblast owns water supply systems and operates water supply systems. The reasons are supposed due to financial difficulty and the recognition that RWSA and Vodokanal are responsible for developing water supply systems. In fact, no local government possesses a section

responsible for water supply, and operation and maintenance. The local government only transfer the request of construction of water supply system to RWSA or Vodokanal.

5.4 RWSA'S FINANCIAL CONDITION

5.4.1 FINANCIAL RESULTS

The RWSA is one of the state public enterprises that come under the MMWR, however, it should run all its works by self-finance accounting. Presently, the RWSA has two operation groups as its structure business. One is the water supply service for the rural people and the other is water facility construction. It shall run its business by itself, however, in providing water supply service that is its obligatory works. It is financially supported by the MMWR due to insufficient revenue to cover the expense from said water supply services. This shall be discussed in some detail.

Table 5.4.1 shows RWSA's aggregated financial results of the rural water supply services for year 2005 and 2006.

Table 5.4.1 RWSA Financial Result of Rural Water Supply Service

	2005	2006
Revenue	1,104,807	1,097,432
Expenses	1,292,146	1,314,880
Deficit	-187,339	-217,448

	2005	2006
Cash balance (Jan. 1)	15,603	4,187
Cash in	748,562	991,991
Water supply	554,004	621,349
Subsidy	173,817	174,200
Others	20,741	196,442
Cash out	759,978	984,954
Cash balance (Dec.31)	4,187	11,224

	2005	2006
Receivable balance	2,202,777	2,463,158
Water supply	2,057,194	2,356,971
Others	145,583	106,187
Payable balance	1,721,886	1,868,880
Tax withheld	243,259	205,068
Pension charge	83,103	157,646
Others	1,395,524	1,506,166

Source: RWSA Unit: Somoni

5.4.2 REVENUE AND EXPENSES OF RURAL WATER SUPPLY

In both 2005 and 2006, water supply services ended in deficit. Expenses exceeded revenue by 17% in 2005 and 19% in 2006. In general, and to follow the NDS which says at least 90% of expenses shall be covered by water charges to users, some measures, such as increasing the water supply volume, raising water tariffs, cutting expenses by more efficient and effective operation, etc. are necessary.

(1) Cash-in from Water Supply Service

Water supply tariffs are charged monthly and collected from water users, however, a large portion of charged water tariffs remain uncollected. This had caused a large discrepancy between the revenue booked and cash on hand. To improve this condition, the RWSA is changing water supply contracts from organizations to individuals, and it is bringing unsettled collection accounts to courts.

Revenue changes to cash in and accounts receivable. Regarding accounts receivable, They increased by about 300 thousand Somoni in the year (2006). If this amount would been converted into cash, cash on hand would have been substantially over revenue, though subsides should be taken into account. And a large number of not paid payable accounts due to as shortage of cash on hand could have been settled. Revenue and Expenses of RWSA Branches (for the year 2006) are shown in *Table 5.4.2*.

Table 5.4.2 Revenue and Expenses of RWSA Branches (for the year 2006)

	Kurgan-Tyube		Temurumarik		Kulyab		Dangara		Khuroson		Istravshan		Farkhar		**Total**
		Shakhritus		Vose		Sogd		Gissar		Isfara		Yevon		Mastchoh	
Water supply (1,000 M3)															
Contract	19,620	650	400	300	200	800	1,600	1,315	1,100	10,300	600	2,300	500	65	**39,750**
Planned	19,620	650	400	300	200	800	1,600	1,315	1,100	10,300	600	2,300	500	65	**39,750**
Supplied	12,135	163	400	150	130	428	1,533	1,303	320	6,828	236	403	24	67	**24,119**
Discrepancy	-7,485	-487	0	-150	-70	-372	-67	-12	-780	-3,472	-364	-1,897	-476	2	**-15,631**
Realization	62%	25%	100%	50%	65%	54%	96%	99%	29%	66%	39%	18%	5%	103%	**61%**
Expenses															
Salary	78,307	11,000	13,440	8,573	4,060	15,350	35,186	46,472	22,451	81,763	3,429	7,162	2,340	2,898	**332,431**
General exp.	23,492	2,750	7,680	2,143	1,595	5,748	11,400	16,210	12,768	20,215	1,308	1,784	720	1,260	**109,073**
Tax	19,577	2,750	3,360	2,143	1,015	3,837	8,796	11,618	5,613	20,441	857	1,790	585	724	**83,106**
Electricity	11,369	2,011	1,729	355	943	2,790	48,610	12,343	1,557	33,859	3,777	4,559	203	0	**124,105**
Depreciation	103,053	8,060	1,531	5,500	4,000	22,500	31,017	8,708	3,344	23,936	11,352	6,423	4,960	0	**234,384**
Material	58,416	3,961	22,965	2,003	2,863	4,529	44,504	33,426	2,508	60,500	2,769	428	708	1,170	**240,750**
Repair	14,249	0	0	0	867	2,366	0	14,326	0	31,685	6,870	0	0	1,885	**72,248**
Chlorine	55,304	0	0	211	0	0	0	1,467	0	4,098	300	1,372	505	0	**63,257**
Others	8,832	270	40	342	555	6,450	14,795	7,753	244	3,077	12,001	625	280	268	**55,532**
Sub-total	372,599	30,802	50,745	21,270	15,898	63,570	194,308	152,323	48,485	279,574	42,663	24,143	10,301	8,205	**1,314,886**
Revenue															
Water supply	297,602	9,699	44,800	4,550	8,369	23,442	100,387	95,749	36,794	273,493	11,963	13,249	1,392	4,948	**971,328**
Subsidy	39,830	21,103	3,407	850	2,620	9,000	34,505	5,694	1,940	2,850	13,174	6,550	2,380	3,257	**147,460**
Sub-total	337,432	30,802	48,207	5,400	10,989	32,442	134,892	101,443	38,734	276,343	25,137	19,799	3,772	8,205	**1,118,788**
Net revenue	-35,167	0	-2,538	-15,870	-4,909	-31,128	-59,416	-50,880	-9,751	-3,231	-17,526	-4,344	-6,529	0	**-196,098**
Per Water M3															
Expenses	0.0307	0.1890	0.1269	0.1418	0.1223	0.1486	0.1268	0.1169	0.1515	0.0409	0.1805	0.0599	0.4292	0.1232	**0.0545**
Revenue	0.0245	0.0595	0.1120	0.0303	0.0644	0.0548	0.0655	0.0735	0.1150	0.0401	0.0506	0.0329	0.0580	0.0743	**0.0403**
Number of employees															
Planned	160	20	13	11	8	43	60	37	45	104	15	15	4	8	**543**
Actual	87	24	18	13	9	34	56	45	27	108	14	14	4	9	462

Source: RWSA, JICA Preliminary Study Report

Unit: Somoni

(2) Receivables and Payables of the Water Supply

For both year 2005 and 2006, receivables and payables are comparatively large in terms of amount to the revenue from water supply services. The receivable balance is over two times the water supply revenue and payable equals almost twice the amount of revenue.

A large portion of the receivables is of water supply charges to water users and to be collected. As of June 30th 2007, the uncollected balance amounts to approximately 2.7 million Somoni. About 350 thousand Somoni was newly added to receivable accounts in the first half year of 2007. It is larger than the yearly increment between 2005 and 2006, so that it is difficult to find a tendency of water charge collection improvement using these.

Payables are summed up in three groups, the first is employees' income tax withheld, the second is pension premiums that the RWSA has to shoulder and social insurance premiums withheld from employees' salary, and the third is others including payables to the MMWR which is 10% of water supply revenue. The total amount of payables has reached, by 2006 December 31, at 1.7 times of yearly water supply revenue.

On paper, the receivables amount far exceeds the payables amount, however, considering the difficulty of water supply charge collection, it seems not enough if payables are settled. For instance, even if half (50%) would be collected, it is not enough to pay off the payables balance.

(3) Subsidies from MMWR

For the RWSA, the subsidy from the MMWR is to provide only for the water supply service. The RWSA has water supply construction business as its important work, however, it should be run by a completely self-financed account due to no subsidy being given to this business.

For 2005 and 2006, the subsidies for the RWSA were respectively 173.8 thousand Somoni (23% of cash-in) and 174.2 thousand Somoni (17% of cash-in). Considering RWSA financial condition ended in deficits, with a large balance of receivables and payable, and very small cash- on-hand balance, subsidy of the MMWR is necessary to continual, though the subsidy dependence for the year 2006 has improved.

For 2006, the subsidy requested by the RWSA to the MMWR was 375 thousand Somoni while 173.8 thousand Somoni (equivalent to 46% of requested amount) was actually subsidized.

The procedure of the subsidy service is as follows: At the end of the fiscal year, the RWSA makes the income and expenditure plan which contains a subsidy in the next fiscal year and by the name of the RWSA president, applies for the subsidy service to the Economic Forecasting Department of the MMWR. As a result of an examination in the Economic Forecasting Department, a subsidy allowance is fixed and actually subsidized from the MMWR to RWSA. In most cases, there is gap between the actual allowance and the planned. It is also substantial.

(4) Upper-Organization Support Fund Transfer

As upper organization support fund, the RWSA Rayon branches shall transfer 10% of the water charge collected amount to the RWSA headquarters. In other words, the branches are able to spend 90% of water supply charges collected in their operation, including reserving it for future spending. As for the RWSA and the MMWR, the RWSA shall pay 10%, as the upper organization support fund, of the rural water supply revenue which is transferred from branches, however, poor the cash balances of the RWSA, the payment to the MMWR has been large.

(5) Water Tariff

Every year, the RWSA calculates next year's water tariffs for the each Rayon separately. Application of the new tariff is required to get approval by the Anti-Monopoly Commission who has the power to control the public utility tariffs, and the Commission usually holds down the tariff below what the RWSA is asking. Considering the minimum monthly wage of Tajikistan is 20 Somoni, it seems difficult for the RWSA to raise tariffs substantially in the near future, and the RWSA seems inevitably to continue its business in difficult financial conditions.

The water tariff of the RWSA varies presently between about 2 and 15 Diram/m^3 of water. However, viewing the results of the year 2006, the actual revenue per cubic meter was scattered between 2.5 Diram and 11.5 Diram, and 2.2 Diram and 22.3 Diram in expenses. There is nearly 5 times a difference between branches' revenues per m^3, where expenses are 10 times.

This difference seems to come from the difference in people's affordability and also from the difference in water sources, a well water a supply or surface water supply through the pipeline (*Table 5.4.3*).

Table 5.4.3 Operation Results of RWSA Branch in 2006

	Water supply, (thds m^3)			Expense & Revenue (Somoni)			Expense & Revenue (Diram /m^3)		
	Plan	Actual	Ratio	Expense	Revenue		Exp.	Rev.	
					Water Tariff	Subsidy		W. Tariff	Sub.
Kurgan-Tyube	19,620	12,135	62%	269,546	297,602	39,830	2.2	2.5	0.3
Shahritus	650	163	25%	22,742	9,699	21,103	14.0	6.0	12.9
Temurumarik	400	400	100%	49,214	44,800	3,407	12.3	11.2	0.9
Vose	300	150	50%	15,770	4,550	850	10.5	3.0	0.6
kuryabu	200	130	65%	11,898	8,369	2,620	9.2	6.4	2.0
Sogd	800	428	54%	41,070	23,442	9,000	9.6	5.5	2.1
Dangara	1,600	1,533	96%	163,291	100,387	34,505	10.7	6.5	2.3
Gissar	1,315	1,303	99%	143,615	95,749	5,694	11.0	7.3	0.4
Khuroson	1,100	320	29%	45,141	36,794	1,940	14.1	11.5	0.6
Isfara	10,300	6,828	66%	255,638	273,493	2,850	3.7	4.0	0.0
Istravshan	600	236	39%	31,311	11,963	13,174	13.3	5.1	5.6
Yevon	2,300	403	18%	17,720	13,249	6,550	4.4	3.3	1.6
Farkhar	500	24	5%	5,341	1,392	2,380	22.3	5.8	9.9
Mastchoh	65	67	103%	8,205	4,948	3,257	12.2	7.4	4.9
Total	39,750	24,119	61%	1,080,502	971,328	147,460	4.5	4.0	0.6

Source: RWSA

Process of Water Tariff Setting: At the year end, each RWSA's Rayon branch office develops its plan for the aggregated water supply volume and expenses, including direct and indirect costs, of all rural water supply systems under the branch management, and sends it to the Planning Division of RWSA headquarters. The Planning Division calculates the unit price of the water (the water tariff per cubic meter) to supply based on water volume and the expense data being sent from the Rayon branch office. These water tariffs are calculated by Rayon respectively, even if more than one water supply system is operated by the branch in the Rayon. And these tariffs are notified to

the respective RWSA branch office. At the Rayon branch office, it submits the water rate which is notified by the headquarters to the Anti-Monopoly Commission of the Rayon to examine whether it is acceptable or not to the Rayon. The water rate is often asked to be lower than calculated. Then, the water rate is fixed with approval of the Commission for the next year, and this fixed water rate is informed to the Panning Division.

The following is the data to be prepared by the Rayon branch office and sent to the Planning Division of RWSA headquarters.

- Yearly water supply volume of the system
- Yearly direct cost for facility operation, consisting of:
  - Salary of staff assigned to the facility operating
  - 25% of the salary (Pension premium)
  - Electricity charge
  - Depreciation cost of facility (10 % of asset value)
  - Material cost (Chlorine, etc.)
  - 95% of facility repairing cost (remaining 5% is added on asset value for depreciation)
  - Other miscellaneous expenses and contingency expenses

(6) Water Volume Fluctuation

In 2006, in terms of water supply volume, there were large discrepancies between the planned and actual situation. In total, the actual situation differed less than 40% from the plan. The difference of Kurugan-Tyube which is supplied large volume of water mainly through Vakhsh Conduits was 62%. At this moment, reasons for such results are not available, but, it is necessary to see the reasons why it happened in addition to the water tariff rationality for improving the water supply works.

(7) RWSA's Next Year Financial Plan Compilation

Every fiscal year end (December), next years water supply works revenue and expenditure plan is compiled. RWSA runs two businesses, one is a rural water supply service and the nother is a construction works of water supply facility. Since being difficult to forecast how many constructions orders would be planed next year, only the revenue and expenses of the rural water supply service is included in the next year plan.

Same as the plan compilation, financial reports of the rural water supply service and construction works are also made separately and no aggregated financial report of the RWSA is prepared. All costs of the RWSA operation is shouldered by the rural water supply service business. Only the direct cost of construction works is allocated to and shouldered by separately construction works, all other indirect costs are included in the rural water supply service.

The next year plan of the rural water supply works of the RWSA is compiled as follows: Step 1 Set up water tariff setting; Step 2 Plan development --- RWSA's Planning Division develops the next year financial plan of the water supply works by calculating the revenue and compiling the expenses based on the data sent by branches and the headquarters. Then, the subsidy is discussed. After approval of RWSA President, RWSA's financial plan with the request subsidy is submitted to the MMWR. The subsidy amount is discussed by the MMWR and other government offices concerned with the national budget compilation and fixed in the national budget. Incidentally, when

a disaster occurs ,which requires funds from the national budget, the actual subsidy to the RWSA sometimes falls below the amount determined in the national budget.

(8) Water Tariff Collection of Rural Water Supply

The total balance of uncollected (consumer unpaid) water supply charges have increased to more than 2 million Somoni by the beginning of July, this year (Number of uncollected accounts is unclear at this moment). Incidentally, it is approximately equivalent to 2.5 times of the water supply yearly revenue of the RWSA. There are some law suits that RWSA has filed with courts. The following are considered as reasons for the low collection rate of water supply charges: 1) Low income of water supply users; 2) Payment refusal from a not timely water supply; 3) Others, such as in appropriate water charge collecting system.

Water tariffs are presently collected by RWSA's employees and persons having influential power in the water supply area. The RWSA makes a contract with them for the water tariff collection. Persons and/or organizations will get from RWSA ordinary 10% of the collected amount as a commission to expedite water supply charge collection. RWSA makes water supply contracts with the following entities: Jamoat, Dehkan, Individual farmhouses and Vodokanal.

The unpaid charge rate of contracts with Jamoats and Dehkans is rather higher than that with individual farms. For instance, the rate of unpaid water supply charge is lower than 10% in Isfara Rayon in Sogd Oblast, where the most of the contracts are made with individual farms. On the contrary, the rate of charge collection of Khatolon Oblast is about 50%, where the majority of contracts are made with Jamoats and Dehkans. Incidentally, the national average of the water charge collection rate is assumed at 60%. In order to improve the charge collection rate, the RWSA is seeking more water supply contracts with individual farms. This way has been learned from studying the electricity and telephone charging system.

(9) Contracts of Construction Works

The RWSA has a capacity and a license of construction works, and it has a comparatively large number of construction contracts. Construction works contracts are usually made with clients of other state organizations wanting water supply facilities, such as the Ministry of Agriculture. In 2006, the RWSA had fourteen contracts of water facility construction, and out of them, nine construction contracts amounting to 386 thousand Somoni were implemented. This amount is more than three times the revenue of rural water supply services. However, the spending of construction works was almost the same as the revenue from them, consequently, no profits were left for the RWSA.

CHAPTER 6 OPERATION AND MAINTENANCE SYSTEM FOR RURAL WATER SUPPLY SYSTEMS

6.1 GENERAL

The UNDP (2004) estimated that approximately 50 percent of the rural water supply systems in the country are not functioning or are seriously damaged. An inventory survey, conducted in the target area of the Study for rehabilitation of rural water supply system (i.e. piped water supply system) in Ryons of Kabodiyon, Nosiri-Khisrav, Shakhritus and Pyandzh, revealed that 59 systems among all 118 existing systems are currently not functioning.

Development issues pertaining to operation and maintenance of the rural supply system has ranged widely from policy and legislative shortcomings to the community's capacity in system management. Former parts of this chapter discussed these development issues in operation and maintenance of rural water supply systems from the following view points: 1) Policy and legislative issues, 2) Organization/Entity responsible for operation and maintenance, 3) Ownership and usufruct of the water supply system, 4) Community participation and mobilization, 5) User's ability to make service payment, and 6) Community awareness in water use and sanitation. Current efforts undertaken by the state institutions and donor communities for improved operation and maintenance are reviewed in the latter part of this chapter.

6.2 CURRENT DEVELOPMENT ISSUES FOR OPERATION AND MAINTENANCE

6.2.1 POLICY AND LEGISLATIVE ISSUES

Previously, all lines of communication for the ministries involved in water supply and management ran directly to Moscow. Specialized agencies submitted reports and funding requests to the center, and there was little coordination among ministries at the regional or republic level. Since the break-up of the Soviet Union, this command structure has effectively been decapitated, depriving it even of the centralist direction provided. Ministries in the republic are currently faced with the challenge of coordinating their own policy on the basis of little prior experience.

The Water Code was developed in 2000, in order to regulate water relations with the goals of rational use, protection of water resources and providing a legal framework to protect the right of physical and legal persons in water relations. However, the Code mainly deals with water resource management and does not sufficiently deal with the issues of rural water supply including operation and maintenance of the rural water supply systems. There is also no policy and strategy for operation and maintenance of the rural supply system stipulated neither in "Clean Water and Sanitation Program" and "Water Sector Development Strategy". In fact, the Water Sector Development Strategy points out "poor legal framework" as one of major problems in the water supply and sanitation sector, although it does not provide the institutional and legislative framework for improved operation and maintenance.

Poor legal framework in the rural water supply and sanitation sector leads to an undefined and fragile array of state institutions, local authorities, and water user communities in operation and maintenance of the rural water supply systems.

Since the mid 90's after the civil war, government and many donor communities have concentrated their efforts on addressing the emergent needs for rehabilitating rural water supply systems constructed in the Soviet era. However, without having the proper policy and legislative framework for operation and maintenance, a considerable number of these supply systems are

currently not functioning and again are in dire need of large-scale rehabilitation due to lack of proper operation and maintenance.

Thus, it is necessary to elaborate a specific policy and law concerning operation and maintenance of rural water supply systems.

6.2.2 ORGANIZATION/ENTITY RESPONSIBLE FOR OPERATION AND MAINTENANCE

Currently, it is considered that the responsibility for operation and maintenance of rural water supply systems rests with provincial and district branches of the Tajik Rural Water Supply Authority (RWSA) and Vodokanal, local authorities (Jamoat) and/or the management of farming entities (former state and collective farms). However, functional roles and responsibilities in operation and maintenance of rural water supply systems among these stakeholders have not been defined clearly in the national sub-sector policy and strategy.

In a given legislative environment, it is commonly understood that the entity responsible for operation and maintenance is the one that also owns the supply system. In case the state entities such as the Rural Water Supply Authority (RWSA) and Vodokanal is the system owner, system management including operation and maintenance is provided by them according to their mandate. However, as discussed in the next section (ownership issues), in many cases that *de facto* handing-over of the rural supply system is made to the user communities from Jamoat, roles and responsibilities for system operation and maintenance are less determined among state institutions, local authorities, and user communities.

In the Study Area, a considerable number of rural water supply system have been rehabilitated since the mid 90's as emergency programs and *de facto* handing-over was made to user communities. It is due to that most rehabilitated systems were once owned and managed by former state and collective farms, and ownership of the system has not been redefined after dissolution and reallocation of these state and collective farms to private farms of *Dehkan*. However, awareness and capacity of user communities in the system operation and maintenance has not developed at all, consequently ending with system breakdowns and abandonment in most cases. Although the legal owner and operator of these systems once owned by state and collective farms may be defined as local authority (*Jamoat*), it shall be noted that *Jamoat* has also not been involved in the operation and maintenance of these rural supply systems rehabilitated.

Although some international organization and NGOs currently introduce community-based operation and maintenance to rural system management, they are reported as "having weak capacity of the maintenance personnel in the communities to sustain the infrastructure, inactiveness of the community inhabitants, weak control of water quality, low local collecting capacity of water fees" (UNDP, 2007).

6.2.3 OWNERSHIP OF THE RURAL WATER SUPPLY SYSTEM

Ownership and usufruct (i.e. right to use) is one of important issues when considering who owns, operates, and maintain rural water supply systems. The Water Code regulates the property right of any water supply systems in Article 57, stipulating "centralized and decentralized water supply systems shall be property of the republican, local government, and/or legal entity. Thus, in principle, state ownership and operation and maintenance of the rural water supply systems shall be assured. According to the inventory survey carried out under the Study, there are 118 systems owned and operated and maintained by either state entities such as Tajik Rural Water Supply Authority (RWSA), Vodokanal, or state or *Dehkan* firm entity, or *Jamoat*.

However, undecided ownership of rural water supply systems, particularly which were once owned by former state and collective farms, complicates issues pertaining to operation and maintenance of

the rural water supply system. The former state and collective farms have been dissolved and reallocated to the private farm, namely *Dehkan* in accordance with the Land Reform Law (1992). However, the Land Reform Law and its subsequent decrees and resolutions do not stipulate ownership of non-land property such as rural water supply systems after dissolution and reallocation of land, while the Water Code prohibits privatization of the water supply systems. Thus, ownership of these supply systems has been unclear.

Since state ownership is principle in the Water Code, it is assumed that these rural water supply systems once owned by former state and collective farms shall be owned and managed by *Jamoat*. In fact, it is reported in the inventory survey that 58 rural water supply systems among the total of 118 are owned by *Jamoat*. However, ownership of these systems by *Jamoat* is considered as an expedient since a relevant and competent institution to own and manage then does not existed. Although the entities which own the supply system are the ones which operate and maintain it, *Jamoat* has less capacity to manage in terms of human and financial resources. In reality, *de facto* handing-over of the rural water supply system was made to the user communities in many cases as explained earlier, while *Jamoat* is keeping its legal ownership and the right of operation and maintenance. However, user communities also lack capacity to operate and maintain supply systems. Indeed, according to the inventory survey, abandonment of supply systems are concentrated in those owned by *Jamoat*.

The following table (*Table 6.2.1*) shows the mode of ownership and current condition of the supply systems.

Table 6.2.1 Current Functional Condition of Rural Water Supply System by Ownership

Owner of Rural Water Supply System	Number of System	Number of Functioning System	Functioning Rate (%)
Jamoat	58	23	40%
Dehkan Farm Association	1	1	100%
Vodokanal	14	11	79%
RWSA	21	8	38%
Kolkhoz	18	12	67%
Others	6	4	67%
Total	118	59	50%

Source: Inventory Survey, 2008, JICA Study Team

Although there might be factors contributing to the functioning rate of the supply system such as overage and other inevitable accidents, the functioning rate of the systems owned and operated by *Jamoat* is relatively low at 40%. On the other hand, it is observed that functioning rate of the system owned and operated by the state entities is considerably higher, such Vodokanal (67%) and Kolkhoz (67%), although the one owned by RWSA has deteriorated to 38%.

It is obvious through the table above that supply systems owned by the state entities such as Vodokanal and Kolkhoz are operated and maintained in a sustainable manner, due to their competence in system management in terms of technical, managerial, and financial capacities. As will be discussed later, there are an increasing number of Vodokanal among which are interviewed by the Study Team interested in owning and managing rural water supply systems currently possessed by *Jamoat*, if rehabilitation and ownership issues are resolved. As far as sustainability of the supply system is concerned, engagement of these state entities in operation and maintenance could be a good practice with resolution of ownership issues, considering their competence and cost effectiveness utilizing the existing structure and capacities.

6.2.4 COMMUNITY PARTICIPATION AND MOBILIZATION

In the Study area, communities are less mobilized and participated in planning and implementation, as well as operation and maintenance of the rural water supply systems. It is due to this supply-oriented approach taken under the emergency program to address immediate needs for rehabilitating the rural infrastructure, particularly rural water supply systems. Thus, communities have been less organized and responsible for sustainability of rural water supply systems.

Recently, the UNDP, under the Community Program, initiated the creation of a Water User Association for improved rural water supply. At a foundation of the UNDP's approach to sustainability is the engagement of all stakeholders, involving communities in identification of needs, planning, implementation and monitoring of the program through Jamoat Development Committee (JDC). Communities are consulted and responsibilities are shared among stakeholders for implementation of the program. Communities are provided with managerial and technical guidance for operation and maintenance of the supply system. A formal arrangement is also made between WUA and system owner. This approach increases the sense of ownership among communities and sustainability of the rural water supply. In the Study area, such interventions by the UNDP were made in two rural water supply systems in Kabodiyon. However, there are no such interventions in other districts in the Study area.

6.2.5 USER'S ABILITY TO MAKE SERVICE PAYMENT

The Study revealed that, in most of the communities in which rural water supply systems are rehabilitated, the arrangement was made for a free electricity supply for pumping units for two to three years after rehabilitation. Moreover, the government announced and implemented a free water supply policy in the area in order to attract ex-residents to return and other population to resettle in planned settlements. Thus, in most rural water supply systems currently owned by Jamoat and de facto handing over is made to the user communities, water fee collection has not been carried out. Communities were not mobilized to collect water tariffs for repair and maintenance. It can be said that the free water policy in the area deteriorated user's willingness to pay and there seems no public consensus for service payment at present.

By contrast, in the Study area, water fee collection is carried out for the supply system owned and managed by state entities such as the RWSA and particularly Vodokanal. Tariff setting varies from 2.5 Diram to 12.5 Diram per cubic meter (1.0 USD = 3.4 Somoni = 340 Diram), according to their mandate and type of water supply system. Assuming a household with six (6) persons consumes 25 liter/day/person, the monthly water fee ranges from 3.4 to 16.9 Somoni per household (equivalent to 1.00 to 4.97 USD per household).

In a given impoverished rural state in the Study Area, the community's ability and affordability to pay is considerably limited. The National Statistics Office (2006) indicates the average monthly wage and salary per capita in the Khatlon Oblast amounts to 79.71 Somoni (equivalent to 23.44 USD: 1.0 USD = 3.4 Somoni). The Staff of the UNDP suggested a monthly service payment of 4.0 to 5.0 Somoni per household can be affordable and acceptable in the communities in Khatlon Oblast through their current experience in program implementation where a tariff structure is established. This amount is also supported by NGOs involved in rehabilitation of the rural water supply systems. However, it is revealed that this tariff setting can only fulfill the expense for electricity for pumping units, salary for operators, tax, and minor maintenance. Thus full operation and maintenance cost recovery including major maintenance and replacement cost can not be realized.

6.2.6 COMMUNITY'S AWARENESS IN WATER USE AND SANITATION

In spite of the fact that the literacy rate in Tajikistan is very high, it is generally said that many families continue to have low levels of awareness and skills regarding hygiene practices and use of appropriate sanitary facilities. Moreover, there is a clear gap between knowledge and practice. For example, in the field interview of the target communities under the Study, most community members were aware of the necessity to boil water fetched from canal for drinking and domestic use. However, at the same time, field observation found children drinking water direct from the canal without any treatment and females washing dishes at the canals.

Increased awareness of hygiene and sanitation is indispensable not only to maximize the health impact by improved water supply, but also to enhance community participation in operation and maintenance to realize sustainable supply services. Through field interviews and observation of the target communities, it seems that communities place less value on safe drinking water provided through an improved supply system. It is often mentioned by donor communities and NGOs in Tajikistan that a community believes in the pureness of surface water including canals, due to the traditional belief that water run through grasses and rocks is purified and static water such as groundwater in a well is stagnant and polluted. Thus, it is reported that some community members continue to use canal water for drinking and domestic purposes even though improved water supply service is the provided through implementation of project by the government and donors.

Communities placing less value on water and sanitation could be also less mobilized and participate in operation and maintenance of the improved water supply system. Lack of community's awareness on water and sanitation brings less community motivation to participate in operation and maintenance of the improved water supply system.

6.3 CURRENT EFFORTS UNDERTAKEN FOR IMPROVED OPERATION AND MAINTENANCE

6.3.1 DEVELOPMENT OF POLICY AND LEGISLATIVE FOR IMPROVED OPERATION AND MAINTENANCE

In accordance with Article 8 of the Water Code of the Republic of Tajikistan, the Government is considering state duties and powers for drinking water supply including "adoption and realization of state and local strategy for owners of the centralized system, for organization which uses these systems, as well as for organizations which provide equipment, machinery, material, and chemicals in order to meet the needs of drinking water, subsidies, low-interest loans, and costume benefit". Unfortunately, these strategies have still not been developed.

In June 2006, a Water Sector Development Strategy was developed and adopted. The Water Sector Development Strategy states that adoption of the Law of the Republic of Tajikistan "on Drinking Water and Water Supply" in order to resolve the water supply problem, including an undefined national strategy for improved operation and maintenance of rural water supply systems. Development and adoption of the Law on Drinking Water and Water Supply is also stipulated in the Poverty Reduction Strategy as a priority to be achieved during 2006 to 2008. However, it has not been realized.

Lack of the strategy in rural water supply sector has been pointed out, in which detailed development approaches, shared roles and responsibilities of each stakeholder, and ownership of the rural water supply system shall be defined. In the end of 2007, UNICEF in collaboration with UNDP have planned consultative meetings in which all state stakeholders, donors, and NGOs involved in the sub-sector discuss and make consensus on development issues regarding improved operation and maintenance, ownership, roles and responsibilities of stakeholders, and so forth. Through the consultative meetings, it is expected that good practices in operation and maintenance

of the supply system is shared among development partners, which are duly incorporated in development the sub-sector strategy. However, necessity to address the disaster caused by the energy crisis in Khatlon Oblast in early 2009 prolonged the consultative meeting. The meeting has not been held by the end of 2008.

6.3.2 ESTABLISHMENT OF COMMUNITY-BASED ORGANIZATION FOR OPERATION AND MAINTENANCE

The issue of supporting the establishment of community-based organizations, namely the Water User Committee (WUC) or Water User Association (WUA), for improved operation and maintenance of the rural water supply system has been discussed in recent years in order to share and standardize the best practices and approaches. In this section, therefore, current development of community-based organizations undertaken by the UNDP and NGOs aimed at improved operation and maintenance of the supply system is discussed and reviewed.

(1) UNDP

The rehabilitation of rural water infrastructure for domestic use and irrigation has been the main domain of activity of the UNDP Community Program. Currently the UNDP has increasingly put emphasis on the question of sustainability of rehabilitation intervention and energy is spent to deal with the creation of the WUC or WUA, as well as with water system owner capacities to maintain and repair the newly rehabilitated infrastructure. This is an important effort not only to ensure the rehabilitated water supply system will be taken care of over time but also in terms of improving the governance and provision of essential services at the local level.

The previous project funded by the European Commission Humanitarian Aid Office (ECHO) anticipated establishment and development of the WUC or WUA engaged in provision of care for the newly rehabilitated water system. Initially, the main function of the WUC or WUA was to mobilize the rural population and to serve as a link between the communities and water system owners.

Under the previous ECHO funded project on water system rehabilitation, then, it was agreed to attach more power to the WUC including more functions and responsibilities and to have the WUC, which will be responsible for maintaining and operating the systems to also controll water supply and utilization.

However, as discussed earlier in this chapter, in the given limited capacity of community in operation and maintenance, they often have difficulty to sustain the water supply system. The UNDP (2006) reported in its annual progress report of Community Programs that “key problems remain such as the weak capacity of the maintenance personnel in the communities to sustain the infrastructure, inactiveness of the community inhabitants, weak control of water quality, low collecting capacity of water fees and unrealistic fees, etc”. Thus, the UNDP currently employs policy and strategy to involve state institutions, such as the Rural Water Supply Authority, Vodokanal , and Kolkhoz/state (farm) enterprises, competent in operation and maintenance of supply system as system owner particularly for major repair and maintenance, instead of relying on the WUCs and WUAs for all duties and tasks involved in supply system management.

These WUCs and WUAs were established through meetings and discussions with the beneficiaries residing in the area of the systems’ operation. Depending on the coverage area, the WUC and WUA may consist of four (4) to nine (9) members who would be trained and provided with tools and relevant equipment to run the systems. Together with the system owners, the WUC and WUA would provide a comprehensive support in development of water distribution systems, as well as work with the local population in order to ensure sustainable delivery of water.

The WUCs and WUAs established by UNDP have often been responsible for mobilization of the communities to submit water user fees; have collected those fees; and have undertaken explanatory works among the local populations as to the necessity of fee payment for the timely upkeep and operation of the system. Where necessary, the WUC and WUA is formed under Jamoat Resource Centre (JRC), that used to be called the Jamoat Development Centre (JDC). JRCs are also community-based organizations set up and supported by the UNDP as the focal point for any community development initiatives in collaboration with local authority.

It is expected that WUCs/WUAs and JRC can also serve as a vital link, both during project activities and after them, to initiate a dialogue between system users and system owners on system sustainability as well as daily operations. Whether to channel fees collected to the system owner; to alert the owner about potential or existing problems with the supply system; to raise any other concerns of users; or to act as a focal point for community mobilization to undertake any necessary manual repairs which can involve local labor.

(2) NGOs

Some NGOs actively involved in rural water sub-sector development in Khatlon Oblast, for example Action Against Hunger (AAH) and Acted, have also established and support WUAs in implementing the rehabilitation of rural water supply system. After participatory identification of community needs and awareness building on clean and safe water for the community, WUA is formed either through community election/nomination or based on the existing community structure, such as traditional *Mahalla* (Village) Committee or JRC.

These WUAs formed by NGOs are often registered as public associations under the Ministry of Justice in accordance with Law of the Republic of Tajikistan on Public Associations. The Law defines a public association as “a voluntary, self-governed, non profitable association of individuals established on the basis of their common interests to pursue their common goals declared in the charter of a public association”.

Charter and bylaws of the WUA are required for registration. The process to prepare these charters and bylaws enhance not only consideration on rules and regulation for operation and maintenance of rural water supply system, but also the sense of community ownership.

State registration invest the WUA with the right of legal entity, which duly enables and authorizes WUA to be a legal owner of the rural water supply system. In implementing the rehabilitation of the rural water supply system, legal ownership of the supply system is often handed over from the former owner to the WUA, based on the mutual agreement among former owner, WUA, and local authority (Jamoat Hukmat).

WUAs are provided with training in operation and maintenance by NGOs, of which emphasis is placed on technical operation and maintenance, accounting and transparency in fee collection and management, and monitoring of the system operation and management.

Under the implementation system of these NGOs, WUAs become legal owners as well as system operators of the rural water supply system. However, it is observed that WUAs formed and even trained have limited capacity to cope with major maintenance and replacement of the supply system. Thus, involvement of state entities, such as RWSA, Vodokanal, and Kolkhoz/firm entity is suggested in particular for major maintenance and replacement, redefining duties and tasks among the WUA, state entity, and local authority.

6.3.3 INVOLVEMENT OF STATE ENTITY AND STATE OWNERSHIP FOR IMPROVED OPERATION AND MAINTENANCE

The legal owner of the rural water supply system could be the body responsible for operation and maintenance of the supply system. Water User Associations (WUA) can not be the system owner and operator in a legal sense, unless they are registered as public associations in accordance with the Law on Public Association. On the other hand, as it is observed, WUAs established and even trained in operation and maintenance often lack human, technical, and financial resources to sustain the rural water supply system.

Considering the current situation of operation and maintenance, state ownership and operation could be one of the most feasible and realistic models to sustain the rural water supply system. Indeed, it is observed in the inventory survey conducted under the Study and *Table 6.3.1* above that the supply system run by the state entity, such as Vodokanal and Kolkhoz are relatively well kept functional for years, due to their competence in technical and human resources.

Indeed, in Khatlon Oblast, 19 rural water supply systems were rehabilitated under the UNDP's Community Program by the end of 2006. Along with current policy and strategy of UNDP, the ownership of these rehabilitated supply systems is rearranged and transferred to the state entity, either RWSA, Vodokanal, or Kolkhoz/or farm entity competitive in system operation and maintenance. It can be observed that engagement of these state entities is considerably contributing to the sustainability of the supply system.

Involvement and engagement of state entities could also be feasible and cost effective rather than introducing other operation and maintenance mechanism, due to reliance on and utilization of existing capacity in human, technical, and financial aspects.

However, it does not mean that communities and WUAs are exempted from operation and maintenance, rather emphasizing their roles and responsibilities in community mobilization to enhance proper use of facilities, moderate consumption of water to prevent over-use where the tariff is fixed, monitoring and reporting system break-downs to the system owner/operator, and tariff payments. Tasks and duties in operation and maintenance are consulted among system owners, the user community, and local authorities, and properly shared among them. Through these consultations, the following issues are negotiated and clarified: who should be operating the supply system, how to implement maintenance, what water service fee to pay for, what is the Government/system owners contribution to system operation and/or maintenance, and any other questions and concerns the user community may have to ensure their engagement and participation. The UNDP is further suggesting to carry out the following consultations in order to establish a firm mechanism for improved operation and maintenance:

Table 6.3.1 Operation and Maintenance Consultation by UNDP

Consultations	Description
Beneficiary consultations	Issues to be addressed include but may not be limited to: define general operation guidelines for summer periods; define general operation guidelines for winter periods (closure of part of the system); general understanding of fee paying for service received and general; evaluation of opportunities for forming an operating organization jointly with the system owner (WUC).
Owner consultation	Issues to be addressed include but may not be limited to: evaluation of beneficiary defined general operation guidelines for summer periods; evaluation of beneficiary defined general operation guidelines for winter periods (closure of part of the system); budgetary contributions from Government to system O&M; evaluation of opportunities for forming an operating organization jointly with the system users (WUC).

Consultations	Description
Agreement of operation principles	Issues to be addressed include but may not be limited to: composition and formation of the Operating Organization agreed between stakeholders; operation procedures defined for summer and winter periods; maintenance procedures defined (at level of system, major sections within system perimeter) in terms of service, annual/routine maintenance and refurbishment interval; reporting requirements defined (interval, type of information, display locations).
User fee agreement	Issues to be addressed include but may not be limited to: composition of the fee structure agreed and fee rates defined (by HH, season, amount) under consideration of agreed maintenance structure and procedure; vulnerability criteria applied to exempt families unable to meet user fees; fee paying mechanism agreed (add to operation fee, conduct collections, seek outside funding) to meet cost of maintenance (service, annual/routine, refurbishment, cost recovery); reporting requirements defined (user fee collected, expenditures, maintenance related fees and expenditures, time interval, location to display).
Penalty agreements	Issues to be addressed include but may not be limited to: agreement on criteria for penalizing water users obtaining service from within the supply perimeter; agreement on procedures to penalize water users (1^{st}, 2^{nd}, 3^{rd} warning etc, public announcements, shutting down services to individual HH/road/section) serviced by the supply system; reporting requirements defined (name, amount of defaulting users, announcement of penalty, time interval, location to display).

It is thought that engagement of state entities and active participation of the user community can highly enhance improved operation and maintenance, and sustainability of water supply services in the rural area.

6.3.4 ESTABLISHMENT OF WATER FEE

The UNDP developed a standard cost calculation for system operation and maintenance costs for the rural water supply system, based on the following estimation basis categorized by major operation and maintenance costs.

Table 6.3.2 Basis of Cost Estimation for Operation and Maintenance of Rural Water Supply System

Items	Description
1) System operation cost	Must be calculated separate for summer and winter operation, includes at least all direct operation costs: electricity, fuel, and any other regular consumable items but not lubricants; operator cost, fee collection staff cost; there may be other costs not mentioned here.
2) System service cost	Includes at least all costs related to works and activities specified under "service activities", selection system maintenance including but not limited to lubricants, and regular consumable items; skilled and unskilled labor cost to execute works; labor cost to inspect works; there may be other costs not mentioned here.
3) System routine / annual maintenance cost	Includes at least all costs related to works and activities specified under "routine/annual maintenance", section "system maintenance" plus including but not limited to spare parts; skilled and unskilled labor cost to execute works; labor cost to inspect completed works; there may be other costs not mentioned here.
4) Major system component refurbishment cost	Includes at least all costs related to works and activities specified under "breakdown maintenance/refurbishment", section "system maintenance" plus including but not limited to spare parts; technical advisor cost, procurement cost, skilled and unskilled labor cost to execute works; labor cost to inspect completed works; there may be other costs not mentioned here.
5) Investment recovery cost	An estimate to establish the total system replacement cost, this may assume an overall lifetime for the whole system including all components, or separate assessments for different system components;

	e.g. concrete works 50 years, pipe work 30 years, mechanical equipment 5-10-15 years; based on the estimates, the total required investment may be stated at a future time, but this may also be translated into an annual cost contribution and a monthly fee rate.

The UNDP's experience has shown that the rural community is willing to pay for water and other public services, as long as it is clear and the fees paid by them are indeed being rationally used. However, it is also stated that the rural community can afford, among operation and maintenance costs listed above table, only for; 1) System operation cost, 2) System service cost, and 3) System routine/annual maintenance cost. Therefore, among the items listed above, 4) Major system component refurbishment cost, and 5) Investment recovery cost shall be subsidized by the state.

Moreover, the water fee calculated shall be submitted to the Agency for antimonopoly policy and entrepreneurs support department for final approval. In a given unprivileged condition in rural areas and state policy for public service provision, Tajik Anti-monopolies body regulates water fees at considerably lower levels. It is often requested that water fees should be equal to 19-29 Dirams per person per month. The household which has access to water from domestic standpipes is charged 25-50 Dirams per household members per month. This is assuming 25 liters per person in a day on average.

The UNDP's experience shows that a community in the Study area can afford 4.0 to 5.0 Somoni per household (equivalent to 66 Dirams per person, considering the average number of population in household in the country to be estimated at 6 persons), which can cover, at least, the daily system operation cost, system service cost, and system routine/annual maintenance cost. Thus, it is obvious that the tariff regulated by the Tajik Anti-monopolies body is low in terms of the community's willingness and affordability to pay, and could cover only the daily operation cost and staff salaries without coping with even minor repair and maintenance.

The right to collect water fees resides with the legal owner of the supply system. To establish fees, they must first be approved by the Tajik Anti-monopolies body, Tajikstandard, by submitting the following documents:

- Letter to the Chairman of the State Department for Antimonopoly Policy;
- Status of the water supply system owner/operator;
- Contract with subscribers
- Contract for electricity supply with the regional department of energy supply and water supply system owner/operator;
- Schematic plan of the water supply system;
- Calculations of tariffs with detailed justification

Upon submission of the required documents, the antimonopoly commission reviews the request and makes a decision on whether the fees are acceptable. Under the UNDP's program, fees have been calculated by the system owners/operators in accordance with guidelines provided by the UNDP and after all the required documentation is prepared, the antimonopoly committee will be approached. Through the proper documentation by the guidelines provided by UNDP and negotiation with the antimonopoly commission, the UNDP has set the water fee at 4.0 to 5.0 Somoni per household per month.

In accordance to the calculation made on amortization of water debit discharge and norms established by the Agency for antimonopoly policy and entrepreneurs support under Republic of Tajikistan, each member of a household benefiting from the system is responsible to pay on

average 0.19 up to 29 Diram every month. These figures vary depending on the kind of exploited system, water facilities available at home and number of taps installed on the street.

6.3.5 IMPROVEMENT OF COMMUNITY AWARENESS IN WATER AND SANITATION

To ensure that the rehabilitated rural water supply systems were used in an appropriate manner and to improve personal hygiene and public sanitation standards within the supply perimeters of the water distribution network, a number of international donors and NGOs engaged the Khatlon Healthy Lifestyle Centers to undertake community awareness campaigns on sanitation and hygiene in their target area.

The Healthy Life Style Center forms a branch of the Ministry of Health. The main goal and objectives of the center are to conduct information and awareness campaigns, training and seminars on health-related problems to the local population. Previously these activities were responsibilities of a special department within the SES but due to structural changes in the Ministry of Health in 1999, the Health Life Style Centers were established as independent structures of the Ministry of Health.

The Healthy Life Style Center possess trainers, and has gained experience working with the communities and international donors and NGOs including the UNDP, Merlin, ACTED, COOPI on water and sanitation issues among others. The Center has also collaborated with UNICEF. Based on its experiences and mandate, the Health Life Style Center was selected to implement Sanitation and Hygiene Awareness Campaigns under UNDP's Community Program.

All local NGOs, other organizations and departments involved in training at the household level shared their experience and collaborate efforts with SES and the Healthy Lifestyle Center. One of the components of the civic awareness campaign was an informative session titled "Role of water in my community".

Based on the data collected from local communities, UNDP personnel and local NGOs developed material containing information on how to use water, how to protect water sources and how to prevent water born infections. This was presented in short informative leaflets and attached to the walls of health care facilities, schools and kindergartens.

6.4 SUMMARY OF DEVELOPMENT ISSUES FOR IMPROVED OPERATION AND MAINTENANCE FOR RURAL WATER SUPPLY SYSTEM

The Study reviewed and identified various development issues and needs for improved operation and maintenance of rural water supply systems in the Study, which could be summarized as followed:

- Insufficient policy and legislative framework for improved operation and maintenance, which defines system ownership, tasks and duties of stakeholders involved in operation and maintenance, national standards for system management, and so forth;
- Lack of community and community-based organization's capacity in operation and maintenance. Although relative competence of state entities, such as RWSA, Vodokanal, and Kolkhoz/farm associations in operation and maintenance is observed, they are not actively taking over currently malfunctioning supply systems, due to undefined system ownership, and lack of a state budget for rehabilitation;
- Undefined ownership issues, which prevents systematic institutional and community development for improved operation and maintenance;
- Lack of community participation in operation and maintenance, due to less community

mobilization in planning, implementation, and monitoring, placing emphasis on addressing emergent needs to rehabilitate rural water supply systems after the civil war. It also prevented enhancing the sense of ownership for the rehabilitated supply system among communities.

- Less community's awareness in water users and sanitation, which decreases the impact on personal hygiene through rehabilitation of the supply system.

Reviewing these development issues and needs for improved operation and maintenance, current undertakings to cope with each of these issues and needs are also identified in the Study. These undertakings include the initial steps taken for development of a Law on Drinking Water and Water Supply, establishment of community-based organizations (i.e. WUA and WUC) for improved operation and maintenance, active engagement of state entities in system management, establishment of water fees, and improved sanitation and personal hygiene. These undertakings are further reviewed and the best practices being feasible and effective in socio-political, cultural, and economic conditions are identified, which becomes the basis for the strategy and plan for improved operation and maintenance.

6.5 STRATEGY FOR IMPROVED OPERATION AND MAINTENANCE

Reviewing the said development issues, the following strategy and plan for improved operation and maintenance in the Study area is suggested to determine approaches taken in the possible future implementation of projects planned under the Study. The strategy and plan shall satisfactorily cope with current development issues for operation and maintenance, namely:

- Undefined ownership of the rural water supply facilities
- Undefined roles and responsibilities among state entities, communities, and local authorities in operation and maintenance
- Lack of community participation in operation and maintenance
- Less community affordability to pay for water fees
- Poor community awareness in water use and sanitation

An insufficient policy and legislative framework is also an important development issue for improved operation and maintenance in order to define system ownership, tasks and duties for stakeholders involved, national standard for system management, and so forth. Therefore, based on the interpretation of existing policy and legislative framework with consideration on their future improvement, strategy and plan for improved operation and maintenance of rural water supply system under the Study is developed. Considering the development issues stated above, the following strategy and plan for improved operation and maintenance has been prepared.

6.5.1 Transfer of Ownership of Rural Water Supply System to State Entities Specialized for Water Supply

As reviewed, rural water supply systems currently not functioning in the Study area are concentrated in the system owned by the local authority or Jamoat. In principle, the system owner shall be also responsible for operation and maintenance in the country. However, it is also seen that Jamoat lacks technical, managerial and financial capacity for operation and maintenance of the rural water supply system, and *de facto* handing over of the system to the community has been made as expedient. Community in the Study area lacks more capacity to operate and maintain in terms of technical, organizational, and financial means. On the other hand, it is observed that the supply system owned and managed by the state entity, particularly Vodokanal and the state firm has

been well operated and maintained in a relatively sustainable manner, due to their technical and financial capacity.

Wherever possible, therefore, the Study suggests transfer of system ownership vested by Jamoat to state entities of Vodokanal or state firms if the system is located within their premises. Other options for ownership arrangement could be the concession or lease of the supply system to these state entities, defining ownership, and tasks and duties in operation and maintenance among Jamoat, state entities, and the community. Involvement and engagement of the state entity is considered a feasible and cost effective means for improved operation and maintenance, due to reliance and utilization of current existing capacity in human, technical, and financial aspects. Having a number of rural water supply systems in its mandatory areas and existing town water supply systems, Vodokanal could also cross subsidize operation expenditure and maintenance among systems and system management and operation and maintenance services can be provided in an effective and efficient manner.

As observed, it has been proven that the communities can not afford the cost for major maintenance and replacement of the rural water supply system. Thus, within the existing financial capacity of Vodokanal and state firms, it can be expected that they can subsidize the cost for major maintenance and replacement of the supply system in order to enhance sustainability of the water supply service, which can not be funded through user fee collection that covers costs for daily operation and maintenance, and minor repair.

It has been confirmed in the Study that the current legislative framework allows legal transfer of system ownership through procedures determined by Ministry of State United Enterprises. Indeed, in the Community Program under the UNDP, such arrangement to transfer the system ownership from Jamoat to Vodokanal was made. Through the interview with Vodokanal in the Study area, several of them expressed their increased interest to engage in operation and maintenance of the rural water supply system. It might be because, by owning and managing a number of rural water supply systems in their mandatory premises, increased allocation of state and provincial budget to Vodokanal is also expected.

Transfer of system ownership from Jamoat to Tajik Rural Water Supply Authority, as a competent state entity involved in rural water sector development, can also be considered. However, compared to Vodokanal, the Tajik Rural Water Supply Authority (RWSA) has put the largest emphasis in their mandate on “construction” of rural water supply systems and management of large-scale rural water supplies such as the Vakhsh pipeline, instead of provision of supply services directly to the population through the rural water supply system. It is also stated in this chapter that the functional rate of the supply system owned and managed by the RWSA is considerably low compared to Vodokanal , due to lack of funds for major maintenance and replacement. Thus, the transfer of system ownership to the RWSA shall be carefully studied from the viewpoint of autonomous expansivity.

6.5.2 Establishment of Water User Association

In a given situation and conditions of operation and maintenance for the rural water supply system as reviewed in this chapter, the Study is not necessarily denying the introduction of conventional community-based operation and maintenance models for system management. However, considering a larger gap between technical and financial requirements for operation and maintenance of the rural water supply system and current existing capacity of the community, introduction of a conventional community-based model alone could not address all the issues pertaining to current operation and maintenance problems. The technical capacity of the community to cope with maintenance and repair for the supply system is limited, particular in major maintenance, even provided with training for operation and maintenance. The financial

capacity of the community for operation and maintenance is also lacking, and it was proven that the community can afford only daily operation and minor maintenance costs, but not costs for major maintenance and replacement. Moreover, from a financial aspect, establishing an independent community-based entity in each and every supply system for operation and maintenance with supply of necessary tools and equipment and provision of training in technical, managerial, and financial aspects, considerably increases the transaction cost for the establishment of an improved operation and maintenance mechanism. Thus, introduction of a conventional community-based operation and maintenance model seems to be less feasible in the Study area.

However, it does not mean that communities are exempted from operation and maintenance of the rural water supply system. The Study suggests formulating a Water User Association (WUA) among user communities through consultation with Jamoat, user communities, and the system owners. It is expected that major roles and responsibilities of the WUA will be redefined as community mobilization as follows:

- Being a focal point for community mobilization;
- Facilitation of moderate consumption of water to prevent over-use where the water tariff is fixed;
- Monitoring and reporting system break-downs to the system owner/operator;
- Facilitation of tariff payments, or collection and channeling the fees collected to the system owner/operator;
- Reconciliation of dispute among water users

Roles and responsibilities of the WUA are not limited to the above mentioned, but it shall be further defined and agreed through consultation.

It is intended that WUA is composed of all system users, of which four to five persons are elected as executive organ bearing primary responsible for community mobilization in operation and maintenance of the water supply system, as well as for consultation with the system owner in its management.

6.5.3 Defined and Agreed Roles and Responsibility to be Shared among Stakeholders

Undefined roles and responsibilities among system owners, system operators, the WUA, user communities, and local authorities has been one of major problems in operation and maintenance of the rural water supply systems in the Study Area. The Study advocates the clear definition of roles and responsibilities to be shared among these stakeholders through consultation.

For system operation, constraints in operation shall be considered for rational consultation and negotiation between system owners, system operators, and the user community. To enhance sustainable operation, the following two generalized planning exercises may be undertaken, and operational conditions shall be mutually understood and agreed among stakeholders:

- Operational conditions in the summer period (24 hours operation), determining pump operation under conditions of unlimited power supply with regard to storage volume and user demand, description of recurring needs to interrupt operations or supply, needs for system chlorination;
- Operational conditions in the winter period (restricted operation), determining Pump operation under condition of limited power supply; the role of storage installations and their volumes to balance flow; operations to ensure proper operation of some part of the system

and why part of the system should be closed down.

For system maintenance, tasks and duties of system owner/operators, the WUA, and local authorities shall be clearly defined and agreed in the following three categories of maintenance required for improved sustainability of the rural water supply:

- Service Activities, which includes chlorination at regular intervals, inspection of all system components; cleaning of any system components except wells, reservoirs, etc.; caretaking of installations at the site of the water source including surroundings; leakage testing of minor sections and disinfection.
- Routine/Annual Maintenance, which includes minor repairs such as replacement in taps; cleaning of reservoirs including disinfection; leakage testing; regular painting and insulation tasks; winter operation; and minor structural repairs.
- Breakdown maintenance and replacement, which includes activities executed in a broader cycle of five (5) years and/or when the lifetime of major components are exceeded or when emergency maintenance is to be carried out: repair/replacement of pumping equipment and any related installation; repairs necessitating temporary closure of major parts of the distribution system; repair of reservoir installations including disinfection; system pressure tests.

Duties and tasks among stakeholders shall be defined through consultation, and shall be finally agreed by a memorandum of understanding.

6.5.4 Establishment of Water Fee and State Subsidies for Improved Operation and Maintenance

The practical objective of fee collection is to ensure financial sustainability of the supply system. The water fee shall be established to cover all expenses for system operation and maintenance including major maintenance and replacement. However, given the impoverished state of the rural population (i.e. rural poverty), it is understood that rural communities can afford only the cost for daily operation and minor maintenance. However, instituting payment for water supply services, even it can not cover the cost for major maintenance and replacement, can be an important contribution toward sustainability and may deepen a sense of ownership in a symbolic manner among the user community towards the rural water supply system.

User fees shall be established through consultation with system owners, operators, the WUA, and local authorities, addressing the following issues:

- composition of the fee structure agreed and fee rates defined (by HH, season, amount) under consideration of the agreed maintenance structure and procedure;
- vulnerability criteria applied to exempt families unable to meet user fees;
- fee paying mechanism agreed (add to operation fee, conduct collections, seek outside funding) to meet the cost of maintenance (service, annual/routine, refurbishment, cost recovery);
- reporting requirements defined (user fees collected, expenditures, maintenance related fees and expenditures, time interval, display location)

The Study also advocates state subsidies for major maintenance and replacement of the rural water supply system, which the community can not afford. Provided that the state entity such as Vodokanal and state firms are vested with the system ownership and engaged in system operation, funding for such major maintenance and replacement could be expected to be within their financial

capacity. However, they may also have limitations in funding all the major maintenance and replacements. Thus, state subsidies to support major maintenance and replacements are vital for the sustainability of the rural water supply system, along with establishments of a channel and procedure for funding. It shall be considered as one measure to cope with rural poverty, in accordance with state poverty reduction policy and strategy.

6.6 ACTIVITY FOR IMPROVED OPERATION AND MAINTENANCE

The following activities were considered to realize the above stated strategy for improved operation and maintenance of the rural water supply system.

Stage 1: Pre-Planning

- Conduct orientation for stakeholders such as Hukmat of Rayon, Jamoat, community representatives, state entities involved in rural water sector development to discuss and reach general consensus on the strategies for improved operation and maintenance of the rural water supply system, including ownership transfer, establishment of the WUA, roles and responsibilities among stakeholders, and establishment of user fees.

Stage 2: Formation of WUA

- Conduct community meetings to discuss and reach general consensus on the strategies employed for improved operation and maintenance of the rural water supply system, including ownership transfer, establishment of WUA, roles and responsibilities among stakeholders, and establishment of user fees.
- Formulate the executive organ of the WUA either through community election, nomination, or utilizing existing organizational structures in the community.

Stage 3: Participatory Planning

- Conduct “management” consultation with Jamoat, the WUA, community representatives, and state entities to discuss and select a possible and effective mode of ownership and management of the rural water supply system for improved sustainability, and to form general consensus on the selected mode of ownership and management.
- Conduct “operation” consultation with Jamoat, the WUA, community representatives, and state entities to discuss and determine conditions and standards, and tasks and duties of each stakeholder in the system operation.
- Conduct “maintenance” consultation with Jamoat, the WUA, community representatives, and state entities to discuss and determine conditions and standards, and tasks and duties of each stakeholder in system maintenance, categorizing these into service activities, routine and annual maintenance, and breakdown maintenance and replacement.
- Conduct “operation and maintenance cost” consultation with Jamoat, the WUA, community representatives, and state entities to discuss and determine the cost for operation and maintenance, and water fees for the user community. It also determines which stakeholder shall take responsibility to cover the following categories of the operation and maintenance cost, namely, system operation costs; system service costs; system routine and annual maintenance costs; major system component replacement costs, and investment recovery cost.
- Concluding memorandum of understanding among Jamoat, the WUA, community representatives, and state entities on the issues discussed and agreed in the consultations above.

- Identify the capacity gap and prepare a training plan for the WUA to satisfy the roles and responsibilities determined through a series of consultations.

Stage 4: Capacity Development of the WUA for Improved Operation and Maintenance

- Implement the training program for the WUA in accordance with the training plan prepared.

Stage 5: Operation and Maintenance, and Monitoring

- Monitor the performance of each stakeholder in their tasks and duties in operation and maintenance of the rural water supply system.
- Conduct follow-up consultation with stakeholders on the issues identified as weak in operation and maintenance.

CHAPTER 7 PUBLIC HEALTH

7.1 OVERVIEW

7.1.1 PROFILE OF POPULATION

The total population of Tajikistan is approximately 6.6 million (2006), of which about 25% lives in urban areas. The proportion of the population 0 to 14 years old, which slightly decreased in 1990s, is about 36% (2005) and relatively high in comparison to neighboring countries. On the contrary, the proportion of the population over 65 years old is the lowest among member countries of the Commonwealth of Independent States (CIS), and estimated to be 6% by 2030. According to WHO (2005), the life expectancy of the Tajik population is estimated to be 61 years for the both sexes, 59 for men and 63 for women. The official figures of life expectancy based on the regular registration of deaths in the country are more than ten years longer as shown in *Table 7.1.1*. This is mainly due to under-reported deaths of children, which can be generally observed in the Central Asia. The gap, however, is the biggest for Tajikistan among countries in the region.

Table 7.1.1 Selected Indicators of Demography

		Official statistics	WHO estimates
Total population (1000)		6591.0 (2006)	--
Proportion of 0 to 14 (%)		35.87 (2005)	--
Proportion of 15 to 64 (%)		59.72 (2005)	--
Proportion of over 65 (%)		4.41 (2005)	--
Urban population (%)		24.9 (2004)	--
Crude birth rate (per 1000 population)		26.15 (2005)	--
Crude death rate (per 1000 population)		4.18 (2005)	--
Natural population growth (per 1000 population)		23.0 (2001)	--
Life expectancy at birth (years)	Total	73.72 (2005)	61 (2005)
	Male	71.21 (2005)	59 (2005)
	Female	76.25 (2005)	63 (2005)

Source: Health for All Database, November 2007, WHO Regional Office for Europe
WHO (2005)

7.1.2 TRENDS IN MORTALITY

(1) Child Mortality

The infant mortality rate is the probability of dying between birth and one year of age shown per 1,000 live births, and the figures reported by the Ministry of Health of Tajikistan are 27.9 (2001), 17.2 (2002) and 13.5 (2003 and 2004). These are significantly lower than WHO estimates which is 51 (2004) and the results of other relevant surveys. The under-five mortality rate is the probability of dying between birth and five years of age shown in the same manner as the infant mortality rate. The under-five mortality rates reported by the Ministry of Health are 28 (2001), 17 (2002) and 14 (2003, 2004). Adjusting for the above mentioned bias, WHO calculated the under-five mortality rate of Tajikistan to be 86 (2001) and 63 (2002). According to the results of the Multiple Indicator Cluster Survey (MICS) by Tajikistan State Committee on Statistics and UNICEF, the figures were 89 (MICS 2000) and 65 (MICS 2005).

Table 7.1.2 Under-Five Mortality Rates in Tajikistan

	1997	1998	1999	2000	2001	2002	2003	2004
Official statistics	31	23	19	16	28	17	14	14
WHO estimates					86	63		
MICS2000/2005		89					65	

Source: Multiple Indicator Cluster Survey 2005, Tajikistan State Committee on Statistics/UNICEF
Highlights on Health in Tajikistan 2005, WHO Regional Office for Europe

(2) Maternal Mortality

The rate of maternal mortality, the deaths of women from pregnancy-related causes, when pregnant or within 42 days of termination of pregnancy, is shown per 100,000 live births. It is known that maternal mortality is difficult to ascertain even in countries with reliable vital statistics. Given the uncertainty of vital statistics in Tajikistan, the assessment of situation of maternal mortality in the country is quite difficult. Nevertheless, a tendency to progress can be seen between 1993, when the rate was 105 maternal deaths per 100,000 live births as a peak in early 1990s, and the recent years, when around 50 maternal deaths per 100,000 live births are reported in the country. The maternal mortality rate reported by MICS is 97 per 100,000 live births (2003). The adjusted figure by WHO is 100 per 100,000 live births (2005).

(3) Tendency of Mortality by Age Group

According to nationally reported statistics, non-communicable diseases (NCD) account for about 80% or more of all deaths in Tajikistan, while communicable diseases account for 5% or less. However, age-standardized death rates calculated by the WHO Regional Office for Europe suggests that the rate of death caused by communicable diseases and respiratory diseases, mainly pneumonia, is relatively higher, while those of NCDs are lower in Tajikistan than neighboring countries. Based on the age-standardized death rates for international comparison, WHO points out the following characteristics of mortality of Tajik population by age group.

In the group of 0 to 14 years of age, the mortality rate is higher than the neighboring countries, though it improved in the last decade. The reported deaths due to perinatal causes are relatively less but the number of non-registered deaths is considered high. The total mortality rate of the group of 15 to 29 years of age is considerably lower in comparison to neighboring countries mainly due to lower rates from external causes. In this age group, the levels of mortality from most causes of death have fallen below those of 1990. However, mortality from infectious and respiratory diseases is relatively high. In the 30 to 44 years age group, the situation is similar to the 15 to 29 years age group, although the levels of general mortality remain slightly higher than those of 1990. Same trends can be seen in the 45 to 50 years age group, and the mortality from all causes is lower than the average of Central Asian countries. Particularly the deaths from external causes and cardiovascular diseases in males are relatively less. Although the trends in the older age groups are less stable, the mortalities of those groups are considered almost average of the neighboring area.

7.1.3 BURDEN OF DISEASE

The disability-adjusted life-year (DALY) is used as a measure that combines the impact of illness, disability and mortality on population health. The top ten leading causes of total DALYs in Tajikistan calculated by WHO are shown in *Table 7.1.3*. Infectious and parasitic diseases are among top three causes as well as cardiovascular diseases and neuropsychiatric conditions for both sexes. This is characteristic of disease burden of Tajik population.

Table 7.1.3 Leading Causes of Total DALYs in Tajikistan (2002)

	Males		Females	
	Disability groups	DALYs (%)	Disability groups	DALYs (%)
1	Infectious and parasitic diseases	14.6	Neuropsychiatric conditions	16.7
2	Cardiovascular diseases	13.8	Cardiovascular diseases	14.9
3	Neuropsychiatric conditions	13.2	Infectious and parasitic diseases	13.6
4	Perinatal conditions	10.7	Respiratory infections	9.7
5	Unintentional injuries	9.9	Perinatal conditions	8.5
6	Respiratory infections	9.0	Digestive diseases	4.4
7	Intentional injuries	4.5	Maternal conditions	4.3
8	Digestive diseases	4.5	Nutritional deficiencies	4.2
9	Respiratory diseases	3.4	Respiratory diseases	3.9
10	Malignant neoplasms	3.2	Sense organ diseases	3.3

Source: WHO (2003)

Unsafe water, sanitation and hygiene are counted as the fourth leading risk factor of disease burden for both sexes in the country as shown in *Table 7.1.4*. Actually a considerable rate of reported cases of infections in Tajikistan is water-borne or caused by unsafe drinking water.

Table 7.1.4 Leading Risk Factors of Disease Burden in Tajikistan (2002)

	Males		Females	
	Risk factors	DALYs(%)	Risk factors	DALYs(%)
1	Alcohol	7.1	High blood pressure	6.6
2	High blood pressure	5.1	High BMI	6.2
3	High BMI	4.7	Indoor smoke from solid fuels	4.8
4	Unsafe water, sanitation, and hygiene	4.3	Unsafe water, sanitation, and hygiene	4.3
5	Tobacco	4.0	Childhood and maternal underweight	4.2
6	Childhood and maternal underweight	3.9	High cholesterol	3.2
7	High cholesterol	3.8	Iron deficiency	3.1
8	Indoor smoke from solid fuels	3.6	Alcohol	2.1
9	Low fruit and vegetable intake	1.9	Low fruit and vegetable intake	1.6
10	Physical inactivity	1.7	Physical inactivity	1.6

Source: WHO (2003)

A transition of disease patterns, i.e. a shift of main diseases from infectious diseases to NCDs, is already observed in Tajikistan as well as other member countries of the CIS. On the other hand, water-borne infections as well as malaria and other infections remain most important issues in the public health of the country, and it is problem of a great magnitude. Extraordinary low temperature in January and February 2008 revealed a latent problem due to the fragile water supply with little preparedness for disaster that suddenly and sharply increases the risk.

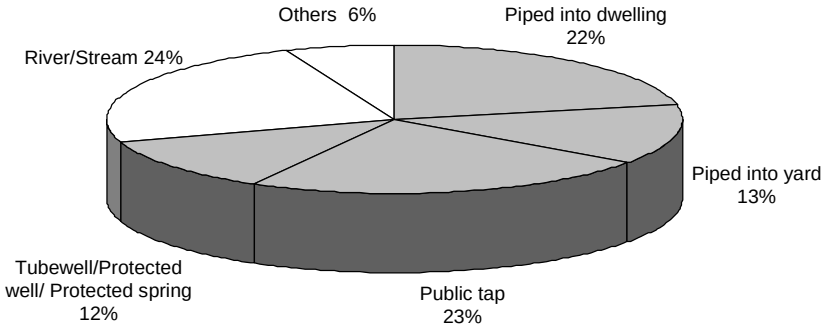
7.2 UNSAFE WATER, SANITATION AND HYGIENE

7.2.1 ACCESS TO DRINKING WATER

Water-borne diseases: diarrhea, typhoid, cholera, dysentery, hepatitis and others are significantly important issues in Tajikistan. They are evidently caused by the poor conditions of water in the country, although an epidemiological assessment of the exact situation is not available.

The assessment of water supply and sanitation in 2000 by WHO/UNICEF found the distribution of the Tajik population by source of drinking water as shown in *Figure 7.2.1*. Overall 70% of the population, 93% in urban areas and 61% in rural, has access to piped water, public taps,

borehole/tubewell or protected well/spring/rainwater, which are defined as improved sources of drinking water by UNICEF, and the ratio has increased in the last several years.



Source: Multiple Indicator Cluster Survey 2005, Tajikistan State Committee on Statistics/UNICEF

Figure 7.2.1 Distribution of Population by Source of Drinking Water (2005)

According to the national report in 2005, 99% of the population in Dushanbe uses piped water. The quality, however, matters in view of sources and treatment of supplied water. The situation is considerably worse in Khatlon and GBAO regions. The total percentage of the population with access to the defined improved water is 51 to 55% and only 30% of population uses piped water in these regions.

7.2.2 SANITATION AND HYGIENE

In Tajikistan, more than 90% of households have a flush toilet connected to sewage system/septic tank/pit latrine, ventilated improved pit latrine, pit latrine with slab or composing toilet, which are defined as improved sanitation facilities by UNICEF. A majority or more than 70% of households in Dushanbe have a flush toilet piped to a sewer system, while a bigger proportion of them or more than 80% of households in Khatlon, Sogd and DRD regions have a pit latrine with slab. Another issue is personal hygiene, namely methods for disposal of waste water, garbage and animal excreta, manners of using public water, handling and storing of drinking water in households, hand washing and others. People's behavior such as taking their animals to and around sources of drinking water is a significant problem to be improved by raising their health awareness

7.3 FINDINGS ON KHATLON OBLAST FROM RECENT SURVEYS

In Khatlon Oblast with a population of approximately 2.5 million, the proportion of urban population is small and the rural population is 80 % or more: the general condition of the oblast is described in *Chapter 2*.

The annual number of reported malaria cases in Tajikistan peaked in 1997, when it reached nearly 30,000 cases. Since then, it has decreased to some 1,300 cases in 2006, but the malaria situation in the country remains serious. The total number of malaria cases within the country, including both symptomatic and asymptomatic cases, is estimated between 300,000 to 400,000. An area in Khatlon Oblast, which borders Afghanistan, is the area with high percentage of malaria, and the WHO Malaria Center considers that three quarters of reported malaria cases in Tajikistan occurred in Khatlon Oblast. According to a study in this area in 2001, more than 10% of the study population had asymptomatic parasite carriers of P.vivax and P.falciparum.

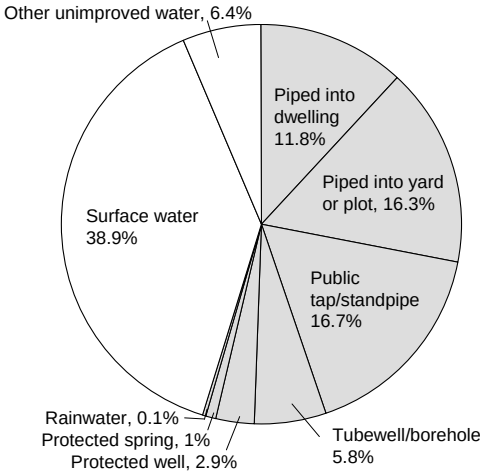
A survey on micronutrients status by the Ministry of Health of Tajikistan in 2003 raised the problems of anemia, deficiencies of iron/iodine/folic acid, child feeding and general food intake. At the time of the survey, the prevalence of anemia in Tajikistan was considered moderate to severe or 15 to 40%, and the result of the survey indicated that the prevalence is extremely high in

Khatlon Oblast being 63% of women in the reproductive age, and 52% of children in age of 6 to 59 months. A similar trend was reported on iodine deficiency in the oblast.

MICS 2005 by UNICEF reported that child mortality rate was higher in Khatlon Oblast than the other regions, and it was also suggested by another survey in 2004 using an adaptation of the standard verbal autopsy methods of WHO. The nutritional status of children was relatively worse in Khatlon and GBAO in Tajikistan. The proportion of households using adequately iodized salt was 27% in Khatlon, while the national average was 46%.

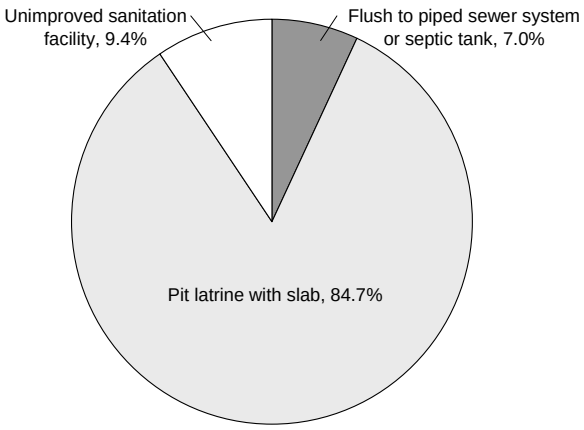
Given the risk of unsafe water, it is most important if possible health problems can be recognized and managed in the earliest stages at home. In this context, a level of home management of children's diarrhea, namely preventing dehydration and malnutrition by increasing fluid intake and continued feeding can be a useful indicator to understand the knowledge and practice of the general population. The percentage of practiced adequate home management of children's diarrhea is estimated to be low in Tajikistan and much lower in Khatlon Oblast though the latest figures by region are not available yet.

The distribution of household population in Khatlon Oblast by source of drinking water defined by UNICEF is shown in *Figure 7.3.1*. The distribution of household population in Khatlon Oblast by sanitation facility categorized by UNICEF is shown in *Figure 7.3.2*.



Source: Multiple Indicator Cluster Survey 2005, Tajikistan State Committee on Statistics/UNICEF

Figure 7.3.1 Distribution of Population by Source of Drinking Water in Khatlon Oblast (2005)



Source: Multiple Indicator Cluster Survey 2005, Tajikistan State Committee on Statistics/UNICEF

Figure 7.3.2 Distribution of Population by Sanitation Facility in Khatlon Oblast (2005)

45% of the population uses piped water into dwelling, yard/plot or public tap/standpipe. On the other hand, almost 40% uses surface water, and this proportion is bigger in Khatlon Oblast than any other region in the country. It is estimated that the appropriate treatment, namely boiling of drinking water, is practiced at some 80% of households regardless of water sources.

Most sanitation facilities are pit latrines with slabs in the oblast, and those of only seven percent of households are flush toilets piped to sewer systems (6.9%) or septic tanks (0.1%). The rest are pit latrines without slabs, open pits and others.

7.4 IMPORTANCE OF PEOPLE'S KNOWLEDGE AND PRACTICE

A pilot project to verify the proposed system of operation and maintenance was included in the second phase of the study as described in Chapter 6. Based on the findings of field surveys, it was recommended to develop the capacities of the Water User Association (WUA) and Kolkhoz as the operating bodies of rural water supply system, accordingly a component of their capacity development described in Chapter 7 was significant in the pilot project. In this context, knowledge and practice of people in the village, individual users of water, should be an important factor. People's utilizations of tap water would be prerequisite of satisfying effect of stable water supply. At the same time, their careful good uses of new taps as well should be indispensable conditions of sustainable operation and maintenance by WUA and Kolkhoz.

According to the above mentioned statistics provided by UNICEF, the ratio of population drinking surface water was around 40% in the area. It was considered, however, more population in the Bolshevik village drank water from canal, partially because their water supply system was out of order. It was likely because of their less awareness of safe drinking water. It was observed that a parent or other adults did not warn a child when he/she scooped up canal water with their hand and drinks, as if they were oblivious of cleanliness of water young children actually drank. In such circumstances, it was concerned that the people would not use the rehabilitated tapped water or would not pay for it. In fact, existing taps with no water were neglected in the village for long. These were almost simple jungle gyms for young children.

Public water taps can be used by everyone in the village. It is desired that rehabilitated water system will be utilized with understanding the importance of safe drinking water, and that good operation and maintenance by WUA and Kolkhoz will be supported by careful good use of rehabilitated taps.