AZERSU JOINT STOCK COMPANY (AZERSU JSC)

SPECIAL ASSISTANCE FOR PROJECT IMPLEMENTATION (SAPI) FOR THE PROVINCIAL CITIES WATER SUPPLY AND SEWERAGE PROJECT IN THE REPUBLIC OF AZERBAIJAN

FINAL REPORT

March 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

Tokyo Engineering Consultants, Co., Ltd.

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ABBREVIATION AND ACRONYMS

İXTİSARLAR VƏ AKRONİMLƏR

AZN	New Azerbaijani Manat	Yeni Azərbaycan Manatı	AZN
IDPs	Internal Displaced Persons	Məcburi Köçkünlər	MK-lər
JBIC	Japan Bank for International Cooperation	Yaponiya Beynəlxalaq Əməkdaşliq Bankı	JBIC
JICA	Japan International Cooperation Agency	Yaponiya Beynəlxalq Əməkdaşliq Agentliyi	JICA
JSC	Joint Stock Company	Səhmdar Cəmiyyət	SC
LEP	Local Executive Power	Yerli İcra Hakimiyyəti Orqanı	YİHO
O&M	Operation and Maintenance	İstismar və Texniki Xidmət	İTX
SPPRED	State Programme on Poverty Reduction and Economic Development	Yoxsulluğun Azaldılması və İqtisadi İnkişaf üzrə Dövlət Programı	YAİİDP
SPPRSD	State Programme on Poverty Reduction and Sustainable Development	Yoxsulluğun Azaldılması və İqtisadi İnkişaf üzrə Dövlət Programı	YAİİDP
WSS	Water Supply and Sanitation	Su Təchizatı və Kanalizasiya	STK

CURRENCY EQUIVALENTS	VALYUTA EKVİVALENTLƏRİ
(December 2009)	(December, 2009)
US$ 1.00 = AZN 0.80	1 ABŞ dolları = 0.80 AZN

EXECUTIVE SUMMARY

The existing water supply and sewerage facilities of provincial cities in the Republic of Azerbaijan were constructed in the former Soviet Union era. Since operation and maintenance of the facilities has not been done appropriately, the existing facilities have become decrepit, that resulted in malfunctioning of most facilities.

The Government of Azerbaijan recognize the rehabilitation of water supply system in the provincial cities as the highest priority. And in May 2007, the Azerbaijan Government requested to the Government of Japan for improvement of water supply and sewerage facilities and strengthening of project management as well as operation and maintenance techniques of the 10 provincial cities. JBIC implemented SAPROF study in 2007. The SAPROF Study, however, is required to be substantially reviewed since the facility plan and cost estimation was prepared provisionally. This Japanese Yen loan project was approved in May 2009. It is necessary to review the study result and update the current situation , since almost two years has passed after SAPROF Study.

The main objectives of the Study are as follows:

- To identify the current situation and examine the technical issues in the two provincial cities of Khachmaz and Gusar, among the target cities of the "Provincial Cities Water Supply and Sewerage Project" to be implemented under the Japanese Yen Loan
- To collect basic information necessary for detailed design after selection of the Consultants
- To realize prompt and smooth implementation of the project

Implementing Organizations of the Republic of Azerbaijan are: Azersu JSC, and Khachmaz Sukanal as well as Gusar Sukanal.

The Study areas are located at approx. 150-200 km north-west of Baku and situated at east foot of Greater Caucasus. The topography includes mainly diluvium plateau and alluvial plain which was eroded by several rivers flowing parallel from Greater Caucasus. The area belongs to subarctic humid climate zone. And annual precipitation is less than 400mm in Khachmaz and less than 600mm in Gusar. In winter season, the minimum temperature drops blow zero and there is snow fall.

After examination of hydro-geological conditions of the study area, spring water recharged by the Caucasus mountains are rich in potential in Khachmaz region and the spring water is concluded to be a valuable water source for urban water supply system. In Gusar, as spring water and groundwater potential is very small due to the narrow catchment area of Gusar river, it is concluded that Gusar riverbed water after filtration is a probable water source for water supply system.

The existing water supply systems of the study areas are summarized in Table-1.

Table-1 Summary of the Existing Water Supply System

Item	Khachmaz	Gusar
Service area	Khachmaz town: (38,500 persons, year 2009) Qaraqurtlu: (1,898 persons, year 2006) Qaraçı: (660 persons, year 2006)	Gusar town: (16,200 persons, year 2009) Çiləgir: (950 persons, year 2006) Həsənqələ: (872 persons, year 2006) Balaqusar: (1,382 persons, year 2006)
Population served	Approx. 14,500 persons (year 2009)	Approx. 12,166 persons (only Gusar town, year 2009)
Rate of population served	38.8 %	75.1 %
Number of registered customers	Domestic: 5,100 households (Khachmaz) 500 households (Qaraqurtlu, Qaraçı) Non-domestic: 231 customers	Domestic: 4,966 households - Permanent: 4,467 - Non-permanent: 499 Non-domestic: 165 customers - Government institute: 31 - Commercial: 133 - Industry: 1 (factory)
Water supply hours	Intermittent water supply	Intermittent water supply (Morning: 2 hours, Evening: 2 hours)
Water source	Dandali (constructed in 1954), Chakh-chakhly (in 1968), Uchgun (in 1978) and Ahmad springs	Gusar Riverbed Water (Left Bank of Gusar River, at 18km, 15km, 7km and 5km distance from the town) Groundwater (2 wells in Right Bank)
Production capacity	Design capacity: 21,900 m^3/day (254.2 L/sec, year 1978) Current capacity: 15,000 m^3/day	Estimated 8,000 m^3/day

Based on design criteria provided by Azersu and collected data in the Study, water supply plan is reviewed. The result of review is summarized in Table-2.

Table-2 Summary of Review of Water Supply Plan

Item	Khachmaz	Gusar
Target Year	Year 2030	Year 2030
Population Served (2030)	56,125 persons	26,110 persons
Domestic unit water demand	120 L/person/day	120 L/person/day
Average daily water demand	11,695 m^3/day	6,073 m^3/day
Maximum daily water demand	15,204 m^3/day	7,895 m^3/day

After examination of water source of Khachmaz, necessity of new water source development is identified since the existing Uchgun spring source has been decreasing in its production capacity. As the probable alternative water source, development of new Uchgun Spring source is recommended which is located north adjacent to the existing Uchgun Springfield. Exploitable capacity of the new Uchgun spring source is estimated to be approx. 9,000 m^3/day. And water quality is confirmed to be suitable for drinking. Rehabilitation work of the existing Uchgun spring source is very difficult as the existing intake can not be suspended. Thus, it is proposed that rehabilitation of the existing source is to be out of scope of the project and it should be used by reducing the production capacity.

As a result of examination on water supply system of Khachmaz, the gravity flow system is proposed that includes the aforementioned two water sources, transmission pipelines, service reservoirs with disinfection system and two distribution networks of high and low zones. Concept of the water supply facility plan is illustrated as Figure-1 and summarized in Table-3.

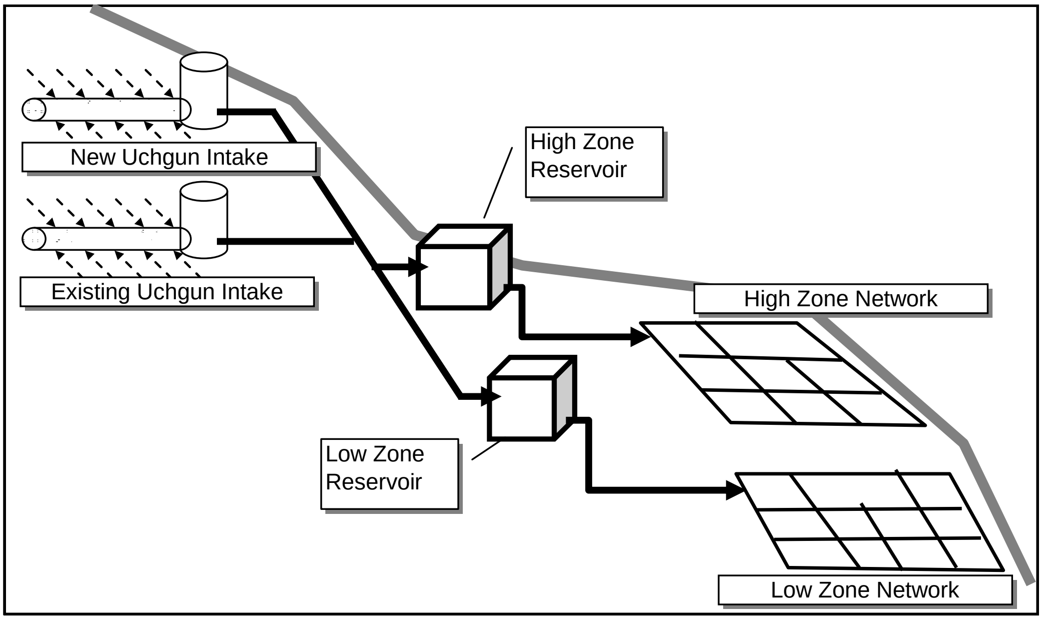

Figure-1 Concept of Water Supply System of Khachmaz

Table-3 Summary of Water Supply Facility of Khachmaz

	Specification/ Capacity
1) Water Intake Facility	
Existing Uchgun Spring Intake	− Perforated collecting pipe − Intake capacity: 6,000 m^3/day
New Uchgun Spring Intake	− Perforated collecting pipe − Intake capacity: 9,000 m^3/day
2) Transmission Facility	
Raw water transmission pipeline (Existing intake – connecting point A)	− GRP, Dia. 450mm x 0.5 km
Raw water transmission pipeline (New intake – connecting point A)	− GRP, Dia. 450mm x 1.3 km
Raw water transmission pipeline (Connecting point A – High zone reservoir)	− GRP, Dia. 450mm x 0.4 km

	Specification/ Capacity
Clear water transmission pipeline (High – low zone reservoir)	− HDPE, Dia. 355mm x 1.0 km
3) Service Reservoir	
High Zone Reservoir	− 3,500 m^3 x 2 tanks (water level gauge, flow meter) − Disinfection facility
Low Zone Reservoir	− 1,500 m^3 x 2 tanks (water level gauge, flow meter)
4) Distribution Pipeline	
High Zone Network	− Total Length: 101,472m (Dia. 80-500mm)
Low Zone Network	− Total Length: 49,700m (Dia. 80-400mm)

As the water source of Gusar, currently used Gusar riverbed water is proposed. Since the existing intake facilities are so old that new intake facilities are proposed to construct. Type and structure of the intake facility is proposed to be similar to the existing facilities. But some design modification is required such as water tightness to prevent the muddy water intrusion and preventive measures against erosion.

As the water supply system of Gusar, two independent systems of left and right bank of the Gusar river are proposed. And three distribution zones are proposed in the left bank system. Both system can be performed by gravity flow from intake to distribution. Disinfection facility is to be constructed in service reservoir. Concept of the water supply facility plan is illustrated as Figure-2 and summarized in Table-4.

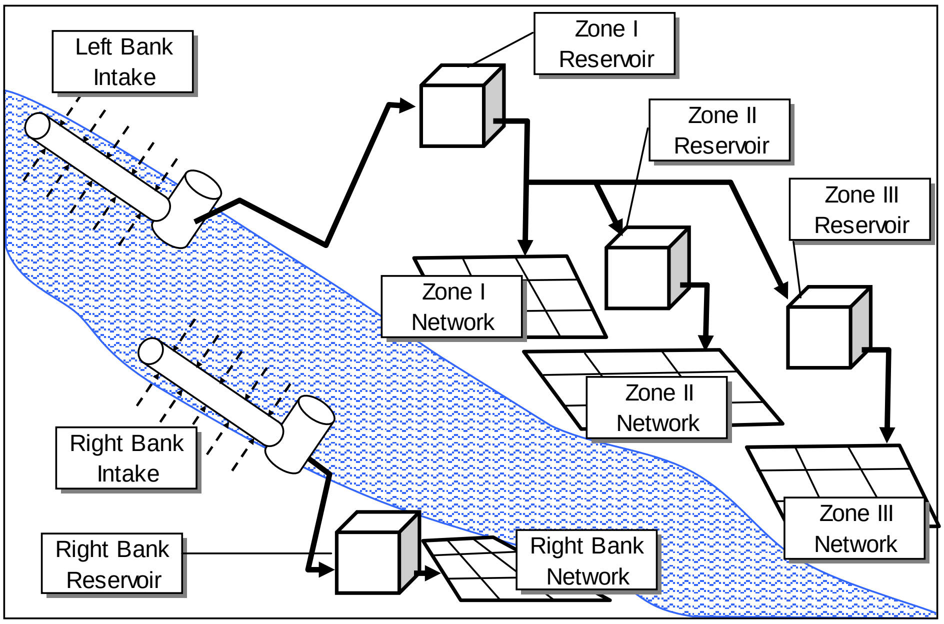

Figure-2 Concept of Water Supply System of Gusar

Table-4 Summary of Water Supply Facility of Gusar

	Specification/ Capacity
Left Bank System	
1) Water Intake Facility	
18km Riverbed Water Intake	− Perforated collecting pipe − Intake capacity: 7,900 m^3/day
2) Transmission Facility	
Raw water transmission pipeline (Left bank intake – Zone I reservoir)	− GRP, Dia. 400mm x 14.9 km
Clear water transmission pipeline (Zone I – Zone II reservoir)	− HDPE, Dia. 200mm x 0.3 km
Clear water transmission pipeline (Zone I – Zone III reservoir)	− HDPE, Dia. 180mm x 2.4 km
3) Service Reservoir	
Zone I Reservoir	− 1,000 m^3 x 2 tanks (water level gauge, flow meter) − Disinfection facility
Zone II Reservoir	− 1,000 m^3 x 2 tanks (water level gauge, flow meter)
Zone III Reservoir	− 700 m^3 x 2 tanks (water level gauge, flow meter)
4) Distribution Pipeline	
Zone I Network	− Total Length: 28,011m (Dia. 80-300mm)
Zone II Network	− Total Length: 35,099m (Dia. 80-300mm)
Zone III Network	− Total Length: 14,274 m (Dia. 80-250mm)
Right Bank System	
1) Intake Facility	
5km Riverbed Water Intake	− Perforated collecting pipe
2) Transmission Facility	
Raw water transmission pipeline (5km intake – Right bank reservoir point)	− HDPE, Dia. 140mm x 4.7km
3) Service Reservoir	
Right Bank Reservoir	− 500 m^3 x 1 tank (water level gauge, flow meter) − Disinfection facility
4) Distribution Pipeline	
Right Bank Network	− Total Length: 7,552 m (Dia. 80-200mm)

As a result of review of construction cost estimation, that of Khachmaz and Gusar is estimated to be JPY1,366 million and JPY 1,147 million respectively, which is approx. 25% up from the estimation of the SAPROF report. It seems that the cost increase is caused mainly by increased pipe length. Construction period is estimated to be approx. 30 months in Khachmaz and 28 months in Gusar.

For the implementation of the Project, “Project Management Unit (PMU)” and “Project Implementation Unit (PIU)” will be established under Azersu JSC to be responsible for overall project management and supervising construction. Operation and maintenance of the water supply facilities will be carried out by Sukanal of each province, who is also currently engaged in. Since the current O&M practice of Sukanals is generally insufficient, comprehensive capacity development program is recommended which includes upgrading of billing and revenue collection, in addition to technical training for O&M of the facilities to be provided under the JICA project.

The following items are pointed out as the recommendations:

- Review of the all project cost to examine countermeasure
- Cost reduction
- Coordination meeting
- Capacity development

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FINAL REPORT

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CHAPTER 1 INTRODUCTION

1.1 Background

With regard to water supply and sewerage sector in the Republic of Azerbaijan, water supply coverage ratio of the capital city of Baku is estimated to be 95%, while that of provincial cities is only approx. 33% and 24hours continuous water supply is not performed in the most cities. The existing water supply and sewerage facilities were constructed in the former Soviet Union era. However, operation and maintenance of the facilities was not done appropriately due to lack of finance since several years back from the year 1991 when the former Soviet Union collapsed. As a result, the water supply facilities including pipes and machineries have become decrepit and repair and rehabilitation has not been done properly, that resulted in malfunctioning of most facilities.

In the action plan of “The State Program for Poverty Reduction and Economic Development (SPPRED)”, which is the national program for economic development and poverty reduction issued in 2003, rehabilitation of water supply system in the provincial cities are listed as one of the highest priority issues. Also, in the “State Program on Socio-Economic Development of Regions of Azerbaijan Republic, 2004－2008”, which was prepared for socio-economic development of every provincial city in accordance with SPPRED, improvement of the public services including water supply is raised as the main issue to solve.

Under the circumstances, in May 2007, the Government of Azerbaijan requested to the Government of Japan for improvement of water supply and sewerage facilities (new construction and rehabilitation) and strengthening of project management as well as operation and maintenance techniques in the 10 provincial cities, namely Sirvan, Salyan, Neftchala, Khachmaz, Barda, Yevlakh, Khizi, Gusar, Gobustan and Naftalan. In response to that, the former JBIC (currently merged into new JICA) implemented SAPROF study from August until November 2007 in order that water demand and cost estimation was technically examined. The SAPROF study, however, is required to be substantially reviewed, since the study has been done in a short period, and the facility plan and cost estimation was provisional. This Japanese Yen loan project was approved in May 2009. It is necessary to review the study result and update the current situation, since almost two years have passed after SAPROF Study.

The SAPI study is to be implemented in parallel with selection of the Consultants for the loan project, in order to utilize time effectively. The main objectives of the SAPI Study are to identify the current situation and examine the technical issues in the two provincial cities of Khachmaz and

Gusar, to collect basic information necessary for detailed design after selection of the Consultants, and to realize prompt and smooth implementation of the project.

1.2 Objectives of the Study

The main objectives of the Study are as follows:

- To identify the current situation and examine the technical issues in the two provincial cities of Khachmaz and Gusar, among the target cities of the “Provincial Cities Water Supply and Sewerage Project” to be implemented under the Japanese Yen Loan
- To collect basic information necessary for detailed design after selection of the Consultants
- To realize prompt and smooth implementation of the project

1.3 Study Area

The Study Areas are Khachmaz and Gusar of the Republic of Azerbaijan. Location map of the Study Area is shown in the following page.

Location Map of the Study Area

1.4 Implementing Organization of the Republic of Azerbaijan

Implementing Organization: Azersu JSC, and Khachmaz Sukanal as well as Gusar Sukanal

1.5 Member of the Study Team

The JICA Study Team is composed of the following members.

Name	Assignment	Company
1 Mr. Naoto Tohda	Team Leader	Tokyo Engineering Consultants, Co., Ltd. (Japan)
2 Mr. Komei Ozaki	Hydrogeologist/ Intake Facility Designer	Tokyo Engineering Consultants, Co., Ltd. (Japan)
3 Mr. Hiroshi Kobayashi	Civil Engineer/ Structural Engineer	Tokyo Engineering Consultants, Co., Ltd. (Japan)
4 Mr. Sermet Adiguzel	Pipeline Facility Engineer	DOLSAR Engineering Limited (Turkey)
5 Mr. Burhan Arioz	Mechanical and Electrical Facility Engineer	DOLSAR Engineering Limited (Turkey)
6 Mr. Isao Masui	Procurement Planner/ Cost Estimator	Tokyo Engineering Consultants, Co., Ltd. (Japan)

1.6 Study Schedule

The Study is implemented by the following five steps.

[1] Domestic preparation work — Beginning of October 2009
[2] The first field survey — October – November 2009
[3] Domestic work — December 2009
[4] The second field survey — February – March 2010
[5] Domestic finalization work — March 2010

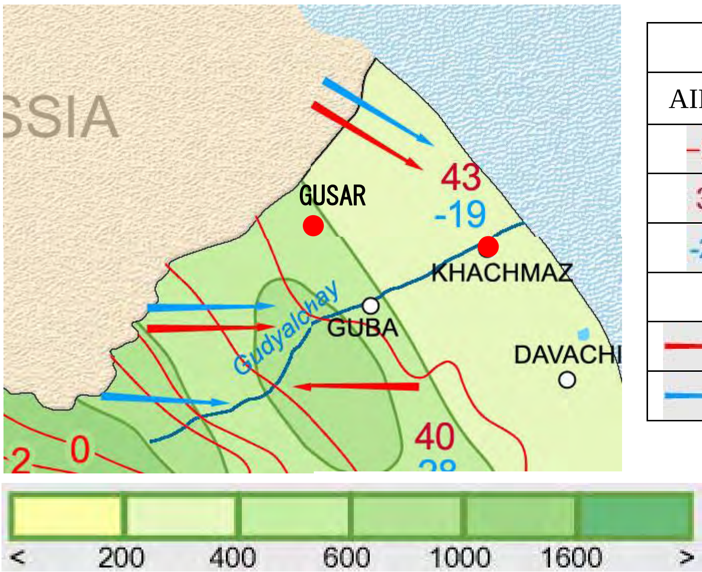
CHAPTER 2 CURRENT SITUATION

2.1 Natural Conditions

2.1.1 Climate

The study area is located in subarctic humid climate zone and it is relatively mild and moist climate throughout the year in Azerbaijan. As shown in Figure 2.1, annual precipitation is less than 400mm in Khachmaz and less than 600mm in Gusar.

Major rivers in the water system over the both city flows from Greater Caucasus in south-west of the study area to Caspian Sea in north-east. Greater Caucasus as source of water system of the study area receives 1,000mm to 1,600mm of rain annually, therefore major rivers are flowing throughout the year.



Conventional signs	
AIR TEMPERATURE (Centigrade)	
-2-	middle annual isotherms
37	absolute maximum
-23	absolute minimum
WIND DIRECTIONS	
(red arrow)	in July
(blue arrow)	in January

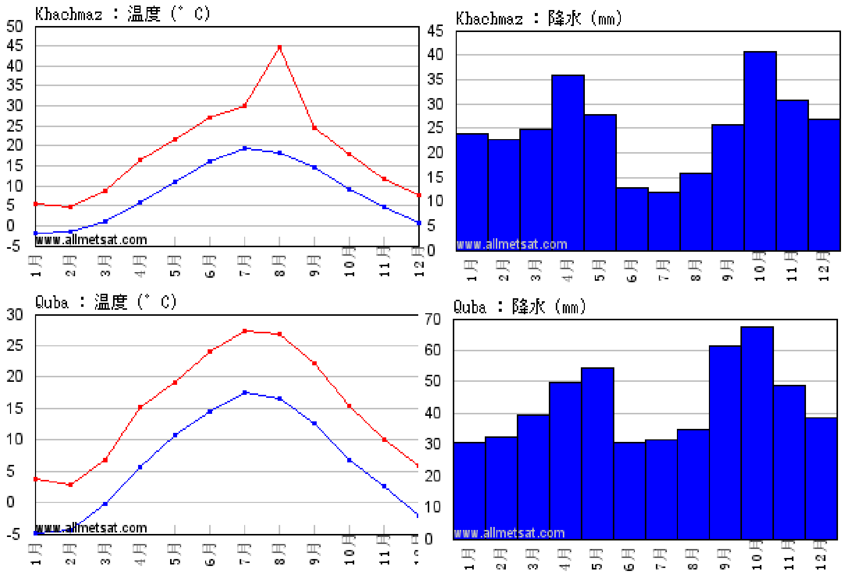
Source: Heydar Aliyev Foundation

Figure 2.1 Distribution map of an annual rainfall of the study area

Monthly mean temperature and rainfall of Khachmaz and Guba is shown in Figure 2.2. According to field survey and interview to Sukanal about on climate conditions, the following issues are concerned for construction works.

- Maximum river flow is observed in May and September. The highest water level from the riverbed reaches to approx. 3m which vary with meteorological conditions of the year.

- River bank and river bed of major rivers are conspicuously eroded by flooding.
- It is difficult to cross over a dirt road by standard car when unpaved road becomes soft after rainfall that is remarkable in around of Khachmaz.
- River flows water throughout the year. It has seasonal fluctuation.
- There is affected by drop to below freezing in the field from December to February.
- Usually there is about 60cm snow coverage in Gusar area after November. Therefore construction and survey works in the area shall be planned in consideration of winter conditions.
- It is difficult to cross over a road by a standard car when snow coverage in Khachmaz.



Fuiger 2.2 Monthly mean temperature and rainfall of Khachmaz and Quba (source: Allmetsat)

2.1.2 Topography and Geology

(1) Topography

Greater Caucasus dominates in west to north border of Azerbaijan while Lesser Caucasus running through in south of the country that on the Caspian Sea in east. Kura basin is located between Greater Caucasus and Lesser Caucasus where in the water system of Caspian Sea. Khachmaz and Gusar are located in Gusar plain at east foot of Greater

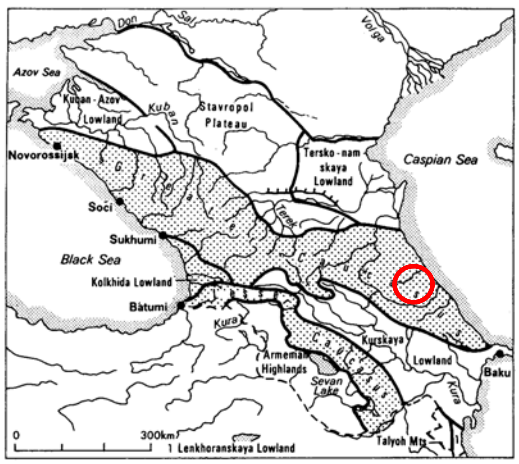
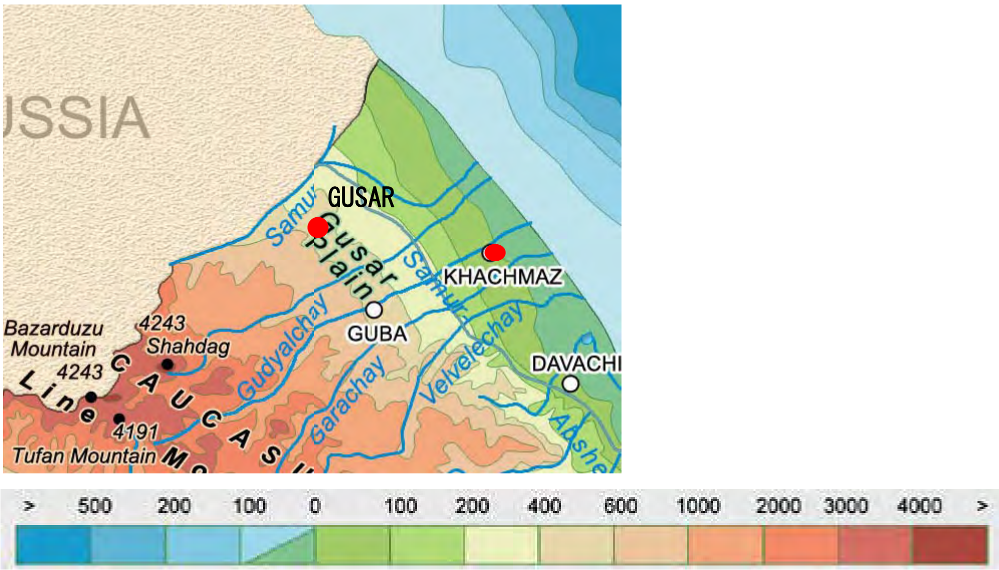


Figure 2.3 Topographical division map of Azerbaijan (Geomorphology of Europe, 1984)

Caucasus (see Fig. 2.3. Red marked is the study area.).

The topography in the study area includes mainly diluvium plateau and alluvial plain which was eroded by several rivers flowing parallel from Greater Caucasus to Caspian Sea (see Fig. 2.4. Red marked is the study area.).



Source: Heydar Aliyev Foundation

Figure 2.4 Topography of the study area.

Topographical feature of the study area are outlined as follows (see Table 2.1).

1) Topographical feature of Khachmaz

Khachmaz locates in the alluvial plain, and a river flowing from south-west to north-east both side of north and south of the urban area. The urban area is divided between the central part of the city and Old-Khachmaz area at River Gudyal. River Gudyal is about 50m in width and 5m in height of river bank in the urban area.

Uchgun spring field locates along the boundary between alluvial plain and diluvium plateau in south-west of the urban area. Terrace cliff has eroded and some part of it has been exposed. Therefore, the boundary is not clear. Many spring water points are distributed around the boundary.

The urban area and surrounding it is moderately sloping from south-west to north-east. Braided stream is distributed in the area. Some of rivers gradually sink in the downstream. A valley head of stream formulates spring water source such as Uchgun spring water.

2) Topographical feature of Gusar

Both banks of River Gusar were divided into many flat terraces. The urban area is located on a terrace, and it is divided between left bank and right bank at River Gusar.

River terrace continues from the urban area to upstream that the height from riverbed to terrace surface is maximum about 50m with nearly vertical cliff. The urban area is moderately sloping from south-west to north-east parallel to riverbed.

Table 2.1 Topographical feature of the study area

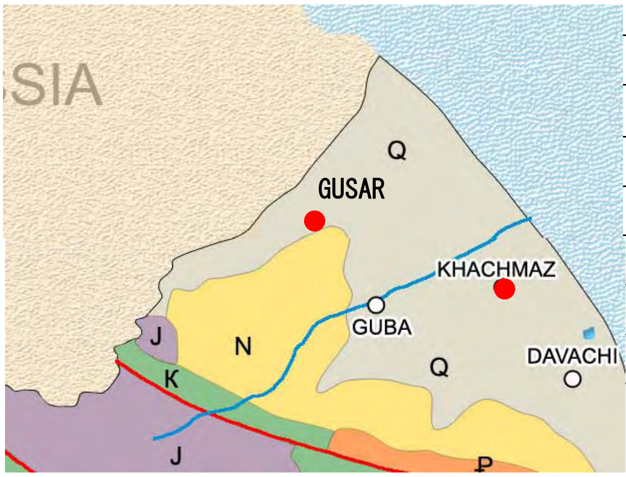
Study area	Topography	Zone	Feature
Khachmaz	Alluvial plain (urban area)	The whole urban area is located. Gudyal river flows through north of the urban area.	Moderately sloping from south-west to north-east. The urban area is divided into two area where central part of the city and Old-Khachmaz at Gudyal river. The river is about 50m width and 5m high from river-bed to a road level.
	Diluvium plateau (southwest of the urban area)	This plateau is located southwest of the the urban area. Uchgun springs are located along the boundary between alluvial plain and diluvium plateau.	The boundary is not clear. Terrace cliff has eroded and some part of it has been exposed. Many spring water are distributed along the boundary. Valley head of stream formulates spring water source. Braided stream is distributed in the area. Some of rivers gradually sink in the downstream.
Gusar	Gusar river	The river flows into Caspian sea from the greater Caucasus through Gusar city.	The river width is about 50m to 100m. The city area moderately sloping from south-west to north-east parallel with riverbed and lower surface level terraced to the river.
	River terrace (depositional terrace)	Several terrace surfaces are distributed along Gusar river.	The city is located on a terrace surface and divided between left bank and right bank at Gusar river. Major terrace in the area is diluvium. These terraces continue to the hilly area which forms ridge line of both side of Gusar river.
		River terrace continuance to upstream from the urban area.	The height from river-bed to terrace surface is maximum about 50m with nearly vertical cliff.

Study area	Topography	Zone	Feature
	Hilly area	Around ridge lines of both side are on a parallel with Gusar river is hilly area.	Ridge line of the hilly area is the dividing ridge of Gusar river water system. The ridge line forms hog-backed. There is deciduous tree across the hilly area.

(2) Geology

According to the result of field survey, geological feature of the study area is summarized below. Also, Table 2.2 shows geological future of the study area.

Eastern part of Greater Caucasus is composed of mainly Jurassic shale and Cretaceous limestone. Basic rock underling hilly area and plateau in the study area is composed of mainly Neocene sedimentary rock. The Quaternary overlying the basic rock is extensively distributed in this area (see Fig. 2.5).



Conventional signs	
Q	Fourth era sediments
N	Neogene sediments
Ꝑ	Palaeogene sediments
K	Lime sediments
J	Jura sediments
(red line)	Tectonic cracks

Source: Heydar Aliyev Foundation

Figure 2.5 Geological map of the study area.

1) Geological feature of Khachmaz

Topographical feature of Khachamz is reflected in geology of the area. The area covers from in the middle of the Uchgun Spring Field and Khachmaz Sukanal office to Caspian Sea is alluvial plain that consist of mainly sandy layer. Thickness of the alluvial layer is more than 7m at riverbed in the area.

In contrast, the area higher than Uchgun Spring Field consists of mainly politic layer of diluvium and it forms upland or hill. The politic layer is composed of muddy layer and sandy layer with thickness of about 5m at Uchgun Spring Field. It is low-permeable layer.

Gravel layer occurs as permeable layer, well-rounded with ranging in size 1cm to 2cm under the politic layer. Spring water in Uchgun Spring Field originates from this gravel layer. This gravel appears at some riverbed of stream or spring point.

2) Geological feature of Gusar

The urban area locates on several terraces along River Gusar. Major terrace in the area is composed of mainly diluvium terrace deposits. This terrace deposits occurs clearly along the river side and continue to upstream for several kilometers with maximum about 50m in height. Talus cone deposit is distributed at the bottom of terrace cliff with several meters in height.

The politic layer consists mainly of mud with gravel and sand, occurs surface along the ridge line or a valley in the area where higher than terrace.

The riverbed deposits of River Gusar consist of mainly gravel with bolder and sand. The grain size distribution in the riverbed is irregular. A bolder with the maximum diameter is more than 1m occurs in places along the junction of River Gusar brunch. It seems a bolder is provided from a brunch of the river. Some of brunches in the both side of the river form small an alluvial fan at around the junction in the riverbed.

In experience of the existing facility, in the riverbed, a low-permeability layer such as muddy sediment exists in 5-7 meters in depth.

There is not flood deposit in the riverbed within about 18km from the urban area to upstream.

Table 2.2 Geological feature of the study area

Age	Stratum	Geology	Distribution	
			Khachmaz	Gusar
Quaternary	Alluvium	Mainly sandy layer (alternate layer of gravel, sand and clay)	From Uchgun Spring field to all over the urban area.	Surface and terrace
	Riverbed deposit	Mainly gravely layer (Boulder to sand, and clay)	Riverbed such as Gudyal river	Riverbed of Gusar river. There is not mud-flow deposit.
	Diluvium (Terrace	Terrace sand and gravel	—	Major terrace

Age	Stratum	Geology	Distribution	
			Khachmaz	Gusar
	deposit)			
	Diluvium (Diluvium upland and hill)	Mainly politic layer (alternate layer of gravel, sand and clay)	An area higher than Uchgun Spring Field	Along ridge line of both side of Gusar river
Neocene	Basement rock	Alternation (conglomerate, sandstone, mudstone)	unconfirmed	unconfirmed

2.1.3 Hydro-geology

(1) Hydro-geological Basin

According to the Geology Institute of Azerbaijan, Azerbaijan is divided into three major hydro-geological basins (see Figure 2.6). And three major basins are subdivided into 16 regions.

The three major hydro-geological basins are listed below.

I. Greater Caucasus Basin (from north-east foot of Greater Caucasus to Caspian Sea)
II. Kura Depression Basin (from Kura basin to Caspian Sea)
III. Lesser Caucasus Basin (Lesser Caucasus and surrounding area)

According to the hydro-geological division, Khachmaz and Gusar are placed in Gusar region in Greater Caucasus Bain (see Figure 2.6 and Table 2.3).

(2) Feature of groundwater in the study area.

In Gusra region, thick continental series is aquifer with high content of Br, B has been revealed in Mesozoic-Cenozoic deposits. Groundwater is widely used for water supply in cities.

(3) Utilization and development potential of groundwater in the study area.

As shown in Table 2.2, The Geology Institute of Azerbaijan estimated an amount of exploitation reserves of groundwater in Gusar

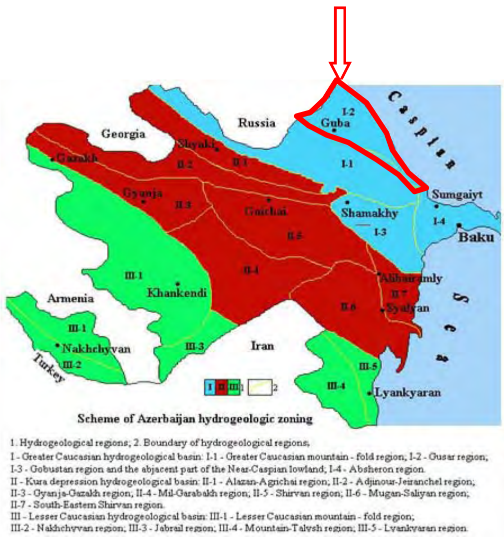


Figure 2.6 Hydrogeological map of Azerbaijan
（Geology Institute, ANAS)

region is about 3,470,000m^3/day. About 49% of the reserves that amount is about 1,686,00m^3/day are approved to develop.

Present use of groundwater is 375,600m^3/day for economic-drinking needs and irrigation, technical needs are 31,100m^3/day. A total 406,700m^3/day, about 24% of exploitation reserves is used.

It is estimated that approx. 1,279,300m^3/day of other reserves is available.

Table 2.3 Relationship between the study area and Azerbaijan hydro-geological Zoning

Basin*	Region*	Groundwater, th. m^3/d *				Study Area
		Exploitation reserves		Used at present		
		Forecasted	Approved by Commission on reserved	Economic - drinking needs	Irrigation, technical needs	
I. Greater Caucasus Basin	I.1. Greater Caucasus mountain-folded region	1008.87	17.7	7.8	12.4	
	I.2. Gusar region	**3470.72**	**1686.1**	**375.6**	**31.1**	**Khachmaz Gusar**
	I.3. Gobustan region	not estimated	not approved	2.5	1.9	
	I.4. Absharon region	241.92	0.3	0.1	0.4	
II. Kura depression basin	II.1. Azer - Agrichal region	3822.0	2000.0	32.7	263.3	
	II.2. Ajinour – Jeiranchel region	not estimated	not approved	-	-	
	II.3. Gyanja – Gazakh resion region	4218.6	4218.6	91.3	751.3	
	II.4. Mil – Garabakh region	7909.92	2231.5	63.9	1212.3	
	II.5. Shirvan region	517.7	517.7	20.5	14.0	
	II.6. Mugan – Salyan region	130.0	76.0	7.2	5.8	
	II.7.South-east Shirvan resion	waters are highly mineralized and are mot to be used				
III. Lesser Caucasus basin	III.1. Lesser Caucasus mountain-fold region	989.35	98.9	3.7	3.1	
	III.2. Nakhchyvan region	902.2	902.2	56.1	85.9	
	III.3. Jabrall region	344.0	234.6	Occupied territory	Occupied territory	
	III.4. Mountain-Talysh region	Include this region in Lesser Caucasus mountain-fold region (III.1.).				
	III.5. Lyankyaran region	209.0	86.0	13.0	48.3	

Note)* Azerbaijan hydro-geological Zoning （Azerbaijan National Academy of Sciences GEOLOGY INSTITUTE）

(4) Hydro-geological conditions of Khachmaz and Gusar

According to the result of field survey, the hydro-geological conditions for drinking water source such as surface water, riverbed water, spring water and groundwater in Khachmaz and Gusar are summarized below (see Table 2.4).

1) Hydro-geological Conditions of Khachmaz

Water source of Khacaz are envisaged to be surface water (riverbed water), spring water and groundwater (artesian water). Given this, it is assumed that riverbed water is not suitable for drinking water source on account of water pollution from the densely inhabited areas in the upstream, such as Guba. Khachmaz town is situated on alluvial plain composed of alluvial sediments. It is said that groundwater in town has rich potential. As the aquifer is formed by the unconsolidated alluvial layer, excessive pumping of groundwater for long term might cause land subsidence. Excessive pumping more than natural groundwater recharge value for long term might be leading to polluted water intrusion in the urban area and a cause of groundwater pollution.

The Uchgun Springfield is permanently recharged by the mountainous area and water flows according to the terrain. The new Uchgun Springfield is located approx. 1km north adjacent to the existing Uchgun spring source. The hydrological conditions are same as the existing Uchgun Spring field. According to the result of water flow measurement in the downstream of the new Uchgun Spring field, the amount of water intake is estimated 13,000m^3/day. Consequently, it is concluded that Uchgun Springfield is a quite valuable water source.

2) Hydro-geological Conditions of Gusar

As the water source of Gusar, riverbed water, spring water and groundwater is considered. Spring water at around riverbed or terrace cliff line and wells are used only in the small water supply system. Among them, spring water and groundwater is excluded since they have too low potential as the drinking water source of Gusar.

The surface water is muddy due to intrusion of fine particles, such as mud and fine sands, caused by erosion in the upstream. It is therefore not practical to use surface water or drinking water source without treatment. In experience of the existing facility, the surface water is naturally filtered through penetration into the riverbed sediments and clean water to be suitable for water source. Consequently, it is concluded that Gusar riverbed water after natural filtration is a quite valuable water source.

Table2.4 Water source and Hydro-geological condition of Khachmaz and Gusar

Water source	Hydro-geological conditions	
	Khachmaz	Gusar
Surface water and riverbed water	1) Aquifer is composed of riverbed deposits. 2) River comes from Greater Caucasus and rain fall in the water system is source of river. 3) Sewage contamination in the upstream.	1) Aquifer is composed of riverbed deposits. 2) River comes from Greater Caucasus. The surface water is muddy caused by erosion in the upstream. 3) Riverbed water after natural filtration is a quite valuable water source and it has been used.
Spring water	1) Aquifer is composed of diluvium gravel layer. 2) Rainfall and surface water in the area includes Greater Caucasus is water source. 3) There is a lot of spring water in Uchgun area.	1) Aquifer is composed of diluvium terrace deposits. 2) Rainfall and surface water in the area ia water source. Spring water is located along cliff line in the riverbed. 3) It has too low potential as the drinking water source.
Groundwater	1) Aquifer is composed of mainly alluvium gravel layer. 2) Rainfall and surface water in the area includes Greater Caucasus is water source. 3) Long term exploitation might cause land subsidence.	1) Aquifer is composed of diluvium terrace deposits. 2) Rainfall and surface water in the area is water source. Basin area is too small. 3) It has too low potential as the drinking water source.

Note: 1) Feature of aquifer
2) Recharge system
3) Points of concern

2.2 Existing Water Supply Systems

2.2.1 Khachmaz

The existing water supply system is summarized in the Table 2.5.

Table 2.5 Summary of the Existing Water Supply System of Khachmaz

	Item	Description	Remarks
[1]	Service area	Khachmaz town: (38,500 persons, year 2009) Qaraqurtlu: (1,898 persons, year 2006) Qaraçı: (660 persons, year 2006)	Population data of the State Statistical Committee (No. 5/2-103, 2008)
[2]	Population served	Approx. 14,500 persons (year 2009)	Estimated by Sukanal
[3]	Rate of population served	38.8 %	[3] = [2] / [1]
[4]	Number of registered	Domestic: 5,100 households (Khachmaz)	Approx. half of non-registered customers

	Item	Description	Remarks
	customers	500 households (Qaraqurtlu, Qaraçı) Non-domestic: 231 customers	have own wells. And the other half reportedly connect illegally without registration. Railway department of has own water supply system with the production capacity of 2,000 m^3/day. Some households are also supplied by the railway system.
[5]	Water supply hours	Intermittent water supply	
[6]	Water source	Dandali (constructed in 1954), Chakh-chakhly (in 1968), Uchgun (in 1978) and Ahmad springs	
[7]	Production capacity	Design capacity: 21,900 m^3/day (254.2 L/sec, year 1978) Current capacity: 15,000 m^3/day	Design capacity is as of year 1978 when the existing Uchgun spring water intake was constructed. Current capacity is estimated by the Study Team.
[8]	Characteristic of raw water quality	Suitable to drink	
[9]	Water treatment plant	Not required. Disinfection is currently not performed.	
[10]	Service reservoir	3,000 m^3 x 2 tanks (for higher zone at Sukanal Office site) 1,000 m^3 x 2 tanks (for lower zone near town rotary)	
[11]	Distribution	Gravity water supply Distribution pipe network - Primary distribution main pipe (Steel pipe, Cast iron) Dia. 630mm x 1.7km, 530mm x 1.7km, 325mm x 3.4km, 279mm x 3km, 219mm x 25.9km - Secondary pipe (Steel pipe and cast iron) Dia. 114mm x 12km, Dia. 89-76mm x 22.5km Leakage: More than 50%	
[12]	Water meter	Domestic: 700 nos. Non-domestic: 250 nos.	
[13]	Number of Staff	Head office: 10 staff Accounting: 4 staff Customer Service: 18 staff Water Supply O&M: 22 staff Sewerage O&M: 6 staff Total: 60 staff	Information by Sukanal (2009) Total staff number consists of 53 staff for Khachmaz and 7 staff for Xudat.
[14]	Billing consumption	Total: 130,000 m^3/month - Domestic: 80,000 m^3/month	

	Item	Description	Remarks
		- Non-domestic: 50,000 m^3/month	
[15]	Mode of payment	Cash payment to inspector (meter reader), Bank payment, Partial payment is accepted Approx. 72% of domestic customer reply to the bill properly. The rest 28 % have difficulty but respond anyway.	

2.2.2 Gusar

The existing water supply system is summarized in the Table 2.6.

Table 2.6 Summary of the Existing Water Supply System of Gusar

	Item	Description	Remarks
[1]	Service area	Gusar town: (16,200 persons, year 2009) Çiləgir: (950 persons, year 2006) Həsənqələ: (872 persons, year 2006) Balaqusar: (1,382 persons, year 2006)	Population data of the State Statistical Committee (No. 5/2-103, 2008) Water supply system for the 3 villages are independent from Gusar system.
[2]	Population served	Approx. 12,166 persons (only Gusar town, year 2009)	Estimated by Sukanal - 11,667 persons as the permanent inhabitant - 499 persons as the non-permanent inhabitant
[3]	Rate of population served	75.1 %	[3] = [2] / [1] (only Gusar population)
[4]	Number of registered customers	Domestic: 4,966 households - Permanent: 4,467 - Non-permanent: 499 Non-domestic: 165 customers - Government institute: 31 - Commercial: 133 - Industry: 1 (factory)	
[5]	Water supply hours	Intermittent water supply (Morning: 2 hours, Evening: 2 hours)	
[6]	Water source	Gusar Riverbed Water (Left Bank of Gusar River, at 18km, 15km, 7km and 5km distance from the town) Groundwater (2 wells in Right Bank)	
[7]	Production capacity	Estimated 8,000 m^3/day	Estimation by the Study Team, considering the fact that 7 tanks of 500m^3 (total 3500 m^3) are filled-up during night time (10 hours).
[8]	Characteristic of raw water quality	Suitable to drink (Water contamination is reported when river flow swells and water intrusion	

	Item	Description	Remarks
		from the top of the connection chamber of the intake)	
[9]	Water treatment plant	Not required. Disinfection is currently not performed.	
[10]	Service reservoir	500 m^3 x 5 tanks (for the highest zone) 500 m^3 x 2 tanks (for the second highest zone) 500 m^3 x 2 tanks (for lower zone) No reservoir in the right bank	
[11]	Distribution	Gravity water supply Raw water transmission: - Yukhari Leyel route : SP Dia.200mmx 18km - Cilegir route : SP Dia.200mm x 7km - Garabowa route : SP Dia.300mm x 5km Distribution pipeline: - SP : 70-80%, DIP : 20-30% - Diameter : 76-114mm - Total length: 70-80km	
[12]	Water meter	Domestic: 287 nos. (including 100 mulfunctioning meters) Non-domestic: - 65 nos. (commercial) - 12 nos. (government institution)	
[13]	Number of Staff	Head office: 9 staff Accounting: 2 staff Customer Service: 4 staff Water Supply O&M: 44 staff Sewerage O&M: 11 staff Bill collector: 9 Total: 79 staff	Information by Sukanal (2009)
[14]	Billing consumption	Total: 120,000 m^3/month - Domestic: 109,240 m^3/month - Non-domestic: 10,760 m^3/month - Institution: 7,160 m^3/month - Commercial: 2,277 m^3/month - Factory: 1,260 m^3/month	Information by Sukanal as of September 2009 It should be noted that consumption are calculated by norm, since most customers are not installed with water meter.
[15]	Mode of payment	Cash payment to inspector (meter reader), Bank payment, Partial payment is accepted Approx. 95% of domestic customer reply to the bill properly.	

2.3 Conditions Related to Facility Design and Construction

2.3.1 Applicable Standard and Criteria

(1) Drinking water quality standard

GOST 2874-82 has been used as the drinking water quality standard of Azerbaijan. On the other hand, an official opinion was presented by the deputy prime minister of Azerbaijan in April 2009; that application of European standards should be considered in development of project documents within the framework of activities for reconstruction of water supply and sewerage systems. Azersu also applies the EU Council Directive 98/83/EC as the drinking water quality parameters to be referred in implementing international donor funded projects.

Taking into account of the above, European standard (EU98/83/EC on quality of water intended for human consumption) should also be referred to.

(2) Design criteria

Azersu JSC has set up the design criteria in implementing water and sewerage project funded by the World Bank. The World Bank project is implemented in parallel with the JICA project with the same project objective for the different cities. Given this, the criteria shall be applied to the JICA project insofar it is reasonable, in order to avoid complications in the activities of local entities.

The summary of the design criteria is shown in the table below:

Table 2.7 Summary of Design Criteria

Code	Item	Criteria
G1	Design horizon	Year 2030 (20 years)
G2	Population & population growth rate	According to the State Statistical Committee
	Demand	
W1	Specific domestic daily water demand	120 L/c/d
W2	Commercial sector demand in towns	8% of the domestic demand
W3	Commercial sector demand in villages	3% of the domestic demand
W4	Institutional organization demand in towns	4% of the domestic demand
W5	Institutional organization demand in villages	2% of the domestic demand
W6	Industrial sector demand in towns	8% of the domestic demand
W7	Industrial sector demand in villages	3% of the domestic demand
W8	Unaccounted-for water	15% of the average total demand

Code	Item	Criteria
W9	Peak seasonal daily factor for network	1.15
W10	Hour peak factor for network	1.35
W11	Total hour peak factor for distribution mains	1.55
W12	Total hour peak factor transmission mains	1.30
W13	Firefighting demand	20 L/s at any point of the network at minimum pressure of 1 bar
W14	Duration of firefighting	3 hours
	Hydraulic Design	
W15	Design formula	Darcy-Weissbach (Colebrook-White)
W16	Roughness coefficient of pipes	k-1mm (includes local losses at valves, bends, etc.)
W17	Minimum operating pressure in distribution mains	2.5 bars, (2 bars in exceptional cases)
W18	Maximum static pressure	6.0 bars
W19	Minimum flow velocity	0.50 m/s (0.30 m/s in exceptional cases)
W20	Maximum flow velocity	2.0 m/s (3.5 m/s in exceptional cases)
	Transmission Mains	
W21	Pipe material	Smaller than Dia. 400 mm: HDPE Dia. 400 mm or larger: GRP
W22	Number of parallel mains	Less than 15,000 inhabitants: 1 15,000 or more inhabitants: 2
W23	Minimum pipe laying depth	1.0m from pipe crown
W24	Minimum trench width (W) for outer pipe diameters (Dout)	Dout=32-225mm: W=Dout+400mm Dout=226-350mm: W=Dout+500mm Dout=351-700mm: W=Dout+700mm Dout=701-1200mm: W=Dout+850mm
W25	Minimum trench width for different trench depth	Depth<1.00m: no min. width defined Between 1.00 – 1.75m: W=800mm More than 1.75 and 4.00m or less: W=900mm More than 4.00m: W=1000mm
W26	Selection of trench width W	Maximum value according to W25 and W26
W27	Washout	At each low point of the pipeline preferably near creeks
W28	Air release valve	At each high point of the pipeline and minimum every 2-3 km for operation, repair and maintenance purpose
W29	Isolation valves	Maximum every 7.5km
	Distribution Network	
W30	Water storage capacity for the drinking water reservoir	75% of the average total demand + firefighting demand
W31	Pipe material	Smaller than Dia. 400 mm: HDPE Dia. 400 mm or larger: GRP
W32	Pipe diameters for house connections	32mm for 1 household 40 mm for 2-3 households 50mm for 4-6 households 63mm for 7 households or more
W33	Type of network	Preferably loops with minimum dead ends

Code	Item	Criteria
W34	Pipe arrangement	Road width 15m or less: single pipe on one side of the road Road width more than 15m: two pipes (one on each road side)
W35	Fire hydrant arrangement	Above ground at about 150 m distance according to local firefighting regulations
W36	Valve arrangement	Proper isolation of parts of the network for repair, maintenance and operation
W37	Washout	Not required
W38	Air release valve	Not required
	Raw/Clear Water Pumping Station	
W39	Type	Wet chamber + control chamber
W40	Pump type	Submersible water pump
W41	Number of pumps	Operation + stand-by
W42	Pump control	Water level controlled, in special cases frequency controlled
	Water treatment plant	
W43	Type	Chlorination or full treatment scheme depending on the parameters of the raw water
W44	Drinking water quality parameters	According to EU Council Directive 98/83/EC

(Source) Information provided by Azersu

(3) Environment

The proposed loan project is categorized as "Category B" in accordance with JICA guideline for environmental and social consideration. And it is concluded that any major negative environmental impacts are not forecasted.

According to the Environmental Protection Law of Azerbaijan (1999), the EIA shall be concurred by the Ministry of Ecology and Natural Resources. In this Project, EIA is to be carried out by the Consultant in detailed design stage to submit to Azersu. Azersu then receives concurrence by the Ministry of Ecology and Natural Resources.

2.3.2 Specification and Grade of Material to be Used

(1) Concrete Structure

1) Concrete

The water-impounding tanks such as sedimentation and reservoir tank shall be thoroughly watertight. Therefore an admixture such as air-entraining agent and water reducing admixture shall be added to the concrete to effect water reduction, increase of workability for getting water tightness and increasing resistance capacity against freezing and thawing.

The design of concrete mixes shall be determined in appropriate proportion so as to secure durable, strong, watertight, and wear-resistant concrete through trial mixing in accordance with the specifications.

The compressive strength of reinforced concrete shall be over 21MPa (by cylinder test) after curing for 28 days.

2) Reinforcing steel bars

Reinforcing steel bars shall be deformed and shall meet the requirements of an internationally authorized standard of "Steel Bars for Concrete Reinforcement", for example, JIS G 3112 Class SD295A, ISO6935-2 or equivalent. Yield point shall be over 295 N/mm^2.

(2) Water Pipe

All pipes, fittings and jointing materials required for pipe-laying work shall be of good quality and manufactured and furnished in compliance with the internationally authorized standards or regulations (for example, ISO, BS, DIN, JIS, AWWA, JWWA) or equivalent.

The performance of the material to be used should be simple and excellent in terms of strength and durability, (in particular, against both outer and inner pressure), and should be easy to handle and maintain.

1) Perforated Ground Water Collecting Pipe

Perforated pipe to collect ground water will be buried in a high permeable layer and maximum earth cover of it will be around 4m~5m. Strength of pipe against such outer pressure should be considered at the selection of pipe, whereas high opening rate is favorable for collecting ground water efficiently. Therefore confirmation of pressure resistance under several opening rate is indispensable before the selection of pipe.

High Density Poly-Ethylene pipe (HDPE) produced for sewerage in Azerbaijan is the most practicable material in the aspects of technical and economical points

2) Water Transmission Pipe

Water transmission from intake to reservoir could be done by the force of gravity at Khachmaz and Gusar. High Density Poly-Ethylene pipe (HDPE) of allowable inner pressure 1MPa is suitable for water transmission pipe smaller than Dia.350mm (inner diameter) but Glass-fiber Reinforced Polyester (GRP) pipe of allowable inner pressure 1MPa is more advantageous for water transmission pipe bigger than 400mm (inner diameter) in the aspect of economical point and it is also on the aspects of installing speed because joint method of it is socket-spigot type, whereas joint of HDPE is thermal welding at site. Transportation cost of those pipes can be saved much more than imported one because those are being produced in Azerbaijan.

3) Water Distribution Pipe

High Density Poly-Ethylene (HDPE) pipe is suitable for distribution pipe because of easiness on attaching of fittings and variety of size, whereas Glass-fiber Reinforced Polyester (GRP) is not suitable for distribution pipe because the minimum inner diameter of GRP commonly produced is 400mm. Some kinds of fittings and apparatus necessary for water distribution pipeline such as stop valve, hydrant, tap and meter should be imported.

(3) Backfill and Pavement Material for Road Restoration

Cushion-sand for pipe shall be placed under, over and around the pipes laid on the bottom of excavated trench, and carefully compacted by watering compaction and tamper or rammer. Especially bottom zone of pipe shall be compacted carefully not to cause settlement of pipe and road surface after restoration.

Re-pavement work on asphalt pavement road should be conducted so that the damaged and deteriorated sections of road may return to the original condition and structure, in accordance with the regulations and standards of Azerbaijan.

1) Backfill sand

Backfill sand around water pipe shall be excavated or purchased sand containing silt and clay (dia.

under 75 micron) less than 10 % by weight to get enough compaction density easily, to avoid settlement of pipe and ground (road) surface after road restoration.

2) Backfill soil

Backfill soil shall be the selected soil from excavated soil containing clay less than 30 % by weight. This soil shall be free from organic matter, top soil, wood, trash and other objectionable materials which cannot be compacted properly. No boulder or stone larger than 50 mm in any dimension shall be contained in the soil.

3) Sub-base Course

Sub-base shall be a layer of coarse, clean sand and gravel that shall be placed and compacted by sprinkling and rolling to the density 95 % of maximum dry density according to JIS A 1210 (Method E) or equivalent.

After compaction, the sub-base layer shall have a uniform thickness required in the specifications.

4) Base Course

Base course of graded aggregate shall be either gravel or crushed stone and sand or fine aggregate that shall be compacted to the density 95 % of maximum dry density according to JIS A 1210 (Method E) or equivalent. Crushed stone shall consist of hard durable particles or fragments of stone, free from dirt or other objectionable matter.

After compaction, the base course layer shall have a uniform thickness required in the specification.

5) Asphalt Concrete

Aggregate shall consist of crushed stone or crushed gravel, with or without sand or other inert finely divided mineral aggregate, shall be composed of sound, tough, durable particles, free from clay balls, organic matter and deleterious substances.

Asphalt shall have a swell of not more than 1.50% when tested in accordance with AASHTO (American Association of State Highway and Transportation) T 101 or equivalent, and shall not show evidence of stripping when tested in accordance with AASHTO T 182 or equivalent.

The design of asphalt concrete mixes shall be determined in appropriate proportion so as to secure durable, strong asphalt concrete through trial mixing in accordance with the specifications.

The stability of asphalt concrete shall not be less than 500kg by stability test in accordance with ASTM (American Society for Testing and Materials) or equivalent.

(4) Filter Material for Perforated Pipe

Perforated pipe shall be covered by gravel for prevention of solid material infiltration and for increasing permeability. In this regard, perforated pipe in the River Gusar shall be covered up by the excavated soil to retain sufficient natural filtration function. It should be planned with reference to the existing facility.

The filter media for perforated pipe is planned as described below with reference to the Japanese guideline of waterworks facility design (JWWA; Japan Water Works Association).

1) Filter Media for Perforated Pipe

Total three (3) layers of filter material are planned to covers up around the perforated pipes with thickness of 50cm each.

First layer (the bottom of layer / cover up the pipes): 40mm – 50 mm in diameter/gravel.

Second layer (the middle of layer): 30mm – 40 mm in diameter/gravel.

Third layer (the top of layer): 20mm –30 mm in diameter/gravel.

2) Filter Material for Incurrent Pore of Perforated Pipe

Diameter of incurrent pore of perforated pipe is planned with 15mm in diameter it shall be covered by chemical fiber fabric to prevent from muddy substances. Palm tree epidermis has been used as a filter for perforated pipe of Gusar river existing intake facilities. However, economical chemical fiber fabric is planned for filter of the pipes.

2.3.3 Construction Method, Procurement Plan

(1) Construction Method, Procurement Plan

1) Concrete Structure

The concrete used for reinforced concrete structure shall be produced at concrete plant nearest from the site and equipped sufficient facilities to produce the concrete of required quality.

The concrete used for plain concrete such as thrust anchoring concrete-blocks may be produced by small mixer at site, but care shall be taken on weighing the materials (cement, Aggregate, water) precisely according to design of concrete mixes.

There are same existing concrete suppliers located near to the construction sites which can be used for the projects without new mobilization of exclusive concrete plant. The contractor can use same of them for his works after checking its capability and reliability on quality control.

The machine to pour concrete shall be concrete pumping car or crane with concrete bucket, chute method may be employed for the concrete of small structure such as thrust anchoring concrete-block.

To secure water tightness of reservoir care shall be taken not only to quality of ready mixed concrete but also to construction methods such as compaction of poured concrete, construction joints and curing.

Daily mean temperature is expected under four (4) degrees Celsius in January and February. The concrete being mixed, placed, and cured during that time shall be taken anti-cold weather-measures.

2) Water Pipe Installation

The machines employed for earth work, pipe transportation and installation such as excavator, roller, cargo truck and crane seems to be mobilized easily in Azerbaijan, although it depends on the contractor choice whether to procure in Azerbaijan or import from another country.

The existing asphalt pavement shall be cut with concrete cutter before excavation to get smooth cutting line of pavement, avoid unnecessary destruction of the road. It is also effective to restore the pavement smoothly.

Small size construction machine (excavator with bucket $0.2m^3$~$0.4m^3$, dump truck 4t~6t) should be employed for excavation because the width of excavation is 0.5m~1.2m and the depth of excavation is smaller than 1.5m at almost all area of pipe installation. Those machines are favorable for smooth execution of the works especially on a narrow road if closing public traffic is not allowed.

Retaining system to support excavated earth wall shall be employed to protect the workers from the disaster of wall collapse where the depth of trench is over 1.5m.

Minimum earth cover of pipes shall be 1 m except service pipe (Dia.50, 75, 100mm) for house connection which is installed parallel with big distribution pipes (Dia.250mm over), minimum earth cover of service pipe for house connection shall be 60 cm.

On pipe installation care shall be taken especially on pipe jointing works to avoid leakage and backfill works to avoid damage of pipe and road settlement after backfilling and road restoration.

3) Road Restoration

Small size machine should be employed for road restoration because the width of road restoration is 0.5m~1.2m on water pipe installation. Small asphalt finisher (wide =1m~3m) and roller (weight=2t~3t) are favorable for smooth execution of the works especially on a narrow road.

4) Intake Facility

New Uchgun Spring Intake Facility

- Open cut shall be planned to construct perforated pipes and excavate the riverbed indirectly below maximum about 2.5m in depth includes 1.5m of filter material thickness, diameter of perforated pipe and foundation stones in that the good quality water exists in the area. Earth work productions fill up on the filter material as backfilling for surface protection.
- It to be expected that need to excavate the slope on the riverbank along the narrow valley. In this case involve a great deal of works, therefore topographic survey is required for design works.
- According to the geological survey, the slope inclination of excavation is planned at a slope of 1: 0.6.
- According to Khachmaz Sukanal, it is very difficult to cross over the area by foot for earth works when surface becomes soft after rainfall that is remarkable to planning of earth works. It is impossible to conduct earth works for the layers underlies of the surface by manual, need to use an excavator for it in the narrow valley. Additional geological survey is required for planning of the works.

River Gusar Intake Facility

- Perforated pipe installation depth is planned about 6m below surface due to keep the natural filtration function of layers which needs 4m to 5m in thickness.
- According to the results of test pit, it is difficult to installation of a water bar in the riverbed deposits. Open cut is required for earth works with 1:0.6 in slope inclination. Additional geological survey such as a test pit is needs to conform the excavate slope inclination for

safety.

- River flow improvement works and a drainage pump are planned for earth works in conformity to the existing construction works under the condition of groundwater level is about 0.8m below surface.
- It is necessary localization of existing facilities in the riverbed by Gusar Sukanal continuing use of the existing intake facility.
- There is a boulder with maximum about 3m in diameter. It should be planned to remove from the site.
- It should pay attention during earth works to keep grain size distribution of the backfilling for filtration function.

(2) Sources of Procurement

The sources of procurement are assumed as Table 2.8.

Table 2.8 Sources of Procurement

Works	Materials	Sources of Procurement		
		Azerbaijan	Third Countries	Japan
Concrete	Cement	○		
	Coarse, Fine Aggregate	○		
	Deformed Steel Bar	○		
	Timber for formwork	○		
	Plywood for formwork	○		
Water Pipe	Ground Water Collecting Pipe	○		
	Water Transmission Pipe	○		
	Water Distribution Pipe	○		
Miscellaneous for Water Pipe Installation	Sluice Valve		○	
	Water Meter		○	
	Hydrant		○	
Road Restoration	Backfill Sand	○		
	Crushed Stone for Base Course	○		
	Asphalt Concrete	○		

CHAPTER 3 REVIEW OF SAPROF DESIGN REPORT

3.1 Water Supply Plan

3.1.1 Target Year

Target year of the Project is reviewed to be year 2030, considering the same design horizon with the World Bank project.

Table 3.1 Review of Target Year

	SAPROF	REVIEW
Target Year	Year 2027	Year 2030

3.1.2 Service Area

The service area includes urban center of Khachmaz and Gusar as well as their surrounding villages. The area was reviewed through the site reconnaissance as shown in the table below. In case that any villages situated along the raw water transmission line, water demand shall be considered. However no auxiliary facilities (i.e. pump stations, connections, pipes and etc.) shall be included in the design).

Table 3.2 Review of Service Area of Khachmaz

	SAPROF	REVIEW
Urban center	Khachmaz (39,410 persons)	Khachmaz (38,500 persons)
Villages with pipe network	Qobuqiran (915 persons), Köhna Xaçmaz (3,640 persons), Qaraqurtlu (1,970 persons), Qaraçı (685 persons), Armudpadar (1,066 persons)	Qobuqiran (915 persons), Köhna Xaçmaz (3,640 persons), Qaraqurtlu (1,970 persons), Qaraçı (685 persons)
Villages without network (only water demand is included)	-	Armudpadar (1,066 persons)

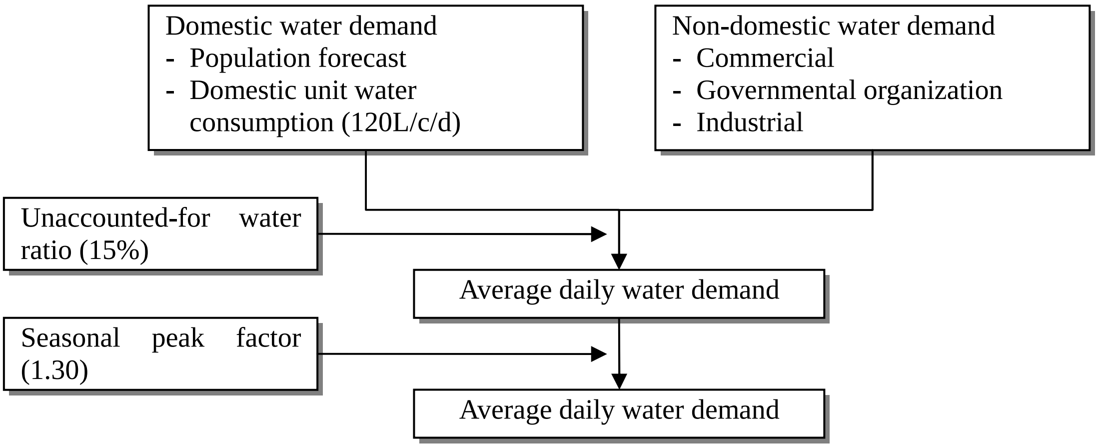
Table 3.3 Review of Service Area of Gusar

	SAPROF	REVIEW
Urban center	Gusar (16,661 persons)	Gusar (16,200 persons)
Villages with pipe network	Həsənqələ (915 persons)	Həsənqələ (905 persons), Balaqusar (1,434 persons)
Villages without network (only water demand is included)	Balaqusar (1,450 persons), Çiləgir (996 persons), Köhnə Xudat (1,864 persons), Yuxarı Ləyər (551 persons)	Çiləgir (986 persons), Köhnə Xudat (1,844 persons), Yuxarı Ləyər (545 persons)

3.1.3 Water Demand Forecast

(1) Demand Forecast Procedure

Procedure for water demand forecast is illustrated as the following figure.



(Note) According to the design criteria of Azersu, the seasonal peak factor is to be 1.15. In this Study, it is reviewed to be 1.3, taking into account that the value of water supply system with population served of 30,000 people in Japan is 1.20 in average and the standard value in Turkey is 1.50.

Figure 3.1 Procedure for Water Demand Forecast

(2) Water Demand of Khachmaz

Summary of water demand forecast of Khachmaz is presented in the following table. Calculation sheet is presented in Appendix 3.

Table 3.4 Summary of Water Demand of Khachmaz

		Unit	Year 2030	Remarks
[1]	Urban population	persons	46,200	State statistical office
[2]	Village population	persons	9,925	Based on statistical figure of 2006 and population growth ratio of 1.25%/year
[3]	Total population	persons	56,125	= [1]+[2]
[4]	Ave. daily urban domestic	m^3/day	5,544	[1] x 120L/c/d
[5]	Ave. daily urban commercial	m^3/day	444	[4] x 8%
[6]	Ave. daily urban institutional	m^3/day	222	[4] x 4%
[7]	Ave. daily urban industrial	m^3/day	2,444	[4] x 8% + 2,000 m^3/day
[8]	Ave. daily village domestic	m^3/day	1,191	[2] x 120L/c/d
[9]	Ave. daily village commercial	m^3/day	36	[8] x 3%
[10]	Ave. daily village institutional	m^3/day	24	[8] x 2%

		Unit	Year 2030	Remarks
[11]	Ave. daily village industrial	m^3/day	36	[8] x 3%
[12]	Unaccounted-for water	m^3/day	1,754	Σ([4]-[11]) / 85% x 15%
[13]	Total average daily demand	m^3/day	11,695	Σ([4]-[12])
[14]	Maximum daily water demand	m^3/day	15,204	[13] x 1.30

(Note)
[7: Industrial sector demand] is estimated by additional demand of 2,000 m^3/day, considering that there are some food processing factories who consume more than 1,000 m^3/day in the peak season.

(3) Water Demand of Gusar

Summary of water demand forecast of Gusar is presented in the following table. Calculation sheet is presented in Appendix 2.

Table 3.5 Summary of Water Demand of Gusar

		Unit	Year 2030	Remarks
[1]	Urban population	persons	19,300	State statistical office
[2]	Village population	persons	6,810	Based on statistical figure of 2006 and population growth ratio of 1.25%/year
[3]	Total population	persons	26,110	= [1]+[2]
[4]	Ave. daily urban domestic	m^3/day	2,316	[1] x 120L/c/d
[5]	Ave. daily urban commercial	m^3/day	185	[4] x 8%
[6]	Ave. daily urban institutional	m^3/day	93	[4] x 4%
[7]	Ave. daily urban industrial	m^3/day	1,685	[4] x 8% + 1,500 m^3/day
[8]	Ave. daily village domestic	m^3/day	817	[2] x 120L/c/d
[9]	Ave. daily village commercial	m^3/day	25	[8] x 3%
[10]	Ave. daily village institutional	m^3/day	16	[8] x 2%
[11]	Ave. daily village industrial	m^3/day	25	[8] x 3%
[12]	Unaccounted-for water	m^3/day	911	Σ([4]-[11]) / 85% x 15%
[13]	Total average daily demand	m^3/day	6,073	Σ([4]-[12])
[14]	Maximum daily water demand	m^3/day	7,895	[13] x 1.30

(Note)
[7: Industrial sector demand] is estimated by additional demand of 1,500 m^3/day, considering that there are some food processing factories who consume more than 1,000 m^3/day in the peak season.

3.2 Design Review of Khachmaz

3.2.1 Water Source Plan

The result of review in water source plan is summarized in Table 3.6.

Table 3.6 Results of Review in Water Source of Khachmaz

SAPROF	REVIEW
1) Uchgun Springfield (Existing) 2) Groundwater of Baku-3 Wellfield (Proposed)	1) Uchgun Springfield (Existing) 2) New Uchgun Springfield (Proposed) 3) Groundwater of Khachmaz Town (Proposed)

Water source of Khacaz are envisaged to be surface water (riverbed water), spring water and groundwater (artesian water). Given this, it is assumed that riverbed water is not suitable for drinking water source on account of water pollution from the densely inhabited areas in the upstream, such as Guba. Consequently, feasibility of spring water and groundwater use is examined hereafter. Comparison of water source is shown in Table 3.7.

(1) Uchgun Springfield

The Uchgun Springfield is located in the south-west of the town and approx. 3km west of Khachmaz Sukanal office. The Springfield is situated around the boarder between diluvium plateau and alluvial plain. Valley head of stream, developed by erosion of the diluvium plateau, formulates spring water source. Other spring sources also distribute along these streams.

The new Uchgun Springfield is located approx. 1km north adjacent to the existing Uchgun spring source. The hydrological conditions are same as the existing Uchgun Springfield.

In the diluvium plateau, diluvial deposits are found from the ground surface to the depth of around 5 m, which is composed of mainly pelitic sediments. And rounded gravel layer of around 1-2 cm in diameter exists beneath the pelitic sediments. It is assumed that the gravel layer forms the aquifer of the Springfield which continuously distributes from the recharging area in the upstream.

Quantity of water intake of the Uchgun Springfield has decreased from 21,900m^3/day in designed value to 15,000m^3/day in present conditions. According to the result of water flow measurement in the downstream of the new Uchgun Spring field, the amount of water intake is estimated 13,000m^3/day. Available quantity of water intake of the new Uchgun Springfield is estimated 70% of it.

Taking into account of the above hydro-geological conditions, the Uchgun Springfield is permanently recharged by the mountainous area and water flows according to the terrain. Considering that pelitic sediments above the aquifer forms the low-permeable layer, possibility of wastewater contamination from the settlements in the upstream of the springfield seems very low.

Consequently, it is concluded that Uchgun Springfield is a quite valuable water source.

(2) Groundwater (Baku-3 Wellfield)

Location of the Baku-3 wellfield is out of territory of Khachmaz Sukanal. It was turned out that Khachmaz Sukanal hasn't had any plan of well construction in the past. Instead, the Sukanal has a negative view in developing Baku-3 wellfield since the water source is approx. 25 km far from the town which makes operation works complicated, and more expensive costs in construction and operation of wells are pump facilities are required. Above all, Sukanal has a strong intention to develop the promising water source of Uchgun Springfield.

Exact location of the Baku-3 wellfield hasn't been identified yet in the field survey under the Study. Seeing the SAPROF Report, it is assumed to be near the boarder between diluvium deposits and alluvium plain. In that area, irrigation channels are developed and the lands are currently used for cultivation and plantation. Therefore, it has not been possible to confirm the water right.

As aforementioned, the groundwater development in the Baku-e wellfield seems not appropriate. Therefore, it is proposed to exclude Baku-3 from the Study Area.

(3) Groundwater (Khachmaz Town)

Khachmaz town is situated on alluvial plain composed of alluvial sediments. It is said that groundwater in town has rich potential. According to proposal by Ministry of Ecology and Natural Resources, groundwater of the town is planned to be one of the water source of Khachmaz. It is assumed that main reasons of selecting groundwater of Khachmaz are; groundwater development causes less impact to the natural forest by cutting trees, which is required in constructing intake facility, and groundwater potential is expected to be rich in good quality.

In particular, the following environmental and operational issues are concerned in case of groundwater use of Khachmaz town.

- As the aquifer is formed by the unconsolidated alluvial layer, excessive pumping of groundwater for long term might cause land subsidence.
- Excessive pumping more than natural groundwater recharge value for long term might be leading to polluted water intrusion in the urban area and a cause of groundwater pollution.
- Operational costs for intake and transmission pumps are permanently required, while they are not required in case of Uchgun Springfield.
- Negative impacts by cutting trees in case of Uchgun Springfield development can be restored after several years by plantation.

For the above reasons, use of groundwater of Khachmaz s not recommended as the priority water source.

Table 3.7 Comparison of Water Sources of Khachmaz

Water Source	Hydro-geological Condition	Condition of Intake Facility	Evaluation
1 Uchgun Springfield (Existing)	1) Intake spring water of diluvium deposits. 2) Groundwater is permanently recharged. 3) Water quality is suitable as the drinking water source	1) Existing water collecting pipe is operational. The facility is aged but detail is not known well since they are buried underground. 2) Intake capacity has been decreased compared to the design capacity.	To be used for future
2. Baku-3 Wellfield (Planned in SAPROF)	1) Located between the diluvial upland and alluvial plain.	1) Exact location is not clearly identified. 2) Costs for intake and transmission pumps are required. 3) It is situated out of territory of Sukanal, that might cause the operation works complicated. 4) The lands near the sites are currently used for cultivation and plantation. Irrigation channels are developed. 5) it has not been possible to confirm the water right	Not recommended
3. New Uchgun Springfield	1) Intake spring water of diluvium deposits. 2) Groundwater is permanently recharged. 3) Water quality is suitable as the drinking water source	1) Perforated collecting pipe is proposed, which is similar to the existing facility. 2) It is located adjacent to the existing Uchgun Springfield. 3) Water supply can be	Proposed as water source

Water Source	Hydro-geological Condition	Condition of Intake Facility	Evaluation
		performed by gravity.	
4. Groundwater of Khachmaz Town	1) Aquifer is alluvium sediments 2) Groundwater level is approx. 5m below the ground level.	1) Deep well 2) Long term exploitation might cause land subsidence 3) Long term exploitation might cause water pollution 4) Intake and transmission pump costs are required	Not recommended

3.2.2 Water Supply System

(1) Outline of Water Supply System

Concept of water supply system is illustrated in the following figure. With Uchgun spring source, all water supply system can be performed through gravity flow, without electric pump. Service area is to be divided into two distribution zones, namely high and low zones, considering appropriate water pressure. Accordingly, two service reservoirs are required at suitable elevation. The proposed site for high zone reservoir is to be at the currently abandoned old reservoir site. And the site for low zone reservoir is to be at the existing low zone reservoir site. At the reservoir site, chlorination facility is required for disinfection purpose.

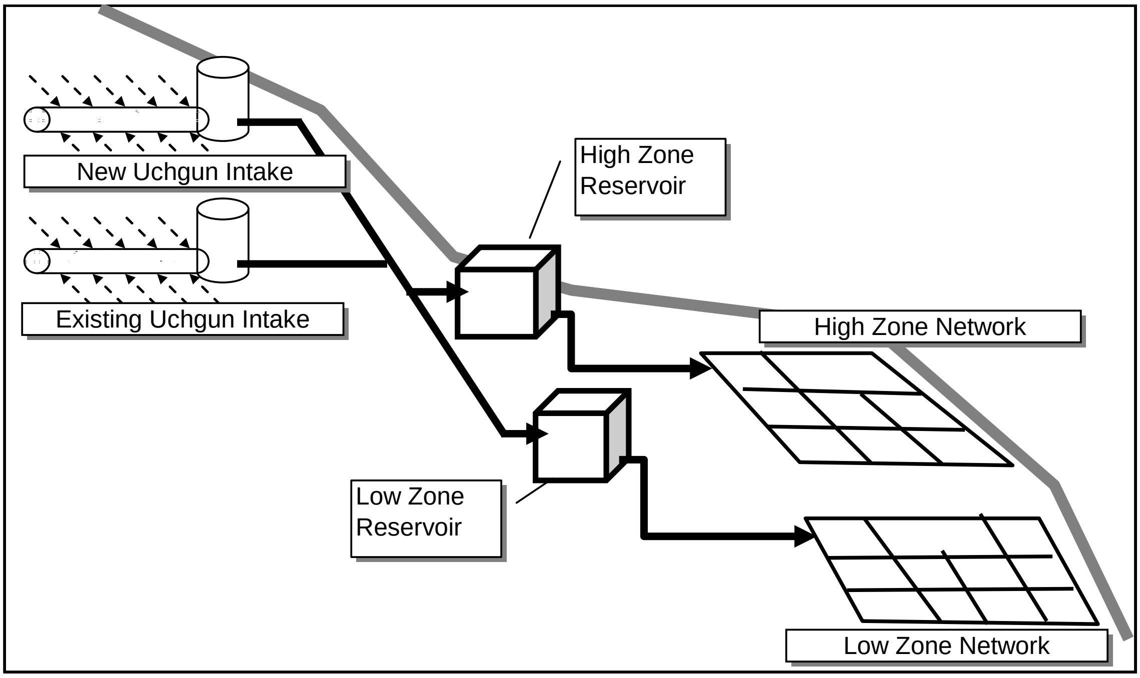


Figure 3.2 Concept of Water Supply System of Khachmaz

(2) Water Demand Allocation by Distribution Zone

Table 3.8 Water Demand Allocation by Distribution Zone of Khachmaz

	Average Daily Demand	Maximum Daily Demand	Hourly Peak Flow
1) High Zone			
Khachmaz Urban (High)#	7,636 m^3/day	9,926 m^3/day	620.4 m^3/hour
Qobuqıran	168 m^3/day	218 m^3/day	13.7 m^3/hour
Köhnə Xəçmaz	666 m^3/day	866 m^3/day	54.1 m^3/hour
Armudpadar	195 m^3/day	254 m^3/day	15.8 m^3/hour
High Zone Total	8,665 m^3/day	11,264 m^3/day	704.0 m^3/hour
2) Low Zone			
Khachmaz Urban (Low)#	2,545 m^3/day	3,309 m^3/day	206.8 m^3/hour
Qaraqurtlu	362 m^3/day	471 m^3/day	29.4 m^3/hour
Qaraçı	126 m^3/day	164 m^3/day	10.2 m^3/hour
Low Zone Total	3,033 m^3/day	3,944 m^3/day	246.4 m^3/hour

(Note)

Water demand of high and low zones of Khachmaz Urban area are allocated as 75% and 25% respectively, by using area-method with consideration that most commercial activities are done in High Zone.

(3) Capacity Calculation by Facility

Capacity of each facility is outlined in the following table.

Table 3.9 Capacity by Facility of Khachmaz

	Specification/ Capacity	Remarks
1) Water Intake Facility		
Existing Uchgun Spring Intake	− Perforated collecting pipe − Intake capacity: 6,000 m^3/day	
New Uchgun Spring Intake	− Perforated collecting pipe − Intake capacity: 9,000 m^3/day	
2) Transmission Facility		
Raw water transmission pipeline (Existing intake – connecting point A)	− Dia. 450mm x 0.5 km − GRP	Maximum flow: 109.13 L/s
Raw water transmission pipeline (New intake – connecting point A)	− Dia. 450mm x 1.3 km − GRP	Maximum flow: 66.88 L/s
Raw water transmission pipeline (Connecting point A – High zone reservoir)	− Dia. 450mm x 0.4 km − GRP	Maximum flow: 176.01 L/s
Clear water transmission pipeline (High – low zone reservoir)	− Dia. 355mm x 1.0 km − HDPE	Maximum flow: 45.64 L/s
3) Service Reservoir		
High Zone Reservoir	− 3,500 m^3 x 2 tanks (water level gauge, flow meter) − Disinfection facility	Required capacity: 75% of average daily demand + firefighting

	Specification/ Capacity	Remarks
		demand (216 m^3): = 6,600 m^3
Low Zone Reservoir	− 1,500 m^3 x 2 tanks (water level gauge, flow meter)	Required capacity: 75% of average daily demand + firefighting demand (216 m^3): = 2,500 m^3
4) Distribution Pipeline		
High Zone Network	− Total Length: 101,472m − GRP Dia. 500mm x 2,501m − GRP Dia. 400mm x 55m − HDPE Dia.350mm x 264m − HDPE Dia.300mm x 1,899m − HDPE Dia.250mm x 3,716m − HDPE Dia.200mm x 2,913m − HDPE Dia.150mm x 2,805m − HDPE Dia.125mm x 5,247m − HDPE Dia.100mm x 22,456m − HDPE Dia.80mm x 59,616m	Peak hourly flow: 704.0 m^3/hour
Low Zone Network	− Total Length: 49,700m − GRP Dia. 400mm x 3,570m − HDPE Dia.250mm x 1,584m − HDPE Dia.200mm x 1,630m − HDPE Dia.150mm x 2,127m − HDPE Dia.125mm x 3,489m − HDPE Dia.100mm x 7,930m − HDPE Dia.80mm x 29,370m	Peak hourly flow: 246.4 m^3/hour

3.2.3 Examination on Facility Plan

(1) Intake Facility

Based on the results of the field survey, intake facility is examined by water source. Outline of the existing intake facility of Uchgun Springfield, and design parameters for facility planning are attached in the Appendix.

Intake facility of the New Uchgun Springfield is outlined in the Appendix. Type of the existing intake facility of the Uchgun Springfield is perforated collecting pipe. The raw water is transmitted to the service reservoir by gravity. Although the facility has become old, the system is rationally designed by using advantages of the topographic conditions.

After technical examination, two alternative ideas of perforated collecting pipe (Type A) and intake pipe (Type B) are proposed for intake facility of the New Uchgun Spring field.

Type A: Perforated collecting pipe (same type of the existing facility)

Type B: Intake pipe (surface stream water collecting)

Table 3.10 Intake Facility Plan of Khachmaz

Water Source	Intake Structure	Remarks	Facility Plan
Existing Uchgun Springfield	Perforated collecting pipe 1) Pipe diameter: 250mm - 600mm 2) Concrete pipe 3) Opening ratio: 1% 4) Diameter of perforated hole: 10mm 5) Vertical connecting chamber at every 50m 6) Depth of pipe: Max. 5m 7) Total length: 2.8km	1) Currently in operation as the major water source 2) Constructed in 1965 3) The facility is aged. But detail is not well-known. 4) Spring water is collected through the perforated pipe and distributed by gravity flow 5) Intake capacity has been decreased from the design capacity	1) To be used for future 2) In the future, it requires renovation.
New Uchgun Springfield	Perforated collecting pipe (Type A) 1) Design concept is basically same as the existing Uchgun intake facility. 2) Material and structure is to be modernized	1) Flow rate of the stream at the confluence is 13,000 m^3/day. 2) Total length of the collecting pipe is to be 6 km. 3) Arborescent pipe layout 4) Diameter is according to spring water flow 5) Gravity flow is possible	1) New construction as the main water source 2) Estimated intake capacity: approx. 9,100 m^3/day (13,000 m^3/day x 70%)
	Intake pipe (Type B) 1) Collecting surface stream water by an Intake Pipe	1) Flow rate of the stream at the confluence is 13,000 m^3/day. 2) Flow rate of the stream at the confluence is 24,000 m^3/day in rainy season. 3) Necessary to prevent turbidity of surface water in rainy season. 4) One intake pipe facility is required only.	1) New construction as the main water source 2) Estimated intake capacity: approx. 9,100 m^3/day (13,000 m^3/day x 70%)

Water Source	Intake Structure	Remarks	Facility Plan
		5) 600mm in diameter is planned for distribution pipe. 6) Gravity flow is possible.	

Perforated Collecting Pipe (Type A)

Main water collecting pipe installed in Khachimaz new water resource should be installed in the layer of high permeability and at the position which has enough head of ground water for collecting ground water efficiently. According to the geological investigation it shall be installed in the underground of 2m - 3m in depth.

Intake Pipe (Type B)

New Uchgun Spring Water is sufficient quality for drinking water source. The water source is planned to enclose with a prevention fence for livestock. On the basis of the above conditions, an intake pipe well be collected clean and safety water.

Common Conditions (Type A, Type B)

New Uchgun Spring Water fielded is covered with dense vegetation. Therefore, topography of the area is not clear. Topographic survey of the area is required for detailed design works.

The quantity of earth works such as excavation and backfill is expected to increase because of deeper position than supposed, it will cause cost increase of pipe installation. Dewatering during pipe installation shall be considered because excavation of layer with high permeability is inevitable.

It must be considered for saving cost to decrease length of pipe and depth of pipe position based on further geological investigation at all area of new water resource.

(2) Pipe Facility

1) Raw water transmission pipelines

To install raw water transmission pipeline under field or road shoulder is much preferable to install it under road pavement because removal and restoration of road pavement cause remarkable cost increase (around 25% of total cost).

Glass-fiber Reinforced Pipe (GRP) is more recommendable than High Density Poly-Ethylene pipe (HDPE) in the aspect of economical view, easiness of joint connection and flexibility of joint whereas caution shall be required to secure water tightness of joint during installation works because the joint is socket type.

2) Primary distribution mains

To install primary distribution mains under field or road shoulder and the employment of Glass-fiber Reinforced Pipe (GRP) are much preferable because of the same reason above. But employment of GRP is restricted because the minimum size of GRP ordinary produced is over 400mm (inner diameter).

Construction method and cost estimation for the existing irrigation canal crossing shall be considered.

3) Distribution networks

High Density Poly-Ethylene pipe (HDPE) is recommendable as distribution networks in the aspect of suitability for various size of pipe diameter and easiness of procurement because it is being produced in Azerbaijan.

Ratio of pavement in the city where distribution networks is constructed is being progressed. Therefore the installation cost of distribution pipe is increasing accordingly because removal and restoration of road pavement is inevitable for pipe installation.

It is recommendable to adjust the depth of pipe installation according to the sizes of pipes for cost saving, for example, the depth of earth cover for the pipes diameter of which is over 200mm is over 1m and under 160mm is over 0.6m.

The extension of service area or increase of pipeline length shall be planned in consideration of allocated budget and need of employer.

Construction method and cost estimation for the existing river and railway crossing shall be considered.

(3) Service Reservoirs

The required functions of reservoir in Kachmaz are not only reserving clean water but also controlling water inflow and water outflow according to the variation in demand because of no facilities considered in Intake Facilities for controlling inflow. Those facilities in the reservoir to control water inflow and outflow shall be easy to access for operation and maintenance.

Existing reservoirs in Kachmaz are semi underground type. One or two thirds (1/3 ~ 2/3) of the reservoir (bottom slab, wall) is buried in underground, remaining portion (wall, top slab) is above ground covered with earth. It seems favorable for reserved water in keeping its temperature and protecting it from contamination and also for concrete structure of the reservoir in protecting it from severe weather in winter. Therefore semi underground type shall be employed in the design of new reservoir.

According to the geological investigation the grounds to sustain reservoirs have enough capability, therefore soil improvement under ground slab or pile foundation seems to be unnecessary.

Dimensions of base, wall and slab thickness are main factors of construction cost of reservoir. Therefore efficient and economical design of those structures should be required to reduce construction cost whereas capacity, durability and water tightness of reservoir are also required.

(4) Disinfection Facility

The disinfectant should be decided in comparison between liquid chlorine which is commonly used in the water supply system of Azerbaijan and sodium hypochlorite which is easy and safety in handling. The dosing pumps will be operated by on-off control in accordance with water level of the service reservoir.

Table 3.11 Outline of Disinfection Facility of Khachmaz

Disinfectant (chemical)	Liquid chlorine of Sodium hypochlorite
Dosing rate	Average: 0.5 mg-Cl_2/L, Maximum: 1.0 mg-Cl_2/L (Dosing rate is controlled manually)
Control system	On-off control by water level indicator installed in the service reservoir

3.3 Design Review of Gusar

3.3.1 Water Source Plan

The result of review in water source plan is summarized in Table 3.12.

Table 3.12 Results of Review in Water Source of Gusar

SAPROF	REVIEW
Riverbed water of Gusar River	Riverbed water of Gusar River

As the water source of Gusar, surface water (riverbed water), spring water and groundwater is considered. Among them, spring water and groundwater is excluded since they have too low potential as the drinking water source of Gusar. Spring water of riverbed or terrace cliff line and wells are used only in the small water supply system.

Riverbed water of Gusar river has been used as the main water source. And it is also effective water source from the hydro-geological point of view. There are several existing intake facilities in Gusar riverbed. They are considered as the same natural conditions.

Hydro-geological condition of the riverbed water of Gusar river is summarized as follows:

- A part of surface water of River Gusar permeates into the riverbed sediments to recharge riverbed water.
- The riverbed water stores and flows in the riverbed sediments which consist of mainly gravel.
- The riverbed sediments consist of rounded gravel, such as mudstone, sandstone and conglomerate. The maximum diameter of gravels is around 3 meters. The grain size distribution in the riverbed is irregular.
- The surface water is muddy due to intrusion of fine particles, such as mud and fine sands, caused by erosion in the upstream. It is therefore not practical to use surface water or drinking water source without treatment.
- In experience of the existing facility, the surface water is naturally filtered through penetration into the riverbed sediments and clean water to be suitable for water source is found around 4-5 meters in depth from the ground level of the riverbed.
- Intake aquifer is to be gravel layer of sufficient permeability. In River Gusar, a low-permeability layer such as muddy sediment exists in 5-7 meters in depth.
- In the riverbed of River Gusar, there is a correspondence between the ground depth where

clean water is found after natural filtration, and the depth of gravel layer of sufficient permeability where water recharge from river water is expected. It is distributed around 5-7 meters depth from the riverbed.

- River Gusar flow water throughout the year. It has seasonal fluctuation.
- Maximum river flow is observed in May and September. The highest water level from the riverbed reaches to approx. 3m.
- According to the result of test pit survey in the riverbed, groundwater level is observed around 0.8 m depth from the riverbed.

According to the result of water flow measurement in the existing reservoir, the total amount of water intake of Gusar river is estimated 8,000m^3/day. Consequently, it is concluded that Gusar riverbed water after natural filtration is a quite valuable water source.

3.3.2 Water Supply System

(1) Outline of Water Supply System

Concept of water supply system is illustrated in the following figure. Two independent systems are considered, namely left and right banks of Gusar river. Both systems can be supplied with water by gravity flow, without electric pumps. In the left bank system, three distribution zones are proposed; Zones I, II and III, considering appropriate water pressure, while one distribution zone is considered in the right bank system. Each zone shall be supplied with water from independent service reservoir. Consequently, four service reservoirs and four distribution zones are proposed. In principle, chlorination facility is required at the reservoir site for disinfection purpose.

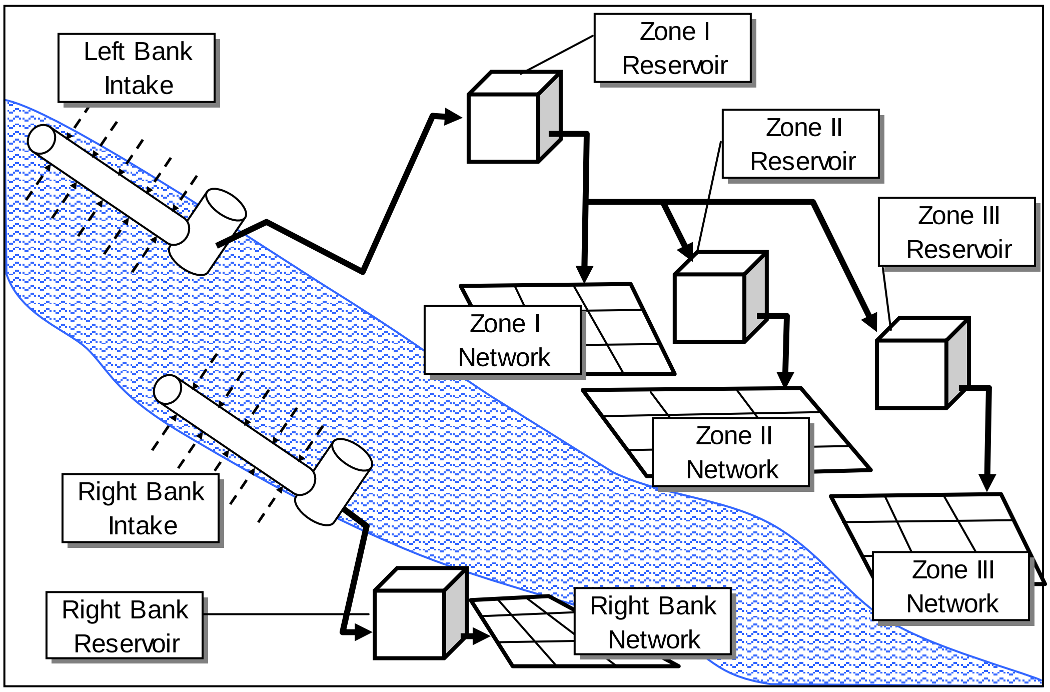


Figure 3.3 Concept of Water Supply System of Gusar

(2) Water Demand Allocation by Distribution Zone

Table 3.13 Water Demand Allocation by Distribution Zone of Gusar

	Average Daily Demand	Maximum Daily Demand	Hourly Peak Flow
Left Bank System			
1) Zone I			
Gusar Urban (High)#	1,797 m^3/day	2,336 m^3/day	146.0 m^3/hour
Köhnə Xudat	338 m^3/day	439 m^3/day	27.5 m^3/hour
Sub Total of Zone I	2,135 m^3/day	2,775 m^3/day	173.5 m^3/hour
2) Zone II			
Gusar Urban (Middle)#	1,908 m^3/day	2,480 m^3/day	155.0 m^3/hour
3) Zone III			
Gusar Urban (Low)#	1,007 m^3/day	1,309 m^3/day	81.8 m^3/hour
Həsənqələ	166 m^3/day	216 m^3/day	13.5 m^3/hour
Balaqusar	262 m^3/day	341 m^3/day	21.3 m^3/hour
Sub Total of Zone III	1,435 m^3/day	1,866 m^3/day	116.6 m^3/hour
4) Villages along Transmission Pipeline			
Yuxarı Ləyər	99 m^3/day	129 m^3/day	8.0 m^3/hour
Çiləgir	180 m^3/day	234 m^3/day	14.6 m^3/hour
Total of Left Bank System	5,757 m^3/day	7,484 m^3/day	467.7 m^3/hour

	Average Daily Demand	Maximum Daily Demand	Hourly Peak Flow
Right Bank System			
Gusar Urban (Right)#	322 m^3/day	419 m^3/day	26.2 m^3/hour

(Note)
Water demand of zones I, II III and right bank of Gusar urban area are allocated as 35.7%, 37.9%, 20.0% and 6.4% respectively, by using area-method.

(3) Capacity Calculation by Facility

Capacity of each facility is outlined in the following table.

Table 3.14 Capacity by Facility of Gusar

	Specification/ Capacity	Remarks
Left Bank System		
1) Water Intake Facility		
18km Riverbed Water Intake	− Perforated collecting pipe − Intake capacity: 7,900m^3/day	
2) Transmission Facility		
Raw water transmission pipeline (Left bank intake – Zone I reservoir)	− Dia. 400mm x 14.9 km − GRP	Design water flow: 91.47 L/s
Clear water transmission pipeline (Zone I – Zone II reservoir)	− Dia. 200mm x 0.3 km − HDPE	Design water flow: 28.71 L/s
Clear water transmission pipeline (Zone I – Zone III reservoir)	− Dia. 180mm x 2.4 km − HDPE	Design water flow: 21.59 L/s
3) Service Reservoir		
Zone I Reservoir	− 1,000 m^3 x 2 tanks (water level gauge, flow meter) − Disinfection facility	Required capacity: 75% of average daily demand + firefighting demand (216 m^3) = 1,600 m^3
Zone II Reservoir	− 1,000 m^3 x 2 tanks (water level gauge, flow meter)	Required capacity: 75% of average daily demand + firefighting demand (216 m^3) = 1,600 m^3
Zone III Reservoir	− 700 m^3 x 2 tanks (water level gauge, flow meter)	Required capacity: 75% of average daily demand + firefighting demand (216 m^3) = 1,300 m^3
4) Distribution Pipeline		
Zone I Network	− Total Length: 28,011m − HDPE Dia.300mm x 197m − HDPE Dia.250mm x 274m − HDPE Dia.200mm x 2,932m	Peak hourly flow: 146.0 m^3/hour

	Specification/ Capacity	Remarks
	− HDPE Dia.150mm x 2,715m − HDPE Dia.125mm x 2,844m − HDPE Dia.100mm x 3,207m − HDPE Dia.80mm x 15,842m	
Zone II Network	− Total Length: 35,099m − HDPE Dia.300mm x 215m − HDPE Dia.250mm x 928m − HDPE Dia.200mm x 1,724m − HDPE Dia.150mm x 2,113m − HDPE Dia.125mm x 3,208m − HDPE Dia.100mm x 3,699m − HDPE Dia.80mm x 23,212m	Peak hourly flow: 155.0 m^3/hour
Zone III Network	− Total Length: 14,274 m − HDPE Dia.250mm x 763m − HDPE Dia.200mm x 1,068m − HDPE Dia.150mm x 1,286m − HDPE Dia.125mm x 1,394m − HDPE Dia.100mm x 3,729m − HDPE Dia.80mm x 6,034m	Peak hourly flow: 116.6 m^3/hour
Right Bank System		
1) Intake Facility		
5km Riverbed Water Intake	− Perforated collecting pipe	
2) Transmission Facility		
Raw water transmission pipeline (5km intake – Right bank reservoir point)	− Dia. 140mm x 4.7km − HDPE	Design water flow: 4.85 L/s
3) Service Reservoir		
Right Bank Reservoir	− 500 m^3 x 1 tank (water level gauge, flow meter) − Disinfection facility	Required capacity: 75% of average daily demand + firefighting demand (216 m^3) = 500 m^3
4) Distribution Pipeline		
Right Bank Network	− Total Length: 7,552 m − HDPE Dia.200mm x 353m − HDPE Dia.150mm x 96m − HDPE Dia.125mm x 2,231m − HDPE Dia.80mm x 4,872m	Peak hourly flow: 26.2 m^3/hour

3.3.3 Examination on Facility Plan

(1) Intake Facility

The existing intake facilities are located at 18km, 15km, 7km and 5km upstream from the town. They are basically same in structure.

The existing intake facilities have been constructed in stepwise in order to supplement the intake capacity. Detail information is not available since the construction work was done in 1950’s-60’s, and even some facilities were constructed recently, any technical documents are not available. In addition, there are some abandoned facilities, as well as collecting pipes of commercial and private purpose.

According to Gusar Sukanal, issue of muddy water intrusion to the existing facility is pointed out. The summary of issues is as follows:

- Muddy water is intruded from the connecting chamber in flood season.
- Muddy water is intruded from joint part of the connecting chamber which is made of concrete or steel.
- Connecting chamber is located at every 50 m interval along the collecting pipe. The height of the structure above ground is approx. 1-2 m. And the total height including ventilation pipe is approx. 3m. For protection of these structure from flood, embankment of gravels around the chambers were constructed. However, the embankment is washed away by flood.

Considering the above, design conditions of the intake facility are proposed as follows:

- The basic structure of intake facility is planned in conformity with existing intake facility. However, structure of the connecting chamber shall be renovated to be water-tightness structure and protected from erosion by flood.
- All existing intake facilities are connected only to the left bank reservoirs. For the system of right bank, new intake facility is planned at approx. 5km upstream of the Gusar river.
- Perforated pipes should be installed about 4m to 5m below the ground level for natural filtration.
- According to the result of topographic survey, an intake facility for right bank shall be construct at an altitude above 720m and above 965m for right bank in Gusar riverbed.
- It should be considered to minimize the diameter of the perforated collecting pipe as much as possible to save earth work costs.
- Rehabilitation of the existing intake facility should also be taken into consideration for cost reduction.
- Since the existing intake facilities should be used even in the construction period, it should be avoided to install the perforated collecting pipes in direction of crossing the river flow of the Gusar river. Instead, pipes should be installed in parallel with the river flow.

Proposed intake facility is summarized in Table 3.15. Outline of the existing intake facility, and design parameters for facility planning are attached in the Appendix.

Table 3.15 Intake Facility Plan of Gusar

Water Source	Existing Intake Facility	Remarks	Facility Plan
Gusar Riverbed Water Intake, 18km Point	Perforated collecting pipe - Old (water source for left bank)	1) Constructed in 1950's 2) Very old and deteriorated. But currently in use.	To be renewal as the water source for the left bank system
	Perforated collecting pipe - New (water source for left bank)	1) Constructed in 2008 2) Currently in use.	To be used for future
Gusar Riverbed Water Intake, 15km Point	Perforated collecting pipe (water source for left bank)	1) Constructed in 2003 2) Currently in use.	To be used for future
Gusar Riverbed Water Intake, 7km Point	Perforated collecting pipe (water source for left bank)	1) Constructed in 1960's 2) Very old and deteriorated. But currently in use.	To be abandon (Water level unfit for gravity discharge to the new reservoir)
Gusar Riverbed Water Intake, 5km Point	Perforated collecting pipe (water source for left bank)	1) Constructed in 1950's 2) Very old and deteriorated. But currently in use.	To be renewal as the water source for the right bank system
	Structure is basically same with each other (see Appendix for detail) Perforated collecting pipe: - Length: 200-250m - Diameter: 500mm Connecting chamber: - Interval: 50m - Height: 7-8 m - Diameter: 1-1.5m	1) Muddy water intrusion from joint parts of the connecting chamber 2) Washing away of the protection embankment by flood.	1) To modernize the design and materials 2) To prevent muddy water intrusion by renovating connection chamber structure 3) Renovation of protection embankment from flood. Estimation (refer Annex) - Construct at an altitude above 956m. - Perforated pipe case ϕ 500mm total length; for right bank: 185m left bank: 3,270m

Water Source	Existing Intake Facility	Remarks	Facility Plan
			case ϕ 900mm total length; for right bank: 135m left bank: 2,380m - Connecting Shaft distance; 100 to 200m height; 7 to 8m diameter; 1.5m - Flood countermeasure; Gabions; 29m^3/shaft

Main water collecting pipe in Gusar river bed should be installed at the position where it can catch the underflow efficiently. According to the geological investigation it shall be installed in the riverbed of 4m~5m depth.

The quantity of earth works such as excavation and backfill is expected to increase because of deeper position than supposed, it will cause cost increase of pipe installation. Dewatering during pipe installation shall be considered because excavation of layer with high permeability is inevitable.

It must be considered for saving cost to decrease length of pipe on the basis of the geological investigation conducted.

(2) Pipe Facility

1) Raw water transmission pipelines

High Density Poly-Ethylene pipe (HDPE) is desirable for raw water transmission pipeline which is installed in river bed because Glass-fiber Reinforced Pipe (GRP) has weakness in fragility and there is some possibility for flood to wash away covering sand and gravel of pipe.

2) Clean water transmission pipelines and Primary distribution mains

To install clean water transmission pipeline and primary distribution mains under field or road shoulder is much preferable to install it under road pavement because removal and restoration of road pavement cause remarkable cost increase (around 25% of total cost).

Glass-fiber Reinforced Pipe (GRP) is more recommendable than High Density Poly-Ethylene pipe (HDPE) in the aspect of economical view, easiness of joint connection and flexibility of joint whereas caution shall be required to secure water tightness of joint during installation works because the joint is socket type. But employment of GRP is restricted because the minimum size of GRP ordinary produced is over 400mm (inner diameter).

It is necessary to compare the unit cost of Glass-fiber Reinforced Pipe (GRP) φ400mm installation with the unit cost of High Density Poly-Ethylene pipe (HDPE) φ350mm installation as a alternative plan.

3) Distribution networks

High Density Poly-Ethylene pipe (HDPE) is recommendable as distribution networks in the aspect of suitability for various size of pipe diameter and easiness of procurement because it is being produced in Azerbaijan.

Ratio of pavement in the city where distribution networks is constructed is being progressed. Therefore the installation cost of distribution pipe is increasing accordingly because removal and restoration of road pavement is inevitable for pipe installation.

It is recommendable to adjust the depth of pipe installation according to the sizes of pipes for cost saving, for example, the depth of earth cover for the pipes diameter of which is over 200mm is over 1m and under 160mm is over 0.6m.

The extension of service area or increase of pipeline length shall be planned in consideration of allocated budget and need of Azersu.

(3) Service Reservoirs

The required functions of reservoir in Gusar are not only reserving clean water but also controlling water inflow and water outflow according to the variation in demand because of no facilities considered in Intake Facilities for controlling inflow. Those facilities installed in the reservoir to control water inflow and outflow shall be easy to access for operation and maintenance.

Existing reservoirs in Gusar are semi underground type. One or two third (1/3~2/3) of the reservoir (bottom slab, wall) is buried in underground, remaining portion (wall, top slab) above ground is covered with earth. It seems favorable for reserved water in keeping its temperature and protecting it from contamination and also for concrete structure of the reservoir in protecting it from severe weather. Therefore semi underground type shall be employed in the design of new reservoir.

According to the geological investigation the grounds to sustain reservoirs have enough capability, therefore soil improvement under ground slab or pile foundation seems to be unnecessary.

Dimensions of base, wall and slab thickness are main factors of construction cost of reservoir. Therefore efficient and economical design of those structures should be required to reduce construction cost whereas capacity, durability and water tightness of reservoir shall be also secured.

(4) Disinfection Facility

The disinfectant should be decided in comparison between liquid chlorine which is commonly used in the water supply system of Azerbaijan and sodium hypochlorite which is easy and safety in handling. The dosing pumps will be operated by on-off control in accordance with water level of the service reservoir.

Table 3.16 Outline of Disinfection Facility of Gusar

Disinfectant (chemical)	Liquid chlorine of Sodium hypochlorite
Dosing rate	Average: 0.5 mg-Cl_2/L, Maximum: 1.0 mg-Cl_2/L (Dosing rate is controlled manually)
Control system	On-off control by water level indicator installed in the service reservoir

3.4 Estimation of Construction Cost

3.4.1 Review on Construction Cost

Review on construction cost is reviewed based on technical examination on facility plan and cost survey on materials, equipment and labor. The summary is shown in the following table and the breakdown is attached in the Appendix.

Table 3.17 Summary of Construction Cost Review of Khachmaz

Item	Cost
1. Construction cost of civil structure	JPY 356.1 million
2. Construction cost of pipe facilities	JPY 907.5 million
3. Material procurement cost	JPY 102.7 million
Total	JPY 1,366.3 million (AZN 12.2 million)

Table 3.18 Summary of Construction Cost Review of Gusar

Item	Cost
1. Construction cost of civil structure	JPY 404.7 million
2. Construction cost of pipe facilities	JPY 683.5 million
3. Material procurement cost	JPY 58.9 million
Total	JPY 1,147.1 million (AZN 10.2 million)

(Note) JPY: Japane Yen, AZN 1 = JPY 112

3.4.2 Analysis on Review Result of Construction Cost

As a result of review, the construction cost is estimated to increase by approx. 25% compared to the SAPROF report. The following factors are considered as major causes of increase.

(1) Cost Increase by Design Specifications

In the SAPROF report, facility plan and cost estimation of the intake facilities of both cities was prepared on the basis of several assumptions. On the other hand, in this Study, the intake facility plan is examined based on field survey. As a result of the study, installation of water collecting pipes at a deep position in wide areas is envisaged which requires a large volume of civil works. Consequently the construction cost has increased.

(2) Cost Increase by Quantity

Since detailed topographic map was not obtained in the Pilot Study and SAPROF Study, the length of distribution pipes was estimated on assuming that pipe length per person is to be approx. 2.0m in comparison with the study result of the existing distribution pipe length per population served. However, it is turned out in this study that the study areas are less densely inhabited than that assumption. As a result of examination of the distribution network by using the topographic map and the land use plan of the Study area, the total pipe length has increased.

(3) Cost Increase by Unit Price

Cost survey on major materials, equipment, labor, etc. has been carried out in this study, in order to update the unit price for cost estimation, while the unit price in the SAPROF report was based on cost estimation prepared in the similar water project by the other donors' funds, such as KfW. Under the recent inflation tendency of Azerbaijan; which has recorded annually 15-20% as consumer price index basis since 2007-2008, unit price has increased as a whole.

(4) Scope of Construction Work

The scope of construction work has not changed from the SAPROF report, in terms of the point that the project includes entire water supply facilities from intake to distribution network and administration buildings. However, as for house connection pipe and water meter, only procurement is considered but installation work is not assumed in the SAPROF report. On the other hand, Azersu has an intension to include the installation work as the scope of construction work under the project. In that case, construction cost would also increase.

3.5 Examination on Construction Schedule

Based on the estimated work volume and local conditions related to construction works, construction schedule is estimated. The construction period of Khachmaz and Gusar is estimated tobe 30 months and 28 months respectively. The construction schedules of both cities are shown in Figure 3.4 and 3.5.

As the major component of the construction work is water pipe installation, it is assumed that the work can be done by the local construction firms. However, it should be noted that the scale of construction work is very big, which includes pipe installation works of approx. 160km and 110 km in Khachmaz and Gusar respectively. In order to complete the work within the given time schedule, construction work shall be done simultaneously by mobilizing a lot of labor forces, machineries to form a number of squads (approx. 10 squads are required in each city). In this case, high level of construction management technique is required in order to ensure time control and quality control appropriately. Therefore, appropriate condition of pre-qualification to select the contractor shall be carefully examined, since qualified contractors shall be procured who has experienced in water supply facilities of similar project scale.

Besides the JICA project, the water supply and sewerage project for 22 provincial cities are currently undergoing under the World Bank finance. It implies that construction works of similar nature will be commenced around the same time with the JICA project. In this case, procurement of pipe material is considered to be the critical pass in construction schedule. If the source country of procurement would be limited to Azerbaijan, production capacity of the domestic manufactures may not be able to meet the soaring demand by both projects, which would cause delay in pipe delivery and price increase. To cope with this, the source countries of these major items should be examined to include the surrounding countries; such as Turkey and Russia, as appropriate.

Construction Schedule of Khachmaz Water Supply Project

Work Item	Specification	Unit	Quantity	Progress	Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
						First Year												Second Year												Third Year					
Mobilization		LS	1			■	■																												
Water Collecting Pipe	φ500mm HDPE Perforated bellows pipe	m	1,000	10m/d･G 240m/m･G	1Group						■	■	■	■																					
Water Collecting Pipe	φ150mm HDPE Perforated bellows pipe	m	2,000	20m/d･G 480m/m･G	1Group										■	■	■	■																	
Transmission Pipe	Water Source~Reservoir-I GRP φ450mm	m	2,270	30m/d･G 720m/m･G	1Group			■	■	■																									
Transmission Pipe	Reservoir-I～Reservoir-II HDPE φ355mm	m	1,020	40m/d･G 960m/m･G	1Group														■																
Distribution reservoir-I	3,500m3/tank x 2tank	LS	1					■	■	■	■	■	■	■	■	■	■	■	■																
Distribution reservoir-II	1,500m3/tank x 2tank	LS	1							■	■	■	■	■	■	■	■	■	■																
Distribution Pipe	GRP φ400~500mm	m	6,130	20m/d･G 480m/m･G	2Group			■	■	■	■	■	■	■																					
Distribution Pipe	HDPE φ150~350mm	m	16,940	30m/d･G 720m/m･G	2Group			■	■	■	■	■	■	■	■	■	■	■	■																
Distribution Pipe	HDPE φ80~125mm	m	128,110	40m/d･G 960m/m･G	8Group										■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
House Connection	HDPE φ32mm	house	11,300	8/d･G 192/m･G	4Group															■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Demobilization		LS	1																																■

Figure 3.4 Construction Schedule of Khachmaz

Construction Schedule of Gusar Water Supply Project

Work Item	Specification	Unit	Quantity	Progress	Group No.
Mobilization		LS	1		
Water Collecting Pipe Left Bank	φ500mm HDPE Perforated bellows pipe	m	1,000	8m/d・G 190m/m・G	2Group
Water Collecting Pipe Right Bank	φ500mm HDPE Perforated bellows pipe	m	500	8m/d・G 190m/m・G	1Group
Transmission Pipe	Water Source~Reservoir–I GRP φ400mm	m	14,930	35m/d・G 840m/m・G	2Group
Transmission Pipe	Water Source~Reservoir–IV HDPE φ140~200mm	m	7,400	50m/d・G 1,200m/m・G	1Group
Distribution reservoir–I	1,000m3/tank x 2tank	LS	1		
Distribution reservoir–II	1,000m3/tank x 2tank	LS	1		
Distribution reservoir–II	700m3/tank x 2tank	LS	1		
Distribution reservoir–II	500m3/tank x 2tank	LS	1		
Distribution Pipe	HDPE φ150~300mm	m	14,670	30m/d・G 720m/m・G	2Group
Distribution Pipe	HDPE φ80~125mm	m	70,270	40m/d・G 960m/m・G	6Group
House Connection	HDPE φ32mm	house	5,560	8/d・G 192/m・G	3Group
Demobilization		LS	1		

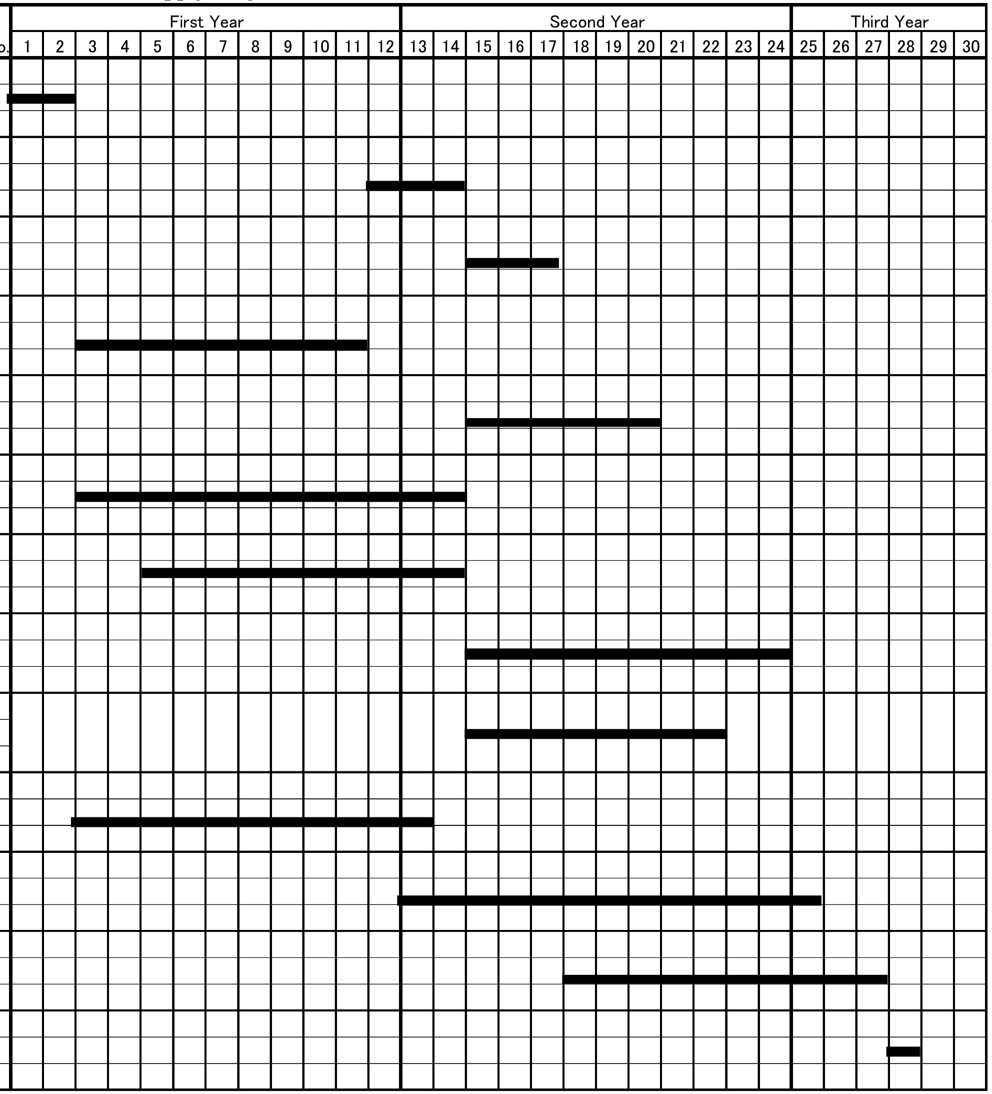


Figure 3.5 Construction Schedule of Gusar

CHAPTER 4 IMPLEMENTATION AND O&M OF THE PROJECT

4.1 Project Implementation Scheme

For the implementation of the Project, as described in the SAPROF report, "Project Management Unit (PMU)" and "Project Implementation Unit (PIU)" will be established to serve as the core organization to lead implementation-related activities on the Azerbaijan side. Both PMU and PIU will comprise representatives of Azersu, United Sukanal and the targeted Sukanals. PMU is responsible for overall management, such as administration, procurement and financing arrangement in association with Azersu as the counterpart of JICA, while PIU is responsible for supervising construction in provinces and report to PMU. The implementation structure is planned in Figure 4.1.

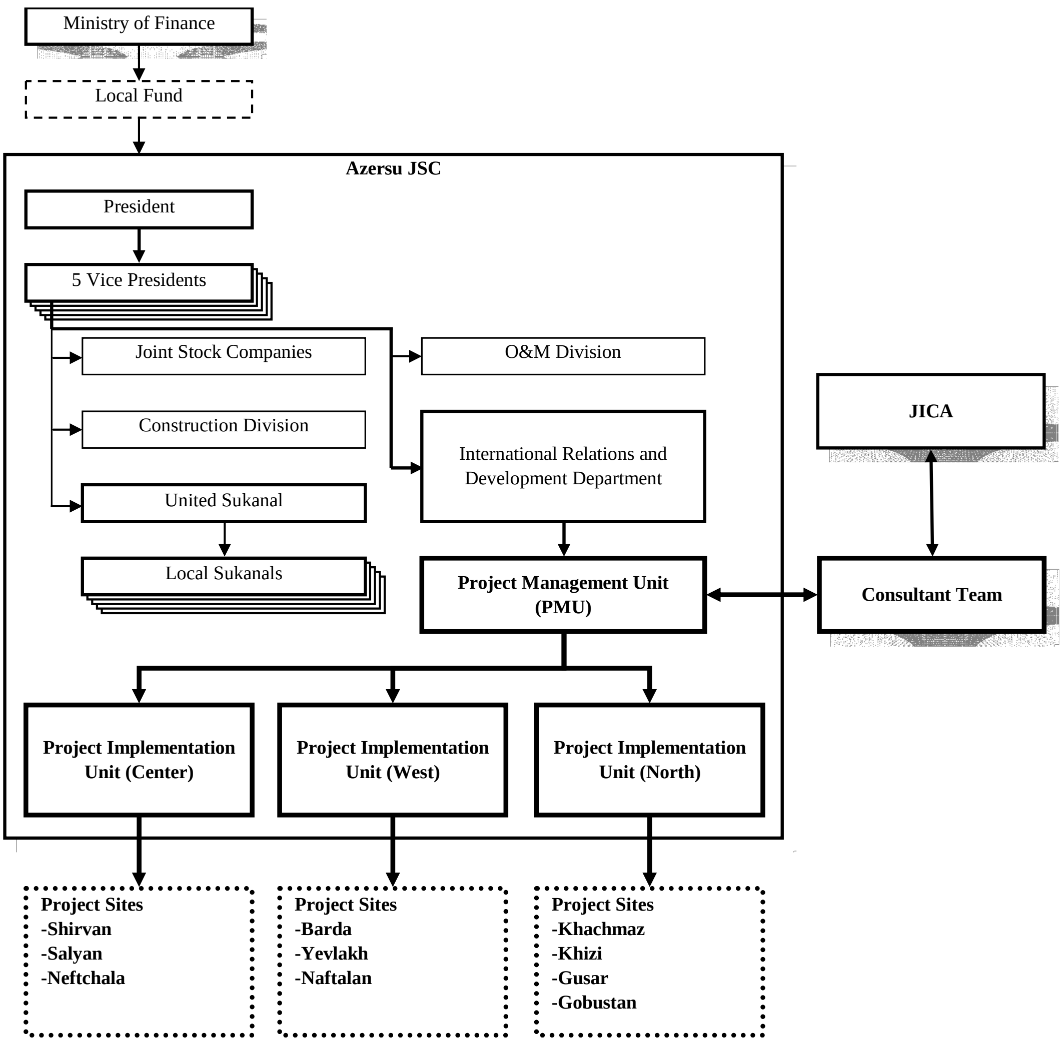


Figure 4.1 Project Implementation Structure

4.2 Operation and Maintenance (O&M) Scheme

4.2.1 O&M Organization

Operation and maintenance of the water supply facilities to be constructed in the Project will be carried out by Sukanal of each province, who is also currently engaged in. Sukanals are the subordinate organizations under the United Sukanal of Azersu JSC, who administrates waterworks management of provincial cities. Sukanals are responsible for O&M of the water supply and sewerage facilities as well as billing and revenue collection with financial technical support from Azersu and United Sukanal.

Since any activities related to public works in a provincial level are to be controlled by the Local Executed Power (LEP) as the provincial administration authority, the Sukanal, regardless of independent organization from LEP, is influenced by LEP and conventionally communicate and report of their activity to LEP. In this connection, LEP sometimes recommend a candidate of the director of Sukanal when Azersu appoints the position.

There are two categories of water and sewerage tariff; one for Baku and some major cities and the another for the other provincial cities. In principle, this tariff is applied uniformly to all cities. In revising tariff, Azersu submits the proposal on revision to the Tariff Council. And new tariff will be enacted upon approval of the Tariff Council. To date, Azersu has perspective to continue the policy of uniform tariff applying to all provincial cities even after completion of the JICA project.

4.2.2 O&M Level of Sukanal

Capacity on O&M is preliminarily studied, through interview with the Sukanal officers. Although a direction to self-sustaining management of Sukanal is recommended in SAPROF report, it seems that the current O&M structure would be practical for the time being, in which Azersu and United Sukanal supports technically as well as financially to Sukanals, since current capacity of human resource is limited in provincial cities.

On recognition that current O&M practice of Sukanals is generally insufficient level, it is recommended to improve the capacities of O&M techniques, billing and revenue collection in order to perform facility management and waterworks management appropriately in provincial level, after implementation of the Project. To that end, comprehensive capacity development program should be considered, in addition to technical training for O&M of the facilities during commissioning of the facilities which is to be provided under the JICA project. In this connection, it is also recommended that Azersu shall promote strategic human resources development program for future, in which staff of local Sukanal can be provided with education and training at regular basis.

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

(1) Review of Water Supply Plan and Water Demand

Water service area and water demand has been reviewed with reference to population census by the State Statistical Committee of Azerbaijan and design criteria provided by Azersu. As a result, the maximum daily water demand fell by 15-23% compared to that of SAPROF report, which is caused mainly due to reviewing unit water demand.

(2) Design Review of Khachmaz

In examination of water source plan, decrease in intake capacity of the existing Uchgun spring source is identified. And the production capacity is estimated to be approx. 70% of the original design capacity. On the other hand, existence of probable spring source as the alternative source has been identified which is situated north adjacent to the existing Uchgun Springfield and has prospective potential as the existing spring source. After the survey, the water source plan is recommended that development of new Uchgun spring source and use of the existing Uchgun spring source by reducing intake capacity.

Transmission and distribution facility plan has been examined and two distribution networks of high and low zones are proposed, taking into account of topographical condition of the distribution areas, both of which are to be fed with water from service reservoirs by gravity. And design capacity of each facility is also calculated. As a result, the total length of the distribution pipe results in 151 km which is approx. 28% longer than the estimation of the SAPROF report.

(3) Design Review of Gusar

Water source plan was examined for Gusar. And riverbed water of Gusar river is identified as the appropriate water source for urban water supply system as recommended in the SAPROF Report. The structure of intake facility was examined, taking into account of current problems of muddy water intrusion and erosion of embankment of the existing connection chamber. And some improvement in design was examined; such as material of perforated collecting pipe, water tightness structure of the connecting chamber and preventive measures to erosion.

Water supply system of Gusar is proposed to be divided into two independent systems of left and right bank of the Gusar river. And each system is planned to be performed by gravity flow without electric energy for pumps. In the left bank system, three distribution zones are established according to the elevation and each zone will be fed with water by service reservoirs which are to be newly constructed in the existing reservoir sites. The distribution network is examined based on topographic map of 1/5000 scale and land use plan. As a result, total length of the distribution pipe becomes 85 km which is approx. 85% longer than the estimation of SAPROF report.

(4) Review of Construction Cost

As a result of review of cost estimation, which is prepared based on examination result of facility plan, construction cost of water supply systems of the two cities is estimated to be JPY 2,513 million (AZN 22.4 million, exchange rate: AZN 1 = JPY 112), which is approx. 25% up from the estimation of the SAPROF report. It seems that the cost increase is caused mainly by increased pipe length.

(5) Project Implementation and O&M Scheme

For the implementation of the Project, “Project Management Unit (PMU)” and “Project Implementation Unit (PIU)” will be established under Azersu JSC to be responsible for overall project management and supervising construction. Operation and maintenance of the water supply facilities will be carried out by Sukanal of each province, who is also currently engaged in. Since the current O&M practice of Sukanals is generally insufficient, comprehensive capacity development program is recommended which includes upgrading of billing and revenue collection, in addition to technical training for O&M of the facilities to be provided under the JICA project.

5.2 Recommendation

(1) Review of the All Project Cost to Examine Countermeasure

As a result of the review of the construction cost estimation for the water supply systems of the targeted two provincial cities, the construction cost is estimated to increase by approx. 25% (JPY 501 million) compared to the SAPROF Report, in which the construction costs are estimated to be JPY 1,409 million for Khachmaz and JPY 602 million for Gusar. Since this the cause of cost increase is not regarded as any specific factor such as significant change of scope of work, etc., it is also concerned of cons increase of the other project components of the eight cities to be implemented by JICA project. Therefore, it is highly recommended to review the cost estimation of the other project components at the design review phase of the consulting service to be commenced under the JICA project. In case that deficiency in the project budget is expected, countermeasures; such as reviewing design criteria, scope of the project, etc., shall be discussed with Azersu.

(2) Cost Reduction

In connection with the above, cost reduction measures shall be considered in designing, in order to reduce the construction cost. In other words, the design criteria which was provided by Azersu would be reasonably reviewed to minimize the cost. For example, the minimum covering depth of the pipe of small diameter could be reviewed to be 80 cm instead of the given criteria of 100cm, on condition that freezing of soil is not observed in that depth. Also criteria of fire hydrant should be reviewed in terms of type, interval and required water discharge. Thus, it is recommended to discuss with Azersu about the cost reduction measures in design review phase of the Project.

(3) Coordination Meeting

While the implementing agency of the JICA Loan Project is Azersu JSC, the Local Executive Power plays a certain role as the supervising authority of public works in each province. Given that, coordination meeting with the local authorities in implementing stage is recommended for information sharing and necessary coordination that could facilitate smooth implementation of the Project.

(4) Capacity Development

As waterworks management by the current Sukanals seems insufficient from technical and financial viewpoints, it is recommended to promote a capacity development on comprehensive waterworks management, besides the technical operational training which is to be provided under the JICA Project. Considering that recruitment of qualified personnel seems difficult in provincial cities, it is recommended that Azersu would develop its own human resource development program for future, in which local staff could be trained regularly to develop their skill and knowledge.

APPENDIX 1

HYDROGEOLOGICAL CONDITIONS

Hydro-geological Conditions

Topography

1. Urban area of Gusar locates on river terrace

2. River Terrace along River Gusar
(Greater Caucasus in the hazy distance)

3. Riverbed and River Terrace of River Gusar

4. Riverbed and Hilly area along River Gusar

5. Diluvium plateau at Uchgun Spring Field

6. A stream in the downstream of New Uchgun Spring Field

Geology

1. Riverbed deposits of River Gusar

2. A Bolder with approx. 3m in diameter at River Gusar

3. Diluvium terrace deposits along left bank of River Gusar

4. Diluvium deposits consist of mainly politic layer at Uchgun.

5. Diluvium deposits, gravel layer occurs along the stream.

6. Alluvial deposits consist of mainly sandy layer in Khachmaz

Water Source

1. River Gusar and Greater Caucasus at 18km

2. Riverbed of River Gusar,

3. Muddy water in River Gusar

4. One of New Uchgun spring water

5. One of New Uchgun spring

6. Stream at downstream of New Uchgun

River flow rate is approx. 13,000m^3/day

Basic Structure of New Uchgun Spring Intake

Basic Structure of Existing Uchgun Spring Intake

Intake facility	Infiltration gallery water collecting drain (Reinforced concrete pipe or steel)
Underground Depth	5m - 7m
Total length	approx. 2.8km
Diameter of the collecting pipe	200mm - 600mm
Opening specification	Diameter: approx. 10mm, Opening ratio: about 1%
Design discharge	252 *l* /sec
Combination well (Utility hole)	Total 49wells and a well per every 50m, Diameter: 1m - 1.5m, Reinforced concrete pipe or steel
Water source	Spring water
Delivery of water	Gravity
Construction Date	1965

Source: Khachmaz Sukanal

Existing Uchgun Spring Intake

Connecting chamber #46

Inner structure of connecting chamber #46

Conditions of the Existing Intake Facility of River Gusar

Typical Design of River Gusar Existing Intake Facility

Intake facility	Infiltration gallery water collecting drain (Reinforced concrete pipe or steel)
Underground Depth	5m - 7m
Total length	200m - 250m
Diameter of the collecting pipe	500mm - 900mm
Opening specification	Diameter: approx. 10mm, Opening ratio: about 1%
Design discharge	Unknown
Combination well (Utility hole)	A well per every 50m, Diameter: 1m - 1.5m, Reinforced concrete pipe or steel
Water source	Riverbed water of River Gusar
Delivery of water	Gravity
Construction Date	1950 - 2008

Source: Gusar Sukanal

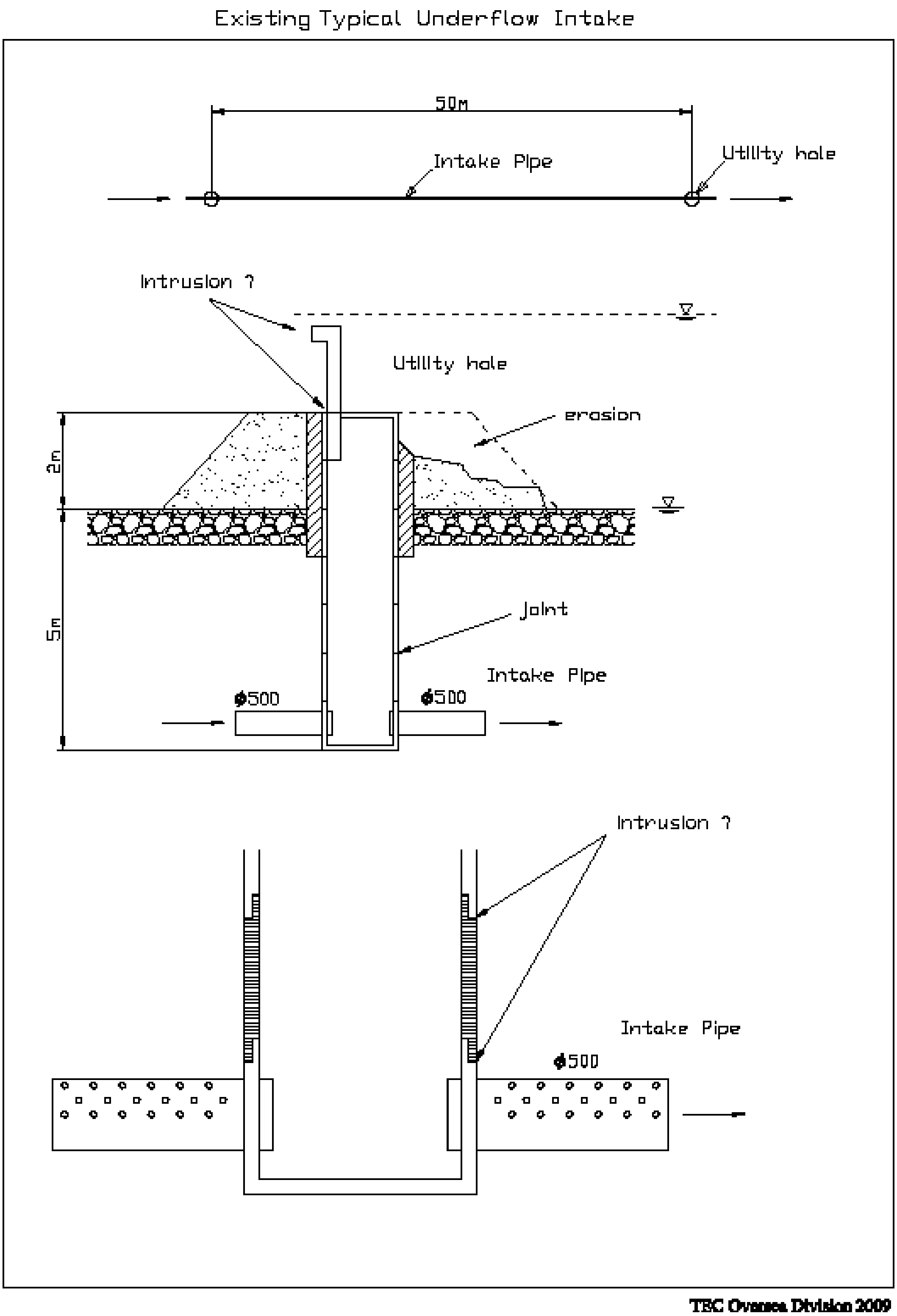
1. Intake facility at Old 18km site

2. Connecting chamber of New 18km site

3. Connecting chamber of 15km site

4. Connecting chamber of 7km site

5. Connecting chamber of 5km site



Schematic design of the existing intake facility for River Gusar

（JICA Study Team）