Ministry of Roads, Transport, Construction and Urban Development
Water Supply & Sewerage Authority of Ulaanbaatar City
MONGOLIA

PREPARATORY SURVEY REPORT
ON
THE ULAANBAATAR WATER SUPPLY DEVELOPMENT PROJECT IN GACHUURT
IN
MONGOLIA

March 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI ENGINEERING INTERNATIONAL CO. LTD.

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PREFACE

In response to the request from the Government of Mongolia, the Government of Japan decided to conduct the Preparatory Survey (Basic Design) on the Ulaanbaatar Water Supply Development Project in Gachuurt in Mongolia and entrusted the survey to the Japan International Cooperation Agency (JICA).

JICA sent a survey team to Mongolia to conduct the preparatory survey at the survey area from August 3 to November 2, 2009. Discussions were held with the officials concerned of the Government of Mongolia, and when the team returned to Japan, further studies were made. Then, a mission was dispatched again to Mongolia to discuss the draft of the basic design, and as a result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries. I wish to express our sincere appreciation to the officials concerned of the Government of Mongolia for the close cooperation extended to the teams.

March 2010

Izumi TAKASHIMA
Vice-President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

We are pleased to submit to you the Preparatory Survey (Basic Design) Report on the Ulaanbaatar Water Supply Development Project in Gachuurt in Mongolia.

The survey was conducted by CTI Engineering International Co., Ltd. under a contract to JICA, during the period from July 2009 to March 2010. In conducting the survey, we have examined the feasibility and rationale of the project with due consideration to the present situation of Mongolia and formulated the most appropriate basic design for the project under Japan's Grant Aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Yoshiharu MATSUMOTO
Chief Consultant
Preparatory Survey (Basic Design) Team on the Ulaanbaatar Water Supply Development Project in Gachuurt in Mongolia
CTI Engineering International Co., Ltd.

SUMMARY

① Overview of Mongolia

Mongolia is a highland and inland country, 2,392 km from East to West, 1,259 km from North to South, with a total area of 1,570,000 km^2. It borders with Russia to the North, and with China to the East, West, and South. On the northern half of the country spreads the grassland that transitions to a coniferous forest zone towards the Russian border, while on the southern half is the dry desert region called the Gobi. The population of Mongolia is approximately 2.7 million people (Ministry of Foreign Affairs: Regional Affairs of 2009), and the population growth rate has been fluctuating between 1.2% and 1.4% in the past decade.

Ulaanbaatar City, which is targeted for the Project, is the capital of Mongolia and the political and economic center of the country with the population of 1.07 million as of 2008. The average temperature in the past decade has been –0.7°C, and monthly average temperature has been above 0°C only between April and October. Approximately 86% of the annual rainfall occurs from May to September, marking 238 mm on annual average and 330 mm in the mountain area in the past decade.

The GDP growth rate of Mongolia was 2% to 4% from 1996 to 1999, and was only at the 1% level from 2000 to 2001. However, it steadily rouse up to the 10% level by 2004, and grew by 7% or more from 2005 to 2007. In late 2008, the worldwide recession and the collapse in copper and gold prices depressed the economy of Mongolia. The inflation rate was also at a high rate, reducing temporarily to 12.3% in 2007, but at the 20% level after 2000. The gross national income was USD410 and USD810/person in 2000 and 2005, respectively. However, due to the benefits from mining resource development, it increased suddenly to USD1,680 in 2008 (World Bank, September 2009).

According to the latest data, the gross regional domestic product (GRDP) of Ulaanbaatar City was USD930 million in 2005, which was equivalent to approximately 48% of the GDP in Mongolia. The GDP per person was USD990, which was around 30% higher than the national average.

② Background, History, and Outline of the Requested Project

The waterworks master plan (M/P) of Ulaanbaatar City was formulated under the JICA study in 1995, namely; “The Study on Water Supply System in Ulaanbaatar and Surroundings,” and the water source development plan in this project was also proposed in the said study. In addition, in the “Water and Waste Water Master Plan of Ulaanbaatar targeting the year 2020 (UBMP2020)” which was implemented in 2006 with support from the World Bank and approved by the Cabinet, the necessity to increase the water supply capacity was pointed out. Subsequently, although it was not approved by the Cabinet, “The Study on City Master Plan and Urban Development Program of Ulaanbaatar City in Mongolia (UBMPS)” was reviewed by JICA in 2009. It was then estimated that the maximum water demand per day will exceed 240,000 m^3/day by 2011 which is the current water supply capacity. Thus, water facility development including this project is proposed as the priority project. With consideration on the study results, the following items were confirmed:

i) It is noteworthy that the migrants inflow from the countryside to Ulaanbaatar City, the capital of Mongolia. Due to the increase which continued to grow by 4% yearly from 2000, the population was estimated to have reached 1.07 million people in 2008, which is equivalent to 40% of the national population. As a result, the urban problem became serious, and especially for water supply, the water demand was estimated to exceed the current supply capacity by 2011. In the occurrence of water shortage, the impact to daily lives and urban functions can be huge, so that the strengthening of the waterworks is an urgent issue.

ii) The water supply of Ulaanbaatar City is under the responsibility of the Water Supply & Sewerage Authority of Ulaanbaatar City (USUG). With the facility development program of the Japan's grant aid, the water supply capacity had reached 240,000 m^3/day. However, water is supplied to the Ger areas through the water supply kiosks and shared by half of the population, but water use is only 7.2 ℓ/person/day. Therefore, the World Bank is extending the water pipes or building additional water supply kiosks to the Ger areas. In the apartment areas where water is supplied by USUG to each household, water consumption is discouraged by shifting to the metered water fee system or through water-saving education campaigns. However, despite the effort, the increase of water supply capacity is still required due to the improved water supply system and population growth in the Ger areas. Besides, water consumption is increasing due to the shift of population from the Ger areas to the apartment areas.

iii) USUG is supplying water from four (4) groundwater sources. These water sources no longer have allowance for further development hence a new water source must be developed at Gachuurt located east of Ulaanbaatar, which has been proposed as the ideal location in the previous study.

In response to the above development study results, the Government of Japan decided to implement the basic design on the facility development plan of water pipes in Ulaanbaatar City (North East Reservoir) and the water source development in Gachuurt.

③ Outline of Study Results and Contents of the Project

JICA sent the preparatory (basic design) survey team to Mongolia to conduct the survey from August 3, 2009 to November 2, 2009. In the on-site study, the details of the request for grant aid was confirmed through discussions with the involved parties of Mongolia, and the natural conditions (landscape, geology, and groundwater condition), social conditions, buried objects, and procurement conditions of construction equipment, etc., were studied. Based on the survey results, a mission for the briefing on the basic design was again sent by JICA from February 21, 2010 to February 27, 2010 and held discussions regarding the direction of the basic design and the burden of Mongolia, etc., and the agreement of the Mongolian side was obtained. The outline of the final plan is as described below.

- Target Year of the Plan and Scale of the Facility

Taking the project implementation schedule and urgency of the grant aid into consideration, the target year of the Plan was set to 2014. The water volume for new development is based on the

past 5-year performance, i.e., for the Ger areas and apartment areas, the water supply population and water use per person per day (Ger area: 25 ℓ/person/day; Apartment area: 230 ℓ/person/day), average water supply volume per day, and the maximum water supply volume per day were estimated. As a result, the amount equivalent to the difference between the water demand expected in 2014 and the current water supply capacity (240,000 m^3/day) was set as the new water volume to be developed, i.e., 25,200 m^3/day.

- Water Source Development Plan

The water source of this project is the subsurface water which will be taken from the riverbed flood plain in Gachuurt at the upstream of the urban area of Tuul River. For the validation of adequacy of the water source, electrical exploration, pumping test, and water quality test results were used to confirm that the volumes of groundwater pumping and recharging are sufficient for supplying the new water supply volume of 25,200 m^3/day to be developed. Regarding the water quality, while colon bacillus and general bacteria exceed the water quality standard in the water supply law of Mongolia, the other items are within the standard value, and thus confirmed that the water can be used for drinking after chlorination.

- Plan for Transmission of Water

The transmission main from Gachuurt Reservoir shall be connected to the North East Reservoir especially for the purpose of water distribution to the Ger areas. The North East Reservoir is located at altitude 1,382m at the northeast slope of Central Ulaanbaatar City. Therefore, in order to convey the water by gravity flow, the head loss must be controlled. For this purpose, the transmission main for this project shall be 700 mm in diameter. Additionally, the pipes shall be the low-cost and easy-to-install fiber reinforced plastic mortar (FRPM). The construction of the main facility of Gachuurt Reservoir shall be borne by the Mongolian side, while the valves and the surrounding pipes for the reservoir shall be borne and installed by the Japanese side since high quality and durability are required.

- Equipment for Waterworks

Mongolia has long years of experience in maintaining, managing and operating water facilities. Therefore, waterworks equipment that differs significantly from the conventional types shall not be selected, and from a sound financial point of view, the equipment to be applied should save energy and be more easily operated and maintained.

- Construction Plan considering the Climate Conditions

Considering the harsh winter season in the area, the following construction plan was prepared based on the points that pitting of the frozen ground is difficult and concrete placement or asphalt-paving are impossible in winter. With regard to the facility plan, the pipeline shall be installed lower than 3.2m below ground level, which is the freezing depth in winter, and for pipes or electric equipment above ground level, low temperature measures shall be taken.

<Facility Overview>

Items	Facilities
1. Transmission Main	
- Transmission Main	Fiber reinforced plastic mortar pipe (FRPM φ700 mm): 18,813m (Class I: 1,800m; Class II: 15,050m; Class III: 1,963m)
- Valve Chest	Butterfly valve (φ700 mm, 10 kgf/cm^2): 11 Discharge valve (φ250 mm, 10 kgf/cm^2): 5 High-speed air vent valve (φ75 mm, 10 kgf/cm^2): 17
- Siphon Pipe	4
- Thrust Block	90 degrees: 11; 45 degrees: 16; 22.5 degrees: 16
2. Conveyance/collection pipe	
- Conveyance Pipe	Ductile-cast-iron pipe (DCIP φ500 mm): 4,240m
- Collection Pipe	Ductile-cast-iron pipe (DCIP φ150 mm～φ500 mm): 2,820m
- Valve Chest	Gate valve (φ350 mm, 16 kgf/cm^2): 1 Gate valve (φ500 mm, 16 kgf/cm^2): 1 High-speed air vent valve (φ75 mm, 16 kgf/cm^2): 2
- Siphon Pipe	2
- Thrust Block	φ150 mm 90 degrees: 1; φ300 mm 22.5 degrees: 1 φ500 mm 90 degrees: 1; φ500 mm 22.5 degrees: 1 T-shape: 19; Reducer: 7
3. Reservoir	
- Inflow Pipe	Steel pipe of φ500 mm at HWL
- Outlet Pipe	Steel pipe of φ700 mm via pit
- Discharge Pipe	Steel pipe and FRPM φ500 mm for discharge pipe, and discharge water to Tuul River
- Overflow Pipe	Overflow water above HWL using a steel pipe of φ500 mm
- Valve	Installation of the following valves to valve chest: ・Gate valve (φ500 mm, 7.5 kgf/cm^2): 2; inflow and outlet pipes ・Butterfly valve (φ700 mm, 7.5 kgf/cm^2): 2; outlet pipe
- Water Level Gauge and Flow Meter	To grasp the water level changes of the reservoir, an immersion level gauge shall be installed. Electromagnetic flow meters to inflow and outlet pipes shall be installed.
4. Well	
- Number of Wells	21
- Pumping Yield	1,200 m^3/day/well
- Distance between Wells	250m
- Depth of Well	TypeA: 20m; TypeB: 30m
- Well Bore Drilling Diameter	400 mm
- Casing Diameter	250 mm
- Screen Length	TypeA: 8m; TypeB: 11m
- Casing/Screen Material	Casing: steel pipe Screen: SUS (V slotted well screen of winding type, 1 mm in width)
- Type of Water Supply Pump	Submersible motor pump
- Power of Electric Motor	30 kW
- Total Pumping Head of Supply Pump	110m
5. Chlorination & Operation House	
- Structure	Reinforced concrete
- Layout	Storage, chlorination room, operation room, electrical room, lavatory
- Chlorination Method	Calcium hypochlorite: $Ca(ClO)_2$
- Chlorine Dosage	Maximum capacity of the facility: 2 mg/ℓ (1 mg/ℓ x 2 units)
- Telemetry System	Wireless

④ Implementation Schedule and Project Cost Estimate

When implementing this project with grant aid from Japan, the expected period for the detailed design is 8.0 months, while it is 38 months for the construction phase. The total estimated cost to be borne by the Government of Mongolia and required for the complete implementation of the Project is estimated to be JPY 150 million.

⑤ Project Evaluation

The project is expected to benefit the Ulaanbaatar residents, as shown in the following table.

<Project Effects and Degree of Improvements>

Present Situation and Problems	Measures by the Project	Direct Effects and Level of Improvement	Indirect Effects and Level of Improvement
The water demand increased with the population increase in Ulaanbaatar City. Especially, the city is in a situation where water supply services to the dwellers of Ger areas do not satisfy the water demand. As the result, it is forecast that the daily maximum water demand of USUG will exceed, in 2011, the capacity of the present water supply facilities.	A new water source will be developed in Gachuurt area which is in the eastern suburbs of Ulaanbaatar City. To supply the developed water, a transmission main of 18.8km will be constructed.	The capacity of the water supply facilities run by the Water Supply & Sewerage Authority of Ulaanbaatar City (USUG) will enhance from 240,000 m^3/day to 265,200 m^3/day.	- The living environment and water supply situation to some 390 thousand Ger dwellers and 43.5 thousand apartment dwellers will improve. - Revenue of USUG will increase because of the increase of accounted water.

The implementation of the Project is expected to bring a great effect as mentioned above, and at the same time will make a great contribution to the sound self-dependent growth of Ulaanbaatar City. Japan, as a top aid donor to Mongolia, has supported the movements for the democratization and the market-oriented economic reform of Mongolia, and the two counties are now in an extremely excellent friendly relation. A further strengthening of the relationship between the two countries can be expected by executing the Project through Japan's grant aid.

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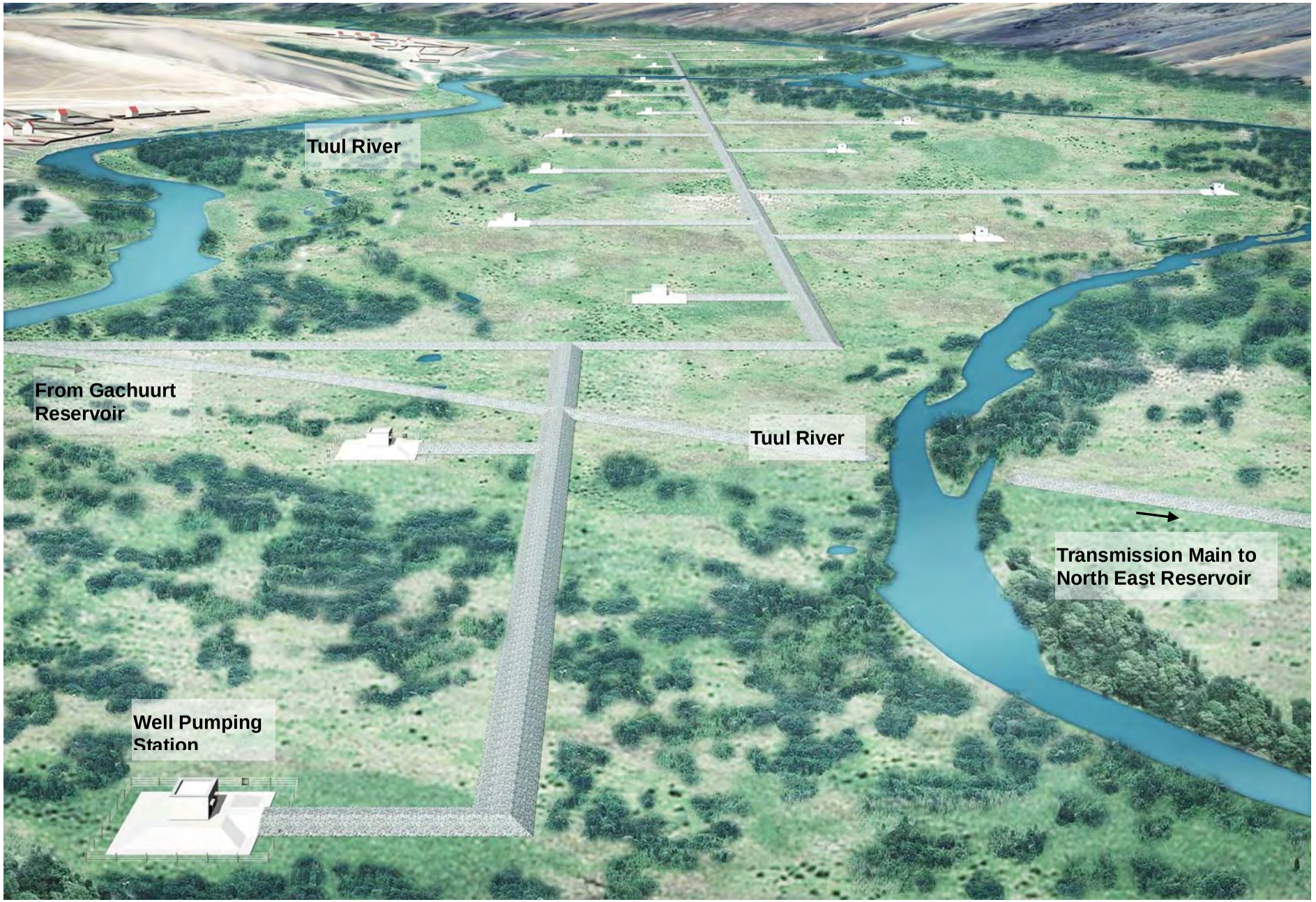
Location Map



Perspective

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Abbreviations

ADB	Asian Development Bank
A/P	Authorization to Pay
B/A	Banking Arrangement
CDM	Clean Development Mechanism
CO_2	Carbon Dioxide
CPI	Consumer Price Index
CTP	Community Heating Center
DCIP	Ductile-Cast-Iron Pipe
D/D	Detailed Design
DSR	Debt-Service Ratio
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EOJ	Embassy of Japan
E/N	Exchange of Notes
FA	Financial Assistance
FDI	Foreign Direct Investment
FILP	Fiscal Investment & Loans Program
FIRR	Financial Internal Rate of Return
FRPM	Fiber Reinforced Plastic Mortar Pipe
F/S	Feasibility Study
GDP	Gross Domestic Product
GIS	Geographic Information System
GNI	Gross National Income
GOJ	Government of Japan
GOM	Government of Mongolia
GPS	Global Positioning System
GRDP	Gross Regional Domestic Product
GTZ	German Technical Cooperation
HDF	Housing Development Fund
HDFI	Housing Development Financing Institute
IBRD	International Bank for Reconstruction and Development
IEE	Initial Environmental Examination
IMF	International Monetary Fund
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
KN/mm^2	Kilo Newton per square millimeter ($1N/mm^2 = 0.101972\ kgf/mm^2$)
LLC	Limited Liability Company
MC	Mortgage Corporation
M/D	Minutes of Discussion
MDF	Mongolian Development Fund
MECS	Ministry of Education, Culture and Science
MFALI	Ministry of Food, Agriculture and Light Industry
MHFC	Mongolian Housing Finance Corporation
MME	Ministry of Minerals and Energy
MNET	Ministry of Nature, Environment and Tourism
MOF	Ministry of Finance
M/P	Master Plan
Mpa	Mega Pascal ($1Mpa = 10.1912\ kgf/cm^2$)
MRTCUD	Ministry of Road, Transport, Construction and Urban Development
MW	Mega Watt
NGO	Non-Governmental Organization
NOx	Nitrogen Oxide
NSO-UNFPA	National Statistical Office and United Nations Population Fund
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
O&M	Operation and Maintenance
OSNAAUG	Housing & Public Community Authority
PC	Prestressed Concrete
PCM	Project Cycle Management
PFI	Private Finance Initiative
pH	Potential of Hydrogen
PPP	Public Private Partnership
TA	Technical Assistance
Tg	Tugrik (Mongolian currency)
VAT	Value-Added Tax

UB	Ulaanbaatar
UBMP2020	Existing Ulaanbaatar Master Plan targeting the year 2020
UBMPS	Study on City Master Plan and Urban Development Program of Ulaanbaatar City in Mongolia
UNDP	United Nations Development Program
UN-HABITAT	United Nations Human Settlements Program
USAID	United States Agency for International Development
USD, US$	US Dollar
USIP	Ulaanbaatar Service Improvement Project
USUG	Water Supply & Sewerage Authority of Ulaanbaatar City
ex-USSR	ex-Union of Soviet Socialist Republic
WB	The World Bank (International Bank for Reconstruction and Development)
WHO	World Health Organization

Chapter1 Background of the Project

1-1 Current State and Issues of the Sectors Involved

1-1-1 Current State and Issues

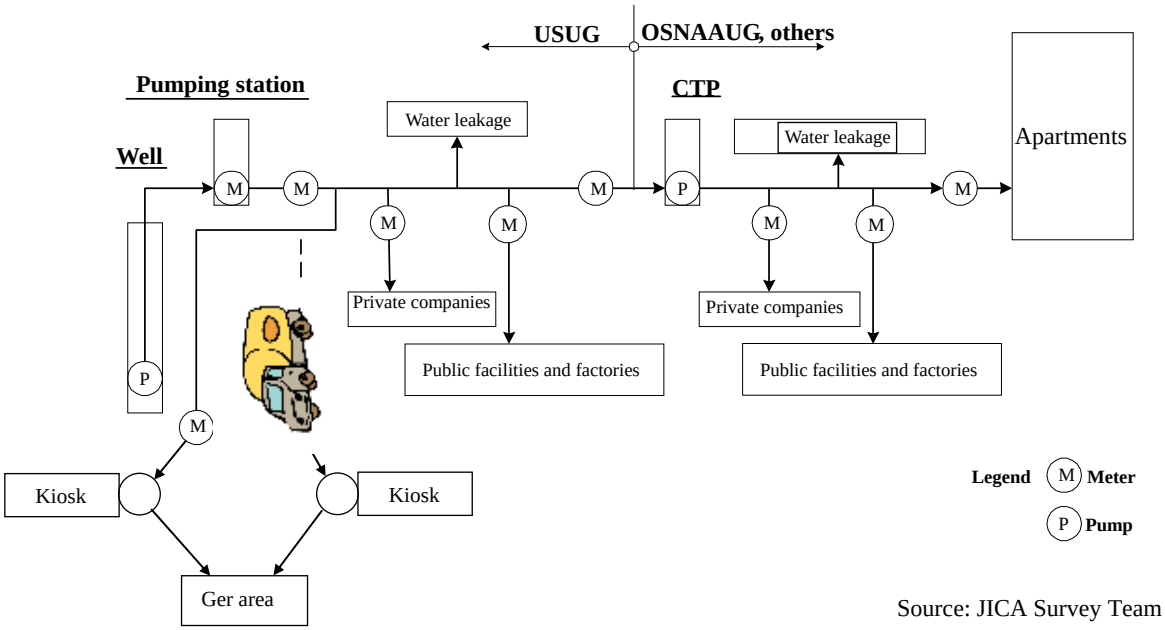
Ulaanbaatar City is the capital as well as the political and economic center of Mongolia with the population of 1.07 million equivalents to 40% (2008) of the national population of 2.7 million (Ministry of Foreign Affairs: Each country/regional situation as of 2009). The migration to Ulaanbaatar has been unstoppable since the democratic revolution after 1990 due to the impoverished countryside by the dzud (snow disaster) which occurred in 1999, 2000 and 2003 resulting in livestock mortality. Under such circumstances, the population growth rate which was less than 1% before 1992, increased substantially to 3-4% after 1993. According to "The Study on City Master Plan and Urban Development Program of Ulaanbaatar City in Mongolia (JICA, March 2009, hereafter referred to as UBMPS)," the population growth rate was estimated to increase up to 3.2% by 2015, and settle to around 2% from 2016 to 2030.

As a characteristic of the residential form and water use of Ulaanbaatar, the city can be categorized into the following: apartment areas, where water is supplied to each household, and Ger areas, where water is purchased at drinking water stores (kiosks). The volume of water use of apartment residents is about 230 ℓ/person/day, while Ger residents use about 7 ℓ/person/day. There are some kiosks where the water supply time is restricted by the defect in water quantity supplied to the Ger areas, i.e., while the water supply is suspended, the users have no choice but to wait for the restart of supply. Additionally, some of the Ger residents are using unsanitary surface water, other than the water sold at kiosks. This indicates a large difference between the apartment residents and Ger residents, and the improvement of living conditions with the improvement of water use volume is a major issue in the city.

Migrants from the countryside build and live in Gers in the suburbs. In the recent years, the Gers have spread to the slopes in the northern part of the city, which is beyond the ideal site for habitation, and is in the midst of air pollution, water pollution, flood damage, and poor water supply. Since the rapid increase of population led to lack of water supply, the government is planning to construct 100,000 units of apartments as the housing measure for Ger residents. However, this can accelerate the water supply shortage, since the unit water consumption in apartments is high.

The water project of Ulaanbaatar City is operated, maintained, and managed by the Water Supply & Sewerage Authority of Ulaanbaatar City (USUG) and the Housing & Public Community Authority (OSNAAUG). USUG is in charge of water intake and chlorination from the water sources, supplying it to OSNAAUG, factories, public facilities (public offices, hospitals, or schools, etc.) and the Ger areas, companies between the pumping station and the Community Heating Center (CTP), and railroad companies. However, OSNAAUG supplies water to the apartment residents who use a large volume of water. USUG is a government-operated entity,

and has marked deficit balances from 2004 to 2008. It had applied for the increase of water fee in order to resolve the deficit, but this was not approved due to political restriction. Operational efficiency and the establishment of an appropriate water fee system are the issues for the development of water resources and strengthening of water supply system, in order to handle the water demand which will increase in the future.



Source: JICA Survey Team

Figure 1-1.1 Conceptual Diagram of the Water Supply of Ulaanbaatar City

The waterworks facilities of Ulaanbaatar City were built in the 1950's up to the 1980's with support from the defunct Soviet Union. However, the supply of parts became difficult after the collapse of the Soviet Union, and appropriate maintenance could not be carried out, causing severe functional decline of the water facilities. In view of this situation, Mongolia had received support from international aid agencies and other countries, and had made efforts to improve water facilities and to develop water sources. In particular, the Government of Japan had implemented through grant aid the feasibility study called "The Study on Water Supply System in Ulaanbaatar and Surroundings (JICA, June 1995 or JICA1995MP)," and based on the result of the feasibility study (F/S), "The Project for Repair of Water Supply Facilities in Ulaanbaatar" from 1996 to 1998, and "The Project for Improvement of Water Supply Facilities at Upper Water Source Area in Ulaanbaatar" from 2003 to 2006 were implemented. Other than these, with the support from the International Bank for Reconstruction and Development (IBRD), Ulaanbaatar City implemented field studies from the early 1990's to 1996 in order to handle the water supply of the rapidly increasing population in the Ger areas, and is continuing to develop the water distribution network as well as the construction of kiosks as a part of the "Ulaanbaatar Service Improvement Project (USIP)" with support from IBRD. Additionally, Ulaanbaatar City and USUG have made efforts in facility maintenance, water leakage measures, and water-saving measures, etc., to reduce the unit water consumption of apartment residents to 270 ℓ/person/day in the recent years, which was 450 ℓ/person/day in the early 1990's. However, according to UBMPS and the result of this

study, the maximum water demand volume per day in 2011 is estimated to exceed 240,000 m^3/day, which is the maximum capacity of the water supply facilities at present.

USUG had utilized the accumulated groundwater at the floodplain of Tuul River which is easy to develop and is low-cost. This water source divides the Tuul River into four (4) sections from the upstream, namely; the Upper Water Source, the Central Water Source, the Industrial Water Source, and the Meat-Complex Water Source. Considering the developable volume of each source, the capacity has reached the limit.

From the above situation, water source development and strengthening of the water supply system are urgent issues.

1-1-2 Development Plan

The waterworks project M/P of Ulaanbaatar City was formulated in the JICA M/P study in 1995 (JICA1995MP), and water source development in this project was proposed in that study. Additional water intake facility was built under the "The Project for Repair of Water Supply Facilities in Ulaanbaatar, 1996-1998" which was implemented based on the proposal of this study, and was followed by the implementation of "The Project for Improvement of Water Supply Facilities at Upper Water Source Area in Ulaanbaatar, 2003-2006," in which a water intake facility of the Upper Water Source was added. This project was equivalent to the development of the last remaining water source at downstream of Nalaikh River, which was one of the proposed water sources in the waterworks of the JICA1995MP. Furthermore, the necessity of expanding the water supply capacity was pointed out in the "Water and Waste Water Master Plan of Ulaanbaatar targeting the year 2020 (UBMP2020)," which was implemented in 2006 with support from the World Bank and approved by the Cabinet. Therefore, although it is still not approved by the Cabinet, it is estimated in the JICA study (UBMPS) that the maximum water demand per day will exceed 240,000 m^3/day which is the estimated water supply capacity by 2011, and thus waterworks facility development is the top priority, including this Project. The concrete plan for the water source/water supply development is the well development of Gachuurt planned in the "2009-2012 Activity Plan of Ulaanbaatar City, December 22, 2008."

From the above plans, the current state and issues have been reviewed based on the new plan, the UBMPS.

(1) Population and Number of Households

The increase of population and number of households had been estimated as follows in the UBMPS. The population and its prediction that was collected by the JICA survey team and the analysis of the data obtained from USUG were the same, in general.

Table 1-1.1 Prediction of Population and Number of Households of Ulaanbaatar City

Items	2007	2010	2015	2020	2025	2030
Total population of Ulaanbaatar City (1,000 people)[*1]	1,031.2	1,173.2	1,325.1	1,537.8	1,695.8	1,870.0
Population of the central 6 districts of Ulaanbaatar City (1,000 people)	973.2	1,107.2	1,250.6	1,437.8	1,585.5	1,739.1
Average annual increase rate of population (%)	4.2[*2]	4.0	3.2	2.3	2.0	2.0
Number of households (1,000 households)	224.2	260.3	315.8	365.6	417.2	479.5
Number of persons per household (person/household)	4.6	4.5	4.3	4.2	4.0	3.9
Population of 3 remote districts (1,000 people)	58.0	66.0	74.5	100.0	110.3	130.9

[*1] 3 remote districts: including Nalaikh, Baganuur, Bagakhangai Source: UBMPS
[*2] Average growth rate of 2000-2005

(2) Land Use and Development Plan

From the water source maintenance perspective, the northern and eastern parts of the present city are protected, and the southern part, which is the nature reserve of Bogd Khan Uul, should be strictly protected. Therefore, Ulaanbaatar City is focusing on the development of the western part in the future. Moreover, due to the high-degree application of the existing urban area and shifting to apartments from Gers, the water demand is expected to increase to a higher value than the population growth rate.

The western area includes Yarmag, Nisekh around the access road to the airport, existing airport, and Bayangol, Torgoit, Bayankhoshuu, etc., on the right bank of Tuul River. An airport city around the new airport is also planned.

(3) Plan Items

The planned items of the water supply and water resource are as follows:

(a) Expansion of water supply capacity; (b) Development of new water sources;
(c) Renovation/improvement of existing water supply facilities; and, (d) Management of water demand

(4) Plan Objective

The objective of the plan is to enable all Ulaanbaatar residents to access piped water.

(5) Balance of Supply and Demand

The supply and demand prediction is set out as: Case 1 (high demand): 230 ℓ/day per apartment resident; and, Case 2 (low demand): 150 ℓ/person/day, considering the demand management. The present city water supply capacity is 161,000 m^3/day on the average, and the design supply capacity is 240,000 m^3/day. The water demand is predicted to exceed the supply capacity by 2013, even in the case of water-saving (low demand: maximum/day).

Table 1-1.2 Balance of Supply and Demand (Unit: m^3/day)

Items	2007	2010	2015	2020	2025	2030
UBMPS: high demand, average/day	154,500	202,898	258,315	318,330	387,030	467,136
UBMPS: low demand, average/day	154,500	194,930	230,292	261,938	292,831	324,133
UBMPS: high demand, maximum/day	179,027	235,108	299,322	368,864	448,470	541,293
UBMPS: low demand, maximum/day	179,027	225,875	266,851	303,520	339,317	375,589
This project: average water supply volume/day	192,167	199,323	225,035	243,495	-	-
This project: maximum water supply volume/day	236,834	236,389	266,882	288,775	-	-

Source: UBMPS

(6) Development Policy

Considering the above situation, it is proposed to carry out the development policies, as mentioned below:

(a) Expansion of water supply capacity: The following three (3) options are considered for the new water source development, however, a long-term demand must be kept in mind upon new water source development: (1) Bio-Complex, and downstream of bio-complex (90,000 m^3/day, UBMP2020); (2) Downstream of Nalaikh (40,000 m^3/day, JICA 1995MP); and, (3) Dam of Tuul River and Terelj River (45,000-225,000 m^3/day).

(b) System improvement: Renovation of the existing facilities to minimize water leakages, and installation of water meters for water-saving/water fee collection (55,000 households planned for installation of water meters in the existing plan).

(c) Review of water fee: Review of the current water fee system: (1) Fair water fee systems for the Ger areas and apartment areas; and, (2) Water fee system which guarantees the operation and maintenance for USUG.

Water distribution system is not stated in UBMPS; however, the above Option (1), Bio-Complex, and downstream of Bio-Complex (90,000 m^3/day, UBMP2020), shall be used for the water source of the western area development, while USUG plans to supply water to Bayangol District from the Upper Water Source via Bayangol Reservoir.

From the above development policies, Option (2), Downstream of Nalaikh (40,000 m^3/day, JICA 1995MP), is the scope of this Project.

1-1-3 Socio-Economic Situation

(1) Mongolia

In 1992, Mongolia changed its political regime from communism of one-party to a presidential system of multiparty and democracy, accompanying the collapse of the Soviet Union. The economic system also changed from the centrally-planned economies to a market economy. The Five-Year National Development Plan with the aid from the socialist countries until then such as the Soviet Union had collapsed, hence restructuring was carried out in the market economy.

The GDP growth rate in Mongolia had been low such as 2-4% between 1996 and 1999, and around 1% between 2000 and 2001. However, the rate increased smoothly until 2004 when 10% was recorded, and indicated more than 7% between 2005 and 2007. However, due to the high inflation rate, the GDP once reduced to 12.3% in 2003, but stayed around 20% after 2000, and had once reached up to 34% due to the price escalation of petroleum oil or cereals, etc., in early 2008. Furthermore, Mongolia had faced an economic downturn due to the worldwide recession and the collapse in the gold/copper price in late 2008. Therefore, even with the economic boom that continued until early 2008, the economic growth of 2008 finally declined to 8.9%. A downward tendency in economy was predicted in 2009, but the later half was expected to be bright due to the agreement of the large-scale copper/gold mine development investment of Oyutolgoi in October 2009.

Farming industry and service industry were having a large share in the economy of Mongolia until 2000. However, the increasing share of the fast-growing mining industry had led larger amount of direct investment from overseas. The production value of mining industry in 2000 was only 20% of the GDP, but increased rapidly to 41% in 2007. Due to the agreement of development of Tavantolgoi coalfield at the south of Mongolia and Oyutolgoi copper/gold mine after 2008, the GDP was predicted to rise higher in 2009.

The table below shows the main index of Mongolia based on the information material from the World Bank (WB).

Table 1-1.3 Major Index of Mongolia

Items	2000	2005	2007	2008
World view				
Population (million people)	2.40	2.55	2.61	2.63
Population growth rate (%)	0.8	1.6	0.9	0.9
GNI, Atlas method (current 1 billion US$)	0.99	2.06	3.36	4.41
GNI/person, Atlas method (current US$)	410	810	1,290	1,680
People				
Life expectancy rate (years)	64	66	67	..
Birthrate (per female)	2.2	1.9	1.9	..
Infant mortality rate (under 5 years old, per 1,000 persons)	63	48	43	..
Economy				
GDP (current 1 billion US$)	1.09	2.31	3.93	5.26
GDP annual growth rate (%)	0.5	7.3	10.2	8.9
Inflation, GDP deflator (year %)	26.1	20.4	12.3	22.4
a) Production output: farming industry (% of GDP)	33	25	23	..
b) Production output: mining industry (% of GDP)	20	34	41	..
c) Production output: service industry and others (% of GDP) [a)+b)+c)=100%]	47	41	36	..
Export (% of GDP)	56	64	64	..
Import (% of GDP)	71	68	66	..
Global links				
Commerce (% of GDP)	105.7	97.5	101.9	117.0
Net barter terms of trade (2000 = 100)	100	128	160	..
Foreign debt (DOD, current 1 million US$)	885	1,302	1,596	..
Foreign direct investment (BoP, current 1 million US$)	54	185	328	..
ODA (current 1 million US$)	217	221	228	..
Source：WB, World Development Indicators database, September 2009				

GDP ratio for major industries in 2008 summarized from other materials is shown in the table below. The ratio may be different from the previous material of WB depending on sorting in other categories, but what is clear from the table is the distinct delay of manufacturers. It can be seen that most of the water supply equipment and parts at the facility repair works have to be procured from foreign countries at self-driven water supply business.

Table 1-1.4 GDP Ratio with Major Industries (2008)

Major Industries	With GDP Ratio (%)	Remarks
Mining and Manufacturing	28.8	10.1% in 2002
Agriculture and Stock Farming	18.8	170 thousand households and 360 thousand persons are engaged. This means that 36.3% over entire Mongolian labors are engaged.
Wholesale/Retailing	14.6	
Transportation/Communication	10.4	Most transportation volumes are by railroad.
Manufacture	6.1	Remarkable Delay
Others	21.9	

Source: Mongolian Statistical Yearbook 2008

Gross National Income (GNI) was approximately USD410 per person in 2000, and USD810 in 2005. However, due to the benefit of the mining development, it showed a rapid growth in 2008 to approximately USD1,680.

Balance of International Trade and International Balance of Payment

The following table shows the past trend of international trade. The table shows excesses of payment over receipts every year except 2006.

Table 1-1.5 Balance of International Trade in Mongolia

(Unit: million US$)

Year	Export	Import	Balance
2005	1,064	1,177	-113
2006	1,542	1,435	107
2007	1,948	2,062	-114
2008	2,535	3,245	-710

Source: Mongolian Statistical Handbook, 2008

In the handbook, physical quantities of imports and exports are reported, but not the amount in monetary terms. However, reported are the share rates of amounts by goods and services of imports and exports instead of the amounts in monetary terms. The following table gives their summaries.

Table 1-1.6 Share Rates of Goods and Services by Category of Imports and Exports in Mongolia in Monetary Terms

(Unit: %)

Commodities of Export/Import	2005	2006	2007	2008
Export	100.0%	100.0%	100.0%	100.0%
Mineral Products	42.7	58.0	66.8	60.3
Textiles and Textile Articles	18.0	16.0	13.5	8.9
Natural or Cultured Pearls, Precious Metals and Jewelry	31.2	17.5	12.1	23.7
Others	8.1	8.5	7.6	7.1
Import	100.0%	100.0%	100.0%	100.0%
Food Products	6.7	6.7	7.7	7.1
Vegetable Origin Products	4.8	4.4	3.8	4.9
Mineral Products	27.7	31.4	29.2	29.7
Chemicals and Chemical Industry Products	4.6	5.0	5.2	4.7
Basic Metals and Articles Thereof	7.3	6.8	8.0	8.3
Machinery, Equipment, Electric Appliances, Recorders, TV Sets and Spare Parts	21.7	18.9	20.6	18.7
Auto, Air and Water Transport Vehicles and Their Spare Parts	9.9	10.4	10.8	14.1
Others	17.3	16.4	14.7	12.5

Source: Mongolian Statistical Handbook, 2008

It is said that Mongolia produces almost all of the mining resources except diamond. However, the country is lacking in processing technology. Therefore, it is presumed from the above table that the country is exporting crude ore and importing finished goods. Besides, it may be gathered from the above table that Mongolia is importing a certain share of greens because of lack of agricultural technology in the country.

Excess payments in the international trade are also recorded in the international balance of payment for 2008. The following table gives a summary of the international balance of payment for the last several years.

Table 1-1.7 International Balance of Payment in Mongolia

(Unit: million US$)

Description	2005	2006	2007	2008
Current Account	88	372	172	-676
Goods and Services	-86	203	57	-752
Goods (Export and Import Goods)	-100	136	-52	-599
Services	14	67	109	-153
Net Income	-51	-43	-98	-129
Current Transfers	225	212	212	205
General Governmental Net Transfers	88	108	108	74
Workers' Remittances	134	77	84	100
Other Net Transfers	3	26	20	31
Capital and Financial Accounts	49	28	329	918
Capital Accounts	0	0	0	0
Financial Accounts	49	28	329	918
Direct Net Investment	185	191	360	683
Portfolio Investment	1	1	75	-35
Other Investment	-138	-164	-106	270
Net Errors and Omissions	-2	-10	-212	-579
Overall Balance of Payment	135	389	288	-337
Reserve Assts	-135	-389	-288	337

Source: Mongolian Statistical Handbook, 2008

(2) Ulaanbaatar City

1) Population and Residence Form

The following table shows the population and residence form of Ulaanbaatar City as of 2008. The population increased from 980,000 people in 2004 to 1.07 million people in 2008. The annual average growth rate was 2.3%.

The population of Ger areas consists of 60% or more of the city population. The population growth rate of apartment areas and Ger areas were 0.86% and 3.25% respectively from 2004 to 2008, which indicates that the population growth rate is overwhelmingly higher in the Ger areas. The population of the Ger areas was further growing in the past 2 years, and is expected to grow continuously at a certain level.

The Ger areas spread mainly in the hills north of the city. However, the city plans to build more apartments and the apartment areas are expected to expand in the future. Therefore, it cannot be concluded at the moment that the imbalance of population of apartment and Ger areas are to continue in the future.

Table 1-1.8 Population and Number of Households in Ulaanbaatar City by District and Type of Housing (2008)

Total		Apartment Areas						Ger Areas							
Total Number of Households (HH)	Population	Public Apartment		Detached Houses w/Infra		Homeless		Detached Houses w/Infra		Simple House		Ger		Homeless	
		Number of HHs	Population	Number of HHs	Population	Number of HHs	Population	Number of HHs	Population	Number of HHs	Population	Number of HHs	Population	Number of HHs	Population
Baganuur District															
7,033	25,877	3,250	10,317	3	17	0	0	4	16	1,345	5,918	2,384	9,435	47	174
Bagahangai District															
908	3,742	480	2,043	0	0	3	11	0	0	167	662	253	1,012	5	14
Bayangol District															
38,672	169,278	27,671	124,533	173	653	23	74	78	362	5,641	21,926	4,933	21,182	153	548
Bayanzurkh District															
56,621	235,192	18,537	75,232	118	760	22	62	527	2,449	17,943	76,185	19,080	79,009	394	1,495
Songinokhairkhan District															
52,770	232,326	14,665	59,741	36	134	61	220	642	2,110	19,423	91,611	17,828	78,072	115	438
Sukhbaatar Disctrict															
31,514	133,108	14,422	59,622	40	128	46	150	270	1,064	9,456	40,838	7,234	31,161	46	145
Chingeltei District															
30,333	140,019	6,849	28,834	9	39	40	111	284	1,221	16,404	77,804	6,621	31,450	126	560
Khan-Uul District															
25,898	98,815	8,305	32,496	188	494	82	274	142	680	11,384	42,340	5,586	21,763	211	768
Nalaikh District															
8,009	29,115	2,087	7,126	0	0	4	10	16	79	3,253	13,030	2,619	8,762	30	108
Ulaanbaatar															
251,758	1,067,472	96,266	399,944	567	2,225	281	912	1,963	7,981	85,016	370,314	66,538	281,846	1,127	4,250

Source: Information from Official Website of Statistical Office of the Capital City of Ulaanbaatar, Mongolia

Number of people per household of each area is shown in the table below.

Table 1-1.9 Family Size by Districts in Ulaanbaatar (2008)

Item	District									Total
	Baga-nuur	Bagak Hangai	Bayangol	Bayan-surkh	Songino Khairkhan	Sukh-baatar	Chigeltei	Khan-uul	Nalaikh	
Population	25,877	3,742	169,278	235,192	232,326	133,108	140,019	98,815	29,115	1,067,472
Total of HHs	7,033	908	38,672	56,621	52,770	31,514	30,333	25,898	8,009	251,758
Average Family Size	3.68	4.12	4.38	4.15	4.40	4.22	4.62	3.82	3.64	4.24

Source: Information from Official Website of Statistical Office of the Capital City of Ulaanbaatar, Mongolia

2) Gross Regional Domestic Products (GRDP)

GRDP in Ulaanbaatar City has changed, as shown in the following table. Unfortunately, GRDP is shown only by the year 2005 even in the latest statistics. Unfortunately too, because of the different classifications of industry in the "Mongolian Statistical Handbook" and the "Statistical Handbook of Ulaanbaatar," it was impossible to compare the contribution of each industry to the total GRDP and to the total GDP of Mongolia and Ulaanbaatar City, and between them, in the item of the same origin of industry. Furthermore, the former one was reported only from 2005 to 2008 in both the current price level and 2005-constant price level, but the latter one was reported only from 2001 to 2005 in current price level. Therefore, comparison with the current price level is possible for those in 2005 only and not with the constant price level of the certain year. Therefore, they could not be the indices for the clarification of their actual increase rates.

Table 1-1.10 GRDP in Ulaanbaatar City

(Unit: Million Tg)

Industry of Origin	Ulaanbaatar				
	2001	2002	2003	2004	2005
GDP/GRDP	633,267	717,436	848,650	1,028,500	1,337,032
Agriculture, Hunting, and Forestry	9,759	6,416	6,828	7,527	8,441
Manufacturing	158,137	147,494	185,427	223,491	415,078
Construction	15,827	23,460	35,824	38,799	45,284
Trade	246,313	279,272	309,692	396,353	443,700
Hotels and Restaurants	11,954	13,153	13,910	15,471	20,774
Transport, Storage and Communication	110,317	148,051	172,241	193,170	254,779
Financial Intermediation	32,758	34,134	47,840	51,451	82,823
Real Estate, Renting and Other Business Activities	32,802	36,412	42,557	54,318	17,336
Public Administration and Defenses incl. Compulsory Social Security	9,455	14,358	21,306	28,563	52,486
Education	26,239	27,512	33,732	36,824	33,363
Health and Social Works	10,198	10,500	12,015	15,870	16,279
Other Community, Social and Personal Service Activities	2,089	6,636	7,311	8,350	10,223
FISIM[1]	-32,581	-29,962	-40,032	-41,686	-63,532
GDP/GRDP per Capita in Ulaanbaatar (1,000 Tg)	792	865	976	1,129	1,422
Remarks: **GDP of Mongolia incl. all the Economic Activities**	2005	2006	2007	2008	
GDP of Mongolia at current price	2,779,578	3,714,953	4,599,542	6,130,326	
GDP of Mongolia at 2005 constant price	2,779,578	3,017,426	3,325,893	3,620,533	
GDP per Capita					
At Current Price (1,000 Tg)	1,091	1,441	1,759	2,305	
At 2005 Constant Price (1,000 Tg)	1,091	1,170	1,272	1,362	

Sources: Statistical Handbook of Ulaanbaatar 2006 and 2007, and Mongolian Statistical Handbook 2008

GRDP in Ulaanbaatar City as a part of the GDP in Mongolia has shared almost half at 48% to the total GDP of Mongolia in 2005. GRDP per capita in Ulaanbaatar City was around 30% or higher at 1.42 million Tg than that in Mongolia which was 1.09 million Tg in the same year. From these facts, it can be said that a considerable part of economic activities have concentrated in Ulaanbaatar City.

3) Local Government Finance

The annual revenue of Ulaanbaatar City was reported only up to 2005. The total annual revenue of Ulaanbaatar City was 38,196 million Tg, while the total annual expenditure was 21,967 million Tg, and ended earning profit.

[1] Financial Intermediation Services Indirectly Measured

4) Household Economy

Grasping the income and expense of general households is essential information upon determination of the residents' solvency for the water fee. According to the hearing survey of UBMPS in summer and winter, although there is not much difference in the income between seasons, expense in winter is relatively higher than that of summer due to the expense of heating cost, etc.

The following table shows the situation of income and expense of each household.

Table 1-1.11 Status of Income and Expenditure of HHs in Ulaanbaatar City

As of 2007

Item			Family Size									Total
			1	2	3	4	5	6	7	8	9 and Over	
Population			17,761	106,320	262,928	314,977	191,874	94,122	37,855	21,858	15,355	1,063,051
Workable Persons per Household	Males		1,272	8,164	35,992	54,299	34,796	18,894	7,964	5,054	3,402	169,837
	Females		372	9,966	31,324	46,023	30,245	17,619	6,893	4,309	3,712	150,463
	Total		1,644	18,130	67,316	100,322	65,041	36,513	14,857	9,363	7,114	320,300
	Number of Workable Persons per Household (Psns/HH)		0.40	0.74	1.12	1.39	1.48	1.69	1.71	1.87	2.02	1.32
Family Economy	Income (Tg/month per HH)	Summer	184,000	165,000	216,000	222,000	231,000	239,000	228,000	223,000	211,000	217,385
		Winter	184,000	166,000	214,000	225,000	235,000	244,000	227,000	223,000	211,000	219,009
		Average	184,000	165,500	215,000	223,500	233,000	241,500	227,500	223,000	211,000	218,197
	Expenditure (Tg/month per HH)	Summer	195,000	144,000	184,000	197,000	200,000	215,000	201,000	206,000	221,000	191,260
		Winter	193,000	156,000	200,000	205,000	211,000	229,000	216,000	208,000	232,000	202,713
		Average	194,000	150,000	192,000	201,000	205,500	222,000	208,500	207,000	226,500	196,987
Income per Worker (Tg/month)			74,378	61,625	80,131	77,721	68,986	68,191	55,705	52,147	47,436	72,484

Source: UBMPS

The income per household shows a wide range from 184,000 Tg of "single household" to 241,500 Tg of "6 people household." The reason why "8 people household" or "more than 9 people household" have lower income compared to their manpower is assumed that there are more low-salary young workers to maintain the living of the household.

1-2 Background, History, and Overview of the Grant Aid

Since 1990, Mongolia has been advancing with the rapid reform for democratization and market economy. Japan has been contributing to the development in a proactive manner including leading the meeting of the supporting countries.

Ulaanbaatar City, the capital of Mongolia, is the political and economic center of the country. The unstoppable inflow of migrants from the countryside has increased the population growth rate of Ulaanbaatar to 3-4% after 1993. According to UBMPS, the growth rate is predicted to reach 3.2% by 2015, and around 2% in the subsequent years to 2030. These migrants build and live in Gers in the suburbs. The water use of the Ger residents, which accounts for 62% of the population of Ulaanbaatar City (as of 2008), is about 7 ℓ/person/day, while apartment residents use about 230 ℓ/person/day. There is a considerable disparity between the two, resulting in a huge gap between their living environments. The improvement of sanitary and living standard is a major issue of Ulaanbaatar City, and the improvement of water supply system for sufficient water for living is indispensable.

Rapid increase of population leads to water deficiency. Moreover, the government is planning to build 100,000 apartments for Ger residents as a housing measure; however, apartment residents tend to use more water, and thus could worsen the water deficiency if the number of apartment residents increase.

In such circumstances, since the water supply capacity is limited, introduction of metered water fee system and water-saving campaign have been carried out in the apartment areas where water consumption is large, in order to discourage the consumption of water. Additionally, efforts to reduce water leakage have been made, but still the maximum water demand/day is predicted to exceed 240,000 m^3/day of the current capacity of the water supply facilities in 2011. Therefore, the increase of water supply capacity including the development of water sources is an urgent issue.

The water source of USUG is the easy-to-develop and low-cost groundwater of Tuul River. The four water sources are, from the upstream of Tuul River, the Upper Water Source, the Central Water Source, Industrial Water Source, and the Meat-Complex Water Source. Of these water sources, water quality problems are found at the Industrial and Meat-Complex Water Sources. The Central and Upper Water Sources that were still developable according to the analyses of JICA1995MP, were developed by the grand aid projects called "The Project for Repair of Water Supply Facilities in Ulaanbaatar" from 1996 to 1998, and "The Project for Improvement of Water Supply Facilities at Upper Water Source Area in Ulaanbaatar" from 2003 to 2006. Therefore, the existing water sources have no more availability for development from the water quality/water volume perspective.

The future water sources are mentioned in the JICA1995MP and UBMPS. Aiming for 2010, the water source of Gachuurt was the top priority in the JICA1995MP. On the other hand, although depending on the target volume for development, the Bio-Complex (target volume for development: 90,000 m^3/day; UBMP2020), Gachuurt area (target volume for development: 40,000 m^3/day; JICA1995MP), and Dam of Tuul River and Terelj River (target volume for development: 45,000-225,000 m^3/day) are the candidates in the UBMPS. In particular, the water source of the Gachuurt area is considered the most appropriate water source development site near Ulaanbaatar City. However, these technical evaluations are based on the JICA1995MP, and the developable volume in Gachuurt needs to be reviewed based on the changes of the social and natural environment of the next decade of the Gachuurt area.

As to the measures for the above issues, a water source development (25,200 m^3/day) at the eastern suburban area of Ulaanbaatar City based on the results of JICA1995MP and the UBMPS of 2009, and a grant aid were requested from Japan.

The contents of the grant aid request are as follows:

Table 1-2.1 Contents of Grand Aid Request

Item	Contents of Request
Water volume to be developed	25,200 m^3/day
Water supply well	21 wells
Collecting pipe	Steel pipe. Total length: 4.8 km; diameter: ave. 320 mm
Conveyance pipe	—
Distribution reservoir	Volume: 8,000 m^3
Chlorination facility	Entire unit (liquid chlorine)
Control house	—
Transmission main	Steel pipe. Total length: 19.5 km; diameter: 600 mm

Source: JICA Survey Team

1-3 Trend of Japanese Aid

As mentioned above, Japan supports in the field of water supply as described below.

1) The Study on Water Supply System in Ulaanbaatar and Surroundings (JICA1995MP) [JICA1995MP (JICA Development Study, 1993-1995)]

In order to measure the increasing water demand problem, this study was implemented targeting the following objectives:

- To establish an urgent improvement plan for the existing water facilities.
- To establish a water supply master plan for Ulaanbaatar City with the target year of 2010.
- To implement a feasibility study for the priority candidate site for the groundwater development.
- To propose to strengthen the waterworks operation through the formulation of the organization.

2) The Project for Repair of Water Supply Facilities in Ulaanbaatar (Grand Aid Project, 1996-1998)

This project was implemented under grant aid due to the urgent improvement plan of the JICA master plan in 1995. The facilities for the Central Water Source were renewed and improved, and the water supply volume from the Central Water Source to the city was increased from 97,000 m^3/day to 110,000 m^3/day, which contributed a significant relaxation of the frequent water stoppage and troubles of water intake. The following items show the main renewals/improvements of the facilities. The credit line of EN was JPY2.254 billion.

- Rehabilitation of water supply well: 49 wells
- Well construction: 9 wells
- Rehabilitation of water distribution pump: 5 pumps
- Flow meter for water distribution pump: 10 units
- Installation of telemetry system: Entire unit

3) The Project for Improvement of Water Supply Facilities at Upper Water Source Area in Ulaanbaatar (Grant Aid Project, 2003-2006)

In this project, the following facilities of the Upper Water Source were mainly renewed or improved, and the distribution pump of the Central Water Source was also renewed. As a result, the water supply volume from the Upper Water Source to the city increased to 18,000 m^3/day, and the renewal of the water supply pump of the Upper and Central Water Sources enabled the stable water supply and reduction of energy costs. The main facilities are as follows:

- Well construction: 16 wells
- Intake pump for well: 16 pumps
- Renewal of water supply pump: 5 pumps
- Water hammer prevention equipment for water supply: Entire equipment
- Renewal of water distribution pump of Central Water Source: 2 pumps

In order to ensure the effects of the project, the following five (5) soft components were also implemented as well:

- Support for strengthening of operation
- Support for operation and management of the facility
- Support for water leakage inspection
- Support for water quality monitoring
- Support for educational activities of the residents

The period of this project was 32.5 months in total, including 7.5 months for the detailed design, and 22 months for facility construction, construction management, and soft components, etc. The credit line of the EN was JPY1.685 billion, including the JPY17 million borne by Mongolia.

4) The Study on City Master Plan and Urban Development Program of Ulaanbaatar City in Mongolia (UBMPS) [JICA Development Study, 2007-2009]

Based on the request from the Government of Mongolia, this study was implemented from March 2007 to February 2009 for the purpose of revising the existing Urban Master Plan by 2020, by the Ministry of Road, Transportation, Construction and Urban Development (MRTCUD) and the City of Ulaanbaatar. The detailed purposes of the project are as follows:

- To revise the existing Master Plan by 2020, and establish a revised Master Plan that targets 2020 and 2030.
- To create an action plan and give advice to the implementing party for the execution of the revised Master Plan.
- To propose a feasible method, and transfer of technology to Mongolia for providing the capability to establish an urban plan.

Urban planning consists of various sectors, including land utilization, urban transport, housing policy, improvement of living environment, urban utility and environment, etc.

1-4 Trend of Aid of Other Donors

The cooperation to USUG by other donors includes the support from the International Bank for Reconstruction and Development (IBRD) and from the Netherlands.

(1) Aid Projects of the International Bank for Reconstruction and Development (World Bank)

In the early 1990's, IBRD implemented two studies (Phase 1 and Phase 2) for the "Urban Services Rehabilitation Project," and Phase 2 was completed in 1996. In response, the Government of Mongolia and Ulaanbaatar City decided to accept this as the "Ulaanbaatar Services Improvement Project (USIP)," and requested IBRD to continue the project. IBRD accepted the request from the Government of Mongolia and offered an interest-free loan which includes a low-rate administration fee (0.75% of the remaining loan) and a commitment fee (0.5% annual rate during the redemption period) only, and implemented the main construction work. The loan amount was USD18.1 million, and the redemption period was 40 years including 10 years of grace period. Additionally, USD4.5 million of grant aid was provided from Australia in cooperation to the above. The construction was completed in 2004[2].

The Government of Mongolia and Ulaanbaatar City positioned the above USIP project as "USIP 1," and have also decided to implement "USIP 2." They have once more requested the World Bank for assistance in carrying out the study.

IBRD accepted the repeated request, implemented the feasibility study (F/S) followed by the preliminary design, and submitted reports at the end of 2003 at the same time as the completion of USIP 1 in the beginning of 2004[3]. Additional study for the formulation of the master plan was carried out to clarify the whole concept and concrete details of the project, which was completed in 2006[4].

The contents of the loan include USD22.98 million for the entire project and USIP 1, and the redemption period was 40 years including 10 years of deferment period. Under such circumstances, USIP 2 with assistance from the World Bank was processed. Areas covered by USIP 1 and USIP 2 are as indicated in the following figure and table.

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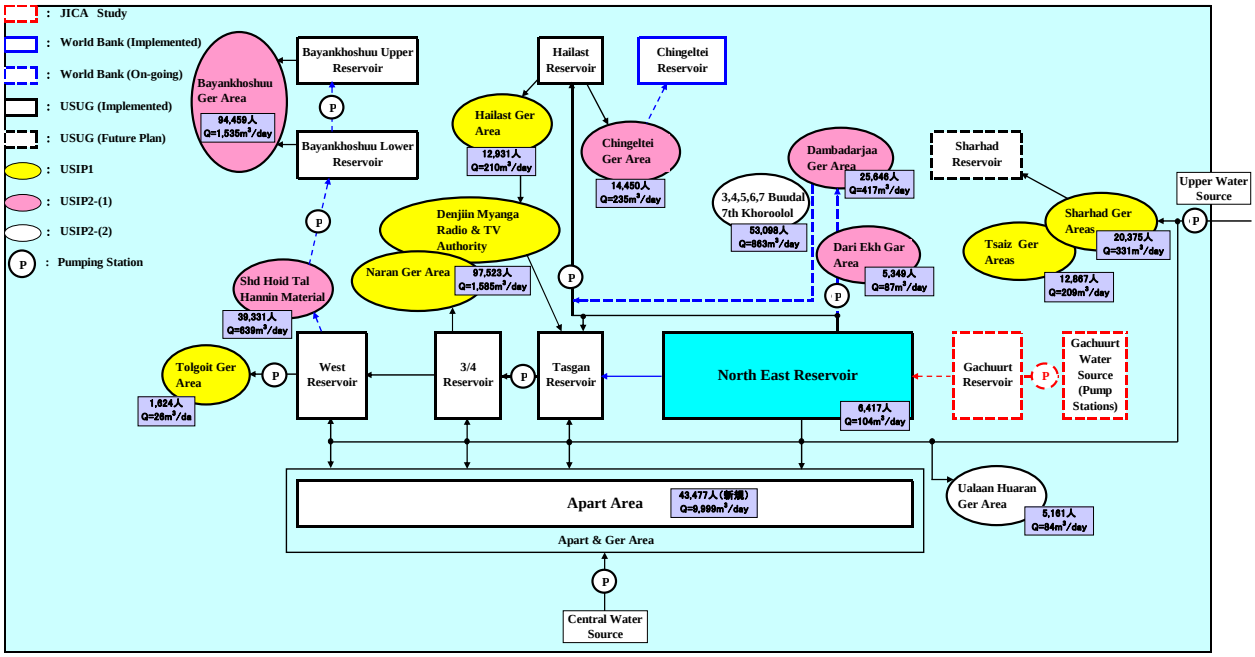
[2] Borrower's Implementation Completion Report on Ulaanbaatar Services Improvement Project financed by World Bank Credit 2973-MOG (Return completion report of borrower of USIP funds, June 2004)

[3] a) Final Feasibility Study Report on Feasibility Study of the Second Ulaanbaatar Services Improvement Project and Preliminary Design of Water Supply Facilities (Project No. TF 051125) - Volume II Appendices, December 2003, and, b) Preliminary Design Report on Feasibility Study of the Second Ulaanbaatar Services Improvement Project and Preliminary Design of Water Supply Facilities (Project No. TF 051125) - Volume I, Main Report, February 2004

[4] Master Plan Report on Water and Wastewater Master Plan of Ulaanbaatar, September 2006



Source: IBRD and JICA Survey Team

Figure 1-4.1 Schematic Diagram of Water Supply in Ulaanbaatar, Mongolia

Table 1-4.1 Population of Ger Areas under USIP

USIP 1 (IBRD: Completed)			USIP 2 (IBRD: Ongoing or to be implemented in the future)		
Name of Ger Area	Population (person)	Water Supply Volume (m^3/d)	Name of Ger Area	Population (person)	Water Supply Volume (m^3/d)
Hailast	9,759	255	Chingeltei	10,905	285
Denjiin Myanga	50,954	1331	Dambadarjaa	19,355	506
Radio & TV Authority Naran Zuragt	22,646	592	Dari Ekh	4,037	105
			Sub-total	34,297	896
In and Around North East Reservoir	4,843	127	Bayankhoshuu	71,288	1862
Tsaiz	9,711	254	She Hoid Tal	5,000	131
Sharhad	15,377	402	Hannin Material	24,683	645
Tolgoit	1,226	32	3,4,5,6,7 Buudal	10,893	285
			7th Khoroolol	29,180	762
			Ualaan Huaran	3,895	102
Sub total	114,516	2,992	Sub total	179,236	4,683
			Total: 293,752		7,675

Source: USUG

For the installation of distribution pipes by IBRD at the northeast of Ulaanbaatar City, which is in progress, it was planned to use the water of the North East Reservoir of the above figure. However, due to the insufficient capacity of the pumping station of the Upper or Central Water Sources, it was ascertained that water could not be supplied to the North East Reservoir. Therefore, the functionality has to be activated for the first time if the water is supplied to the North East Reservoir from the water source of Gachuurt which is planned to be developed in this project.

According to the latest performance report of June 2009, the actual start of construction of USIP 2 was assumed to be 2007. The progress as of June 2009 is as shown in table below.

Table 1-4.2 Progress of USIP 2 Project in Ulaanbaatar Financed by the WB

As of the end of June, 2009

Project Components Details				Progress in Each Area of Districts				Total	Physical Progress (%)
				USUG Office	Chingel-tei	Damba-darjaa	Dari- Ekh	Include other districts	
Construction of 78.2 km water pipeline									
Consists of:									
1.1	(1)	Construction of 8.2 km ductile iron pipes	Constructed ductile iron pipe (km)		-	-	5.454	12.154	148.22%
	(2)	Construction of 70 km high density polyethylene pipes	Constructed high density poly-ethylene pipes (km)		11.500	11.000	5.000	62.250	88.93%
	(3)	Equipment of heat trace for 3.8 km	Km with heat trace (km)		2.400	0.400	0.510	11.774	309.84%
1.2	(1)	Construction of 3 precast concrete reservoirs with associated heating houses and access roads	Number of reservoirs constructed		1	-	-	3	100.00%
			Number of heating houses equipped		1	-	-	3	
			Access roads constructed (km)		Ready			Ready	
	(2)	Construction of 4 pumping stations	Number of pumping stations constructed		1	-	1	4	100.00%
	(3)	Construction of about 67 new water kiosks	Number of newly constructed kiosks		10	4	6	54	41.79%
			Number of reconstructed kiosks		2	3	3		
	(4)	Rehabilitation works of 44 water kiosks supplied by truck tankers	Number of rehabilitated kiosks among 44 existing water kiosks		6	7	5	43	97.73%
	(5)	Water connections to about 16 public institutions, including selected hospitals, schools, clinics	Number of hospitals connected		-	-	-	10	62.50%
			Number of schools connected		1	-	-		
			Number of kindergarten connected		1	-	-		
			Number of clinics connected		-	-	-		
	(6)	Water connection to 7,500 private residences	Number of residents of water connection realized		Not yet	120 HHs (On going)	Not yet	On going	1.60%
1.3	(1)	Provision and installation of up to 10,000 water meters	Number of water meter provided and installed	Cancelled					
	(2)	Construction of various water pumps with associated electrical equipment	Number of pumps constructed		3	Not yet	3	26	-
1.4	(1)	Provision of 10 water tankers with associated spare -parts	Number of water tankers provided with spare-parts	10				10	100.00%
	(2)	Provision of spare-parts for Ulaanbaatar City's existing fleet of water tankers	Progress (%) of provisions realized	Ready				Ready	
	(3)	Provision of 5 vacuum-type fecal vehicles	5 vacuum-type fecal vehicles	5				5	

Note: Actual works started in August 2007 according to Quarterly Progress Report - 2nd Quarter of 2009 - "Semi-Annual Progress Report No. 1 of 2009 for USIP 2

Source: Project description and details: Project Office of the World Bank. Progress Status: USUG

In the above table, the progress of construction of the 8.2 km ductile iron pipes was over 100% because the quantities were more than those in the original plan. Based on the information from USUG, the original plan was changed in the course of construction work. The pipe-laying work on the construction of 70 km high-density polyethylene pipes was 89% completed as of June 2009. On the other hand, the procurement and installation of 10,000 units of water meters were cancelled according to the information from official of USUG. There is no other explanation in the progress report but the project is for the improvement of living condition in the Ger areas as its target, so that the works may be limited to only one direction of improvement of the pipeline network to improve the living condition in the Ger areas. As shown in the table above, the rehabilitation and construction of new water kiosks including reconstruction has considerably progressed in physical terms at 42% and 98% respectively.

The project of USIP 2 was planned to be completed by the Year 2010. Following this, the Government of Mongolia has a plan to further meticulously execute the conceived project for the improvement of living conditions, i.e., USIP 3, and the World Bank is also strongly and zealously committed to continue the project. However, there is no clear indication that the project will be

continued at present. The officials of USUG informed the JICA Survey Team that USUG is now expecting to execute the improvement works of sewerage systems, and it is now preparing documents for the inquiry to the World Bank through the Government of Mongolia. Moreover, individual house connections are planned in future.

(2) Technical Cooperation from the Netherlands

A technical cooperation by VITENS of the Netherlands, namely; the "Water Operators Partnerships (WOP)" is in progress at USUG. The main purposes of WOP are the financial continuity and the independent service of the water and sewerage project. The details are as follows:

- Purpose 1: Improvement of USUG's maintenance and management capacity
- Purpose 2: Improvement of USUG's financial capacity
- Purpose 3: Provision of a continuous water and sewerage service from the sustainable water resources management and environment conservation

The main activities are the following:

- Activity 1: Maintenance/management activity
- Activity 2: Financial independency of USUG
- Activity 3: Sustainable water resource management
- Activity 4: Sanitation
- Activity 5: Training and improvement of ability
- Activity 6: Additional activity: Coordination between international aid agencies, and improvement of sectors

The period of cooperation is 3 years, from November 1, 2007 to October 31, 2010. A total of 1.7 million Euro was planned as the project fund.

This technical cooperation is for the improvement of maintenance and management for the water facilities of USUG, which is contributing to the operation/maintenance/management and the strengthening of sustainability of this project, as well as strengthening of the financial base, and supports for the water resource management including the demand control for the effective use of the water resource. These supportive functions are continued for 3 years with expectations for synergetic effect.

1-5 Situations of the Project Site and its Surrounding Areas

1-5-1 Natural Condition

(1) Geography

1) Tuul River Basin

Tuul River, with a basin area of 50,400 km^2, runs from Henteyn Nuru (mountain range) for a total length of 819 km and merges with Orhon River, which is a tributary of Selenge River that runs into Lake Baikal. Henteyn Nuru is a mountain range that divides the Arctic Ocean, Pacific Ocean, and the closed drainage in the center of Mongolia, and the peak is Mt. Asralt (2,751m) where the river source of Terelj River is located. The mountain range is squeezed by its geological structure, stretching from the northeast to the southwest direction, and is forming a vestige of the ice age - moraine, cirque, and glacial lake.

The basin area from upstream of Zaisan Bridge in Ulaanbaatar is 6,300 km^2, and it is 5,332 km^2 upstream of Gachuurt where the river starts.

Table 1-5.1 Area of Small Basins of Gachuurt Basin

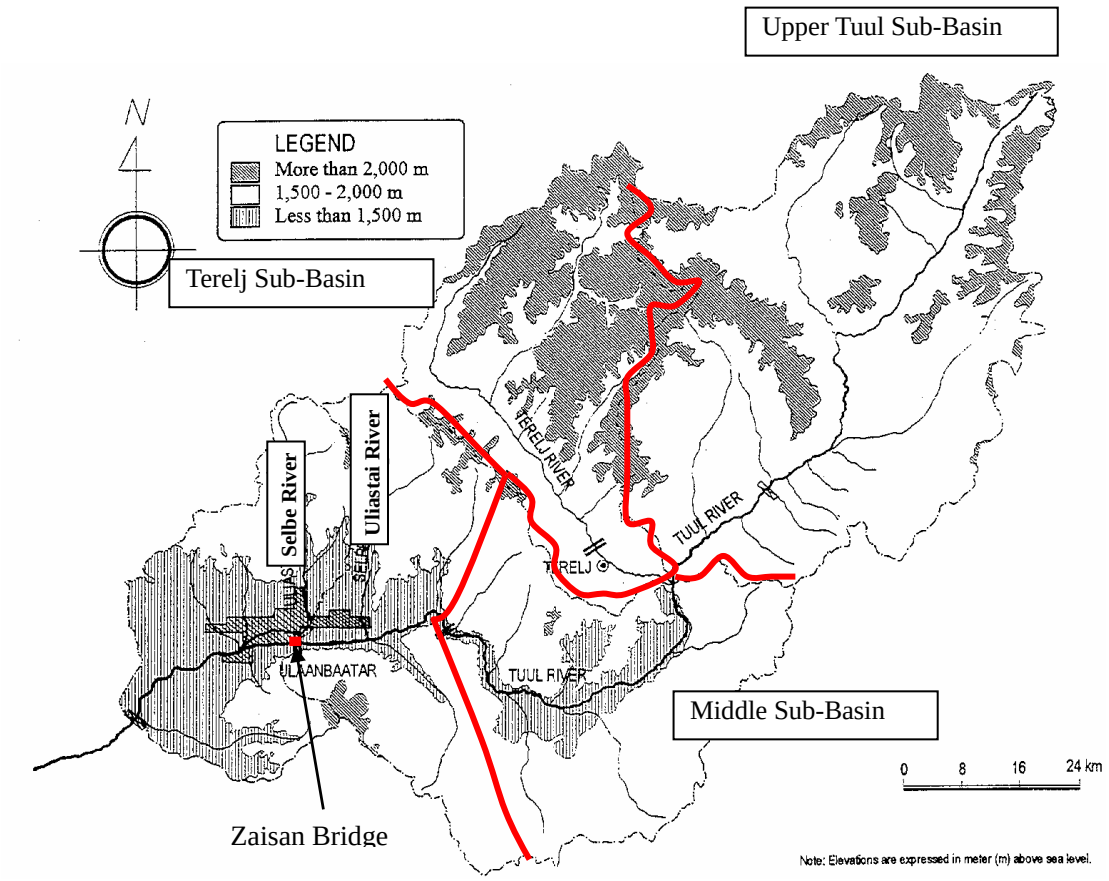
(Unit: km^2)

Sub basin	Altitude			Total
	1500m or lower	1500-2000m	2000m or higher	
Upper Tuul Sub-basin	0	2,114	626	2,740
Terelj Sub-basin	0	797	542	1,339
Middle Sub-basin	200	1,000	53	1,253
Total	200	3,911	1,221	5,332
Ratio	3.8%	73.3%	22.9%	100%

Source: JICA Survey Team

Upstream of Gachuurt village is a mountain terrain of mostly 1,500m or higher, and further upstream is a mountain terrain of 2,000m or higher. The ratio of the basin area in the mountain terrain of more than 2,000m is approximately 23%. On the north-slope is a coniferous forest, with a relatively higher level of rainfall compared to the low altitude area.

On the mountain foot are rolling hills forming a terrace and alluvial fan that are 2-5m higher than the Tuul River and its tributary. Additionally, a 1-2 km wide river plain is formed in the Tuul river basin. Located here are many vestiges of the old channel and are not flat, and many wetlands can be found. The already developed Upper Water Source and the to-be-developed Gachuurt Water Source are located at this river plain.



Source: JICA Survey Team

Figure 1-5.1 Classification Drawing of River Basin/Altitude

2) Geography of the Survey Area

The geography of the survey area is roughly classified into the following 3 types:

- Mountain terrain
- Hills
- River plain

a) Mountain Terrain

The mountain terrain spreads from the Gachuurt village Water Source to the right bank of Tuul River. The slope is 10-35 degrees of carboniferous layer of the Paleozoic Age. On the mountain foot forms a talus slope. Rolling hills are also gradually formed. Altitude is lower than 1,500m.

b) Hills

The hills spread on the mountain foot and forms gentle slopes. Most of the slopes are less than 3 degrees which form a terrace and alluvial fan that are 2-5m higher than the Tuul River and its tributary.

c) River Plain

On the river plain are many vestiges of the old channel and are not flat, and many wetlands can be found, forming slight ups and downs. The Gachuurt Water Source is located in this area, and the valley width is 1 km.

(2) Geology

The study area includes a wide distribution of Altan Ovoo of the Paleozoic Age and the Orgioch Uul Formation. Covering this bedrock are the talus deposit on the mountain foot and the terrace deposit, and the river plain deposit on the river plain.

The Altan Ovoo Formation is distributed on the west side of Uliastai River and is mainly composed of sandstone and clayslate, rarely including a layer of tuff, or, a layer of lens-shaped gravel. The fault at the lower layer of Devonianbed is considered to be the border.

The Orgioch Uul Formation is distributed on the east side of Uliastai River and is mainly composed of sandstone, and rarely distributing alternate layers of sandstone and shale in the middle part.

The surface of the baserock is weathered and loose. In addition, the granulated rocks such as clayslate or shale have slaked.

As for the talus deposit, psephite is distributed on the steep slopes of the mountain terrain. Other talus deposits and terrain deposits are sandy soil mixed with clay and gravel. The river plain deposit is gravelly sand mixed with clay.

The collection pipe of the well runs through the river plain, terrain and talus deposits, and stretches up to the reservoir. The reservoir foundation is talus deposit of sandy soil mixed with clay and gravel. The collection pipe then runs through the bedrock, encountering river and talus deposits, and finally to the North East Reservoir.

(3) Climate and Hydrology

1) Temperature

The weather stations in the project area are the Tahilt observation station, the Ih Surguuli weather station, the National University of Mongolia, the international airport, and the Selbe observation station. Additionally, when expanded to the river basin, the Terelj observation station is included. There is no observation station upstream of the Terelj station.

Based on the temperature data of recent years, the monthly average temperature at the Tahilt station, which represents the city area, and of Tahilt station, which represents the mountain area, are shown in the following table and figure.

Table 1-5.2 Monthly Average Temperatures (°C)

Station	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Tahilt	-21.8	-16.6	-7.2	2.7	2.7	10.3	16.5	19.3	16.8	0.5	-11.5	-19.5	-0.66
Terelj	-24.6	-19.5	-10.8	-10.0	7.2	13.0	15.6	12.1	6.5	-2.6	-13.9	-21.8	-4.07

Observation period: Tahilt: 1996-2006, Terelj: 1996-2008 Source: Hydrological & Meteorological Institute

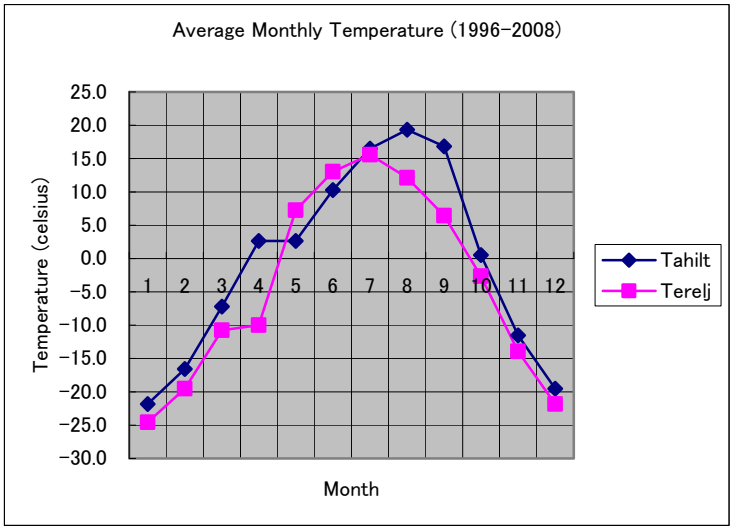


Figure 1-5.2 Monthly Average Temperatures Source: JICA Survey Team

2) Precipitation

Precipitation at the Tahilt station in the suburban area of Ulaanbaatar City (1979-1994) and the Ih Surguuli station (1982-1994) were 274 mm and 296 mm, respectively. On the other hand, precipitation at the Terelj station in the mountain area (1986-1994) was 403 mm.

According to the data for 1996-2008 collected in this preparatory study, the average precipitation at the Tahilt station was 237 mm, while they were 238 mm at the National University of Mongolia (Ulaanbaatar City) and 329 mm at the Terelj station. This indicates that rainfall of the recent years has been low. Rainfall from May to August accounts for 64-68% and rainfall from May to September of the rainy season accounts for approximately 87% for both plain and mountain areas.

Table 1-5.3 Monthly Average Precipitation (1996-2008, mm)

Station	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total.
Ulaanbaatar	2.8	2.4	3.4	8.9	26.1	37.7	63.4	51.5	25.9	6.6	5.3	4.0	238.1
Terelj	3.1	2.4	6.0	11.6	34.3	63.4	80.6	79.6	29.8	10.0	4.4	3.6	329.0

Source: Hydrological & Meteorological Institute

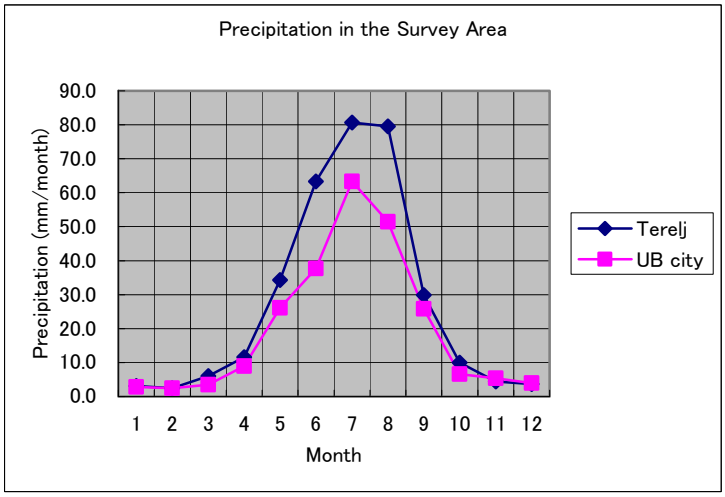


Figure 1-5.3 Monthly Average Rainfall Source: JICA Survey Team

Table 1-5.4 Annual Average Precipitation

Station	Altitude (m)	Annual Average Rainfall (1979-1994, mm)	Annual Average Rainfall (2000-2008, mm)	Annual Average Rainfall (1996-2008, mm)
Tahilt	1300	273.8	237	-
National University of Mongolia	1300	-	-	238.1
Terelj	1540	402.5	-	329.0

Source: Hydrological & Meteorological Institute

Compared to 1979-1994, the rainfall of the city reduced to approximately 13%, and the rainfall of Terelj in the mountain area to approximately 18% in 1996-2008.

3) Discharge

The river flow observation stations in the study area are only two: Zaisan and Terelj. However, in order to examine the water balance at Upper Water Source, the river discharge observation of Tuul River was conducted at Gachuurt village located at lowest portion of Nalaikh Water Source from Nov. 1993 to Oct. 1994 (JICA1995MP, Jun. 1995). The basin area of Tuul River is 5,332 km^2.

Table 1-5.5 Monthly Average River Discharge at Gachuurt Village of Ulaanbaatar City (Nov. 1993-Oct. 1994)

Unit	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
m^3/sec	0.3	0.3	0.9	2.9	3.2	21.4	80.8	212.6	129.8	29.0	7.5	0.6	—
1000m^3/ month	778	778	2,333	7,517	8,294	55,469	209,434	551,059	336,442	75,168	19,440	1,555	1,268,267

Source：JICA1995MP Altitude: 1,340m, Basin Area: 5,332km^2

And the observation data at Gachuurt point are the data of more than 15 years ago and the observation period is only 14 months. The following table shows the river discharge at Zaisan Bridge in Ulaanbaatar City, where observation has been carried out continuously.

Table 1-5.6 Monthly Average River Discharge at Zaisan Bridge in Ulaanbaatar City

	Observation Period: 1972-1991 (Source: JICA1995MP, Hydrological & Meteorological Institute)												
Unit	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total.
m^3/sec	0.03	0.03	0.42	6.72	33.32	49.01	85.32	88.02	55.62	17.49	4.41	0.52	-
1000m^3/ month	77.8	77.8	1,089	17,4189	86,3659	127,034	221,1494	228,148	144,167	45,334	11,431	1,348	883,639
Unit	Observation Period: 1996-2008 (Source: Hydrological & Meteorological Institute)												
m^3/sec	0.03	0.19	0.72	4.85	19.20	23.42	36.64	34.75	25.47	12.48	2.91	0.32	-
1000m^3/ month	72	500	1,866	12,567	49,768	60,709	108,465	90,062	66,016	32,356	7,535	834	430,751

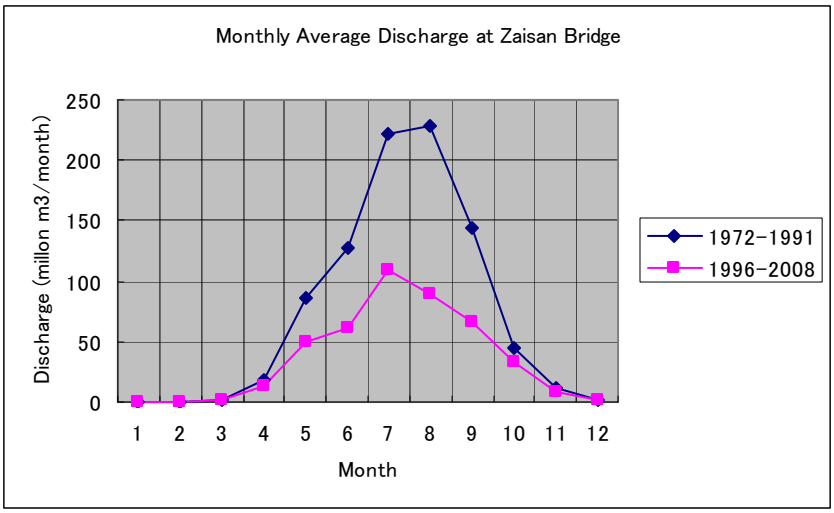


Figure 1-5.4 Monthly Average River Discharge at Zaisan Bridge

The monthly average river discharge at Zaisan Bridge in the recent years has reduced by 51.3% compared to the average from 1972 to 1991. However, this value is extremely high compared to the reduction rate of the precipitation which is around 13-18%, and can be assumed that there were some problems in either of the observation methods of the observed years. However, personnel involved have claimed that there was no problem in the observation method. There was a case in March 2001, where the river water of Tuul River disappeared for 2 weeks at Yarmag (downstream of Zaisan Bridge).

1-5-2 Social Environmental Consideration

(1) Category and Reason

Category : A

Reason : This project aims;

- To dig 21 production wells in Water Source Protection Area.
- To construct underground pipes in Water Source Protection Area.
- To construct reservoir and related facilities near Water Source Protection Area.
- To pump up relatively large amount of groundwater (25,200 m^3/day).

From the above objectives, there is a possibility of significant adverse impacts on society and natural environment such as water use and ground subsidence.

(2) Necessary Procedures Related to Environmental Aspects

The Mongolian Environmental Impact Assessment (EIA) Law was enacted in January 22, 1998 and amended in 2001. The EIA Law is applicable to the Project, as follows:

Table 1-5.7 The Project in the EIA Law

Item	Content	Clause
Subject	Water supply projects where population is more than 10,000 will be subjected to EIA. The Project would require EIA because the population of Ulaanbaatar City is more than 1 million.	3.1.2 Annex
Items of Study, Projection, Assessment	Health and environment for humans including risk of accident and natural hazard of manufacturing process.	3.1.1; 3.1.4
Screening Agency	Ministry of Nature, Environment and Tourism (MNET)	4.4
Implementation Agency	Water Supply and Sewerage Authority of Ulaanbaatar City (USUG)	3.1.3
Other Related Persons	Expert: Specialists who are designated by MNET to examine reports submitted by the assessment specialist Assessment Specialist: Persons who are licensed by MNET to conduct survey and make reports.	3.1.6; 3.1.7
Procedure	1. USUG submits the information to MNET. 2. The Expert examines the necessity of detailed EIA (DEIA) within 12 working days. This project was judged to require DEIA on January 6, 2010. 3. If the DEIA is recommended by MNET, USUG has to prepare the DEIA report through the employment of assessment specialists. As of Feb. 5, 2010, the draft DEIA report was completed. 4. The DEIA report shall reflect the preservation plans, mitigation measures, monitoring plans, and opinions of residents and local governments, and it should be finally submitted to MNET. 5. The Expert examines the validity of DEIA within 18 working days after receiving it from USUG. 6. MNET decides on whether or not to implement the project based on the examination of experts.	4～7

Source : JICA Survey Team

(3) Procedure of Land Acquisition

USUG already started the land acquisition in Ulaanbaatar City in October 2009 and had received the permission of land use along the transmission main from the Gachuurt Water Source to the North East Reservoir. USUG also had requested the Governor of Khoroo not to construct new structures in that permitted land. Fences and some structures at the 18 Gers where the transmission main may pass are supposed to be removed and restored temporarily during the construction stage. These will be compensated by applying the procedure taken in the Asian Development Bank Project (MON2301 Urban Development Sector Project, August 2009) that included the removal and restoration of private properties.

(4) Stakeholder Meetings

Two public consultations and one stakeholder meeting were conducted with USUG's initiative. The purposes of these meetings were to explain the outline of the Project, to collect local and socio-environmental information, and to formulate the agreement on project implementation. No serious objection to project implementation was raised and the participants' opinions are reflected in the implementation policy of the Project.

Table 1-5.8 Public Consultation and Stakeholder Meetings

	Public Consultation 1	Public Consultation 2	Stakeholder Meeting
Venue	Gachuurt Village Hall	USUG in UB City	Puma Imperial Hotel in UB City
Date	Sep. 10, 2009	Sep. 16, 2009	Sep. 24, 2009
Objectives	Explanation of the Project outline and Data collection	Explanation of Project outline and Data collection.	Explanation of Project outline, draft scooping, mitigation policy, and monitoring policy
Facilities	Water source and Distribution reservoir	Transmission main	All facilities
Participants	**Gachuurt Area:** Representatives of administration, residents' committee, Khoroo, and JICA Mongolian Office	**Pipeline Route:** Representatives of 10 Khoroo and military facilities	Representatives of MNET, MRTCUD, Water Authority, military facilities, UB City, District, Khoroo, JICA Mongolian Office, UNDP, ADB, and Vitens (Dutch)
Attendees	43	21	50

Note: MRTCUD: Ministry of Road, Transportation, Construction and Urban Development

Source：JICA Survey Team

Based on the results of the stakeholder meeting, no house is found within the Water Source Protection Area in the site planned for the water supply well, and that Tuul River runs through the private well and the point of water intake. Therefore, the impact caused by the intake of groundwater of the planned facility to the surrounding houses is small. Regarding the impact to water use, the reduction of impact is measured by pushing forward the deadline due to the pipeline construction. Moreover, fences of houses that interfere with the pipelining shall be temporarily removed, but later on restored. It was explained to the participants that no major impact caused by the facility construction is expected with the application of such measures.

(5) Environmental Impacts of Project Implementation to Society

The environmental impacts to society which can be caused by project implementation are as described below.

1) Involuntary Movement of Residents

The transmission main route is planned to avoid permanent structures of timber/concrete; however, the fences surrounding the houses or Gers within the area are required to be removed temporarily and later restored. There are 4 locations where the water pipes will run through the resident's premises, and the houses that may be affected are 20 or so.

2) Impact to Existing Social Infrastructure and Services

At the construction stage of the transmission main, the transportation and commercial functions of Tsaiz may receive a temporary impact. In addition, the activities of the construction machinery may influence the communication devices of the military.

3) Shutdown of Channel during Construction

The channel on the east side must be shutdown during the channel crossing construction of the transmission and conveyance pipes. During the shutdown period, households that utilize the

surface water as domestic water may be affected.

4) Impact to Groundwater

The public well of Gachuurt is on the other side of Tuul River, from the location of the water supply well of the project. In addition, it is located at the point where the subsoil water of Gachuurt River meeting Tuul River from the north can be obtained. The private well located within the premises of a house by the main road of upstream Tuul River is also on the other side of Tuul River from the point of the planned supply well, and it is on a slope 3m higher than the riverbed for the intake. For these reasons, it is considered that the intake of groundwater in this project will not give major impact to the well.

5) Impact to Animals and Plants

Accompanying the collection/conveyance/transmission pipe construction, about 10m width along the pipeline route may be subject to impact due to the excavation, or temporary placement of construction equipment and materials, etc. Therefore, the trees along the route must be removed from the root and should be transplanted. Due to the shutdown of the channel from spring to autumn, animals of low mobility may die in a limited area.

(6) Mitigation Measures for the Impact on Environment

Various adverse environmental impacts are predicted in the planning, construction and operation stages of the Project. Avoidance and mitigation measures related to possible adverse impacts shall be reflected in the basic design and implementation plan. There are no serious impact items (A), but it became clear in the field survey that there are some slight impact items (B). Avoidance and mitigation measures related to possible adverse impacts are summarized in following table.

Table 1-5.9 Avoidance and Mitigation Measures Related to Possible Adverse Impacts

Phase	Item	Avoidance and Mitigation Measures
Planning Phase	Involuntary Resettlement	• USUG and other related institutions shall take proper procedures for land acquisition in coordination with city planning, land use control, and public relations.
	Land Use and Utilization of Local Resources	• To avoid significant impact on existing herding activities, the location of the access bridge shall be selected, avoiding major crossing route of animals. • A gate and a guardhouse shall be provided at the access bridge.
	Soil Erosion	• The reservoir and related facilities are planned on a slope. The site plan should be considered to moderate the amount of surface discharge by rainfall, in order to minimize soil erosion.
	Landscape	• The walls of pump houses shall be covered by materials that match with the surrounding natural landscape, such as natural brick color.
Construction Phase	Involuntary Resettlement	• Prior to the commencement of construction work, USUG shall conduct a field survey along the pipe route to inspect the Ger houses that are to be affected by the construction. When relocation of those houses is necessary, USUG should follow proper procedures and request the residents to relocate the houses to other areas within the housing lots during the construction work. • USUG and the Land Administration Department of Ulaanbaatar City shall

Phase	Item	Avoidance and Mitigation Measures
Construction Phase		take due process, and proper compensation shall be undertaken for the affected households for temporary removal and restoration of private property.
	Local Economy such as Employment and Livelihood, etc.	• USUG shall inform local residents about the schedule of construction work and the traffic control plan during the construction. USUG shall also conduct sufficient traffic control measures on-site. • USUG shall plan and coordinate the construction work efficiently to minimize the length of road closure. • USUG shall set a contact address and locate necessary personnel to receive complaints from affected parties.
	Land Use and Utilization of Local Resources	• After the completion of the temporary access bridge, the bridge shall be guarded 24 hours a day and limit the use of the bridge to those related to the facilities and construction works. • Information about the purpose and duration of the channel closure shall be distributed to all residents concerned. If found necessary, additional guarding shall be considered to prevent illegal logging in the flood plain. • Before the commencement of the construction work, USUG shall organize informational meeting at Gachuurt area with local residents. Construction site and material storage site must be protected with special care to avoid any accidents.
	Existing Social Infrastructures and Services	• Before the commencement of the construction work, USUG shall organize informational meeting at Tsaiz[5] area with local businesses, bus operators, and other related parties to discuss whether it is necessary to move bus stations or to do night construction. Construction site and material storage site must be protected with special care to avoid any accident. • For military facilities, USUG should provide sufficient information about the work plan and expected equipment to be used, and operate construction work according to necessary precautions directed by the military institutions.
	Water Usage or Water Rights and Common Rights	• Construction schedule of crossing structures shall be carefully planned to minimize the duration of channel closure. • USUG shall hold public hearings in Gachuurt area to find out the number and location of households that use surface water and their purpose of water use. During the channel closure, USUG shall coordinate water supply by water truck for those households.
	Accidents	• Drivers of construction vehicles shall receive safety instruction to avoid traffic accidents. • Operators of construction machinery shall receive sufficient training and monitoring for safety operation. • Sufficient marking and fences shall be provided around material storage, dughole and ditches, and storage of dug soil to avoid accidents with cars, pedestrians and animals.
	Groundwater	• USUG shall consult with the local water service provider and owners of private wells prior to the commencement of construction work regarding the planned location of wells, water intake amount, and monitoring plan of groundwater level. • USUG shall measure groundwater level at two test wells drilled during this survey and one representative private well as the background data to evaluate future impact of level change after the commencement of water intake and also carry out the monitoring of water quality.

[5] Tsaiz is located along the transmission main route at 4.5 km east-northeast from the center of Ulaanbaatar. See Figure 2-2.3, Water Supply Area Map.

Phase	Item	Avoidance and Mitigation Measures
Construction Phase	Soil Erosion	• The waterfront of the Gachuurt village shall be protected using sandbags or similar materials before closing the western channel to avoid erosion. • For the waterfront of other sections, the existing condition of waterfront shall be studied during the planning of construction work. Wooded riverbank and sections where strong water current is expected shall be protected by sandbags to minimize soil erosion.
	Flora, Fauna and Biodiversity	• If it is necessary to cut trees during the construction work, Populous laurifolia, Salix ledebouriana, Salix pentandra shall be cut 15-50 cm above ground level, and their root system shall be dug out, about 6m diameter maximum. That root system shall be immediately re-planted to nearby grassland for re-growth, so that reduction of tree may be minimized. • If it is difficult to recover root system of existing trees, saplings of same species shall be bought in local market for planting. • For recovery of root system and saplings, the re-planted trees should be guarded by metal wire net about 1.5m high to avoid feeding damage of cows. • For faster recovery of herb vegetation, seeding of local species over the earth bar on collection pipes shall be considered. • Construction schedule of crossing structures shall be carefully planned to minimize the length of channel closure. • Spring water that emerges in the dried channel shall be released in the channel to mitigate dryness of riverbed as long as the water affects construction work. • To construct the cofferdam to close the channel, materials shall be selectively used among the available on-site materials to minimize water pollution. • After the construction of crossing structures, topography and riverbed shape must be restored as was before to minimize turbulence at the re-opening of river channel.
	Landscape	• Excavated soil shall be set aside in a low trapezoid shape during the construction work to be re-used for refill. • USUG shall consult with the respective personnel at the Hotel Mongolia to be affected during the period of construction of crossing structure. USUG shall take their requests into consideration in the work plan of construction. • After the refill of pipe route, USUG shall consider the necessity of seeding of local plant species for faster vegetation recovery.
	Air Pollution	• USUG and contractor should properly maintain construction vehicles and construction machineries to minimize air pollution. • USUG shall plan and coordinate the construction of the transmission main efficiently to minimize the duration of the construction work.
	Water Pollution	• Materials for the cofferdam must be chosen carefully among the materials available on-site so that clayish soil shall not contaminate the river water. • After the construction of crossing structures, topography and riverbed shape must be restored as was before to minimize turbulence at the re-opening of river channel. • Local residents and officials must be well informed about the possibility and timing of occurrence of muddy water.
	Waste	• To avoid contamination of the surface water of Tuul River, mixtures with bentonite should not be disposed into the river. The mixture should not be sprayed on the ground surface, since the dried betonies will not be washed out from vegetation surface for a long period under the Mongolian dry climate. • The mixture shall be discarded and dried in a shallow hole dug close to the well. The hole shall be filled with soil again after the mixture is dried. For faster vegetation recovery, it is desirable to scatter seeds of local flora.
	Noise and Vibration	• USUG and contractor should properly maintain construction vehicles and construction machineries to minimize noise and vibration.

Phase	Item	Avoidance and Mitigation Measures
		• USUG shall plan and coordinate the construction of the transmission main efficiently to minimize the duration of the construction work. USUG should avoid construction work during night hours and early morning hours as agreed with the local residents before the commencement of the construction work. • If there are phases during which large noise and vibration is expected, USUG shall notify the purpose and duration of such work to the local residents and businesses well before the commencement of the particular work. USUG shall also advertise the contact address to receive complaints from affected parties.
Operation Phase	Land Use and Utilization of Local Resources	• In the operation phase, the temporary bridge shall be guarded 24 hours a day and use of the bridge shall be limited to those related to the facilities.
	Groundwater	• USUG shall measure and record groundwater level at two test wells, one private well and 21 production wells constructed in this project. In case the drawdown amounts to 2m from the water level before the commencement of water intake, pumping discharge shall be controlled until the groundwater level recovers. In order to supply safe drinking water, monitoring of water quality shall be carried out together with the monitoring of water level.
	Accidents	• Delivery drivers of chemicals shall receive safety instructions to avoid chemical accidents. • Chemicals shall be properly stored and managed to avoid accidents such as theft and water contamination. • The mixing process of chemicals into raw water shall be conducted by USUG staff with proper training, wearing proper equipment to prevent any physical damage to their health. • Used containers of chemicals shall be properly stored and disposed. Reuse of the containers shall also be considered to reduce waste disposal. • Sufficient counter-accident procedures shall be planned and the staff shall be periodically trained against possible chemical accidents.
	Waste	• The used containers of calcium hypochlorite shall be kept properly at the vicinity of the facility. • If in charge of abandonment of a container, the container shall be transported to a suitable final disposal site in accordance with the standard for wastes in Mongolia. • The possibility of reuse of a container should be examined.

Source : JICA Survey Team

Detailed Environmental Impact Assessment (DEIA) has been prepared by USUG as of January 2010. First, it will be submitted to MNET and finally it will be submitted to JICA after the examination of MNET in April 2010. The DEIA report will include the description of mitigation measures and monitoring plans, necessary institutional arrangement, and budget to be allocated.

The Consultant shall carry out the monitoring activities based on the JICA guideline for the social and environmental considerations in the construction phase. The Consultant should pay close attention on the following two (2) monitoring activities to make sure that proper mitigation measures are taken to avoid serious social and environmental impacts from the Project. The Consultant shall also provide necessary advice and training for USUG staff to secure the institutional capacity in USUG for such mitigation and monitoring in the future operation phase.

Table 1-5.10 Monitoring Policy in the Construction Stage

Changes in groundwater level	Two (2) test wells drilled during this survey and one (1) privately built well shall be used as monitor wells to observe the groundwater level in each of the water source areas (G-2 and G-3 wells) separated by the river channel.
Temporary impact by relocation of private property of Ger and proper procedures of compensation	The Consultant shall coordinate regular meetings with the UB City Land Administration Department, USUG Project Implementation Unit, and any other related institutions to share information on affected housing lots and any illegal occupation of the Project area, to monitor the compensation and negotiation procedures, and to discuss any difficulty related to project implementation.

Source：JICA Survey Team

Chapter2 Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Overall Goal and Purpose of the Project

Ulaanbaatar City is the capital and political and economic center of Mongolia with the population of 1.07 million or about 40% of the 2.7 million national population. The migration to Ulaanbaatar is remarkable due to several factors such as the democratic revolution after 1990 and the rural regions exhausted by the dzud (snow damage) that occurred in 1999, 2000 and 2003 killing a great number of domestic animals. These migrants have led their lives by establishing Gers in the suburbs of the city.

In the recent years, the Gers have spread to the slopes in the northern part of the city, causing problems such as air pollution, water pollution, flood damage, and poor water supply. The rapid increase in population has led to the lack of water supply. The government is planning to construct 100,000 units of apartments as a housing measure for Ger residents; however, this will accelerate the water supply shortage, since the unit water consumption in apartments is high. Under such circumstances, the water demand is predicted to exceed the current capacity of 240,000 m^3/day in 2011, and thus the increase of water supply capacity including the water source development is an urgent issue. According to "The Study on City Master Plan and Urban Development Program of Ulaanbaatar City in Mongolia (UBMPS; JICA, March 2009)," the water supply demand is expected to reach 510,700 m^3/day by the year 2030.

The Mongolian government formulated a water resource management plan to meet the increasing water supply demand, and aims for a water source development capable of stable water supply required by the residents based on the above planning, etc. One of the goals of this UBMPS is, that "All Ulaanbaatar residents can access the city water supply line" by 2030. To this end, this project aims to develop a new water source capable of supplying a volume of 25,200 m^3/day in Gachuurt, which is located in the eastern suburb of Ulaanbaatar, and to increase the current water supply facility's capacity of 240,000 m^3/day to 265,200 m^3/day.

The overall goal and purpose of the project are as shown in the following table.

Table 2-1.1 Overall Goal and Purpose of the Project

Overall Goal		To enable all Ulaanbaatar residents to have access to the city water supply line, so that sanitary and living conditions will improve.
Project Purpose		To improve the water supply condition to Ulaanbaatar residents by 2014.
Output Indicator	Water Supply Volume and Beneficiary population	In Ulaanbaatar City, especially the Ger areas, sanitary and living conditions will improve with the securement of water supply. Supply Capacity: increased from 240,000 m^3/day to 265,200 m^3/day. ・ Beneficiaries of Ger dwellers: about 390 thousand people (2014) ・ Beneficiaries of apartment dwellers: about 43,500 people (2014)

Source：JICA Survey Team

2-1-2 Contents of the Project

For realization of the overall goal, the Project plans to construct wells in the flood plain of Tuul River near the Gachuurt village, to firstly store the groundwater in the distribution reservoir (regulating reservoir) built in the Gachuurt village at the northeast of Ulaanbaatar, and, to develop facilities for the supply of water to the reservoir by the transmission main. This is expected to improve the living and water supply condition of Ulaanbaatar (especially the Ger dwellers). Requested items and survey results are shown in the following table.

Table 2-1.2 Outline of the Project

	Requested Items	Results of Preparatory Survey	
		Obligations of Japan Side	Obligations of Mongolian Side
Development Volume	25,200 m^3/day	25,200 m^3/day	—
Production Wells	21 wells	21 wells	—
Conveyance Pipe	Length: 4.8 km Ave. SP Dia.: 320mm	Length: 4.3 km DCIP Dia.: 150 to 500 mm	—
Collection Pipes	—	Length: 2.8 km DCIP Dia.: 150 mm	—
Distribution Reservoir	Capacity: 8,000 m^3	—	Capacity: 6,000 m^3
Chlorination Unit	1 unit (Cl_2)	1 unit [$Ca(ClO)_2$]	—
Operation House	—	Chlorination & Telemetry System	—
Transmission Main	Length: 19.5 km SP Dia.: 600mm	Length: 18.8km FRPM Dia.: 700mm	—
Others	—	—	Fence installation Electric power connection Bridge Construction, etc.

Note) SP: Steel Pipe, DCIP: Ductile-Cast-Iron Pipe, FRPM: Fiber Reinforced Plastic Mortar

Source：JICA Survey Team

The Mongolian side decided to develop the supply volume of 25,200 m^3/day and originally planned to connect the transmission main from the new Gachuurt Water Source to the existing distribution main pipes from the Central Water Source to the northern part of Ulaanbaatar. However, this original plan was modified due to circumstances which were confirmed by the JICA Preparatory Survey Team during the field survey in Ulaanbaatar, as mentioned below.

The International Bank for Reconstruction and Development (IBRD) is promoting the installation of a distribution pipeline in the northeastern part of Ulaanbaatar to be connected to the North East Reservoir. However, the pumping stations of the Central Water Source and the Upper Water Source do not have the sufficient capacity to supply water to the North East Reservoir. Therefore, the Mongolian side requested the Survey Team when it visited Ulaanbaatar to examine the method of connection of the new pipeline to the North East Reservoir.

Accepting the modified request of the Mongolian side, the Survey Team examined the location of the distribution reservoir in Gachuurt and the route of the transmission main through reconnaissance, topographic survey and analysis. Based on its findings, the location was changed to a higher place and the route of the transmission main was also modified from the original plan

because of the higher position of the North East Reservoir. In addition, the diameter of the transmission main was revised from 600 mm to 700 mm because of the increased head-loss.

There was also information that, from 2010, liquid chlorine (Cl_2) which is being used for the chlorination at the Central Water Source could no longer be imported from China. Therefore, calcium hypochlorite [$Ca(ClO)_2$] is to be used instead of liquid chlorine despite the increased facility costs, because it is already being used at the Upper Water Source and it is also known for its safety, easier handling, and preservation quality, as well as having an established distribution route from China.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy (Scope of Work and Formulation of Basic Framework)

(1) Basic Policy

The target year of the Project will be 2014 and the water supply facilities should be designed to fulfill the difference of 25,200 m^3/day between the expected water demand in 2014 and the capacity of existing facilities.

(2) Scope of Work by the Japanese Assistance

The scope of work by Japanese Assistance is as follows:

① Development of 21 production wells in the Gachuurt Water Source
② Construction of collection pipes for a length of 2.8 km and conveyance pipe to the Gachuurt Reservoir for a length of 4.3 km
③ Construction of operation house with chlorination and remote control facilities
④ Construction of transmission main for a length of 18.8km

(3) Scope of Work by the Mongolian Side

The scope of the work undertaken by the Mongolian side is as follows.

① Construction of Gachuurt Reservoir with the capacity of 6,000 m^3
② Others (setting-up of fences, electric power connection and construction of bridge for operation and maintenance, etc.)

With respect to the distribution reservoir (with the capacity of 6,000 m^3) for which the Mongolian side has many experiences, and the other facilities (setting-up of fences, electric power connection and bridge for operation and maintenance, etc.), they should be undertaken at the sole responsibility of the Mongolian side. However, when it comes to the valves, flow meters, and piping in the valve rooms, the Japanese side shall provide them in the Project with funds from the Japan's Grant-Aid.

2-2-1-2 Natural Conditions

The relevant project site is exposed to harsh weather conditions with severe temperature changes. The temperature of this area falls below –40°C in midwinter, while it exceeds 30°C in summer. The monthly average temperature only exceeds 0°C during seven months between April and October.

In order to adapt for this climate condition, with regard to the facility plan, the pipeline shall be installed lower than 3.2m below ground level, which is the freezing depth in winter, and for pipes or electric equipment above ground level, low temperature measures shall be taken.

In winter, the ground is frozen until the end of April. Therefore, the construction processes should be planned with these factors taken into consideration, because there may be difficulty in excavation and it could be impossible to construct concrete placements, and for asphalt type pavement to be implemented.

Table 2-2.1 Average Monthly Temperature (°C)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Tahilt	-21.8	-16.6	-7.2	2.7	2.7	10.3	16.5	19.3	16.8	0.5	-11.5	-19.5	-0.66
Terelj	-24.6	-19.5	-10.8	-10.0	7.2	13.0	15.6	12.1	6.5	-2.6	-13.9	-21.8	-4.07

Data: Tahilt (in the City): 1996-2006, Terelj (in the mountain area): 1996-2008

A one-year report that was created based on observations carried out in 1995 under “The Study on Water Supply System in Ulaanbaatar and Surroundings (JICA1995MP)” is the only available reference on streamflow observations at the Gachuurt site. Therefore, this Project proposes a system design for well facilities that adopt a depth of 2m based on the previous maximum flood level for the Upper Water Source and the Central Water Source.

On the other hand, for occasional floods, embankments will be placed around the pump houses built at the water source site and the upper part of collection and conveyance pipes to cope with the flooding problems. In addition, regarding the construction schedule, past rainfall records show that there are on average two days when the daily rainfall exceeds 10 mm/day in July. Considering this fact, work stoppage coefficients should be examined for the formulation of the construction schedule.

2-2-1-3 Socio-Economic Conditions

The construction industry had boosted reflecting the Mongolian favorable economy, and the cost of construction materials had risen continuously until April 2008. However, the banks in Mongolia were then worried about the high inflation rate and controlled the lending of money from March 2008, so that the Mongolian economy went down at that time. The Mongolian economy was still unfavorable in 2009 and the Mongolian Government estimated that the growth rate of GDP might be –1%.

However, the Mongolian Government will promote the construction of 100 thousand apartments to cope with the increase of population. Large projects of mining developers and the construction

of a new airport are also being promoted but prices of construction materials are getting higher, gradually. Therefore, the appropriate price fluctuation rate should be set and the cost estimate should be prepared on the basis of the inflation rate estimated by the International Monetary Fund (IMF) and the Mongolian Statistics Department for the tendering of the Project at July 2011 prices.

2-2-1-4 Construction, Procurement and Local Contractor

(1) Construction Condition/ Procurement Condition

Approximately 80% of construction materials have been imported from foreign countries. Most of them were imported from China, but importation has become seriously unstable because of China's recent increase of domestic demand. Accordingly, construction materials should be procured from stable countries such as Mongolia, Japan and so on.

(2) Local Contractor

The construction tasks that would involve local contractors are well digging, pipeline laying, building, power distribution installation, and fence installation, as well as construction of distribution reservoirs, chlorine injection facility, well remote-control facility, and the management bridge construction. Among these, the distribution reservoir construction (excluding facility installation), management bridge construction, power distribution installation, and fence installation will be at the sole expense of the Mongolian side, so that USUG should select a reliable supplier that also has good technical capabilities and a sound financial structure considering the construction schedule. According to USUG, there are several reliable suppliers, both for well digging and construction work, which have experience completing orders from USUG. For other construction works, there should be no significant problem, if a Japanese construction company is to be the prime contractor performing the construction work upon hiring Mongolian suppliers.

2-2-1-5 Operation and Maintenance for Water Supply Systems

USUG has a long experience and sufficient ability on the operation, maintenance and management of water supply systems and equipment constructed under the previous USSR. USUG also has experience in managing the water supply facilities donated under the Japanese Grant Aid in 1999 and 2007. It had repaired the damaged facilities by itself and replaced the damaged submersible pump into a Russian-made pump using its own funds. However, some parts of the remote control system could not be obtained because they were no longer manufactured, so that USUG abandoned fixing the system, although it is willing to repair it.

Incidentally, the Project aims to achieve a healthy financial condition through energy–saving and reduction of the O&M burden of USUG staff. Upon delivery of the facilities, therefore, operational guidance as well as guidance on maintenance and inspection shall be provided for approximately 10 days to USUG facility operators and technicians. Operation rules for the

prevention of freezing in the pipelines during operation, and the control between intake wells and Gachuurt Reservoir shall be devised.

2-2-1-6 Facility and Equipment Grade Policy

For the facilities and equipment of production wells, selection shall be made putting priority on durability, reliability and energy efficiency to reduce the operating costs.

2-2-1-7 Construction, Procurement and Construction Schedule Policy

A long time will be required to develop the production wells (21 wells), transmission main (18.8 km), and the collection and conveyance pipes (7.1 km). Besides, the construction could not be done during the winter season. From these reasons, the construction period of three (3) years, including summer, is considered to be necessary. Construction noise and vibration must also be controlled, particularly, when laying the transmission main in densely populated Ger areas. Since it is also impossible to deploy a large number of construction crews in such areas, an appropriate number of construction groups should be arranged.

The construction proposed here will require 38 months for equipment procurement and the construction itself. The Japanese A-type bond shall be applied. Materials and machinery necessary for this project shall be procured locally as much as possible. When they could not be procured locally or when the quality specifications of locally procured materials do not comply with the requirements, or when there is a material or machinery that is not typically distributed in regular and stable quantities for purchase in Mongolia, such materials and machinery shall be procured and brought from Japan.

2-2-1-8 Water Supply System

One of the main reasons of increasing water demand is the migration of people from the countryside to Ulaanbaatar City (UB) and it is also the reason for the government's relocation plan to transform the Ger residences into apartments which have a high unit water consumption rate. In this preparatory survey, therefore, the water supply population, unit water consumption, average daily water supply volume, and maximum daily water supply volume were estimated on the basis of the previous records for five years, i.e., from 2004 to 2008, and then water demand in the target year 2014 was forecast. New water development volume shall be set from the difference between the water demand in the target year and the existing water supply capacity of 240,000 m^3/day.

2-2-1-9 Water Sources Development

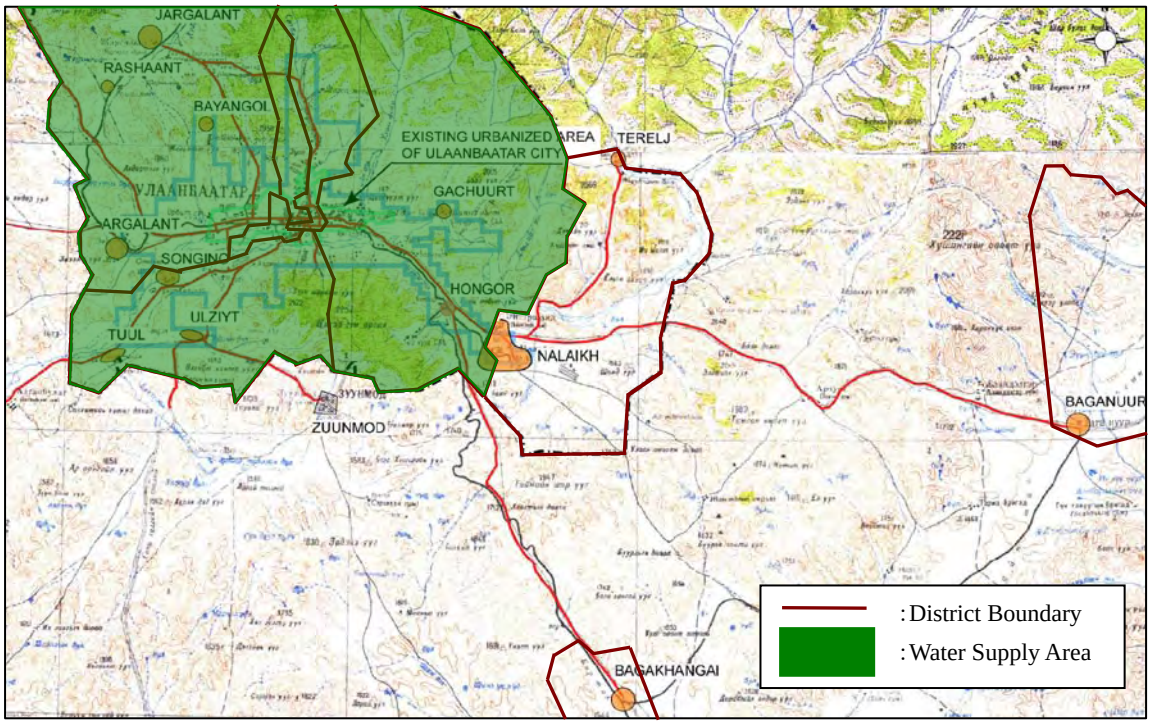
The water source of the Project is located at the Gachuurt area in the upstream of the Tuul River from Ulaanbaatar City, and the exploitation of groundwater by wells is planned. The survey was made under "The Study on Water Supply System in Ulaanbaatar and Surroundings" in 1995, but since about 14 years has passed since then, it is required to verify the water potential and water quality at the project site again by referring to the results of the electrical survey, test drilling and water quality test.

2-2-2 Basic Plan (Construction Plan/Equipment Plan)

2-2-2-1 Water Supply System Plan

(1) Target Water Supply Area

The target water supply area of USUG consists of six (6) districts, including Bayangol District, Bayanzurkh District, Songino Khoirkhan District, Sukhbaatar District, Chingeltei District, and Khan Uul District. Remote areas of Nalaikh District (located 35 km ESE from UB), Bagakhangai District (located 90 km SE from UB), and Baganuur District (located 140 km East from UB) were not included the water supply area of USUG. The water supply area is shown in Figure 2-2.1.



Source: UBMPS

Figure 2-2.1 Water Supply Area of USUG

(2) The Purpose of the Project

The main purpose of the Project is to supply water to the Ger areas and increase the water to apartment areas where there is a water shortage problem. It aims to increase the water supply capacity for the whole Ulaanbaatar City.

The increase of water supply population is primarily due to the growing population of Ger areas, where many are relatively poor. It is therefore important that this Project collaborate with the Water Distribution Network Project for Ger areas by the World Bank, which aims to improve water supply in these areas. The World Bank project plans to use the North East Reservoir, but does not include any plan to build water sources. Given this fact, the Project can contribute significantly to improve water supply in Ger areas by supplying the water developed in Gachuurt to the North East Reservoir. In addition, the water supply conditions in the surrounding Ger areas

and apartment areas can also be improved to a certain degree by supplying water from the North East Reservoir through the Tasgan Reservoir and the 3/4 Reservoir, etc.

(3) Project Plan Methodology

The water supply methods in Ulaanbaatar vary depending significantly on the type of residence. These can be divided broadly into apartments and Gers. Water is supplied to apartments directly through water pipes and faucets. For Gers, water is first delivered to a water shop (kiosk) by truck or through water pipes, and Ger residents go to the Kiosk to buy water. This results in a significant difference of unit water consumption by the two types of residences.

The population predictions as the basic data for this project focus on six (6) areas to which the USUG supplies water. The water supply population in the plan was estimated for 2009 to 2020 based on the water supply population recorded in the apartment and Ger areas in the five years from 2004 to 2008.

The amount of water supply in the plan includes estimates of the unit water consumption, the daily average water supply amount, and the daily maximum water supply based on a close examination of 2004 to 2008 water supply amounts.

The daily domestic water supply amount to apartments is set to 230 ℓ/person/day, since the actual usage record nearly matches the unit adopted by the UBMPS in cases of high demand case. In the Ger areas, the domestic water supply unit is set by linearly interpolating the average value of 7.2 ℓ/person/day over the past five years (2004 to 2008) and 25 ℓ/person/day with the unit water consumption set by the USUG and the UBMPS. The unit water consumption after 2014 is set to 25 ℓ/person/day (the target year).

Water supply for companies, public facilities, factories, and other uses were set using estimation formulas and average amounts over the last few years, based on the water supply figures for the past five years.

(4) Water Demand Estimates

1) Population Estimates

(a) Shifting Administrative District, Water Supply Area, and Water Supply Populations

Shifts in the population of Ulaanbaatar's administrative districts, the aggregate population of the six areas to which the USUG supplies water and the population actually supplied with water are shown in the table below.

Table 2-2.2 Shifting of Administrative Districts and Water Supply Area Population and Water Supply Population

Year	2004	2005	2006	2007	2008
Administrative District Population (person)	915,531	952,410	987,192	1,025,174	1,067,472
Water Supply Area Population (person)	861,510	896,844	930,337	967,189	1,008,738
Water Supply Population (person)	800,841	848,116	883,055	924,766	967,366
Water Supply System Coverage Rate (%)	93.0	94.6	94.9	95.6	95.9

Source: USUG and JICA Survey Team

Note: Water Supply Area: Excluding Bagakhangai, Baganuur, Nalaikh

Water Supply Population is classified according to the residence status based on the reference material from USUG, as shown in the following table.

Table 2-2.3 Shifts in Water Supply Population in Last Five Years

(Unit: Person)

Year	2004			2005			2006			2007			2008		
Residence area	Apartment Area	Ger Area	Total	Apartment Area	Ger Area	Total	Apartment Area	Ger Area	Total	Apartment Area	Ger Area	Total	Apartment Area	Ger Area	Total
USUG (Apartment areas)	265,877		265,877	256,873		256,873	267,271		267,271	265,256		265,256	277,931		277,931
OSNAAUG (Apartment areas	199,694		199,694	219,300		219,300	220,489		220,489	224,173		224,173	226,743		226,743
Sub-total	465,571		465,571	476,173		476,173	487,760		487,760	489,429		489,429	504,674		504,674
USUG (Ger areas)	7,570	327,700	335,270	7,743	364,200	371,943	7,931	387,364	395,295	7,958	427,379	435,337	8,206	454,486	462,692
Total	473,141	327,700	800,841	483,916	364,200	848,116	495,691	387,364	883,055	497,387	427,379	924,766	512,880	454,486	967,366

Source: USUG and JICA Survey Team

(b) Future Population Estimates

i) Estimates of Administrative District Population and Water Supply Area Population

The population of administrative districts (total population of Ulaanbaatar) is based on the estimates. Populations for intermediate years are linearly interpolated.

The population of water supply areas is estimated based on records of the past five years using the estimation method shown below. This is a time-series trend analysis for the average annual number, which is used when linear trends increase.

Estimation formula: $y = 36{,}480 \times x + 823{,}486$ Correlation coefficient = 0.999

y = population, x = year

Table 2-2.4 Estimates of Administrative District Population and Water Supply Area Population

(Unit: Person)

Year	2009	2010	2011	2012	2013	2014	2015	2020
Administrative District Population	1,120,336	1,173,200	1,203,580	1,233,960	1,264,340	1,294,720	1,325,100	1,537,800
Water Supply Area Population	1,042,364	1,078,844	1,115,324	1,151,804	1,188,284	1,224,764	1,261,245	1,458,408

Source: USUG and JICA Survey Team

ii) Water Supply Population Estimates

The following formula is used to estimate the water supply population of apartment areas (apartments and houses) and Ger areas (houses and simple frame houses). Table2-2.5 shows the estimation results.

Apartments: $y = 9{,}146 \times x + 457{,}283$ Correlation coefficient = 0.981

Ger areas (houses): y = 149 × x + 7,436 Correlation coefficient = 0.981

Ger areas (simple frame houses and Gers): y = 31,675 × x + 297,200

Correlation coefficient = 0.997

Table 2-2.5 Estimates of Water Supply Population

(Unit: Person)

Year	2009	2010	2011	2012	2013	2014	2015	2020
Apartment Area	**512,160**	**521,306**	**530,452**	**539,599**	**548,745**	**557,891**	**567,037**	**612,768**
Ger Area(Sub-Total)	**495,579**	**527,402**	**559,226**	**591,050**	**622,875**	**654,698**	**686,522**	**845,640**
Detached with infra	8,328	8,476	8,625	8,774	8,923	9,071	9,220	9,663
Simple house	279,195	297,345	315,494	333,644	351,794	369,944	388,094	478,843
Ger & Simple house	208,056	221,581	235,107	248,632	262,158	275,683	289,208	356,834
Total	**1,007,739**	**1,048,708**	**1,089,678**	**1,130,649**	**1,171,620**	**1,212,589**	**1,253,559**	**1,458,408**

Source: USUG and JICA Survey Team

The ratios of detached houses with infra shits as 1.7% (2004), 1.3% (2005), 1.5% (2006), 1.7% (2007), 2.0% (2008), and the average is 1.6%. Therefore, the ratio of detached houses with infra among the Ger area shall adopt 1.6% by prediction in the future.

The ratio of simple houses and Gers among the Ger area was 57.3% and 42.7% in 2008.

iii) Estimates of the Number of Water Supply Households

The number of water supply households was estimated by setting the average number of household members at 4.3 persons, based on demographic statistics provided by Ulaanbaatar (2008).

iv) Water Supply System Coverage

The coverage of the water supply system is calculated using the formula: (water supply population) ÷ (population of water supply areas) × 100. However, the coverage should be estimated assuming that the water supply rate will have reached 100% by the year 2020.

Estimate results based on the above calculations are shown below.

Table 2-2.6 Estimates of Number of Water Supply Houses Planned

Year	2009	2010	2011	2012	2013	2014	2015	2020
Administrative District Population (person)	1,120,336	1,173,200	1,203,580	1,233,960	1,264,340	1,294,720	1,325,100	1,537,800
Water Supply Area Population (person)	1,042,364	1,078,844	1,115,324	1,151,804	1,188,284	1,224,764	1,261,245	1,458,408
Water Supply Population (person)	1,007,739	1,048,708	1,089,678	1,130,649	1,171,620	1,212,589	1,253,559	1,458,408
Average Number of Household Members (person/house)	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Water Supply Households (house)	234,358	243,886	253,413	262,942	272,470	281,997	291,525	339,165
Water Supply System Coverage Rate (%)	96.7	97.2	97.7	98.2	98.6	99.0	99.4	100.0

Source: USUG and JICA Survey Team

2) Water Consumption Estimates

(a) Trends in USUG and OSNAAUG Water Supply

i) Domestic Water

Table 2-2.17 shows the daily use water supply figures and unit water consumption between 2004 and 2008. In 2004, the total water supply population of the apartment areas (465,571) and Ger areas (335,270) was 800,841. The unit water consumption in the apartment areas was 204 ℓ/person/day and it was 6.6 ℓ/person/day in the Ger areas, resulting in the total water

consumption of 98,638 m^3/day. On the other hand, in 2008, the total water supply population of the apartment areas (504,674) and Ger areas (462,692) was 967,366, and the unit water consumption of the apartment areas was 232 ℓ/person/day and 6.8 ℓ/person/day in the Ger areas, thus increasing the total water consumption to 121,897 m^3/day.

ii) Trends in Different Water Categories

The USUG and OSNAAUG supply the water for companies, public facilities, and factories. The OSNAAUG tallies this water consumption under the "other water" category, so that the water supplied by the OSNAAUG is distributed based on the five-year average supply rate (company=41.9%, public=31.5%, factory=26.6%). Table 2-2.7 shows the total values.

Table 2-2.7 Average Constitution Rate of Water Supply Amount by USUG

(Unit: m^3/day)

Year	2004	2005	2006	2007	2008	Total	Ratio
USUG Water Supply Amount	28,664	26,395	27,806	24,930	27,533	135,328	100%
Private Enterprise	10,486	10,569	10,928	11,178	13,561	56,722	41.9%
Public Institutions	11,344	8,826	7,470	7,388	7,616	42,644	31.5%
Industrial Facilities	6,834	7,000	9,408	6,364	6,356	35,962	26.6%

Source: USUG and JICA Survey Team

Table 2-2.8 Shifts in Water Supply Amount for Private Enterprises

(Unit: m^3/day)

Year	2004	2005	2006	2007	2008
USUG Water Supply Amount	10,486	10,569	10,928	11,178	13,561
OSNAAUG Water Supply Amount	—	7,578	3,580	4,485	5,136
Total	—	18,147	14,508	15,663	18,697

Source: USUG and JICA Survey Team

Table 2-2.9 Shifts in Water Supply Amount for Public Institutions

(Unit: m^3/day)

Year	2004	2005	2006	2007	2008
USUG Water Supply Amount	10,344	8,826	7,470	7,388	7,616
OSNAAUG Water Supply Amount	—	5,697	2,691	3,371	3,861
Total	—	14,523	10,161	10,759	11,477

Source: USUG and JICA Survey Team

Table 2-2.10 Shifts in Water Supply Amount for Industrial Facilities

(Unit: m^3/day)

Year	2004	2005	2006	2007	2008
USUG Water Supply Amount	6,834	7,000	9,408	6,364	6,356
OSNAAUG Water Supply Amount	—	4,811	2,273	2,847	3,261
Total	—	11,811	11,681	9,211	9,617

Source: USUG and JICA Survey Team

(b) Future Water Supply Estimates

i) Domestic Water

When past trends are taken into consideration (as shown in Table 2-2.11), the value provided by the UBMPS as the unit water consumption for apartment areas (including the houses in the Ger areas) should be appropriate to use. Hence, the unit water consumption is set to

230 ℓ/person/day, and the water amount actually supplied to the apartment areas is obtained by multiplying the water supply unit by the water supply population.

Table 2-2.11 Unit Water Consumption of Domestic Water

(Unit: ℓ/person/day)

Actual Value, Planned Value	Actual Value *1						Value Planned by USUG	High Demand Value of UBMPS	0rder153*2
Objective year	2000	2004	2005	2006	2007	2008	2010	After 2009	After 1995
Apartment residents	358	204	190	206	234	232	250	230	230
Ger residents	4.7	6.6	7.4	8.1	7.2	6.8	25	25	25

(note): *1 2000-2008 indicates the water supply volume divided by the population, and includes the leakage volume. Private companies, public, and industrial water are excluded.

*2 Water consumption temporary norm of the population. Appendix 3, Order No: 53, Minister of Environment, dated 1995

Source: USUG and JICA Survey Team

The unit water consumption for Ger areas is 25 ℓ/person/day based on the master plan for the city planning project. However, the increase in water supply capacity due to the expansion of facilities under this project should meet the water demand after the year 2014 when the planned facilities will start operations. For this reason, unit water consumption for intermediate years is linearly interpolated using the 2009 estimates of 7.4 ℓ/person/day and 25.0 ℓ/person/day.

Table 2-2.12～13 shows the results of the above estimations.

Table 2-2.12 Estimates of Accounted-Water in Apartment Area

Year	2009	2010	2011	2012	2013	2014	2015	2020
Unit Water Consumption (ℓ/person/day)	230	230	230	2230	230	230	230	230
Planned Water Supply Population (person)	512,160	521,306	530,452	539,599	548,745	557,891	567,037	612,768
Accounted-Water (m^3/day)	117,797	119,900	122,004	124,108	126,211	128,315	130,419	140,937

Source: USUG and JICA Survey Team

Table 2-2.13 Estimates of Accounted-Water in Ger Area

Year	Type of Residence	2009	2010	2011	2012	2013	2014	2015	2020
Unit Water Consumption (ℓ/person/day)	Simple House	7.4	10.9	14.4	18.0	21.5	25	25	25
	Ger								
Planned Water Supply Population (person)	Simple House	279,195	297,345	315,494	333,644	351,794	369,944	388,094	478,843
	Ger	208,056	221,581	235,107	248,632	262,158	275,683	289,208	356,834
Accounted-Water (m^3/day)	Simple House	3,606	3,241	4,543	6,006	7,564	9,249	9,702	11,971
	Ger		2,415	3,386	4,475	5,636	6,892	7,230	8,921

Source: USUG and JICA Survey Team

ii) Water Estimates by Category

The water amount effectively supplied to private companies has tended to increase recently. Hence, the water amount is estimated with an estimation formula that uses a time-series trend analysis based on performance over the past four years. The formula below is used to estimate the water amount for private companies. Table 2-2.14 shows the estimation results.

Estimation formula: y = 281 × x + 16,053 Correlation coefficient = 0.181

y = water amount, x = year

No significant increase has been observed in the amount of water used by public facilities and factories; therefore, the average amount obtained from the past performance is used as the water amount.

Table 2-2.14 Water Estimates by Category

(Unit: m^3/day)

Year	2009	2010	2011	2012	2013	2014	2015	2020
Private Enterprise	17,455	17,736	18,016	18,297	18,577	18,858	19,138	20,541
Public Institutions	11,730	11,730	11,730	11,730	11,730	11,730	11,730	11,730
Industrial Facilities	10,580	10,580	10,580	10,580	10,580	10,580	10,580	10,580

Source: USUG and JICA Survey Team

iii) Estimation of the Ratio of Accounted-Water

Assuming that the unaccounted water declines due to water leakage protection measures promoted by the USUG, in this Project, the ratio of accounted-water for intermediate years is linearly interpolated using the actual ratio of accounted-water from 2008 (83.94%) and the planned value for 2020 (85%). Table 2-2.15 shows the estimation results.

Table 2-2.15 Ratio of Accounted-Water (Unit: %)

Year	2009	2010	2011	2012	2013	2014	2015	2020
Ratio of Accounted-Water	83.91	84.06	84.22	84.38	84.53	84.69	84.84	85.00

Source: USUG and JICA Survey Team

iv) Load Factor Estimates

Assuming that there is safe and stable operation of water supply facilities, the average rate over the past five years (84.32%) was used as the load factor.

Table 2-2.16 Load Factor (Unit: %)

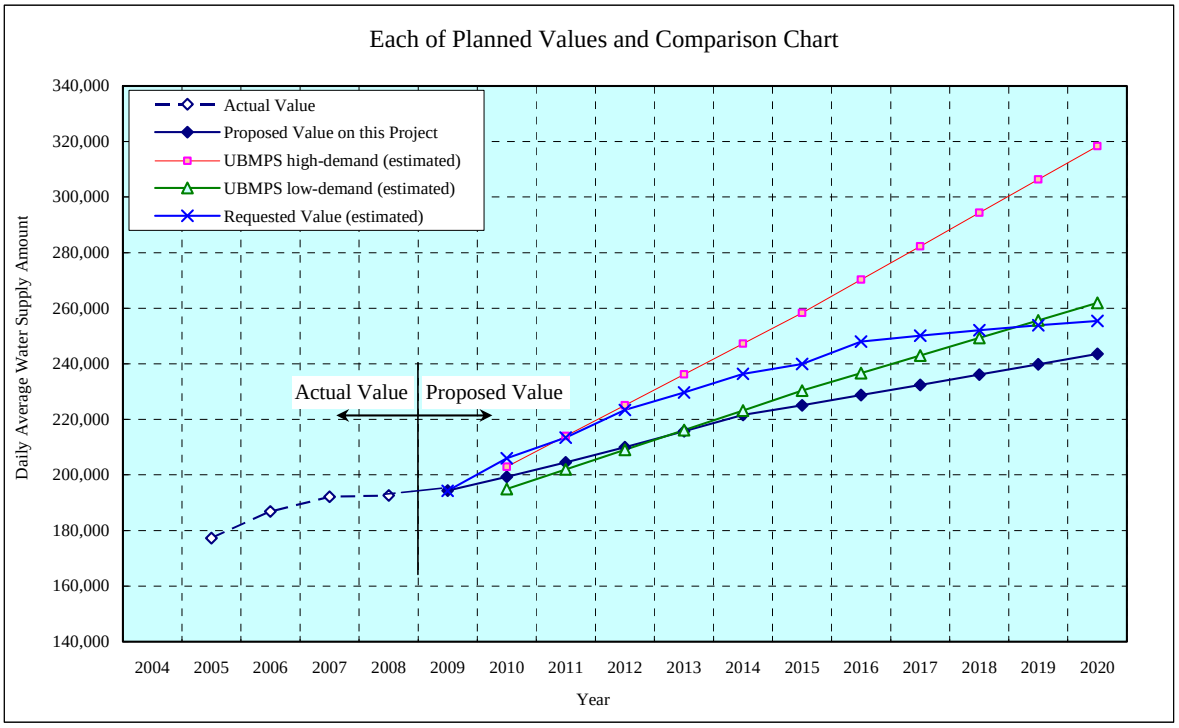
Year	2004	2005	2006	2007	2008	Average rate
Load Factor	84.15	86.03	86.52	81.14	83.75	84.32

Source: USUG and JICA Survey Team

3) Water Demand Forecast

In light of the above, the actual and planned average daily water consumption values (the Project, Request, UBMPS: high demand and low demand) are forecast including the water consumption of apartment areas and Ger areas (water for daily use) and the water consumption for private companies, public facilities, and factories.

When the planned value estimated by the UBMPS is compared with the value used in the Project, it is found to be halfway between the high-demand prediction and the low-demand prediction in 2010, and after 2013, the value falls below the low-demand prediction of the UBMPS.



*1 The requested values are the estimated values of the daily average water supply amount stated in the request document.

*2 The UBMPS values are the investigated values of 2007. The values after 2010 are estimated values, and the values of intermedeate years are linearly interpolated when this chart was created.

*3 The values based on this project until 2008 are investigated values. The values after 2008 are the proposed values and linearly interpolated when this chart was created.

Source: USUG and JICA Survey Team

Figure 2-2.2 Future Water Demand Forecast

Table 2-2.17 shows the estimated and actual water supply population and water supply amount figures that form the basis of Figure 2-2.2 above.

Table 2-2.17 Estimated and Actual Water Supply Population and Water Supply Amount

Item \ Year		Unit	2004	2005	2006	2007	2008 (Actual)	2009 (Proposed)	2010	2011	2012	2013	2014	2015	2020
Population in Ulaanbaatar		person	915,531	952,410	987,192	1,025,174	1,067,472	1,120,336	1,173,200	1,203,580	1,233,960	1,264,340	1,294,720	1,325,100	1,537,800
Population in Water Supplied Areas		person	861,510	896,844	930,337	967,189	1,008,738	1,042,364	1,078,844	1,115,324	1,151,804	1,188,284	1,224,764	1,261,245	(1,458,408)
Population in Water Supplied Areas															
【Apartment Areas】															
Apartment (High, Middle and Low Class)		person	465,571	476,173	487,760	489,429	504,674	512,160	521,306	530,452	539,599	548,745	557,891	567,037	612,768
【Ger Areas】															
Detached with Infra		person	7,570	7,743	7,931	7,958	8,206	8,328	8,476	8,625	8,774	8,923	9,071	9,220	9,963
Simple House w/o Infra		person	327,700	364,200	387,364	427,379	454,486	279,195	297,345	315,494	333,644	351,794	369,944	388,094	478,843
Ger & Simple House w/o Infra		person						208,056	221,581	235,107	248,632	262,158	275,683	289,208	356,834
Total		person	800,841	848,116	883,055	924,766	967,366	1,007,739	1,048,708	1,089,678	1,130,649	1,171,620	1,212,589	1,253,559	1,458,408
No. of House Hold	(4.3～4.5	house	177,965	192,754	200,694	210,174	224,969	234,358	243,886	253,413	262,942	272,470	281,997	291,525	339,165
Water Supply Unit	Apartment	ℓ/pers./day	204	190	206	234	232	230	230	230	230	230	230	230	230
	Detached with Infra	ℓ/pers./day													
	Simple House w/o Infra	ℓ/pers./day	6.6	7.4	8.1	7.2	6.8	7.4	10.9	14.4	18.0	21.5	25.0	25.0	25.0
	Ger & Simple House w/o Infra	ℓ/pers./day													
Rate of Water Supply		%	93.0%	94.6%	94.9%	95.6%	95.9%	96.7%	97.2%	97.7%	98.2%	98.6%	99.0%	99.4%	100.0%
Accounted-for Water															
【Apartment Areas】															
Apartment	Water Consumption per Day	m^3/day	94,920	90,506	100,578	114,743	116,884	117,797	119,900	122,004	124,108	126,211	128,315	130,419	140,937
【Ger Areas】															
Detached with Infra	Water Consumption per Day	m^3/day	1,543	1,472	1,635	1,866	1,901	1,915	1,949	1,984	2,018	2,052	2,086	2,121	2,291
Simple House w/o Infra	Water Consumption per Day	m^3/day	2,175	2,686	3,140	3,076	3,112	3,606	3,241	4,543	6,006	7,564	9,249	9,702	11,971
Ger & Simple House w/o Infra	Water Consumption per Day	m^3/day							2,415	3,386	4,475	5,636	6,892	7,230	8,921
Sub-total		m^3/day	98,638	94,664	105,353	119,685	121,897	123,318	127,505	131,917	136,607	141,463	146,542	149,472	164,120
Private Enterprises	Water Consumption per Day	m^3/day	–	18,147	14,508	15,663	18,697	17,455	17,736	18,016	18,297	18,577	18,858	19,138	20,541
Public Institutions	Water Consumption per Day	m^3/day	–	14,523	10,616	10,759	11,477	11,730	11,730	11,730	11,730	11,730	11,730	11,730	11,730
Industrial Factories	Water Consumption per Day	m^3/day	–	11,811	11,681	9,211	9,617	10,580	10,580	10,580	10,580	10,580	10,580	10,580	10,580
Sub-total		m^3/day	–	44,481	36,805	35,633	39,791	39,765	40,046	40,326	40,607	40,887	41,168	41,448	42,851
Total		m^3/day	–	139,145	142,158	155,318	161,688	163,083	167,551	172,243	177,214	182,350	187,710	190,920	206,971
Non-Revenue Water		m^3/day	41,096	38,082	44,658	36,849	30,932	31,272	31,772	32,273	32,805	33,372	33,934	34,115	36,524
Daily Average Water Supply Amount		m^3/day	–	177,227	186,816	192,167	192,620	194,355	199,323	204,516	210,019	215,722	221,644	225,035	243,495
Daily Maximum Water Supply Amount		m^3/day	–	206,006	215,922	236,834	229,994	230,497	236,389	242,547	249,074	255,837	262,861	266,882	288,775
Rate of Water Consumption		%	–	78.51	76.10	80.82	83.94	83.91	84.06	84.22	84.38	84.53	84.69	84.84	85.00
Rate of Loading		%	84.15	86.03	86.52	81.14	83.75	84.32	84.32	84.32	84.32	84.32	84.32	84.32	84.32

Source: USUG and JICA Survey Team

(5) Target Year

As the target year, 2014 is set since there is an urgent need for grant aid and, judging from the construction process at this point, it is highly likely that the water supply facilities will have been completed and the earliest operation started by 2014.

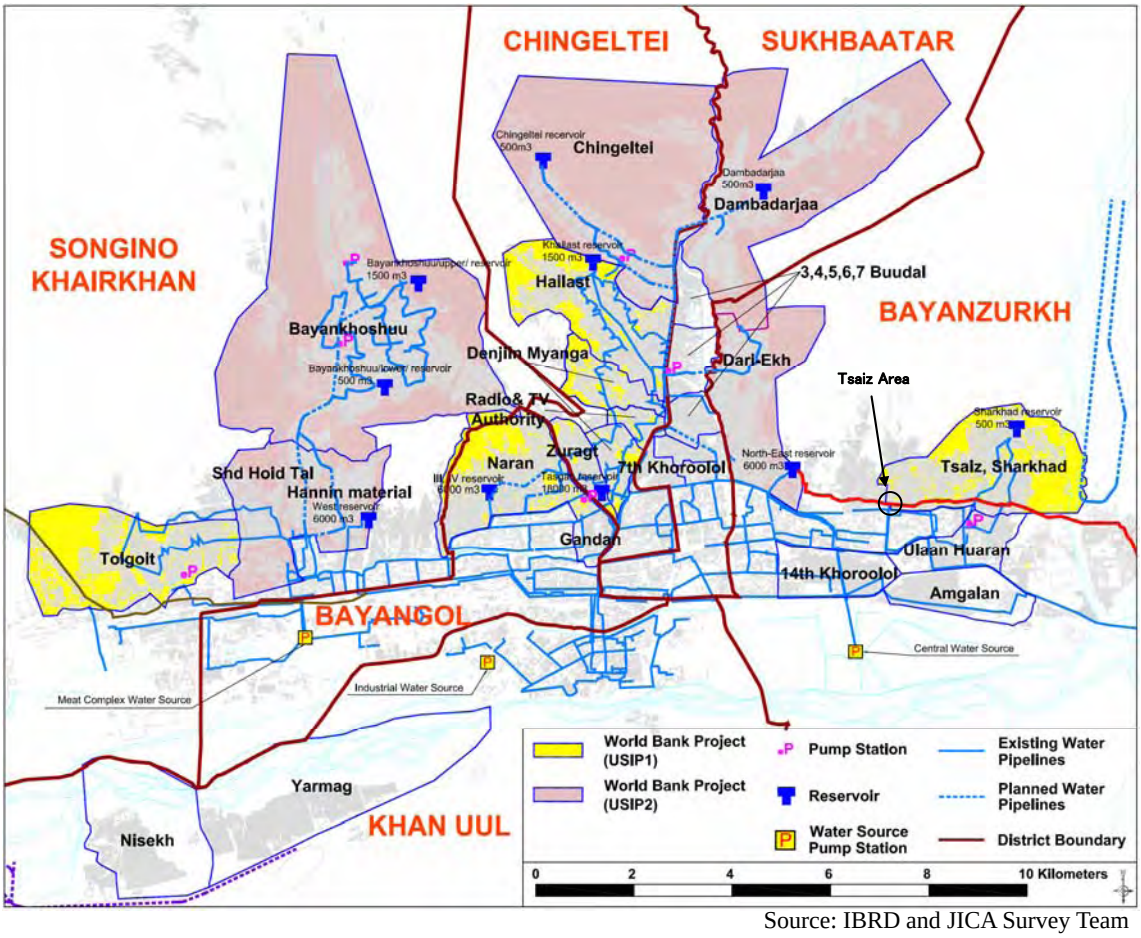
(6) Water Amount of the Project Plan

The water amount of the Project Plan is 25,200 m^3/day which is based on the difference of 22,861 m^3/day between the maximum water amount per day in 2014 (262,861 m^3/day) and the current supply capacity of water supply facilities (240,000 m^3/day), and adding to an undefined amount of 10% considering the possibility of a temporary increase in water leakage due to water distribution pressure rises.

(7) Benefited Population

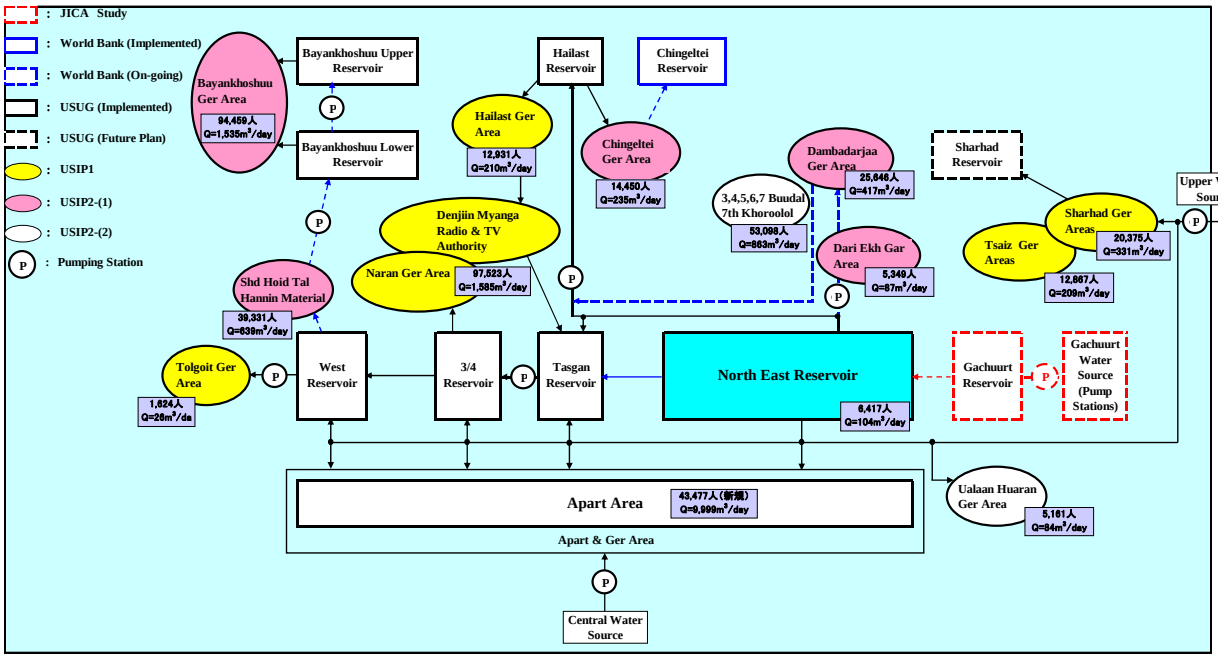
The Project plans to supply the newly developed water in the Gachuurt area to a population of 34,297 in Dari Ekh area, Dambadarjaa area, and Chingeltei area via the North East Reservoir. Plans call for water to be supplied to a population of 45,000 by the target year of 2014. Moreover, through the Tasgan Reservoir and the 3/4 Reservoir, the water will be supplied to the surrounding Ger areas for an estimated population of 345,000 in 2014. Consequently, this will make it possible to supply water to approximately 390,000 people in the Ger areas as a whole.

As well as the water supply to the Ger areas, water is also supplied to apartment areas in order to improve the water supply conditions of these areas, where there is currently the possibility that service will be shut off due to lack of water. In view of this improvement, water can be supplied to approximately 43,500 people in the apartment areas.



Source: IBRD and JICA Survey Team

Figure 2-2.3 Diagram of Water Supply Plan



Source: IBRD and JICA Survey Team

Figure 2-2.4 Diagram of Water Supply Distribution from the North East Reservoir to the Ger Areas

Table 2-2.18 Project Beneficiary Ger District Population Chart

WB Completed Project (USIP 1)	Estimated Population		WB Current Project and Future Schedule (USIP 2)	Estimated Population	
Ger District Name	2009	2014	Ger District Name	2009	2014
Hailast	9,759	12,931	Chingeltei	10,905	14,450
Denjiin Myanga	50,954	67,516	Dambadarjaa	19,355	25,646
Radio & TV Authority Naran Zuragt	22,646	30,007	Dari Ekh	4,037	5,349
			Sub-Total	34,297	45,445
In and Around North East Reservoir	4,843	6,417	Bayankhoshuu	71,288	94,459
Tsaiz	9,711	12,867	She Hoid Tal	5,000	6,625
Sharhad	15,377	20,375	Hannin Material	24,683	32,706
Tolgoit	1,226	1,624	3,4,5,6,7 Buudal	10,893	14,434
			7th Khoroolol	29,180	38,665
			Ualaan Huaran	3,895	5,161
Total	114,516	151,738	Total	179,236	237,495

Source: USUG

Estimated beneficiary population and water supply with the Project between 2014 and 2020 are as shown on the table below. Before the Project, the beneficiary Ger districts are the service districts supplied by water kiosks, and the unit water consumption was estimated at 7.4 ℓ/person/day in 2009, and at 10.9 ℓ/person/day in 2010. On the other hand, the estimation value of the day maximum water supply will reach to 242,547 m^3/day in the entire Ulaanbaatar in 2011, and it is predicted that the 240,000 m^3/day of existing water supply plant capacity will be exceeded. Therefore, the water supply amount from 2011 will reach the limit at the beneficiary Ger districts before 2014 when the facility will start supplying by the Project implementation. For this reason, it is predicted that the unit water consumption will keep decreasing down to 9.2 ℓ/person/day by 2013, due to the increase in growth of population. Therefore, the deficit of 15.8 ℓ/person/day of the planned unit water consumption (i.e., 25 ℓ/person/day - 9.2 ℓ/person/day) will be supplied to the number of population in 2013 through access to the Project in 2014, and the planned unit water consumption of 25 ℓ/person/day will be supplied to meet the population growth. The development amount of water by the Project shall supply water by giving priority to the Ger districts, and the surplus water will be supplied to the apartment house areas. As a result, the water supply to 43,500 people will be attained in 2014 for the planned unit water consumption of 230 ℓ/person/day of an apartment house area.

Table 2-2.19 Estimated Project Beneficiary Population and Water Supply

Item	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Beneficiary Ger District Population	293,752	312,848	331,944	351,040	370,137	389,233	408,329	427,425	446,521	465,618	484,714	503,810
Max. Daily Water Supply Volume (m^3/day)	3,073	4,811	4,802	4,793	4,784	22,861	22,861	22,861	22,861	22,861	22,861	22,861
Average Daily Water Supply Volume (m^3/day)	2,591	4,057	4,049	4,041	4,034	19,276	19,276	19,276	19,276	19,276	19,276	19,276
Average Daily Water Revenue (m^3/day)	2,174	3,410	3,410	3,410	3,410	16,325	16,354	16,360	16,365	16,371	16,377	16,385
Average Daily Water Revenue for Beneficiary Ger District (m^3/day)	2,174	3,410	3,410	3,410	3,410	6,326	6,803	7,280	7,758	8,235	8,713	9,190
Average Daily Water Revenue for Apartment District (m^3/day)	0	0	0	0	0	9,999	9,551	9,080	8,607	8,136	7,664	7,195
Water Supply Populaton in Apartment Area	0	0	0	0	0	43,500	41,500	39,500	37,400	35,400	33,300	31,300
Unit Water Consumption in Ger Area (ℓ/person/day)	7.4	10.9	10.3	9.7	9.2	25	25	25	25	25	25	25
Unit Water Consumption in Apartment Area (ℓ/person/day)	-	-	-	-	-	230	230	230	230	230	230	230
Revenue Ratio (%)	83.91	84.06	84.22	84.38	84.53	84.69	84.84	84.87	84.90	84.93	84.96	85.00
Load Ratio (%)	84.32	84.32	84.32	84.32	84.32	84.32	84.32	84.32	84.32	84.32	84.32	84.32

Source：JICA Survey Team

2-2-2-2 Water Sources Development Plan

(1) Suitability for the Selection of Water Sources Site

1) As the water sources of the Project, production wells will be constructed in the flood plain of the Tuul River to intake groundwater (subsoil water) in the Gachuurt area located in the upper reaches of Tuul River, which flows from east to west through Ulaanbaatar. Research was also conducted in the developmental study called “The Study on Water Supply System in Ulaanbaatar and Surroundings” (1993-1995). In this study, the development capacity of the existing water sources was examined, and the alternative water sources were also discussed. The research concluded that the development capacity of existing water sources is small, and that the Gachuurt Water Source is only a short distance from Ulaanbaatar City.

Table 2-2.20 Available capacity of each water source and alternative water sources

Water Source	Potential Water Source (m^3/day)	Developed Water Amount in 1995 (m^3/day)	Developed Water Amount in 2009 (m^3/day)	Available Development Capacity in 2009 (m^3/day)
Upper	90,000	24,000	90,000 Wells: 55	0: Phase 2[*1]; Increased between 2003 and 2006
Central	114,300	97,000	110,000 Wells: 93	0: Phase 1[*2]; Increased between 1996 and 1998 Regarding the remaining amount of 4,300 m^3/day, water source development was impossible because the upstream area was opened for housing land and farmland.
Industrial	25,000	25,000	25,000 Wells: 16	0: Except heat power plants, 80,000 m^3/day

Water Source	Potential Water Source (m^3/day)	Developed Water Amount in 1995 (m^3/day)	Developed Water Amount in 2009 (m^3/day)	Available Development Capacity in 2009 (m^3/day)
Meat-Complex	15,000	15,000	15,000 Wells: 11	0
Gachuurt	40,000 or less	0	0	40,000 or less
Total	284,300 or less	161,000	240,000 m^3/day Total No.of wells: 175	40,000 or less

*1: The Project for Improvement of Water Supply Facilities at Upper Water Source Area in Ulaanbaatar, 2003-2006 (supported by Japan Grant Aid)
*2: The Project for Repair of Water Supply Facilities in Ulaanbaatar, 1996-1998 (supported by Japan Grant Aid)

Source: JICA1995MP & JICA Survey Team

The UBMPS also considers water source development in the Gachuurt area to be a top-priority project. Given the above circumstances, developing the Gachuurt Water Source in this Project is deemed appropriate.

2) The Gachuurt flood plain was proclaimed as a water source protected area and sanitary zone of water supply under Ministry Ordinance No. 51/57 in March 2009 of the Ministry of Nature, Environment and Tourism on the basis of the Action Plan of Ulaanbaatar City, 2009-2012. Only the development of domestic water is permitted, and there is no private well and permanent structure in the area.

3) The rate of groundwater recharge or groundwater potential at the Gachuurt Water Source is set at 9% (Appendix 5) based on the cases of water balance at Zaisan Bridge at the south of the center of Ulaanbaatar City and the water balance of Altai City. Hence, the volume and rate of groundwater recharge are calculated as follows:

Basin area (**A**): 5,332 km^2= 5,332,000,000 m^2
Average Annual Precipitation (P) = (237 x 3.8% + 323 x 73.3% + 577 x 22.9%)
= 378 (mm/year) = 0.378 (m/year) [Refer to Table 2-2.22]
Recharge Rate (R) = 9%
Groundwater Recharge Volume ＝ A x P x R
＝ 5,332,000,000 (m^2) x 0.378 (m/year) x 0.09
＝ 181,394,640 (m^3/year) ＝ 496,972 (m^3/day)

The recharge volume is thus estimated as 181 million m^3/year, or 496,972 m^3/day.

The developed volume of the Upper Water Source is 90,000 m^3/day and sufficient groundwater with a volume of about 407,000 m^3/day remains at the Gachuurt Water Source as computed below. Therefore, there is sufficient development capacity of approximately 25,000 m^3/day which is the planned water development volume in the study.

Water balance at Gachuurt area = 496,972－90,000 = 406,972 (m^3/day)

Environmental load will not occur since the groundwater cultivated amount remains at approximately 152,000 m^3/day for the development water volume (320,000 + 25,200) of all water sources.

Water balance at the whole UB City = 496,972－(320,000 + 25,200) = 151,772 (m^3/day)

Table 2-2.21 Existing Water Source and Developed Volume（As of August 2009）

Water Source	Number of Wells	Capacity (m^3/day)
Upper	55	90,000
Central	93	110,000
Industrial	16	25,000
Meat-Complex	11	15,000
USUG Source Total	175	240,000
Power Plant 2,3,4	30	80,000
Grand Total		320,000

Source: JICA Survey Team

Table 2-2.22 Sub-Basin Area and Precipitation in the Elevation of Gachuurt Basin (Unit：km^2)

Sub-basin	Elevation			Total
	<1500m	1500-2000m	Over 2000m	
Upper Tuul Sub-basin	0	2,114	626	2,740
Terelj Sub-basin	0	797	542	1,339
Middle Sub-basin	200	1,000	53	1,318
Total	200	3,911	1,221	5,332
Ratio	3.8 %	73.3%	22.9%	100%
Estimated Annual Average Precipitation	237mm	323mm	577mm*[1]	377.9mm

*[1]: Formula is given in relation elevation and precipitation (P) as follows.
P=0.3583 x 2,250–228.83=577.3mm

Source: JICA Survey Team

4) Water Quality

Past Water Quality Analysis Results

In 2006, water quality analysis was conducted for the Tuul River around the water source and the wells in the Gachuurt village. Judging from the facts that the water quality of the Tuul River meets the drinking water quality standards as well as environmental standards for water quality and the wells in the Gachuurt village meet the drinking water standards, it can be said that the sewage of the Nalaikh area that flows into the Tuul River at the location of approximately 10 km upstream does not have any influence on the Gachuurt Water Source. However, the groundwater analysis results show that coliform bacteria were found. Therefore, chlorination is absolutely necessary when using groundwater.

Table 2-2.23 Water Quality Analysis Result around the Gachuurt Water Source (May, 2006)

	pH	EC	Cl	NH_4	NO_2	NO_3	Fe	COD	Bacteria Coil	Viable Bacteria	Turbidity	SS	BOD	PO_4
Unit	-	μS/cm	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	-	Nos./ml	-	mg/ℓ	mg/ℓ	mg/ℓ
Well*1	7.2	356	9.5	0.001	0	1.4	0	0.8	0	>100	-	-	-	-
Drinking Water Quality Standards	**6.5-8.5**	**-**	**350**	**1.5**	**1**	**50**	**0.3**	**-**	**0**	**100**	**-**	**-**	**-**	**-**
Tuul River*2	7.1	116	4.5	0.053	0.004	0.2	0.006	2.4	114	>100	-	-	-	-
Nalaikh Drainage Channel*3	7.3	348	18.9	12.9	-	-	-	48.9	>100	>100	6.7	320	16.0	0.67
River Water Quality Standards (Natural Environment)	**6.5-8.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**50**	**-**	**-**	**25**	**1**	**-**

Note: *1.Well; Wells in Gachuurt Village, *2.Tuul River; River Water of Water Source
*3.Nalaikh Drainage Channel; The upstream point where the Nalaikh Drainage Channel joins the Tuul River. (10km Upstream From Point 2)

Source：USUG

Water quality of influx drainage to the Nalaikh disposal plant and after arrangement of water is shown in the following table.

Table 2-2.24 Water Quality of Influx Drainage to Nalaikh Disposal Plant and After Arrangement of Water

Item	Water Quality of Influx Drainage	Drainage Water Quality after Arrangement
Unit	mg/ℓ	mg/ℓ
BOD	120	64
SS	49 - 68	20

Source：「Gachuurt Water Source Development Planning Report」2006

BOD of the sewage processed by the Nalaikh disposal plant decreases from 64 mg/ℓ to as low as 16 mg/ℓ as the result of natural aeration while flowing through the open channel for 7 km before it interflows into the Tuul River. The fact that particles of suspended solids have become larger is presumed to be due to the mixing of soil at the time of sampling. The result is also presumed from the fact that the water quality of the Tuul River meets the river environmental standard for water quality and the well at the Gachuurt village also meets the drinking water quality standards. Therefore, it is judged that the sewage of Nalaikh City would not affect the Gachuurt Water Source.

However, in case of utilization of underground water, since the coliform bacteria group counts exceed the reference value of 100 groups/mℓ, chlorination is required. Also in case of utilization of river water, only the coliform bacteria group count and the general bacteria groups exceeded the drinking water quality standards, so that the river water could be safe.

Current Water Quality Analysis Results

Water quality analysis was conducted for the groundwater sampled by a drawdown test when

test drilling was done at the Gachuurt Water Source. This analysis was conducted in order to determine whether the water is adequate for drinking. The location of test drilling is shown in Figure 2-2.6.

Water quality inspections based on 30 criteria were conducted according to the Mongolian water quality standards (MNS900-2005). Due to the absence of large-scale farms that use agricultural chemicals, mines, and refineries in the basin upstream of the water source, no examination was made with respect to agricultural chemicals and organic compounds that are not specified in the Mongolian water quality standards.

The water quality analysis criteria and the result of the water quality analysis of the water sampled from sample wells in 4 locations are shown in Table 2-2.25. With regard to mercury, the value is within the measurable limit of the equipment owned by the Central Geological Laboratory of Mongolia, but the value is not accurate.

The groundwater in this water source recorded coliform and other common bacteria in amounts exceeding the water quality standards set by the Water Law of Mongolia, but the values for other criteria were within the regulation. Therefore, chlorination is sufficient when using the groundwater in this water source for drinking purposes.

Table 2-2.25 Water Quality Analysis Results

No.	Parameter	Unit	G-1	G-2	G-3	G-4	Water Quality Standard Values
1	Turbidity	NTU	0.08	0.21	-	-	5
2	Acidity pH		6.33	7.05	6.65	6.95	6.5-8.5
3	Conductivity	micro-S/cm	0.18	0.08	0.15	0.07	-
4	Chloride	mg/ℓ	10.28	6.74	27.65	6.74	350
5	Sulphate	mg/ℓ	7.41	8.23	13.99	14.81	500
6	*Silica*	*mg/ℓ*	0.83	0.82	0.55	0.46	-
7	Calcium	mg/ℓ	10.02	12.02	10.02	18.04	100
8	Magnesium	mg/ℓ	1.85	1.80	5.47	<0.50	30
9	Sodium	mg/ℓ	10.69	8.96	7.90	2.09	200
10	*Potassium*	*mg/ℓ*	0.01	0.02	3.06	0.74	-
11	Aluminum	mg/ℓ	<0.025	<0.025	0.032	<0.025	0.5
12	Total hardness	mg/ℓ	35.0	37.5	47.5	45.0	350
13	Dry residuals	mg/ℓ	68.4	74.0	96	68	1000
14	Nitrates	mg/ℓ	0.62	1.12	0.01	0.01	50
15	Nitrites	mg/ℓ	<0.01	<0.01	<0.01	<0.01	1.0
16	Ammonium	mg/ℓ	0.70	0.70	4.50	0.70	1.5
17	Iron	mg/ℓ	<0.03	<0.03	0.09		0.3
18	Manganese	mg/ℓ	0	0.01	0.01	<0.01	0.1
19	Copper	mg/ℓ	<0.01	<0.01	<0.01	<0.01	1
20	Zinc	mg/ℓ	0.02	<0.01	0.02	0.01	5
21	Silver	mg/ℓ	<0.05	<0.05	<0.05	<0.05	0.05
22	Arsenic	mg/ℓ	<0.05	<0.05	<0.05	<0.05	0.05
23	Cadmium	mg/ℓ	<0.005	<0.005	<0.005	<0.005	0.01
24	Cyanides	mg/ℓ	<0.002	<0.002	<0.002	<0.002	0.01
25	Chromium	mg/ℓ	<0.02	<0.02	<0.02	<0.02	0.05
26	*Mercury*	*mg/ℓ*	<0.005	<0.005	<0.005	<0.005	(0.0005)

No.	Parameter	Unit	G-1	G-2	G-3	G-4	Water Quality Standard Values
27	Molybdenum	mg/ℓ	<0.03	<0.03	<0.03	<0.03	0.25
28	Lead	mg/ℓ	<0.01	<0.01	<0.05	<0.05	0.03
29	Total coliforms	Nos./100ml	70	55	23	49	Not Detected
30	General bacteria colony counts	Nos./ml	0	0	110	240	20

(Note) Italicized items do not exist in the Mongolian water standards. Values in parentheses are Japan water quality standards and are shown as reference. Source: JICA Survey Team

5) Impact of the Dam Plan

Russia has been planning for the construction of a dam on the Tuul River since the 1970's. The planned dam sites are shown in Figure 2-2.5. According to USUG, specific reviews are not in progress and this is not included in the plan for future water sources. The planned water source developments following Gachuurt are large diameter wells in the Yarmag district. Currently, the Water Authority is at the stage of examining the water supply and has not yet reached the design phase.

The remaining basin area of the Gachuurt Water Source when the dams are constructed and the amount of groundwater recharge are shown in the following table. The development reserve is calculated by subtracting 90,000 m^3/day (for the already-developed Upstream Water Source) from the groundwater recharge amount.

Table 2-2.26 Changes in the Catchment Area and Groundwater Recharge Amount at Gachuurt Point with Dam Plan

Dam location No.	Dam Catchment Area (km^2)	Remaining Basin Area (km^2)	Groundwater Recharge Amount (m^3/day)	Development Potential (m^3/day)	Issue
Dam1	1,560	3,772	351,385	261,385	None
Dam2	2,541	2,791	259,999	169,999	Low recharge
Dam3	817	4,515	420,600	330,600	Environment
Dam4	1,150	4,182	389,579	299,579	Environment
Dam5	4,079	1,253	116,724	26,725	Low recharge
No dam	**5,332**	**5,332**	**496,972**	**409,972**	

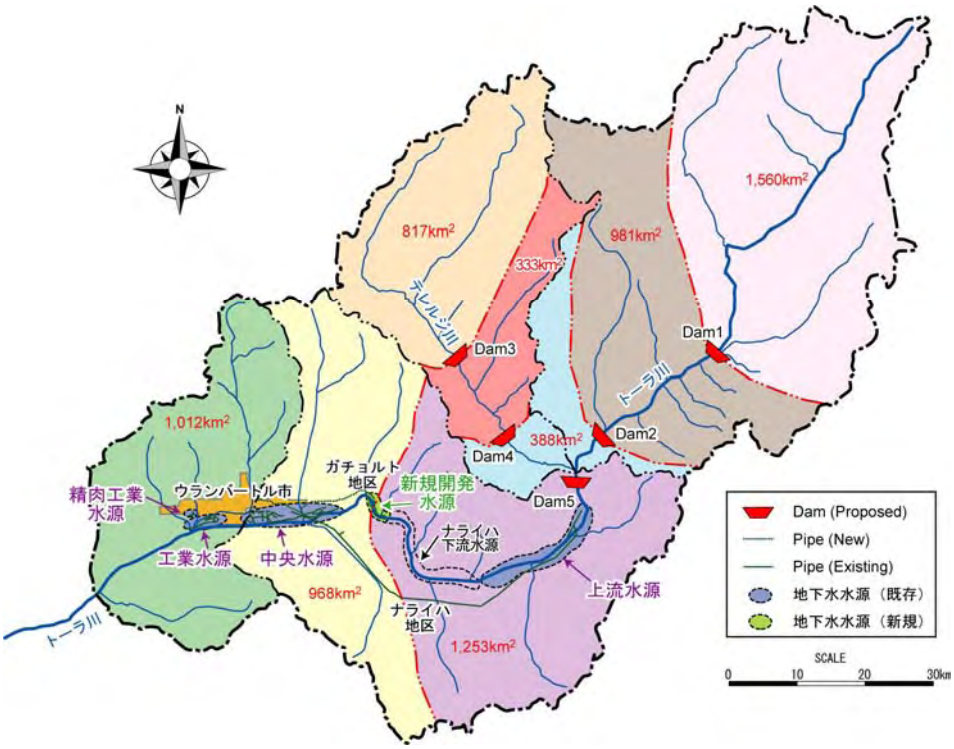
Source: JICA Survey Team

Dam1: Q1= 3,772,000,000 (Basin area) x 0.3778 (Annual average precipitation) x 0.09 (Groundwater recharge) = 128,255,544 (m^3/year) = 351,385 (m^3/day)
Dam2: Q2= 2,791,000,000 x 0.3778 x 0.09 =94,899,582 (m^3/year) = 259,999 (m^3/day)
Dam3: Q3= 4,515,000,000 x 0.3778 x 0.09 = 153,519,030 (m^3/year) = 420,600 (m^3/day)
Dam4: Q4= 4,182,000,000 x 0.3778 x 0.09 =142,196,364 (m^3/year) = 389,579 (m^3/day)
Dam5: Q5= 1,253,000,000 x 0.3778 x 0.09=42,604,506 (m^3/year) = 116,724 (m^3/day)

If Dam5 at the point furthest downstream is constructed, it only leaves 26,725 m^3/day of development potential. As the Gachuurt Water Source development requires 25,200 m^3/day, the plan of Dam5 will cause the shortage of groundwater recharge and a subject remains.

The basin area downstream of the Zaisan Bridge, which is downstream of the water source, covers 6,300 km^2 and an additional remaining basin of approximately 1000 km^2. The

groundwater recharge amount is approximately 79,643 m^3/day. Taking this into account and considering the 230,000 m^3/day of already developed water source in the central region, industrial purposes, meatpacking factories, and thermal power generation, the plan for Dam2 leads to a shortage of groundwater recharge (169,999+79,643=249,642 m^3/day). Dam1, Dam3, and Dam4 can use existing groundwater sources in terms of development reserve; however, Terelj has a national park, and Dam3 and Dam4 on the Terelj River are left with environmental conservation issues.



Source：JICA Survey Team

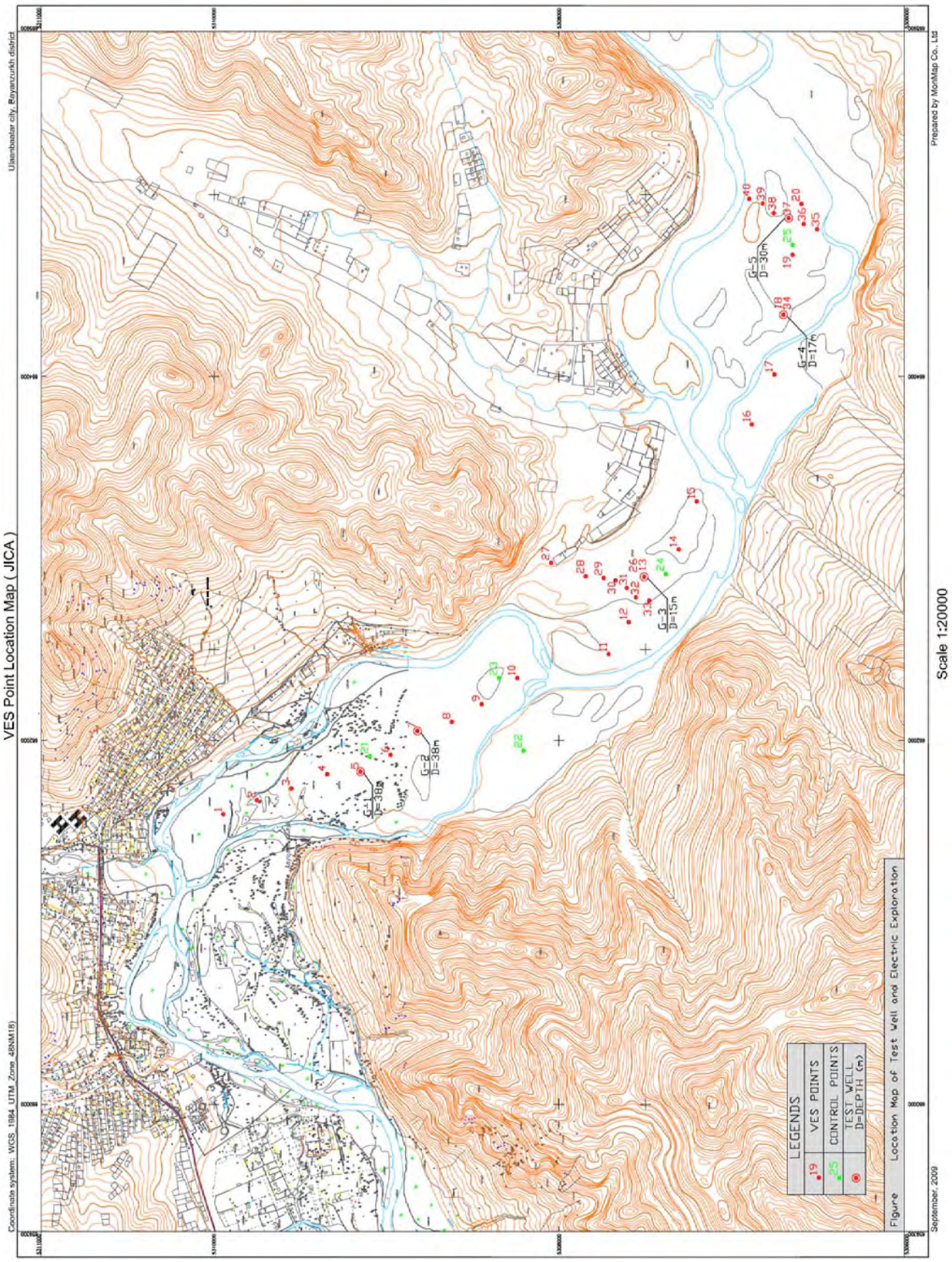
Figure 2-2.5 Dam Plan Location Map

The Central Water Source, Industrial Water Source, and Meat-Complex Water Source are exposed to the risk of water pollution as well as to urbanization despite legal regulations. This leaves room for considering abandoning these groundwater sources and switching to using surface water. The dam plans are promoted under the auspices of Russian aid, but have not yet seen specific onsite investigation. At any rate, with regard to the water resources in Ulaanbaatar City, in order to collect data on the storage of groundwater and surface water and review their utilization, an integrated water resource management plan survey must be commenced as soon as possible.

2-2-2-3 Planning and Design of Production wells

(1) Vertical Electrical Survey Results

The Vertical Electric Survey (VES) was conducted to determine the stratigraphy of the subsurface geological formations and water-bearing formations. This survey was conducted at a total of 40 measurement points. Figure 2-2.6 shows the locations of the VES and test well drilling, and Table 2-2.27 shows the survey results.



Source: JICA Survey Team

Figure 2-2.6 Locations of the VES and Test Well Drilling

Table 2-2.27 List of VES Results: Estimated Soil Layers

VES	North Latitude: N	East Longitude: E	Altitude (m)	First layer thickness (m)	Second layer thickness (m)	Third layer thickness (m)	Depth to Bedrock (m)
1	47°55' 20"	107°09' 47"	1300.16	1.0	6.5	5.0	12.5
2	47°55' 14"	107°09' 50"	1299.97	1 .0	9.0	20.0	30?
3	47°55' 08"	107°09' 53"	1300.96	4.7	7.8	22.5	35
4	47°55' 01"	107°09' 56"	1301.03	1.3	3.0	>5.7	more than 10
5	47°54' 55"	107°09' 57"	1300.84	1.2	6.2	12.6	20 (G-1)
6	47°54' 49"	107°10' 01"	1300.93	1.2	3.1	35.7	40?
7	47°54' 44"	107°10' 07"	1302.23	1.2	4.8	1.0	7.5 (G-2)
8	47°54' 38"	107°10' 09"	1302.29	1.2	2.9	8.4	12.5
9	47°54' 32"	107°10' 14"	1303.45	1.9	8.1	10.0	20
10	47°54' 25"	107°10' 20"	1303.80	1.9	2.6	4.5	9
11	47°54' 08"	107°10' 26"	1305.24	1.1	6.4	0	7.5
12	47°54' 04"	107°10' 34"	1305.47	1.1	1.8	4.6	7.5
13	47°54' 01"	107°10' 46"	1305.68	1.3	3.7	5.0	10 (G-3)
14	47°53' 54"	107°10' 53"	1306.42	1.2	1.7	6.1	9
15	47°53' 51"	107°11' 06"	1307.53	1.2	4.8	3.0	9
16	47°53' 40"	107°11' 26"	1307.51	1.2	3.8	7.5	12.5
17	47°53' 35"	107°11' 39"	1308.36	1.2	1.7	3.1	6
18	47°53' 33"	107°11' 54"	1308.99	1.2	4.8	3.0	9 (G-4)
19	47°53' 31"	107°12' 10"	1310.20	1.2	2.8	21.0	25
20	47°53' 29"	107°12' 24"	1309.70	1.2	2.8	4.0	8
21	47°54' 53"	107°10' 01"	1300.90	1.2	6.3	5.0	12.5
22	47°54' 24"	107°10' 01"	1303.17	1.2	6.3	7.5	15
23	47°54' 28"	107°10' 20"	1303.92	1.2	11.3	12.5	25
24	47°53' 57"	107°10' 47"	1305.94	3.0	4.5	7.5	15
25	47°53' 31"	107°12' 13"	1310.39	1.2	2.8	2	6
26	47°54' 04"	107°10' 46"	1334	1.0	3.5	4.0	8.5
27	47°53' 59"	107°10' 41"	1335	0.7	4.3	0	5
28	47°54' 02"	107°10' 42"	1336	1.0	1.0	3.5	5.5
29	47°54' 08"	107°10' 44"	1335	1.5	3.5	1.2	6
30	47°54' 08"	107°10' 46"	1337	0.5	5.5	0	6
31	47°54' 12"	107°10' 47"	1338	1.0	5.2	0	6
32	47°54' 14"	107°10' 49"	1335	0.8	4.8	0	5.6
33	47°54' 17"	107°10' 50"	1343	1.0	2.5	0	3.5
34	47°53' 33"	107°11' 55"	-	1.2	4.8	3.0	9 (G-4)
35	47°53' 24"	107°12' 09"	-	1.5	6.5	5.0	13
36	47°53' 27"	107°12' 13"	-	0	8.5	4.5	13
37	47°53' 29"	107°12' 14"	-	3.0	6.0	0	9m: Fractured Zone
38	47°53' 32"	107°12' 17"	-	3.5	6.5	6.0	16
39	47°53' 35"	107°12' 20"	-	2.5	9.5	10.5	22.5
40	47°53' 38"	107°12' 22"	-	5.0	6.5	0	11.5
Average				1.5	5.0	5.0	11.5-12.8

Source: JICA Survey Team

The resistivity layer is divided into four (4) layers, as follows:

First Layer: The surface layer, about 0.5m to 1m, is a gravel layer partly mixed with plant roots and corrosives. The layer thickness is generally about 1m; however, the layer at the upstream measurement point (VES37-40) was measured to be thick. The groundwater level distributes under the ground level of this layer about 1m to 1.5m. The average layer thickness is 1.5m.

Second Layer: This layer is a gravel layer with high permeability, which is a fine water-bearing layer. The average layer thickness is approximately 5.0m.

Third Layer: This layer is a sand layer with clay and gravel. Even though this layer is inferior to the second layer, it can still serve as a water-bearing layer. In some places, there is a possibility that the clay layer that has accumulated on the old slip-off

slope distributes in a lenticular form. The average layer thickness is approximately 5.0m.

Bedrock: This layer consists of sandstone and slate belonging to the Palaeozoic Era Carboniferous Period. The depth to the bedrock is 6m at the shallowest point, while it is 35m at the deepest point. The average depth is estimated to be approximately 12m.

Aquifer: The water-bearing layer in the Gachuurt Water Source is a layer combining the second layer with the third layer. The average layer thickness of the water-bearing layer is approximately 10m.

(2) Pumping Test Results

After the completion of the electric exploration, five (5) test wells were drilled and pumping tests were conducted in the five test wells. The locations of the test wells are shown in Figure 2-2.6 and the pumping test results are shown in the following table.

Table 2-2.28 Test Well and Results of Pumping Test (Constant Discharge Test)

Well No.	Depth (m)	Depth to Rock (–m)	M Thickness of aquifer (m)	Static WL (GL–m)	Dynamic WL (GL–m)	Drawdown (m)	Q (m^3/d)	⊿s (m)	T (m^2/day)	K (cm/sec)
G-1	38	20.0	19.00	1.00	2.64	–1.64	1,617	0.12	2,466	$1.5x10^{-1}$
G-2	38	7.5	6.35	1.15	*5.05*	*–3.90*	*916*	*0.26*	*645*	*$1.2x10^{-1}$*
G-3	15	10.0	8.55	1.45	2.30	–0.85	2,304	0.06	7,027	$9.5x10^{-1}$
G-4	17	9.0	7.65	1.35	4.44	–3.09	1,506	0.41	626	$9.5x10^{-2}$
G-5	30	10.0	7.81	2.19	5.50	–3.31	1,088	0.14	1,531	$2.3x10^{-1}$
Ave.	-	-	-	-	-	-	1,404		1,541	-

Source: JICA Survey Team

Note: M= thickness of aquifer, Q=pumping volume, T=Transmissivity, K=Permeability
⊿s=unit water level drawdown
Qaverage: excluding max. and G-2. Taverage: excluding max. and G-2.
G-2: turbulent flow may be happened.

Method of Analysis: Jacob's linear analysis

$$T=\frac{0.183Q}{\Delta s}$$

$$K=\frac{T}{M}$$

Pumping rate is to be estimated as about 920m^3/day to 2,300m^3/day with an average of about 1,400m^3/day. However, dynamic water level fluctuated from –0.85m to –3.3m, which indicate that a large quantity of groundwater exploitation may affect the environment. The transmissivity was computed as 626 to 7,027 m^2/day, and the average is 1,500 m^2/day excluding the maximum value.

(3) Examination for Production Well Number and Pumping Rate

Water sources in Tuul River are protected by the "Recommendation of Water Authority: dynamic water level should be within 2 meters". The production well has to be designed with the verification of pumping rate, interval of well, and interference of well based on pumping test.

For safety, the transmissivity is set at 1,200 m^2/day, which is 80% of the computed average transmissivity, because the result is for only five tests in the wide water source (length about 3 km, width about 1 km).

Table 2-2.29 Trial Drawdown of Water Level in the Well

Interval (m)	Well Number	Pumping Rate	Drawdown	Interference	Total Drawdown
symbol		Q	⊿h	⊿s	H
Unit	Number	m^3/day/well	−m	−m	−m
200	30 (15 x 2line)	840	0.89	0.31	1.20
300	20 (10 x 2line)	1,260	1.37	0.39	1.76
333	18 (9 x 2line)	1,400	1.53	0.43	1.96
400	14 (7 x 2line)	1,800	2.00	0.49	2.49
500	12 (6 x 2line)	2,100	2.36	0.51	2.87

Source: JICA Survey Team

Example:

Total intake volume of the Project: 25,200 m^3/day; well number 3000m/300m=10 wells x 2 lines = 20 wells

Storage capacity: S = 0.1 (0.1 to 0.15, adopt 0.1 to be safe)

Precipitation: 240 mm on average in UB City

T = pumping duration: one year, 365 days, r = well interval

Computation example of 20 wells, 300m interval

$$\Delta h = \frac{2.3Q}{2\pi T}\log\frac{re}{rw} = 1.37$$ ---------drawdown in the well

$$\Delta S = \frac{0.183Q}{T}\log\frac{2.25Tt}{r^2 S} = 0.39$$ ----------drawdown by interference with Jacob's Formula

$$re = \sqrt{\frac{Q}{\pi R}} = 782.11\,(\mathrm{m})$$

rw: well radius＝0.212m、R=240 mm/365day (recharge rate: m^3/m^2/day)

(=0.66 mm/day (in Japan: 1mm/day))

(=6.56 x 10^{-4} (m/day))

Pumping rate of 1,200 to 1,300 m^3/day shall satisfy the "Recommendation of Water Authority: dynamic water level shall not exceed the limit (2 meters)" and well interval shall be about 300m based on the computation using the Jacob's formula.

Moreover, the drawdown of interference is less than its pumping rate, so that well intervals are

possible to become shorter. Considering the topographic characteristic of the Gachuurt Water Source with a length of about 3,000m and width of about 1,000m, pumping rate is recommended to be 1,200 m^3/day/well and well intervals shall be 250 meters. Based on the available physical parameters, the total drawdown of groundwater level in the Gachuurt Water Source is computed at –1.70 meters, which is within the limit permitted under the Recommendation of Water Authority. The results of the calculation are shown in Table 2-2.30.

Table 2-2.30 Pumping Rate, Well Interval, and Drawdown

Pumping Rate	Well Interval	Drawdown in Well	Drawdown by Interference	Total Drawdown	Assessment
m^3/day/well	m	–m	–m	–m	
1,200	250	1.30	0.40	1.70	◎: pass

Source: JICA Survey Team

Conclusion

About 21 production wells should be constructed with 1,200 m^3/day/well pumping rate to totally exploit 25,200 m^3/day. The interval between wells should be a minimum of 250m.

(4) Well Design

1) Production Well Depth

The results of the test drilling survey and the VES show that the depth to the bedrock is varied by measurement point. According to the VES results, the depth at measurement point 3 (VES3, downstream) is approximately 35m, approximately 20m to 40m at measurement points 5 to 6, approximately 23m at measurement point 39 (most upstream), and approximately 5m to 15m at the other measurement spots. According to the test drilling survey results, the depth to the bedrock is 20m at test well G-1 (measurement spot 5), and approximately 8m to 10 m at other test well spots.

In principle, the depth of a production well is determined depending on the depth to the bedrock. The purpose of such production wells is to secure the thickness of the water-bearing formations which is necessary to obtain the above-mentioned pumping rates. The VES confirmed that the second layer (mainly consisting of gravel layer) and the third layer (mainly consisting of sand layer with gravel) are the water-bearing formations. Furthermore, according to the results of the drawdown test conducted at test wells, the required amount of water in the aquifer is expected to be obtained from the fissure water since there are many cracks on the upper part of the foundation rock. Therefore, in the spots where the depth to the foundation rock is shallow (5m to 15m), the well depth can be determined with the expectation that this fissure water can also be pumped up. However, those spots where the depth to the bed rock is shallower than 10m should not be selected as production wells, if possible. For these reasons, the well depth should be set to the following two types:

- Type A: The depth is 20m for 19 wells other than the wells below (depth to the bed rock: 10m to 20m, aquifer thickness: 10m to 15m)

・Type B: The depth of the two developed wells[6] (No. 3 and No. 7) is 30m (depth to the bedrock: 20m to 30m, aquifer thickness: 20m to 25m). These are located at around measurement points 3, 5, and 6 where the VES was conducted. The depth of bedrock at VES2 is estimated to be 30m, but this is unclear.

The following table shows the positional relationship between the production wells planned and the sounding location of vertical electric sounding:

Table 2-2.31 Relationship between the Location of Production Wells Planned and Vertical Electric Sounding Points

Production Well No.	Closest Vertical Electric Sounding Point	Depth to Bedrock (m)	Type
1	VES2	30	A
2	VES1	12.5	A
3	VES3	35	B
4	VES4	more than 10	A
5	VES4	more than 10	A
6	VES5	20	A
7	VES6	40?	B
8	VES7	7.5	A
9	VES7	7.5	A
10	VES8	12.5	A
11	VES8	12.5	A
12	VES9	20	A
13	VES10	9	A
14	VES11	7.5	A
15	VES12	7.5	A
16	VES30	6	A
17	VES33	3.5	A
18	VES13	10	A
19	VES14	9	A
20	VES14	9	A
21	VES15	9	A

Source: JICA Survey Team

In the above table, planned production well No.3 and No.7 are treated as Type B, differentiating them from other planned production wells due to their outstanding depth to bedrock. The other 19 production wells mostly have a depth to bedrock of 10-20m and are labeled as Type A. Electric sounding should be conducted once more at the time of the detailed design for the final determination of Type A and Type B categorization.

2) Casing Diameter and Well-Drilling Diameter

Since the well specifically requires a water pump (φ100 mm caliber) to pump 1,200 m^3/day water if the diameter of the casing is φ250 mm (φ100 mm caliber), the pump rate of less than 1,500 m^3/day specified on page 106 of "A Guide for Designing Water Supply Facilities." shall be adopted. Due to the packing gravel and other factors, the well-drilling diameter shall be φ 400 mm.

[6] Refer to Figure 2-2.6 or the design outline diagram A-140 for the location of production wells planned.

3) Design and Material of Casings and Screens

Steel pipes shall be used for casing similar to the existing wells, and a winding V-slot screen (stainless steel with 1.0 mm mesh width) with a high aperture ratio and clog resistant screen shall be adopted.

4) Screen Length

The screen length shall be set to 1/2 to 1/3 for the thickness of the aquifer. An unnecessarily long screen length produces a large perpendicular groundwater flow toward the screen, which might cause a decline in the groundwater level.

- Type A (water-bearing layer thickness: 10-15m): 8m screen length
- Type B (water-bearing layer thickness: 20-25m): 11m screen length

The screen length for Type B should be longer in order to secure the necessary pumping rate because the VES and test drilling survey results confirmed that the third layer (mainly a sand layer mixed with gravel) is thick.

5) Verification of the Groundwater Flow Velocity

The groundwater flow velocity at the well screen shall be 1.5 cm/sec or less. If the aperture ratio of the screen adopted for the project is 20%, the flow velocity becomes as follows:

With a 10m screen length, pumping water at a rate of 1,200 m^3/day

V = Q/A = 1,200/(0.25×3.1416×0.2×10) = 764 m/day = 0.88 cm/sec, hence the flow velocity becomes 1.5 cm/sec.

6) Well Specifications

The table below shows the specifications of the production wells.

Table 2-2.32 Specification of Production Wells

Well No.	Well Depth (m)	Well-digging Diameter (mm)	Casing Diameter (mm)	Screen Length (m)	Type
19 wells other than the wells below	20	400	250	8	A
No.3 & No.7	30	400	250	11	B

Source: JICA Survey Team

(5) Intake Pump

1) Capacity of Intake Pump and Quantity

- Water intake amount planned: 25,200 m^3/day
- Number of wells: 21
- Capacity of intake pump: the capacity of one intake pump is 25,200 m^3/day / 21 pumps = 1,200 m^3/day = 50 m^3/hour = 0.833 m^3/minute

2) Type and Construction of Well Pump

- The type of well pump shall be the submersible water pump.
- Since the relevant area is located in a cold region, machinery and electrical equipment shall be contained in the well pump house in order to achieve easy operation and maintenance.
- Supply voltage shall be 3 phase x 380V x 50 Hz --- distribution line voltage of 3 phase x 10 kV x 50 Hz stepped down by a transformer installed in each pump house.

3) Total Pump Head

The total pump head of the well pump shall be as follows.

Total pump head = Actual pump head + Collection and conveyance pipe head loss

= (Gachuurt Reservoir HWL – each well LLWL) + Collection and conveyance pipe head loss

= HWL 1,419m – (EL+1,342.40m – 5.5m) + 21m = 103.1m (Most upstream well: No.21)

= HWL 1,419m – (EL+1,335.10m – 5.5m) + 9m = 98.4m (Most upstream well: No.2)

The total pump head of intake pumps shall be 110m for all 21 locations to unify the pump specifications.

The specification of pumps shall be φ100 mm x 50 m^3/h x 380V x 50 Hz x 30 kw based on the manufacturer's selection chart.

2-2-2-4 Planning and Design of Gachuurt Reservoir

(1) Location

The location of the Gachuurt Reservoir is proposed to be the hillside owned by Ulaanbaatar City to about 300m east from the edge of the Gachuurt residential area which has a comparatively gentle slope and where it is easy to secure a flat area for facility planning and avoid the lower part of the weathering slope. On the slope near the proposed site, inclination of the slope is changing near the altitude of 1,425m. The proposed height of the Gachuurt Reservoir is set near the altitude of 1,415m where it is below the changing point on the slope. There is soft rock stratum at the depth of 4.5m from the surface of the ground on the upper part of the changing point of the slope inclination. Lowering the position slightly has the advantage of lowering the distribution reservoir construction costs and making construction easier.

(2) Capacity

The two distribution reservoirs and shall contain a planned 12-hours worth of maximum water supply per day in order to attain the following goals:

- To compensate for the fluctuations in the demand of water over time.
- To stably supply water even at times of power failure, well pump stop due to contingencies, and when cleaning the distribution reservoir.
- During wintertime when the temperature drops below –40 degrees Celsius, water flow in the pipes is to be maintained 24 hours a day as a reinforcement measure to prevent freezing in the distribution pipes.

As a result, a capacity of 25,200 m^3/day ÷ 24 hr x 12 hr = 12,600 m^3 is needed. Since a capacity of 6,000 m^3 is already secured in the North East Reservoir, the designed capacity is 12,600 m^3 – 6,000 m^3 = 6,600 m^3 ≈ 6,000 m^3 (3,000 m^3 x 2 reservoirs).

(3) Effective Water Depth

Effective water depth shall be set to 4.0m in consideration of the existing distribution reservoir with a depth of 3m to 6m built by the USUG.

(4) Water Level

Design level of Distribution Reservoir shall be set to 1,415m corresponding with the LWL of the Reservoir. Fifteen centimeters (15 cm) shall be secured between the invert level and LWL considering the sedimentation volume. Water level condition shall be set as follows:

LWL: 1,415.0m (15cm is raised from the invert level of 1,414.85m considering sedimentation volume)
HWL: 1,419.0m (LWL + Effective water depth)

(5) Structure

Flat slab reinforced concrete structure is proposed for the design of the reservoir. The preliminary design features of the Distribution Reservoir are given as follows:

Table 2-2.33 Design Feature of the Gachuurt Reservoir

Item		Design Features
Outer Size	Reservoir Tank	L x W x H = 31.0m x 51.5m x 5.25m
	Valve Room	L x W x H = 8.5m x 9.0m x 8.0m
Inlet Pipe		φ500 mm steel pipe is connected at HWL.
Outlet Pipe		φ700 mm steel pipe is discharged out from the pits.
Drain Pipe		φ500 mm steel pipe is installed in pit and connected to FRPM drain pipe to drain to Tuul River.
Overflow Pipe		φ500 mm steel pipe is installed at HWL.
Inspection Chambers		φ600 mm of manhole x 4 are provided for the entrance to the tanks.
Ventilators		φ350 mm x 8 are provided in the inspection chambers.
Valves		Valve chambers are provided separate from the tank for the distribution reservoir, and flow adjustment valves and water control valves are installed in the following locations: ・Water control valves: inlet pipe and drain pipe ・Flow adjustment valves: outlet pipe
Water level gauge and flow meters		Water level gauges are provided in each tank. Electromagnetic flow meters are provided at both pipes of the inlet and the outlet.
Freezing prevention and waterproof works		Embankment of 1:2 slope covers the side walls. Asphalt roofing and thermal insulation are provided at the top slab.

Source: JICA Survey Team

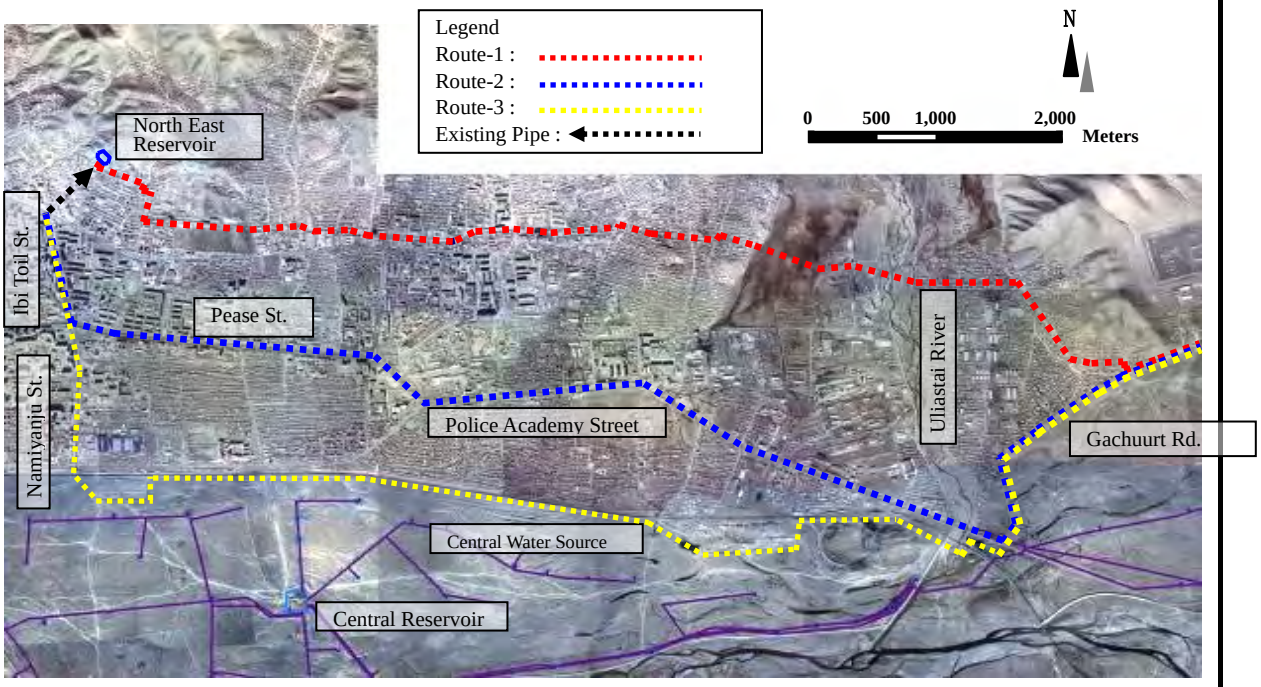
2-2-2-5 Planning and Design of Transmission Main

(1) Route of Transmission Main

The transmission main shall be selected with a route that will minimize the negative impacts to the social environment such as traffic jam, land acquisition and house relocation, etc. The proposed and designed route of the transmission main is, that it will start from the proposed Gachuurt Reservoir and turns behind the Hotel Mongolia through the floodplain confined by the bifurcation of the Tuul River, then runs parallel with the sewage pipe alongside the Gachuurt Road toward the west, and finally crosses the mentioned road toward the north at the pylons. The pipe crosses the swamp area of the Uliastai River after passing through the Ger area and goes up and down through the residential area to the B. Dori Street. After crossing the B.Dori Street, the pipe runs through the residential area and two army bases, and finally reaches the North East Reservoir.

Table 2-2.34 Route Selection of Transmission Main

Route Map



Item	Route-1: North Route		Route-2: Central Route		Route-3: South Route	
Facility	L = 18.8 km FRPMφ700: 18.8 km DCIPφ700: partially applied		L = 20.5 km FRPMφ700: 20.5 km DCIPφ700: partially applied		L = 21.6 km FRPMφ700: 21.0 km DCIPφ700: 0.6 km	
Water Head Characteristics	○	Route passes relatively through high altitude and maximum water pressure is low. The maximum water head pressure is : P = 10.8 kgf/cm^2	△	Route altitude is moderate, and the pressure is medium as well. The maximum water head pressure is : P = 12.1 kgf/cm^2	x	Altitude of the route is low and water head pressure is high. Costly pipe material is necessary. The maximum water head pressure is : P = 13.1 kgf/cm^2
Construction Characteristics	○	There is a relatively small number of obstacles such as underground infrastructure, electric poles, road signs, overhead wires.	x	Underground infrastructure, electric poles, road signs, overhead wires along the Peace Street will be obstacles for this construction.	x	Underground infrastructure, electric poles, road signs, overhead wires along the Namiyanju Street will be obstacles for construction.

Item	Route-1: North Route		Route-2: Central Route		Route-3: South Route	
Social and Environmental Impact	○	There are relatively small volumes of traffic, and less length of traffic control is expected. Necessary construction work in and at the border of housing lot shall include recovery of existing condition of ground and fences.	x	Construction will require traffic control on busy street. Relatively significant traffic jam is expected.	x	Traffic volume on the Namiyanju Street is very large. Traffic control will cause significant impact and permission of such construction will be difficult to conduct.
River/Road Cross Sections	○	・With Rivers: 4 Sites ・With Streets: 4 Sites ・Removal/Recovery of Pavement: 1.4 km ・With Military Facilities: 2 Sites	x	・With Rivers: 4 Sites ・With Streets: Over 10 Sites ・Removal/Recovery of Pavement: 8.5 km ・With Railroads: 4 Sites	△	・With Rivers: 4 Sites ・With Streets: 4 Sites ・Removal/Recovery of Pavement: 2.2 km ・With Railroads: 5 Sites
Relative Cost	○	1.00	x	1.08	x	1.17
Evaluation	○		x		x	

Source: JICA Survey Team

(2) Laying Location of Pipes

The pipes are fundamentally laid at the center of the road. The distance between the sewage pipe alongside the Gachuurt Road and the proposed transmission main is secured at 10m. However, if the distance of 10m is not available, the distance will be allowed to be minimally 5m.

(3) Laying Depth of Pipes

The laying depth of the pipes is more than the freezing depth and calculated using the following formula:

$Z = C \cdot \sqrt{F}$

Z: freezing depth (cm)

F: freezing index [7](℃ days) = 2,410.5

C: constant[8] = 5.81

The freezing depth is set to 285 cm as calculated by the above formula. Overburden of 3.5m from the pipe center is applied (D = 285+70/2 = 320cm => 3.5m) since the pipes of φ700 are applied. (After discussing with USUG, this was confirmed in the Technical Note.)

(4) Pipe Diameter

The water passage method of the transmission main is the natural-flow closed type. The pipe diameter is determined so that the value obtained by subtracting the total head loss indicated in the equation below from the L.W.L. of the Gachuurt Reservoir is equal to or higher than the H.W.L. of the North East Reservoir.

Total head loss = Friction head loss + Shape head loss

---

[7] The freezing index is the cumulative total value of the average temperature per day in the freezing periods between September and April where the temperature goes below 0 degrees Celsius.

[8] Value C is a constant which is the value determined based on the soil thermal constant, water content, dry density, the surface temperature before and after freezing periods, and the freezing index.

a) Friction Head Loss

Friction head loss is calculated using the Hazen-Williams formula.

$$V = 0.849C \times R^{0.63} \times I^{0.54}$$

V : average flow velocity (m/s)
C : flow velocity coefficient
(Ductile-cast-iron pipe (DCIP): 130, fiber reinforced plastic mortar pipes (FRPM): 150. C = 110 is applied considering the bending head loss generating all the way of the transmission main route.)
R : hydraulic radius
I : hydraulic gradient

Based on the above formula, the following formulas are obtained for the case of circular pipe.

$$V = 0.355C \times D^{0.63} \times I^{0.54}$$
$$Q = 0.279C \times D^{2.63} \times I^{0.54}$$
$$D = 1.626C^{-0.38} \times Q^{0.38} \times I^{-0.21}$$
$$I = hf / L = 10.67C^{-1.85} \times D^{-4.87} \times Q^{1.85}$$
$$hf = 10.67C^{-1.85} \times D^{-4.87} \times Q^{1.85} \times L$$

D : diameter (m) φ600 mm, φ700 mm
hf : friction head loss (m)
Q : discharge (m^3/s) = 25,200 m^3/day ÷ (24 x 60 x 60) sec = 0.292 m^3/sec
L : pipe length (m) = 18,813m

b) Shape Head Loss

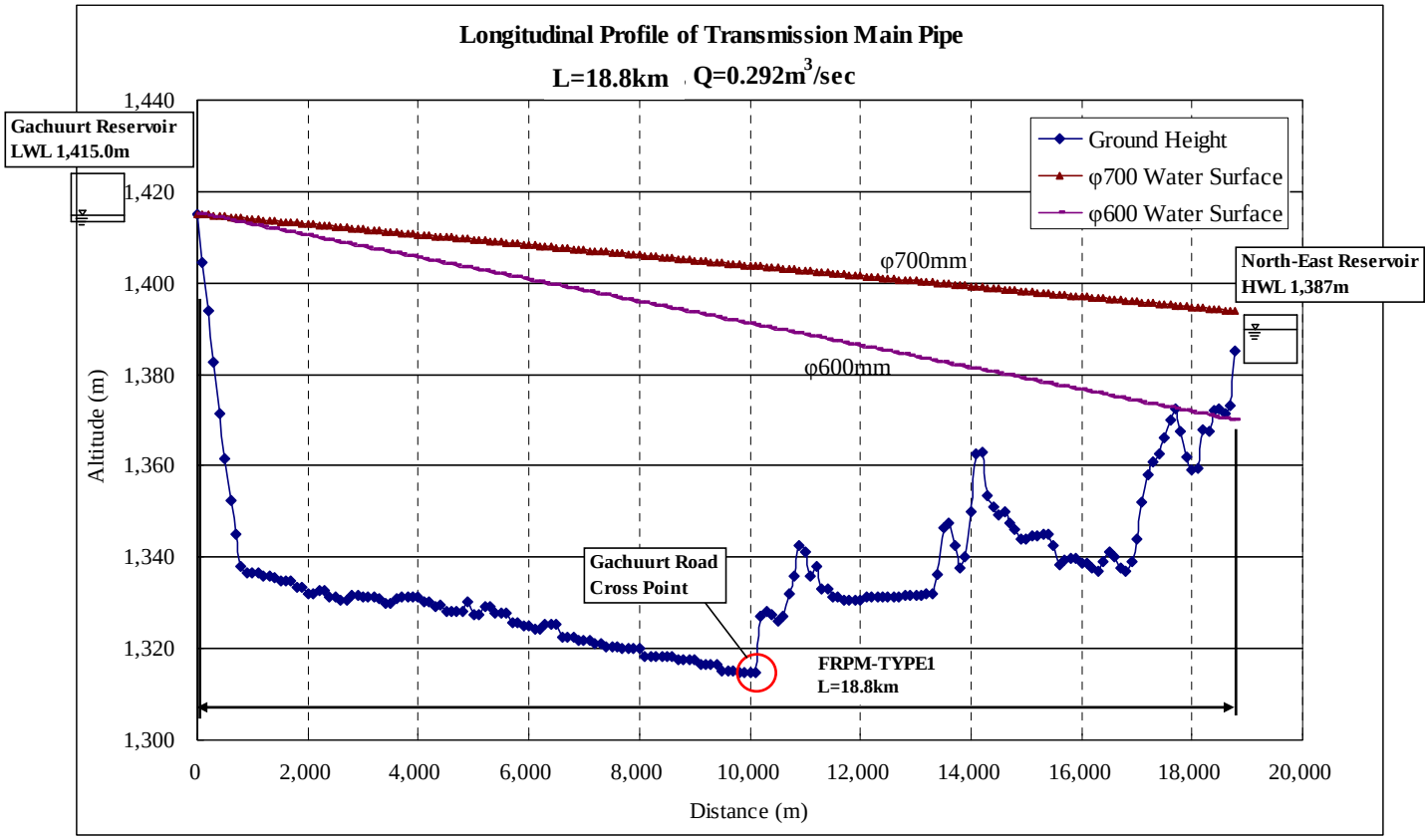
The shape head loss includes the inflow loss and outflow loss at the upstream/downstream distribution reservoirs, the refraction loss according to the pipeline form, and valve loss. These losses are collectively handled through reducing the coefficient of flow velocity to C = 110.

The calculation results of head loss and terminal water level are shown in the following table, for both cases of pipe diameter (φ600 mm and φ700 mm). The results from hydrologic accounting are shown in the following table.

Table 2-2.35 Calculation Result Chart

Case	Altitude of Origin	Total Head Loss in Section h (m)	Terminal Water Level WL (m)	Goal Water Level	Result
	Gachuurt Reservoir LWL (m)			North East Reservoir HWL (m)	
Case I (φ600)	1,415.0	41.22	1,369.66	< 1,387.0	NG
Case II (φ700)	1,415.0	19.41	1,393.65	> 1,387.0	OK

Source: JICA Survey Team



Source: JICA Survey Team

Figure 2-2.7 Hydraulic profile

c) Water Hammer Pressure

When the momentum of the water in the pipes changes due to the opening and closing of water-control values installed in the pipeline, a pressure wave forms and is transmitted at a speed unique to the pipe. In-pipe water pressure increases when the water control valves are closed due to the effect of water hammer pressure from the pressure wave, and decreases when the water control valves are closed. On the other hand, based on the Allievi formula, it was calculated that if the water control valves are closed for more than 2 minutes, the water hammer pressure can be sufficiently reduced. Therefore, only the hydrostatic pressure is considered in the design water pressure, and the water hammer pressure is disregarded.

Since the water head loss becomes larger and the terminal point of water level is under the target water level of North East Reservoir in case of φ600, water conveyance to the North East Reservoir is impossible. On the other hand, in the case of φ700 at the terminal point, the water level is above the target water level and the water conveyance to the North East Reservoir is possible. Therefore, the pipe diameter from the Gachuurt Reservoir to the North East Reservoir shall be all the way φ700 mm.

Table 2-2.36 Comparison Between Pipes with Different Diameters

Pipe Diameter	φ600 mm	φ700 mm
Water Head Loss	・All section water head loss = 41.22m	・All section water head loss = 19.41m
Facility	・Fiber reinforced plastic mortar pipes φ600: 18.8 km ・Production well pump: 55 kw x 21 sites	・Fiber reinforced plastic mortar pipes φ700: 18.8 km ・Production well pump: 30 kw x 21 sites
Economic Efficiency	・Installation height of the distribution reservoir becomes higher, so that a high-lift pump is required and pump cost is increased. ・Advanced pump specifications increase running costs such as electricity fees. ・Compared with the φ700 mm, the distribution reservoir should be installed at a higher place, making the water and collection pipes placed on the slope longer.	・The cost of the pump at the production well is inexpensive compared to adopting φ600 mm. ・The running costs for electricity fees are inexpensive compared to φ600 mm.
	・Installation cost (pipe material cost only) : ***0.82*** ・Running cost : ***1.83*** ＜Electrical charges per month＞ 55 kw x 24 hr x 21 sites x 0.75 x 365 days x 74.8 Tg/kwh = 567.6 million Tg ≒ 37.5 million yen/year	・Installation cost (pipe material cost only) : ***1.0*** ・Running cost : ***1.0*** ＜Electrical charges per month＞ 30 kw x 24 hr x 21 sites x 0.75 x 365 days x 74.8 Tg/kwh = 309.6 million Tg ≒ 20.4 million yen/year
Construction Condition	・Construction needs to be done on a steep slope. This increases difficulty and requires appropriate safety measures. ・According to the results of the boring survey conducted on the upper part of the slope, this option requires not only rock excavation but also more construction processes overall.	・Reservoir construction is conducted on a gently sloping area where flat locations can be easily secured. ・The planned height of the distribution reservoir can be decreased so that the reservoir can be installed on gravel ground. The boring survey results confirmed that no rock excavation is necessary, which can reduce total construction cost.
Operation & Maintenance	・Running costs such as electricity fees become more expensive.	・Running costs such as electricity fees become more inexpensive.
Evaluation	・Water head loss becomes significant, and the distribution reservoir should be planned to be installed at a high location. This is inferior to adopting φ700 mm in terms of economic efficiency, construction efficiency, and operation and maintenance.	・This option has advantages compared to φ600 mm in terms of economic efficiency, construction efficiency, and operation and maintenance.
Judgment	x	○

Note: Economic efficiency is where the construction cost of φ700 mm is 1.0.

Source: JICA Survey Team

(5) Pipe Materials

The design water pressure of the transmission main is 0.73-10.8 kgf/cm^2 and therefore the applicable pipe materials are the Ductile-Cast-Iron Pipe (DCIP), the Fiber Reinforced Plastic Mortar (FRPM), and the Steel Pipe (SP). In this case, upon a comparative review of pipe types as shown in the table below, the Fiber Reinforced Plastic Mortar (FRPM) is adopted.

Table 2-2.37 Comparison between Pipe Materials

Pipe Materials		Ductile-Cast-Iron Pipe (DCIP)	Fiber Reinforced Plastic Mortar Pipe (FRPM)	Water Supply Coated Steel Pipe (SPA)
Pipe Diameter D (mm)		700		
Pipe Type		JIS D4-T, K	JIS 1-C type	JIS STW400A
Water Pressure (kgf/cm^2)	Allowable Water Pressure	32.0	13.5	30.0
	Design Water Pressure	0.73～10.8		
	Evaluation	○	○	○
Economic Efficiency		1.70	1.00	1.69
		△	○	△
Construction Efficiency		○	◎	△
Evaluation (score)		5	7	4
Adoption			◎	

Note: Evaluations (scores): ◎ 3 points, ○ 2 points, △ 1 point, x 0 points.
Economic efficiency is achieved when the construction cost of FRPM is 1.0.
The above planned allowable water pressure uses a straight pipe value.

Source: JICA Survey Team

(6) Foundation Work of Pipes

The soil texture of the section where the pipes will be installed is almost entirely gravel soil. However, some large pebbles may be mixed in the soil, which might cut or damage the pipes. Therefore, the foundation bed shall be tamped with sand or fine soil in advance.

a) Thickness of the Foundation Bed

The standard thickness of the foundation bed shall correspond to the pipe diameter. For the φ700 mm diameter, therefore, the foundation bed shall be 20 cm or thicker. However, the ground at the site contains somewhat large pebbles, so that the foundation bed thickness is set to 30 cm for the protection of the pipes. In addition, a 30-cm thickness shall be secured as the thickness for protecting the top surface of the pipe.

b) Backfilling Materials

Sand or fine soil should be used for the foundation for pipes and backfilling materials. Since the soil of the relevant area is inappropriate for backfilling in this project, another fine earth material (purchased soil) should be used for backfilling.

c) Excavation Width upon Installing Pipes

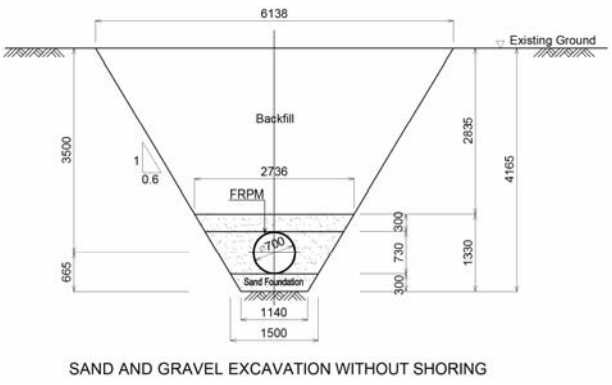
Figure 2-2.8 shows the standard cross-section diagrams for the open-cut method and the sheet pile open-cut method.

【Open-Cut Method】

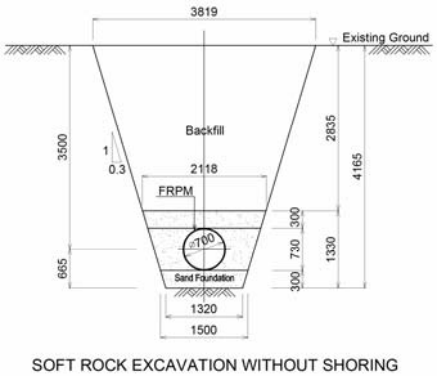
If the excavation width for the open-cut method can be secured for the current road width, the open-cut method shall be adopted. The excavation slope for gravel shall be 1:0.6, and 1:0.3 for

soft rock.

Gravel

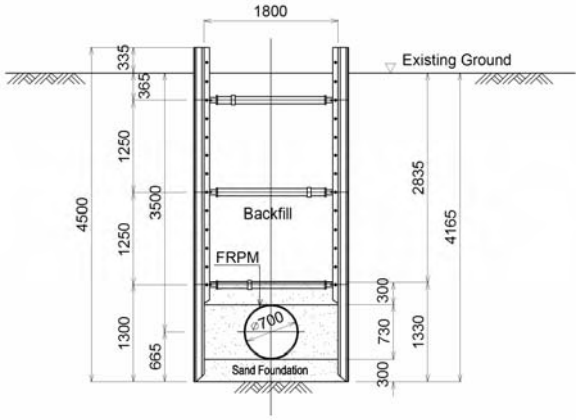


Soft Rock



【Earth-Retaining Open-Cut Method】

If the excavation width for the open-cut method cannot be secured due to private houses or existing building structure, a simple earth-retaining construction shall be conducted for which the excavation width shall be 1.8m.



Source: JICA Survey Team

Figure 2-2.8 Standard Cross-Section Diagrams of the Pipe Installation

d) Appurtenant Facilities

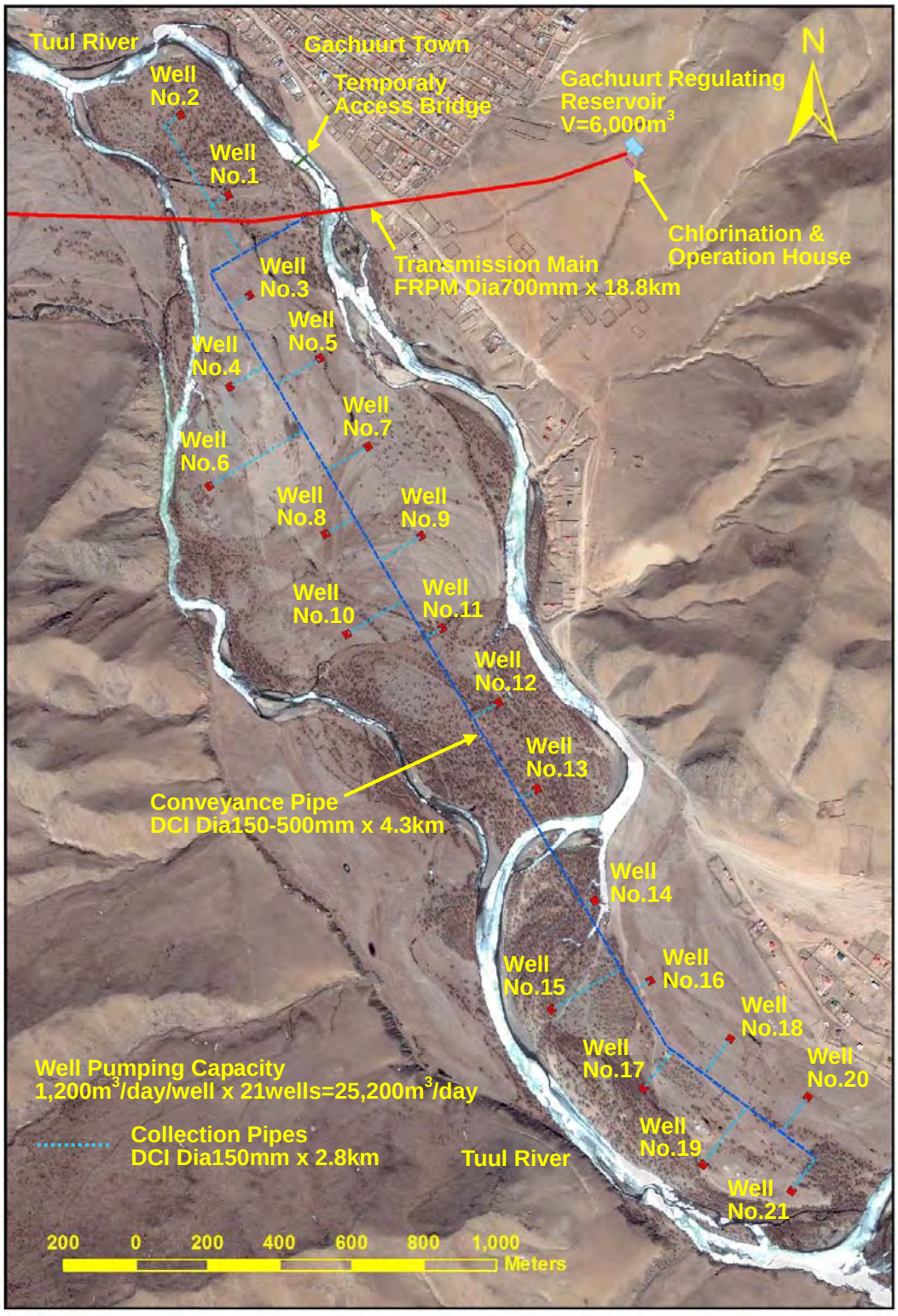
Considering the operation and maintenance of the water supply pipes, water control valves shall be installed at every 2 km along the transmission main. In order to discharge the air from the pipe, air valves shall be installed at salient portions of the ground. In the refracted part, thrust blocks shall be installed to resist the force deriving from the water pressure. On concave portions of the ground near the water discharging destination of a river or a drainage canal, a drainage facility shall be installed. At bending portions where the pushing force due to the water pressure is greater than the pipe's resistance force, thrust blocks shall be installed.

2-2-2-6 Collection and Conveyance Pipes Plan

(1) Route of Collection and Conveyance Pipes

Derived pipes shall led to one line of conveyance pipe through 21 well pumping stations via

collection pipes in order to supply the water pumped up to the Gachuurt Reservoir. The conveyance method of conveyance and collection pipes shall be the closed type by pumping pressure.



Source: JICA Survey Team

Figure 2-2.9 The Alignment of Collection and Conveyance Pipes

(2) Laying Depth of Pipes

As well as the transmission main, the installation depth of the collection and conveyance pipes are necessary to be deeper than the freezing depth, so that a depth of 3.5m should be secured to cover the pipes. At the water source, however, a 2.0m earth fill shall be established in order to ensure that the maintenance road reaches to the well pumping stations where floods occur. With regard to the part traversing the river, an inverted siphon shall be used and concrete placements shall be cast in 360 degrees to secure a 2.0m depth for earth covering from the river bottom for scouring.

(3) Pipe Materials

When selecting the pipe material, the water hammer pressure that occurs in association with the rapid fluctuation in flow derived from pump operation shall be considered. The estimation of water hammer pressure shall be based on heuristic assumption, and should be 60% of the value of dynamic water pressure. The design water pressure is as follows:

Design water pressure = Dynamic water pressure + Water hammer pressure

The dynamic water pressure is calculated by subtracting the head loss at time of water passage from the pump head 110m at pump point. The calculation results of the design water pressure for all 21 wells are shown in Table 2-2.38.

The design water pressure on the collection and conveyance pipes exceeds 13.5 kgf/cm^2, the tolerable water pressure specified by FRPM JIS Type 1. Therefore, high-strength ductile-cast-iron pipes (JIS D3 or ISO K-9) shall be adopted.

Table 2-2.38 Dynamic Water Pressure and Water Hammer Pressure on Collection and Conveyance Pipes

Dynamic Water Pressure (kgf/cm^2)	Water Hammer Pressure (kgf/cm^2)	Design Water Pressure (kgf/cm^2)	Pipe Type	Allowable Water Pressure (kgf/cm^2)	Evaluation
9.706 ～10.593	5.824 ～6.356	15.530 ～16.948	Ductile-Cast-Iron Pipe (DCIP) JIS 1-C	38.5	○
			Fiber Reinforced Plastic Mortar Pipe (FRPM) JIS D3-T	13.5	×

Source: JICA Survey Team

(4) Pipe Diameter

The diameter for collection and conveyance pipes should be set to a diameter that can flow water into the newly developed Gachuurt Reservoir at an ideal flow velocity for certain water amounts. The following conditions shall be met:

LLWL of each well + Pump head + Head loss of collection and conveyance pipes
Distribution reservoir HWL 1,419m

Each well LLWL: (Lowest Low Water Level)

Ground height of the planned well location GL–5.5m

HWL: High Water Level

Water pumping height = 110m

(Water pump: φ100 mm x 50 m^3/h x 380V x 50 Hz x 30 kw is assumed)

Friction head loss: The friction head loss of the straight pipe, h_l, can be obtained by the following formula:

$$h_l = f \times 1/D \times V^2/2g$$

$$f = 134/C^{1.85} \times 1/(D^{1/6} \times V^{0.15})$$

h_l: The friction head loss (m) per 1m of straight pipe

f: Friction head loss coefficient

D: Pipe diameter (m)

V: Average flow velocity (m/s)

g: Acceleration of gravity (m/s^2)

C: Flow velocity coefficient

(Generally, ductile-cast-iron pipe (DCIP): 130, but C = 120 is adopted assuming that loss is accompanied by internal deterioration)

Around-the-pump head loss: The around-the-pump water head assumes a 20% of the friction loss water head.

Table 2-2.39 Breakdown of Collection and Conveyance Pipes

Type	Pipe Diameter (mm)	Extension (m)
Conveyance Pipe	500	1,520
	450	760
	400	640
	350	550
	300	270
	250	260
	200	120
	150	120
Sub-Total		4,240
Collection Pipe	200	160
	150	2,660
Sub-Total		2,820
Total		7,060

Source: JICA Survey Team

(5) Pipe Foundation Construction

Foundation bed with a 30-cm thickness filled with sand or fine earth materials shall be installed in the space above and below the pipe. Backfilling shall be placed in other spaces with soil material collected on-site.

(6) Additional Structure

In consideration of maintenance and management, water control valves and air valves shall be installed before the part traversing the river. Thrust blocks shall be installed in the pipe cross-section variation part and refracted part to resist the water pressure. In the part traversing the river, earth covering with a depth of 2.0m from the river bottom shall be secured for casting a concrete placement of 360 degrees, and to protect against scouring and maintain temperature.

2-2-2-7 Chlorination and Operation House Design

(1) Purpose of Chlorination and the Construction of Operation House

The purpose of chlorination and the construction of operation house is to install the following chlorination facility and telemetry system facility:

- Chlorination Facility: To disinfect the raw groundwater from the well for water intake.
- Telemetry System Facility: To switch the ON/OFF button of the pump of the production well by remote control.

The building structure shall be of reinforced concrete, partially 2 floors, and shall consist of storage room, chlorination room, operation room, electrical room, and lavatory. A 10 kV/380-220V electric transformer of 3-phase and 4-wire system shall be installed in the electrical room, in order to supply the required power for the operation of the facility. Additionally, clean water shall be supplied from a reservoir, and the wastewater/excreta shall be stored in a septic tank and be treated by a sludge withdrawal vehicle. Furthermore, electric heating system shall be installed in each facility to maintain their functions.

(2) Location of Installation

Installation shall be within the premises and nearby the Gachuurt Reservoir.

(3) Details of Design

a) Method of Chlorination

The water quality of the raw groundwater in this project shall not require flocculation, sedimentation, or filtration, but shall require chlorination by using calcium hypochlorite [$Ca(ClO_2)$] bleaching powder, because common bacteria and coliform bacteria exceeding the water quality standards of Mongolia were detected in this survey.

When using chlorination disinfectant other than calcium hypochlorite, liquid chlorine (Cl_2) or sodium hypochlorite (NaClO) are the alternatives, as well as homemade sodium hypochlorite by an electrolyzed sodium chloride (NaCl). Considering the past performance of USUG, cost, safety, preservative quality, handling ability, and method of procurement of disinfectant, it is recommended to use calcium hypochlorite for the chlorination in this project.

With regard to liquid chlorine, it is used for the disinfection method of the Central Water Source. The quality is stable and the effective chlorine concentration is almost 100%, thus

minimizing storage space compared to the other chlorine agents, and also relatively low in facility cost. On the other hand, its high toxicity requires utmost care upon handling. In addition, uncertain information says that the liquid chlorine imported from China, which is the main supplier of the liquid chlorine, should be banned after July 2010 because of safety problems.

Calcium hypochlorite is used for disinfection at the Upper Water Sources. So far, the disinfection facility is operated well with periodical maintenance. Previously, liquid chlorine was used, since 1989, with support from the Soviet Union. However, upon reconstruction of the aging facility by USIP, the disinfection method was changed to calcium hypochlorite, which is still used at present. The calcium hypochlorite used by USUG is in powder from containing more than 66% of effective chlorine concentration. The annual usage of 5 tons is purchased once every year from China, and is stored inside the facility. Hypochlorous acid is generated by the reaction of calcium hypochlorite and water, and also generates a particular chlorine smell when gasified, but no harm to human health has been reported from the medical perspective. A facility to dissolve the powder with water shall be necessary upon automation of the disinfection where in this case the facility cost will increase compared to the use of liquid chlorine. However, it is the most ideal chlorination agent in terms of safety, handling ability, and preservative quality.

Chlorination by sodium hypochlorite is safer and easier compared to liquid chlorine, but the sodium hypochlorite is mostly unstable chemically and is difficult to preserve. Besides, it has not been used by USUG, so that a new supplier shall be necessary. In addition, although the procurement of sodium chloride is easy in Mongolia, the facility cost for homemade sodium hypochlorite by electrolyzation is the most expensive. Considering the above, the disinfection method using sodium hypochlorite is excluded from the options in this project.

b) Chlorine Dosage

Maximum capacity of the facility: 2 mg/ℓ (1 mg/ℓ x 2 units)

The number of chlorine dosing shall be 2 units, including the spare. According to the disinfection regulation of USUG, the amount of chlorine dosage is 0.2 to 0.3 mg/ℓ for both the Upper and Central Water Sources. The capacity of the facility shall have some allowance for additional chlorine dosage in case of epidemic diseases or at the start of water supply after water suspension.

c) Chlorine Dosage and Amount of Storage

Chlorine dosage per day:

Daily maximum water supply amount 25,200 m^3/day x Rate of loading 84.32% x 0.3 mg/ℓ = 6.37 kg/day

Volume of water required for the dissolution of the effective 5% chlorine concentration (standard aqueous solution) is:

6.37 kg/day / 5% = 127.40 kg/day = 127.4 ℓ/day = 0.13 m^3/day

Volume of calcium hypochlorite required for 66% of effective chlorine (specification for USUG) is:

6.37 kg/day / 66% = 9.65 kg/day

The storage amount of calcium hypochlorite shall consider: i) the works involved in the import procedure from China; and, ii) the storage area which should be designed to store an amount for one month (31 days) as follows:

Maximum storage capacity to store one month calcium hypochlorite:

9.65 kg/day x 31 days = 299.15 ≈ 300 kg/month (Equivalent to six 50 kg drums)

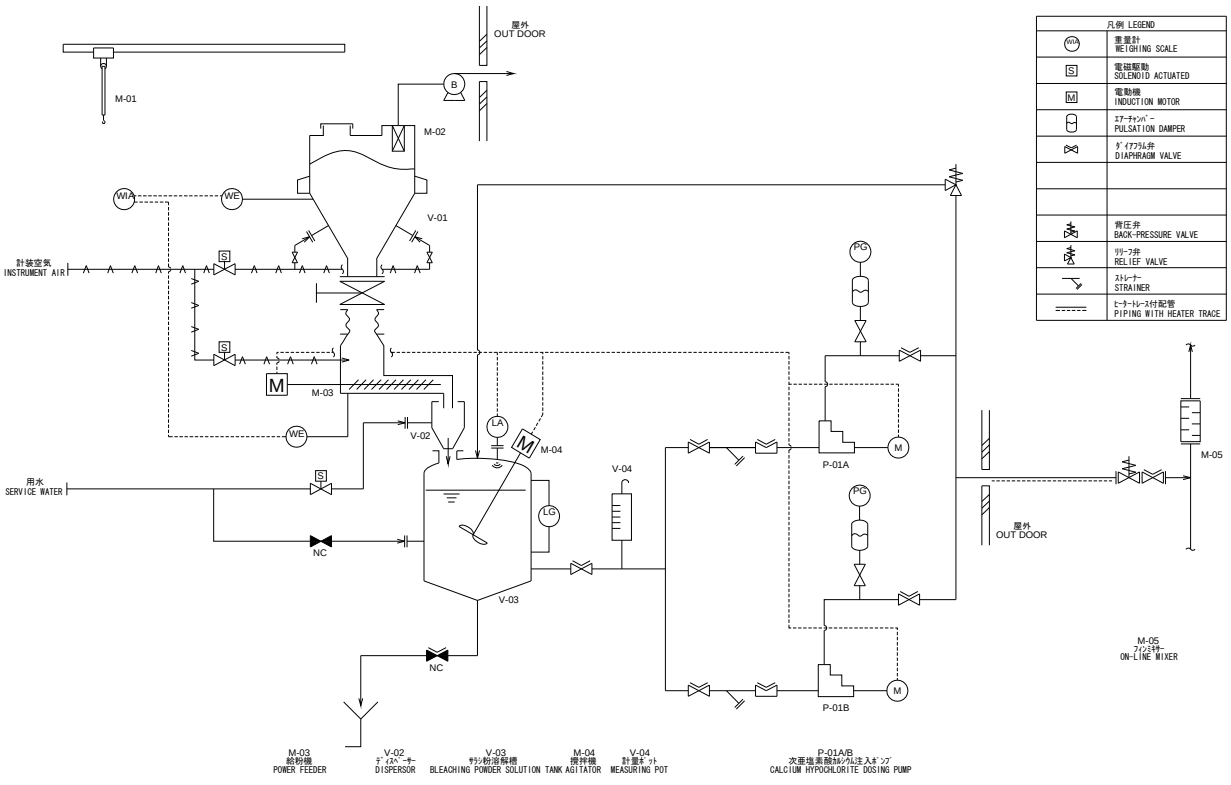
d) Method of Chlorine Dosing

The raw groundwater supplied from the well pump shall be chlorinated at the reservoir. The dosing ratio of calcium hypochlorite to the reservoir shall be proportional to the control method, regardless of the variation in raw water intake volume of the reservoir. The raw water intake volume of the reservoir shall be measured by an electromagnetic flow meter, and the electromagnetic signals obtained shall be transmitted to the chlorine dosing facility.

The dosing procedure of calcium hypochlorite to the reservoir is as below. Additionally, dosing of the solution of calcium hypochlorite shall be operated automatically,

1) Supply water to the solution tank from the reservoir →2) Supply calcium hypochlorite into the hopper →3) Supply the calcium hypochlorite into the solution tank by a powder feeder →4) Mix and stir →5) Measure volume of the solution →6) Obtain signal of raw water intake volume of the reservoir →7) Feed the solution to the reservoir with a dosing pump

The chlorination device used in this project shall consist of water pipe, hopper, weighing scale, powder feeder, solution tank, agitator, measuring pot, dosing pump, solution dosing pipe, control panel, etc., as shown in the below figure.



Source: JICA Survey Team

Figure 2-2.10 Method of Chlorine Feed

2-2-2-8 Telemetry System

Many lightning storms occur in Ulaanbaatar in July. There have been many cases in the wired telemetry system of well where the control devices were damaged due to the induction of surge current caused by lightning, etc. In the previous “The Project for Improvement of Water Supply Facilities at Upper Water Source Area in Ulaanbaatar” which was implemented for the water source development in the Upper Water Source, a wireless telemetry system was however employed, which resulted in the eliminating of lightning damages. Likewise, this Project shall employ the wireless telemetry system.

Installation details of the wireless system are as given below:

① Install an antenna, wireless modem, radio device, and 2 personal computers to create a base radio station in the chlorination and operation house, and display the operation screen on the computer screen. The operator shall remote-control the ON/OFF function of the well pump manually.

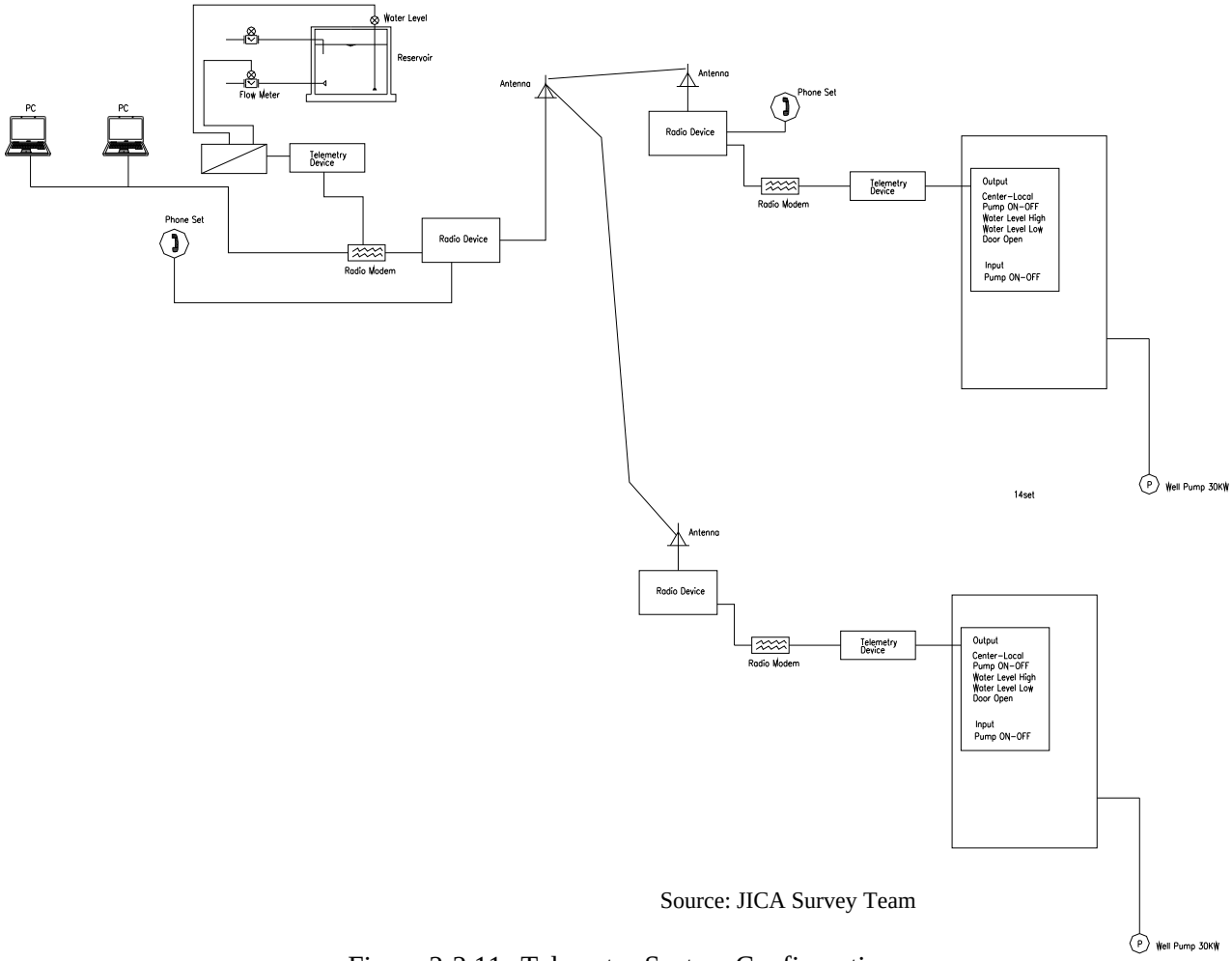
② Install an antenna, wireless modem, radio device, and PLC (Progressive Logic Controller) in each well pump to receive the signal from the operation house and function as a mobile station in order to install signal transmission systems and operation control systems.

③ Prepare 2 radio frequencies for receiving and sending signals, and ensure a two-way communication function. Additionally, prepare a band frequency for voice call for each

frequency, in order to enable verbal communication.

④ Employ the polling method (a system for time-sharing communication between the base radio station and cyclic mobile stations) for the base radio station and mobile stations, in order to enable communication between 1 unit of radio device at the base radio station and one or more mobile stations.

⑤ The frequency band currently owned by USUG can be used for the frequency.



Source: JICA Survey Team

Figure 2-2.11 Telemetry System Configuration

2-2-3 Outline Design Drawing

(1) List of Drawings

Table 2-2.40 gives the list of drawings

(2) Drawings of Basic Design

Drawings of the basic design are attached in Appendix 6 to this document.

Table 2-2.40 List of the Drawings

Drawing Number	Title of Drawing	Scale Size (A3)	Number of Sheets
1	Plan of Transmission Main	1/25,000	1
2	Profile of Transmission Main	H=1/25,000,V=1/500	1
3	Cross-Section of Transmission Main	1/250	1
4	Typical Cross-Section of Transmission Main (1/2)	1/50	1
5	Typical Cross-Section of Transmission Main (2/2)	1/50	1
6	Butterfly Valve Chamber for φ700	1/20	1
7	Air Valve Chamber for φ700	1/20	1
8	Reinforcement Drawing of Valve Chamber	1/10	1
9	Discharge Valve Chamber for φ700	1/20	1
10	Thrust Blocks for Transmission Main	1/40	1
11	Gachuurt Distribution Reservoir Plan	1/250	1
12	Gachuurt Distribution Reservoir Sections	1/200	1
13	Layout of Distribution Reservoir	1/400	1
14	Transmission Main Pipe Connection to North East Reservoir	1/500	1
15	General Layout of Wells	As shown	1
16	Typical Cross-Section for Conveyance Pipe and Collection Pipes	1/60	1
17	Thrust Blocks for Conveyance Pipe and Collection Pipes	1/50	1
18	Gate Valve Chamber for φ350	1/40	1
19	Gate Valve Chamber for φ500	1/40	1
20	Air Valve Chamber for φ350	1/40	1
21	Air Valve Chamber for φ500	1/40	1
22	Siphon No.1 for Conveyance Pipe	1/120	1
23	Siphon No.2 for Conveyance Pipe	1/120	1
24	Well Pumping Station Layout	1/200	1
25	Well Pumping Station Plans	1/100	1
26	Well Pumping Station Elevations	1/150	1
27	Well Pumping Station Sections of Pump House	1/100	1
28	Well Pumping Station Detail and Fitting List	1/100, 1/40	1
29	Chlorination and Operation House	1/150	1
30	Standard Design of Wells	1/60	1
31	Single Line Diagram	-	1

Source: JICA Survey Team

2-2-4 Implementation Plan

2-2-4-1 Implementation Plan Policy

(1) Basic Points upon Implementation of the Project

The basic points upon implementation of the Project are as given below.

i) The Project shall be implemented according to the Japan's Grant Aid scheme after the signing of the Exchange of Notes on the Project by the Government of Japan and the Government of Mongolia.

ii) The executing agency of the Project is the Water Supply & Sewerage Authority of Ulaanbaatar City (USUG), which is under the supervision of Ulaanbaatar City.

iii) The detailed design, consulting services concerning the bidding-related works and supervision of construction, shall be implemented based on a contract for consultancy services executed between a Japanese consulting firm and the Government of Mongolia.

iv) The construction of the Project shall be implemented based on a construction contract executed between the Government of Mongolia and a Japanese construction company, which shall be selected through prequalification and open competitive bidding.

(2) Implementation Project

i) The natural conditions such as local weather, land features, geology, etc., shall be considered for the method and process of construction. Especially for the works to install the large-diameter water pipes at the Ger areas where housing is dense, traffic safety, or prevention of accidents to third parties shall be considered for the planning.

ii) The water supply area is adjacent to the reserved area in both north and south, so that a detailed discussion with the environmental office is required for the environment-friendly construction method.

iii) An appropriate construction specification and construction management standard, as well as a site management organization that satisfies this standard shall be established, and a construction management organization of the consultant shall be planned.

iv) Construction equipment and labor shall be procured locally as much as possible. However, fiber reinforced plastic mortar pipes, ductile-cast-iron pipes, submerged motor pumps, or any other pipes, etc., which cannot be procured locally shall be procured from Japan.

2-2-4-2 Implementation Conditions

Upon establishment of the implementation plan, the specificity of this project must be acknowledged, and appropriate measures with the site characteristic for each detail in mind shall be reviewed, in order to establish a plan feasible for implementation of the entire plan. When establishing the implementation plan, the items below must be considered:

i) In the winter season from November to March, the average temperature goes below 0°C, and in addition, the minimum temperature may go below –10°C. For this reason, working outdoors is impossible, and the process must be planned to avoid winter.

ii) The water intake area is by the riverbed, which is full of boulders. With this condition in mind, the well drilling machinery or the construction method must be carefully selected.

iii) Traffic safety, or prevention of accidents to third parties, must be monitored during the water pipe installation work in the Ger areas where housing is dense.

iv) The period feasible for construction works of pumping station, chlorination and operation house, valve room, thrust block, etc., that use concrete, as well as asphalt-paving, shall be from mid-May to mid-September, considering the past annual temperature records. The

process plan must be established positively targeting execution and completion during this period.

v) The equipment and supplies procured in Japan shall be transported from China to the Ulaanbaatar Station via the Trans-Mongolian Railway. Since the rail gauges of China and Mongolia differ, the transfer of cargo is necessary at the Zamyn-Uud Station which is located at the border. This transfer work takes a long time, and massive cargo congestion caused huge delays in the past. This project also requires massive cargo such as fiber reinforced plastic mortar pipes and ductile-cast-iron pipes, and needs establishment of appropriate transport/packaging plan considering the transport conditions.

vi) Pipelining, installation/trial run of well pump, installation/trial run of chlorination system, and construction for access to electricity, etc., shall be conducted under sufficient supervision of engineers from Japan, due to lack of experienced local engineers.

2-2-4-3 Obligations for Construction and Procurement

The obligations of the Government of Japan and the Government of Mongolia are as given in Table 2-2.41.

Table 2-2.41 Obligations of the Governments of Japan and Mongolia

Item	Contents	Responsibility		Remarks
		Japan	Mongolia	
Procurement of Equipment	Procurement/carry-in	○		
	Customs clearance of equipment		○	
Preparatory Work	Land acquisition for construction		○	Including base camp, temporary yard
	Preparatory work other than above	○		
Main Construction	Pipelining work of transmission main	○		
	Pipelining work of conveyance pipe	○		
	Pipelining work of collection pipes	○		
	Reservoir construction		○	
	Reservoir ancillary facility construction	○		
	Chlorination and operation house construction	○		
	Well pump construction	○		
	Distribution power line installation		○	
	Well pump fence installation		○	
	Management bridge consturction		○	To be completed before facility is in operation
Compensation	Temporary removal and restoration of fence		○	On transmission main pipe route
Inspection	Gachuurt Reservoir and North East Reservoir		○	Water running inspection

Source: JICA Survey Team

2-2-4-4 Construction Supervision / Procurement Supervision

A Japanese consultant shall execute the design works, bidding related works and construction supervision, based on the consultancy contract with the Government of Mongolia.

(1) Detail Design Works

The main contents of the detail design work by the consultant shall be as follows:

i) Discussion with USUG, which is the executing agency, and field survey.
ii) Survey of natural conditions (survey of soil properties, boring survey, electric survey)
iii) Preparation of detail designs and drawings
iv) Quantity survey of project cost

(2) Bidding-Related Works

The main works to be conducted during the period from notice of prequalification of bidders to construction contract are as listed below:

i) Preparation of bidding documents, approval by client, review by JICA (prepared in concurrence with the above execution design)
ii) Notice of prequalification of bidders
iii) Prequalification of bidders
iv) Distribution of bidding documents
v) Question and answer
vi) Bidding and bid opening
vii) Bid evaluation
viii) Construction contract negotiation

(3) Construction Supervision

The consultant shall supervise the construction by the construction company, based on the construction contract and the implementation plan. The main items are as follows:

i) Check/approve the implementation plan
ii) Check/approve the works related to topographic survey
iii) Well acceptance judgment
iv) Quality control
v) Progress control
vi) As-Built control
vii) Safety control
viii) Report on environmental monitoring
ix) Preparation and reporting of monthly report
x) Discussion/coordination with concerned organizations
xi) Guidance on facility and equipment management
xii) Final inspection and handover

As for the construction management, other than the Japanese resident engineers, specialists of each field such as engineers for wells, or engineers for pipelining, etc., shall be temporarily assigned. The engineers for wells shall select the ideal spot for drilling wells, as well as the evaluation of wells, etc. The engineers for pipelining shall make efforts to ensure the required pipelining for the pipeline construction, and progress with care to avoid troubles during construction at Ger areas. The site work covers a broad range; therefore, a local civil engineer shall be employed to support the resident manager. The engineers assigned for the construction shall be allocated as follows:

Table 2-2.42 Construction / Procurement Management System of the Consultant

Personnel		Job Description
Japanese Engineer	Construction Management Engineer	Organize a kick-off meeting with the government organizations of Mongolia prior to the construction; Hold meetings, discussions and confirmation of construction schedule by holding tripartite meetings (construction owner, consultant, constructor); Execute progress control of procurement of goods, and support contractors for efficient progress of construction; Carry out defects inspection.
	Inspection Engineer	Execute plant inspection of equipment; trial run of installed facilities and verification of achievement; Joint inspection at completion of construction; Prepare/submit completion report to construction owner and issue completion certificate; Hold meetings on operation and maintenance.
	Resident Engineer	Execute quality control, schedule control, management of output; Carry out thorough training on safety control to parties involved in the construction; Prepare/submit monthly progress reports to construction owner, JICA and the Japanese Embassy; Obtain approval from the construction owner, JICA and the embassy in case of design change; Report environmental monitoring results; Prepare operation regulations.
	Pipelining Engineer	Hold discussions/meeting at the start of pipelining, and carry out construction management work, quality control, progress control, and management of output of pipelining work.
	Engineer for Wells	Carry out the selection of appropriate well drilling point, and judgment of qualified wells; Provide instruction and management of well pump installation; Perform final check of trial run.
Local Employee	Civil Engineer	Reside at the project site together with the resident construction manager from the start of construction, and provide support in quality control, progress control, and management of output.
	Mechanic/ Electrician	Provide support on the installation of pumps, valves, control boards, chlorination facilities, etc., procurement of mechanical/electrical equipment, and instructions for the trial run, together with the resident construction manager.
	Architect	Provide quality control of operation house, well pump construction, and support output control with the resident construction manager, as well as finishing (interior and exterior), joint inspection of completion inspection with construction manager, and completion report of construction to the construction owner, together with the resident construction manager.
	General Worker	Reside at the project site from the start to the end of construction, and carry out general work in the management office of the consultant.

Source: JICA Survey Team

2-2-4-5 Quality Control Plan

The following table shows the quality control plan.

Table 2-2.43 Items for Quality Control

Item	Items for Inspection	Contents
Construction Materials	Submersible motor pump, control board, air insulation switch, transformer	Factory inspection, inspection sheet of manufacturer, visual inspection at site upon delivery, trial run
	Pipe material, valves	Factory inspection, inspection sheet of manufacturer, visual inspection at site upon delivery
	Electromagnetic flow meter, motorized valve, water gauge, control board	Factory inspection, visual inspection at site upon delivery, trial run
	Chlorine dosing facility	Factory inspection, visual inspection at site upon delivery, trial run
	Telemetry system	Factory inspection, visual inspection at site upon delivery, trial run
Construction Stage	Quality control of concrete	Compressive strength, slump, volume of air, water-cement ratio, temperature
	Quality control of asphalt	Factory inspection sheet, appearance, temperature
	Judgment of the succession of the wells	Verification of more than 1200 m^3/day of pumping by pumping test; Verification of water quality
	Pipeline, reservoir, well pump	Leakage test. Pressure test (Send in water from the reservoir and fill pipe, and closely regulate the test area. Load pressure until the design water pressure, and investigates abnormalities or pressure decrease of the pipe.)
	As-built control of structure	Matching with standard value
	Temporary bridge	Strength test by running a truck on the bridge

Source: JICA Survey Team

2-2-4-6 Procurement Plan

(1) Source of Procurement

The eligible supply source countries for Grant Aid Projects are Japan, or the aid recipient country, in principle. The equipment necessary for this project shall be procured locally as much as possible. However, equipment that are not possible to procure locally, or local equipment that do not conform to the quality specification, as well as equipment that are unstable in terms of supply volume/purchase due to the volume supplied in the market or price, can be procured from Japan, in principle, taking the cost-effectiveness and maintainability, etc., into account.

The main methods of equipment procurement shall be as follows:

a) Construction Materials

Sufficient amount of construction materials including reinforcing steel, cement, fresh concrete, brick, paint, asphaltic mixture, or aggregate material are supplied in Mongolia and have been used in previous Japanese Grant Aid projects without problems in quality. For this reason, procurement of these materials shall be within Mongolia.

b) Architectural Materials

Architectural materials such as expanded polystyrene for thermal insulation, gypsum plaster board for the ceiling, waterproof asphalt material, window sashes, doors, glasses, glass blocks, louvers, roof drains, light steel products, PVC pipes, floor tiles, distribution board, wiring devices, lighting apparatus, air conditioning devices and plumbing are general items of construction equipment and distributed in the market although they are not produced in Mongolia. Since no major quality problems have been reported, they shall be procured within Mongolia.

c) Piping Materials

Piping materials to be used as transmission main, conveyance pipe and collection pipes especially require high quality, durability and implementation technology. Therefore, they shall be procured in Japan.

The transmission main to be used in this project are fiber reinforced plastic mortar pipes of φ150 mm to φ500 mm. Their ancillary equipment includes deformed tubes, butterfly valve, gate valve and air valve. All of these have the design hydraulic pressure of 10 kgf/cm^2 or higher, and are to be installed in the concentrated Ger areas. Since leak accidents by joint defects and so on may lead to large disasters, extremely high quality, durability and implementation technology are required for the piping materials. These pipes are neither manufactured nor distributed in Mongolia and the possible procurement sources are China and Japan considering the quality, price, transport route and so on. However, since problems have been reported as to the quality management by Chinese manufacturers when their past performances were investigated in the survey, Japanese products with reliable quality shall be procured.

d) Appurtenant Equipment for Reservoirs

The ancillary equipment to be installed in the Gachuurt Reservoir includes steel water pipes, electromagnetic flow meter, water gauge, butterfly valve and gate valve. The equipment required for connecting the water pipes of this project to the North East Reservoir include electric butterfly valve, water gauge and control panel. Since none of these are distributed in Mongolia, they will be produced and procured in Japan.

e) Equipment Related to Wells

With regard to submersible motor pump and control panel, USUG has no record of adopting Chinese products because they do not have reliable quality and durability. On the other hand, Japanese products have been adopted in the previous projects for the Central and Upper Water Sources and have been evaluated highly with respect to quality and durability. Therefore, they will be produced and procured in Japan along with the ancillary riser pipes and valves.

Many of the well-related equipment such as submersible motor pump, control panel, riser pipe, gate valve, check valve, casing, screen and centralizer managed by USUG have been procured from the former USSR before 1990 during the socialism era. While they were evaluated highly on both quality and durability, procurement of Russian products is not so common nowadays.

Although casing, screen and centralizer could be procured from well drilling companies in Mongolia, high corrosion resistance is required in screens that shall not cause clogging. Therefore, these materials shall be procured in either Mongolia or Japan upon determining the quality.

High-voltage power receiving facilities, lightning protection facilities and 10 kV/380V transformers to supply power to the underwater pump are not manufactured in Mongolia, and agencies import them when an order is placed. Therefore, these products will be procured in Japan.

f) Telemetry System Facilities

The telemetry system to turn ON/OFF the well pump consists of antenna, wireless modem, radio set, personal computer and control panel, and it will be constructed by the pump manufacturer. In the Upper Water Source, the Japanese pump manufacturer cooperated with the Mongolian system integrator to build the system. Therefore, the telemetry system shall be procured in either Mongolia or Japan.

g) Chlorination System

There are no cases of using calcium hypochlorite (bleaching powder) for the chlorination system of public water in Japan at present. Moreover, although there are manufacturers in the USA or Canada, the cases are rare when looking globally. On the other hand, the parts for the solution dosing system are common to liquid chlorine and sodium hypochlorite. Therefore, a system can be built by adding a hopper, powder feeder, solution tank and agitator, etc. These will be special orders and impossible to procure locally, but it has been confirmed that various manufacturers in Japan are able to manufacture them so that they shall be produced and procured in Japan.

h) Construction Machinery

Ultra-small backhoe for pipe-laying in small spaces, 50-ton crawler crane, vibro hammer and water jet for steel sheet pile construction cannot be procured locally, so that they will be procured in Japan. Other machineries can be procured locally.

i) Temporary Materials

Steel materials for temporary works including steel sheet pile, simple earth retaining materials, covering plates, wide flange beam, channel steel and L-shaped steel are not distributed in Mongolia and are difficult to procure locally, so that rental products from Japan shall be used.

Although temporary work materials such as scaffold and support materials can be procured in Mongolia, their quantity is limited so that the procurement source shall not be limited to Mongolia but it shall be made possible to procure them in Japan as well. Design, procurement and construction of earth retaining work, temporary bridge work, temporary cofferdam work, form support work and so on shall fall within the responsibility of the construction contractor.

j) Spare Parts

Regarding the warranty of facilities introduced in the project and procurement of spare parts, a branch office with local staffs shall be opened in Ulaanbaatar. Up to one (1) year after the start of service shall have charge-free guarantee, but any service longer than a year shall be under the responsibility of USUG, which shall bear the costs of repair. Additionally, materials and equipment which can be found locally shall be procured by USUG. Pumps, valves, control boards, consumables of the chlorination system shall be procured by the branch office. Examples of spare parts are shown in the table below.

Table 2-2.44 Examples of Spare Parts

Category	Details
Pump	Impeller, packing, grease, oil seal, bearing
Valve	Packing
Control Board	Pilot lamp, relay switch, electromagnetic contactor
Chlorinating Facility	Bleach powder, strainer, packing

Source: JICA Survey Team

(2) Procurement Sources

The procurement sources for the major materials and equipment to be used in the construction of this project shall be planned, as follows:

Table 2-2.45 List of Procurement Sources of Construction Materials and Equipment

Material and Equipment	Mongolia	Japan
Cement	○	-
Ready-mixed concrete	○	-
Crushed stones, sand, and embankment materials	○	-
Bricks	○	-
Fuels (gasoline, light oil, kerosene)	○	-
Reinforcing steel	○	-
Steel materials (steel sheet pile, simple earth retaining materials, covering plates, H-beams, channel steel and L-shaped steel)	-	○
Light steel materials (checkered steel plate, roll-formed section, gas pipes)	○	○
Plyboard (for forms)	○	-
Scaffold/Support materials	○	○
Paint (emulsion, oil, epoxy)	○	○
Asphalt mixtures for pavement	○	-
Thermal insulation materials	○	-
Waterproof asphalt materials	○	-
Fixtures (window frames, doors, louvers, glass)	○	-
Ceiling materials (bed materials, gypsum plaster board)	○	-
Roof drains	○	-

Material and Equipment	Mongolia	Japan
Floor tiles	○	-
Electrical equipment for construction (distribution board, wiring devices, lighting apparatus)	○	-
Plumbing and sanitation equipment (lavatory bowls, wash basins, PVC pipes)	○	-
Air conditioning equipment (heaters, ventilators)	○	-
Reinforced plastic duplex pipes, deformed pipes	-	○
Ductile-cast-iron pipes, deformed pipes		○
Steel pipes		○
Valves (electric butterfly, butterfly, gate, air and check)		○
Manhole lid for valve chest		○
Submerged motor pump		○
Instrumentation devices (control panels, water gauge, electromagnetic flow meter)		○
High-voltage power receiving facilities (air switch, lightning protection system, transformers)		○
Wells (screen, casing, centralizer)	○	○
Chain blocks		○
Set of chlorinating facilities		○
Set of telemetry system facilities	○	○
General construction machines (backhoe, bulldozers, dump trucks, trucks, trucks with cranes, truck cranes, concrete pumping vehicles, motor graders, tire rollers, vibration rollers, road rollers)	○	
Unique construction machines (ultrasmall turning diameter backhoe, crawler crane, vibro hammer, water jet)		○

Source: JICA Survey Team

(3) Material and Machinery Transportation Route

The materials and machinery are to be shipped by sea and unloaded at the Port of Tianjin in China, and then transported by rail freight from the Port of Tianjin to the trade zone of Ulaanbaatar. A container train called the block train operates between them, and the goods are to be shipped in 40 or 20 feet containers, while heavy machinery is to be transported individually. Railways in China and Mongolia have different rail gauges (China: 1,435 mm; Mongolia: 1,524 mm), so that cargo cannot be transported without reloading at Zamin-uud Station on the Mongolian border. The railway distance from the Port of Tianjin to Ulaanbaatar is approximately 1,700 km. Zamin-uud Station has five 35-ton reach stackers and five 35-ton bridge cranes for reloading. On the other hand, due to the Mongolian Railway having an insufficient number of freight cars, when a large concentration of cargo arrives from China, the time that the cargo is held up at the Zamin-uud Station increases.

The number of days to transport goods from Japan to the temporary yards depends on the shipping schedule, railway operation conditions, and the concentration of cargo. For this reason, the transportation time is set at 45 days as shown below to avoid delays.

Japanese port => Port of Tianjin (transportation by sea)	10 days
Port of Tianjin => Ulaanbaatar trade zone (railway)	20 days
Customs	14 days
Trade zone => Temporary yards (trucking)	1 day
Total	45 days

2-2-4-7 Guidance Plan for Initial and On-going Operation, etc.

(1) Guidance for Initial Operation

USUG owns and is already operating similar facilities like the wells, collection pipes, conveyance pipe, reservoirs, chlorine-dosing facility, telemetry system, and transmission main to be constructed in the Project. Therefore, 10 days, more or less, shall be sufficient for the guidance on operation of USUG facility operation engineers, functionality guidance on the delivered equipment, operation procedure guidance, and maintenance procedure guidance which shall be conducted on-site prior to the handover of facilities.

The facilities and equipment for maintenance which requires initial operation guidance are as follows:

- Production well (submersible motor pump, control board, air insulating switch, transformer, gate valve, drain valve, drain pipe)
- Distribution Reservoir (electromagnetic flow meter, water-level gauge, control board, gate valve, inlet pipe, outlet pipe, overflow pipe, sludge drainage pipe)
- Transmission main, collection and conveyance pipes (gate valve, air insulation valve, drain valve)
- Existing North East Reservoir (motorized valve, water-level gauge, control board)
- Chlorine dosing facility (water pipe, hopper, weighting scale, powder feeder, solution tank, agitator, measuring pot, dosing pump, solution dosing, control board)
- Telemetry system (software, antenna, wireless modem, radio device, control board)
- Chlorination and operation house (heating system, ventilation system, water supply/discharge system, air insulating valve, transformer)

A representative office shall be established in Ulaanbaatar, for handling the 1-year charge-free guarantee, and non-free guarantee from the second year.

(2) Guidance for On-going Operation

For the operation of facilities and equipment of the Project, attention must be paid especially to prevent the transmission main, conveyance pipe, collection pipes, reservoir, and water inside the pump from freezing during the winter when the temperature reaches below –40°C. Since USUG is experienced in anti-freezing measures, an operation procedure utilizing the expertise of USUG shall be established prior to the handover of the facilities and equipment.

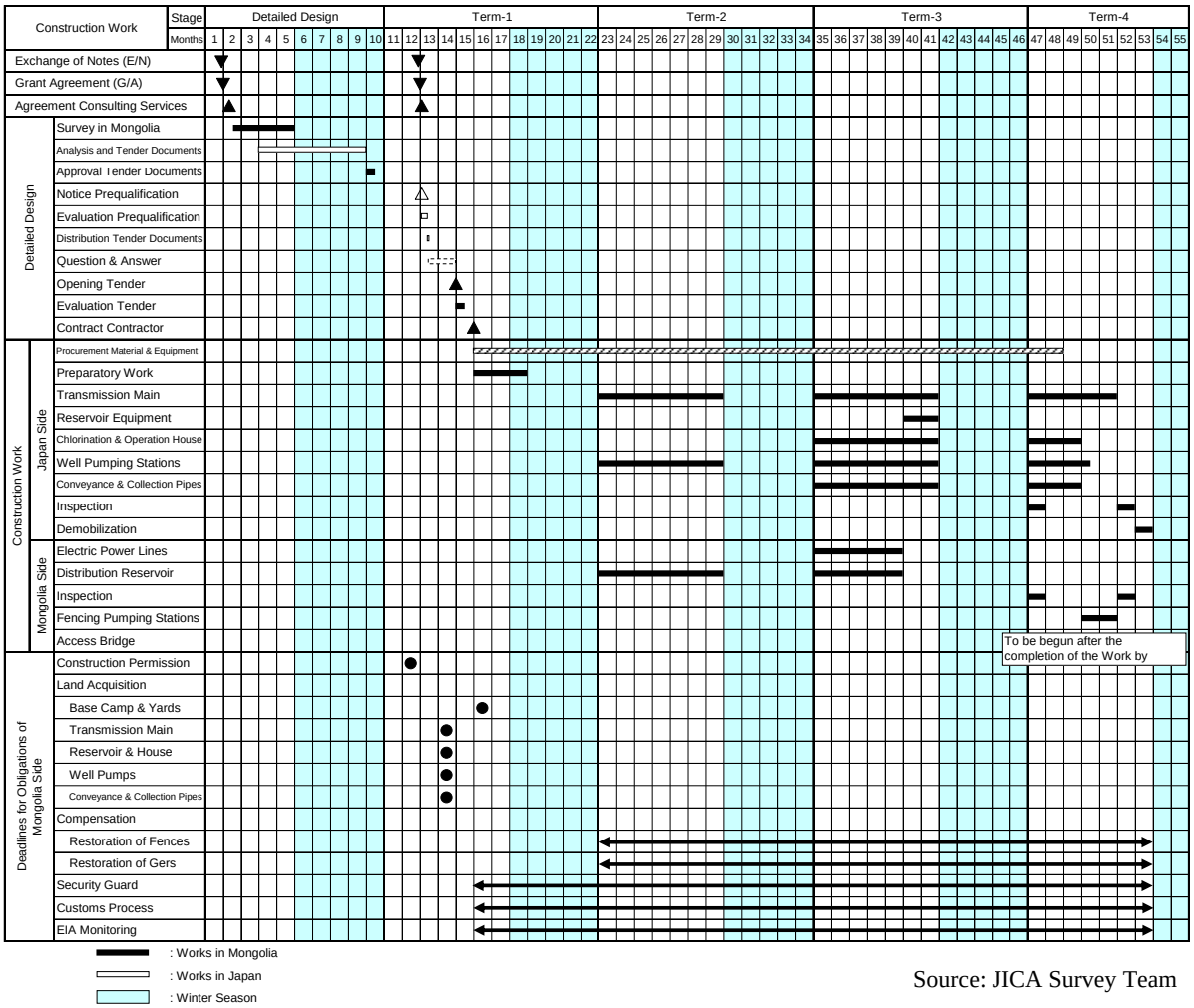
Although the existing facilities run by USUG are the models of the anti-freezing measures of this project, it is essential to keep the water of the facility flowing at all times, and prevent stagnation for further safety. Once frozen, not only does the water supply suspend, but also the swell of ice may cause damage to the facility. In particular, close attention is needed for the transmission main which flow high-pressure hydraulic head that reaches 100m that can result in major accidents.

Regarding the control between the production wells and the Gachuurt Reservoir, the water level of Gachuurt Reservoir shall be monitored, and the well pumps shall be switched ON and OFF

manually. The number of units to be operated shall be determined as well. Furthermore, the control of operation between the Gachuurt Reservoir and the North East Reservoir shall be carried out by the personnel at the North East Reservoir who are monitoring the water level, and who should communicate with the Gachuurt Reservoir and intake well personnel by mobile phone and ensure the required reservoir level that change with time. For the North East Reservoir, a motorized valve, water level gauge, and control board shall be installed, and the water level must be remote-controllable from the control board inside the existing control building in this project. For optimum water operation, an annual, monthly, and weekly demand forecast must be carried out, and operation regulation must be established for ensuring the water pressure compliant to the demand volume and rational operation of valves and pumps.

2-2-4-8 Implementation Schedule

After the completion of the Detailed EIA, the detailed design (D/D) shall be conducted and construction work shall be implemented in accordance with the following work schedule. The detail design period is 8.0 months, and the bidding process period for selection and contract conclusion with the contractor is 3.0 months. Since the region is cold in winter, outdoor construction shall be stopped during winter, and this period shall be used for the manufacture, procurement and transport of materials and equipment. As a result, the overall construction period is 38.0 months.



Source: JICA Survey Team

Figure 2-2.12 Implementation Schedule of the Project

2-3 Obligations of Recipient Country

2-3-1 Obligations of Mongolian Side

The undertakings of the Government of Mongolia for the Project shall be as follows:

1) To take necessary measures to ensure prompt unloading and Customs clearance upon entry into Mongolia and transportation inside Mongolia for the goods procured for the implementation of the Project.

2) To take necessary measures to exempt the contractor and the consultant from Customs duties, internal taxes and other fiscal levies imposed in Mongolia for their supply of goods, services, and equipment.

3) To open an account in a designated bank in Japan for the Banking Arrangement (B/A), and issue the Authorization to Pay (A/P), bear the advising commission of the A/P and the payment commissions to the bank.

4) To execute restriction of development activities and necessary negotiations with landowners for the use of necessary land for the construction work.

5) To obtain construction approval from the authorities concerned for the construction work.

6) To carry out necessary procedures for the Detailed Environmental Impact Assessment (DEIA).

7) To construct the distribution reservoir (6,000 m^3 in volume) for which the Mongolian side is responsible for the construction work excluding the installation of valves, flow meters, level gauges and piping around the reservoir, in compliance with the overall implementation schedule of the Project.

8) To extend the electric power lines with the necessary capacity to the required locations such as the well pumping stations, distribution reservoir and relevant temporary stockyards, and increase the electrical capacity to the required power if the capacity is insufficient.

9) To obtain permission for the use of frequency band for the telemetry system.

10) To conduct a study along the transmission main route to monitor the Ger houses affected by the construction work and to take due process, concurrence and proper compensation for the affected households when temporary relocation and removal of houses and properties is necessary.

11) To provide land for the temporary stockyards for setting-up the site offices and storage of construction materials and equipment during the construction work.

12) To install fences and gates in the premises of the distribution reservoir and the well pumping stations.

13) To provide a bridge over Tuul River for the access, operation and maintenance of the Gachuurt Water Source after the completion of the construction work.

14) To allocate proper security guards for the security of construction work.

15) To conduct environmental and social impact monitoring based on the monitoring plan instructed by the DEIA.

16) To connect the transmission main to the existing inlet pipes (φ500) of the North East Reservoir and to repair the reservoir and the existing peripheral pipes in the event of trouble caused by the discharge, under normal use, to the reservoir.

17) To procure the disinfectant calcium hypochlorite [$Ca(ClO)_2$] for the operation of the chlorination facility.

18) To plan out observation tours for residents to advertise the Project and, in addition, to carry out promotion activities through the media and by creating/distributing project brochures to all stakeholders/entities concerned.

Upon the completion of the detailed environmental impact assessment (DEIA) implemented by the Mongolian side, the Exchange of Notes (E/N) for the detailed design work shall be discussed

between the governments of Mongolia and Japan. The following table shows the obligations and implementation deadlines for the Mongolian side after the conclusion of the E/N of the detailed design work.

Table 2-3.1 Obligations and Implementation Deadlines for the Mongolian Government and USUG

Major Items	Sub-Items	Quantities	Implementation Deadlines (Months after E/N for D/D)
Application for Construction Permission	-	Application to the City of Ulaanbaatar and permission	12 months
Land Acquisition	Base camp and temporary yard	4 sites	16 months
	Transmission main	18.8km	14 months
	Conveyance pipe	4.3km	14 months
	Collection pipes	2.8km	14 months
	Reservoir and chlorination & operation house	1 site	14 months
	Well pumps	21 sites	14 months
Distribution Power Line Installation	Reservoir and chlorination & operation house	1 site	39 months
	Well pumps	21 sites	39 months
Construction	Reservoir	1 site	Budget acquisition : 12 months Construction : 39 months
	Fence at well pumps	21 sites	51 months
	Management bridge	1 site	Before facility is in operation
Compensation	Temporary removal and restoration of fence on transmission main route	Review before construction commencement	Until construction completion after 23 months
	Temporary removal and restoration of Gers on transmission main route		
Inspection	Discharging in Gachuurt Reservoir	1 site	47 months
	Discharging in North East Reservoir	1 site	52 months
Security	-	All construction sites	Until construction completion after 16 months
DEIA Implementation	-	Application to MNET and getting permission	January 2010 – March 2010
Customs Clearance	-	Materials and equipment procured in Japanese	Until construction completion after 16 months
EIA Monitoring	-	All construction sites	Until construction completion after 16 months

Source: JICA Survey Team

2-4 Project Operation Plan

2-4-1 Operation Plan

The facilities to be constructed in this project are as given in the following table:

Table 2-4.1 Contents of the Project

	Results of Preparatory Survey	
	Obligations of Japan Side	Obligations of Mongolian Side
Development Volume	25,200 m^3/day	—
Production Wells	21 wells	—
Conveyance Pipe	Length: 4.3km DCIP Dia. : 150 to 500 mm	—
Collection Pipes	Length: 2.8 km DCIP Dia. : 150 mm	—
Distribution Reservoir	—	Capacity: 6,000 m^3
Chlorinating Unit	1 unit [$Ca(ClO)_2$]	—
Operation House	Chlorination & Telemetry System	—
Transmission Main	Length: 18.8 km FRPM Dia. : 700 mm	—
Others	—	Fence installation; Electric power drawing; Construction of a bridge, etc.

Source: JICA Survey Team

The following points must be kept in mind upon operation.

In order to comply with the “Recommendation of Water Authority: to maintain the dynamic water level drawdown at less than 2m as mandated”, the dynamic water level of the existing Upper Water Source and the Central Water Source, as well as the water supply well, shall be controlled by the water level gauge. Additionally, out of the 5 test wells that were used in this survey, G-2 and G-3 wells shall continue to be monitored as monitoring wells at the time of operation and during construction. If drawdown of each well exceeds 2m, the operation of the water supply well shall be reduced. Regarding the chlorinating facility, calcium hypochlorite shall be dosed, thus the free residual chlorine at the tail shall be controlled within the optimum value of 0.2 ppm to 0.3 ppm (Water Law of Mongolia). USUG is conducting inspection of all wells and reservoirs quarterly, thus the water quality inspection shall follow this rule.

With regard to the water quality inspection, according to the Water Law of Mongolia, taste, smell, color, transparency, electrical conductivity, pH, and coliform and common bacteria are to be checked every day for purified water in the distribution reservoir (chlorinated water). Other water quality criteria are to be checked every month or at least 4 times a year. Raw water shall be inspected twice a year for all wells under the control of USUG.

Distribution reservoirs are subject to water stains and sedimentation of silt from wells. Periodically, the two reservoirs are to be alternately emptied for cleaning.

The inner coating of the concrete of the reservoir may wear due to the chlorine. Therefore, the tank must be drained and cleaned, and concrete must be neutralized and checked for cracks, corrosion of reinforcing steel, and abrasion of the coating. Furthermore, wear of inside/outside of the pipe due to aging, water-tightness/leakage volume research of joints, and water cross-section area survey, etc., must be conducted periodically. The inspection of leakage, corrosion, loosening of bolt/nut, etc., must also be conducted for valves.

For the optimum water supply operation, the demand of distribution volume of the year, month, or week must be forecast, as well as related facilities including pipes, valves, reservoir, or pumps to be operated rationally.

2-4-2 Human Resource Plan

By implementing this project, new personnel for daily operation, maintenance, and management will become necessary for the well, the Gachuurt Reservoir, and the chlorinating facility. The tentative allocation of personnel for the operation, maintenance, and management after the construction is shown in the table below.

Table 2-4.2 Allocation of Personnel for the Operation, Maintenance, and Management for the Gachuurt Water Source (draft)

Designation	Number of Personnel	Remarks
Manager	1	
Electrical Facility Supervisor	1	
Mechanical Facility Supervisor	1	
Chlorination Facility Supervisor	1	
Telemetry Control Operator	3	3 shifts
Administrator of Well and Reservoir	6	3 shifts, 2 heads/team
Chlorination Facility Operator	6	3 shifts, 2 heads/team Total of 2 heads in 3 shifts, in the following formation: ・Generation of chlorine: 1 head ・Feeding of chlorine: 1 head
Administrator of North East Reservoir	3	3 shifts
Total	22	Additional 22 heads (10 heads when 1 shift)

Source: JICA Survey Team

The number of personnel in the above list is considered to be the minimum required personnel in the case of three (3) shifts. It is suggested to rationalize USUG and relocate the 22 personnel from the 243 existing staffs of the Water Supply Division, which is in charge of the operation of USUG facilities, rather than newly hiring the personnel, considering the fiscal health restoration of USUG. The well repairer, well electrician, and well mechanic for the well and well pump, shall be supplemented from the repairers of USUG per request. There are repairers at the wells of the Upper and Central Water Sources, and work is not constantly needed at those locations. In addition, from the past experience, existing personnel is considered sufficient in terms of capacity to handle the aforementioned repairs.

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

The brakedown of respective costs to be borne by the Government of Mongolia has been estimated, as shown in the Table 2-5.1. However, the cost estimate is provisional and would be further examined by the Government of Japan during the approval of the Grant.

(1) Cost Borne by the Government of Mongolia

Project cost (portion borne by Mongolian side) is Approx. 150 million yen, as shown in Table 2-5.1.

Estimated cost: 150 million yen

Table 2-5.1 Project Cost Estimation (Borne by the Mongolian Side)

Work Item			Estimated Cost (million yen)	
Facilities	Reservoir ($V=6,000\ m^3$)	Reservoir	100	150
		Valve Room		
		Overflow Pipe		
	Others	Electric Power Supply	50	
		Fences and Gates		
		Bridge for O/M		

(2) Parameters of Cost Estimation

① Date of Cost Estimate: October 2009

② Currency Exchange Rates:

JPY/USD: USD1.0 = JPY96.53

JPY/Local Currency: 1Tg = JPY0.066

③ Period of Construction: The detailed design and construction works are scheduled as shown in the overall implementation schedule.

④ Others: The Project is implemented in accordance with the framework of the Grant Aid of the Government of Japan.

2-5-2 Operation and Maintenance Cost

The maintenance (periodical inspection, daily maintenance, and repair) shall be carried out by the Water Supply & Sewerage Authority of Ulaanbaatar City (USUG), which is a public corporation. The manpower cost, electrical power cost, repair cost, etc., as the operation and maintenance cost that are expected to increase accompanying the implementation of this project have been estimated and the cost breakdown is in Table 2-5.2.

Table 2-5.2 Annual Operation and Maintenance Cost

<Manpower cost>

Responsibility	Person	Unit price (Tg/month/person)	Month	Total (Tg/year)	Note
Manager	1	2,100,000	12	25,200,000	
Electrical supervisor	1	1,750,000	12	21,000,000	
Mechanical supervisor	1	1,750,000	12	21,000,000	
Chlorinatng facility supervisor	1	1,750,000	12	21,000,000	
Well operation (telemetry)	3	1,050,000	12	37,800,000	3 shifts
Management of well and reservoir	6	700,000	12	50,400,000	3 shifts
Operation of chlorinatng facility	6	700,000	12	50,400,000	3 shifts
Management of North East Reservoir	3	700,000	12	25,200,000	3 shifts
Sub-total	22			252,000,000	

<Electricity>

Item	Electric power production (kwh/year)	Unit price (Tg/kwh)	No.	Total (Tg/year)	Note
Pump: 30KW	197,100	74.8	21	309,605,000	Load factor (including machine efficiency) 75%
Chlorinating facility and others: 11KW	72,270	74.8	1	5,406,000	Load factor (including machine efficiency) 75%
Sub-total				315,011,000	

<Repair>

Item	Equipment cost (Tg)	Repair ratio	No.	Total (Tg/year)	Note
Well repair cost	60,606,000	0.005	21	6,364,000	Annual repair ratio is set to 0.5%
Chlorination system	530,303,000	0.005	1	2,652,000	Annual repair ratio is set to 0.5%
Sub-total				9,016,000	

<Chlorinating material>

Item	Amount (kg)	Unit price (Tg/kg)		Total (Tg/year)	Note
Chlorine bleach	3,600	3,000		10,800,000	300 kg/month x 12 = 3,600 kg
Sub-total				10,800,000	Chlorine injection rate 0.3 mg/ℓ

Sub-total	586.83	million Tg/year

<Raw water intake charge>

Item	Water Supply Volume (m^3/day)	Unit price (Tg/m^3)	No. of days	Total (Tg/year)	Note
	25,200	0.37	365	3,403,260	Applicable to daily maximum water supply amount
				3,403,260	

Total	590.23	million Tg/year

(Note) The above unit of manpower cost includes indirect cost such as retirement payment, legal welfare cost, and reserve for bonuses, etc. Annual repair ratio estimation of 0.5% is based on the past performance.

Source: JICA Survey Team

Based on the above table, the breakdown of income and expenses for the target year 2014 is as shown below. See Table 2-2.15 to 2-2.17 for the maximum daily water supply volume revenue ratio, and load ratio.

【Income】

Average daily water revenue volume: (262,861–240,000=22,861 m^3/day) x Revenue ratio (84.69%) x Load ratio (84.32%) = 16,325 m^3/day

Out of which:

Beneficiary Ger district water supply volume: 370,137 persons x 15.8 ℓ/person/day + 19,096 persons x 25 ℓ/person/day = 6,326 m^3/day

Apartment district water supply volume: 16,325 – 6,326 = 9,999 m^3/day

In the above equation, for the 370,137 estimated beneficiary Ger residents in 2013, the difference between the planned unit water consumption for 2014 (25 ℓ/person/day) and the unit water consumption in 2013 (9.2 ℓ/person/day), specifically 15.8 ℓ/person/day (=25.0–9.2) can be considered as the water supply increase. For the estimated increase in the number of people as of 2014, i.e., 19,096 people, the planned unit water consumption (25 ℓ/person/day) is deemed to be the water supply increase. Water supply developed in the project is first provided to the Ger district and the surplus is provided to the apartment district.

When the planned average water charge for the Ger district kiosk and for the apartments are 500 Tg/m^3 and 256 Tg/m^3 respectively (bulk payment paid by OSNAAUG to USUG), the annual income is as follows:

(6,326 m^3/day x 500 Tg/m^3 + 9,999 m^3/day x 256 Tg/m^3) x 365 days = 2,089 million Tg/year

【Expense】

・Operation and maintenance cost of water supply facility of Gachuurt : 587 million Tg/year

・Raw water intake cost [9] : 3 million Tg/year (25,200 m^3/day x 0.37 Tg/m^3 x 365 days)

Total : 590 million Tg/year

【Profit】

2,089 million Tg/year – 590 million Tg/year = 1,499 million Tg/year

While the annual operation, maintenance and management associated with this project is estimated as 590 million Tg/year, the income from the beneficiary Ger district and apartment district is estimated as 2,089 million Tg/year. As a result, an annual income of 1,499 million Tg/year can be earned, which enables the operation of the facility by the project without acquiring subsidies from Ulaanbaatar City.

2-6 Precautions upon Implementing Cooperative Projects

Upon implementing cooperative projects, care should be taken regarding the following points.

[9] Minister's Notification No. 103 "Evaluation of storage volume of water resource and regulation of water rate related to use of water" of 2003. The raw water intake cost of groundwater for drinking (high-quality) of Ulaanbaatar area is 0.37 Tg/m^3

(1) Land Acquisition, Development Regulation, and Removal and Recovery of Residence Fences

USUG and related organizations must properly acquire the necessary land and implement the procedures for adjusting to ongoing urbanization. There are about 20 private residences where temporary movement on their premises or fence removal/recovery is necessary for this distribution pipe construction. In accordance with the regulations of Mongolia, compensation procedures for each affected residence should be undertaken along with the project implementation plan at the Ulaanbaatar City Office's expense. At the same time, for the acquired land, complying with the regulations against illegal new development and negotiations with landowners is necessary.

(2) Ensuring Implementation of Construction Funded by Mongolia

Work conducted at Mongolia's expense, including the construction of the distribution reservoirs, power lead-in, fence installation, and construction of bridge for maintenance and management, needs to be unfailingly implemented by the given, specified date. In case these tasks becomes impossible within the scope of USUG's capacity, their parent organization, either the Ministry of Road, Transportation, Construction and Urban Development or Ulaanbaatar City, is required to implement these constructions/tasks as their responsibility.

(3) Monitoring of Environmental Load Reduction Measure

In the construction and operation phases of the facilities, the monitoring items in the monitoring form need to be implemented without fail. The monitoring results are delivered be means of monthly reports. The monitoring contents are as follows:

1) Construction Phase

(a) Temporary moving (within the premise) of affected residences along the distribution pipeline; removal and recovery of fences; compensation procedures.
(b) Traffic control
(c) Briefing to military, and organizations operating buses and local industries, etc.
(d) Briefing to local residents in Gachuurt District and other relevant districts.
(e) Cutting down and transplanting trees when clearing is inevitable for construction.
(f) Application of construction method with consideration to scenery.
(g) Observation of underground water level and water quality inspection at test wells.

2) Operation Phase

(h) Prevent trespassing by placing guards at the facilities (security).
(i) Proper storage and handling of chlorine disinfectants (bleaching powder).
(j) Observation of underground water level and water quality inspection at test wells.

Among the above monitoring items, (e) and (f) are conducted by the construction company. The rest is performed by USUG.

(4) Operation, Maintenance, and Management of Facilities

The following items are to be implemented to fully enjoy the benefits of the constructed facilities. Effective water management is also to be promoted.

- Promote the repair and upgrading of existing, aged facilities to reduce non-revenue water volume.
- Price the water charge appropriately and ensure charge collection in order to secure earnings that are necessary for maintaining and managing the facilities.
- Install water meters to promote metered rate and water-saving.

Chapter3 Project Evaluation and Recommendations

3-1 Project Effect

The effects in Table 3-1.1 are expected to be brought to the residents of Ulaanbaatar by executing the Project.

Table 3-1.1 Effect of the Project Execution and Level of Improvement of the Present Situation

Present Situation and Problems	Measures by the Project	Direct Effects and Level of Improvement	Indirect Effects and Level of Improvement
The water demand increased with the population increase in Ulaanbaatar City. Especially, the city is in a situation where water supply services to the dwellers of Ger areas do not satisfy the water demand. As the result, it is forecast that the daily maximum water demand of USUG will exceed, in 2011, the capacity of the present water supply facilities.	A new water source will be developed in Gachuurt area which is in the eastern suburbs of Ulaanbaatar City. To supply the developed water, a transmission main of 18.8km will be constructed.	The capacity of the water supply facilities run by the Water Supply & Sewerage Authority of Ulaanbaatar City (USUG) will enhance from 240,000 m^3/day to 265,200 m^3/day.	- The living environment and water supply situation to some 390 thousand Ger dwellers and 43.5 thousand apartment dwellers will improve. - Revenue of USUG will increase because of the increase of accounted water.

Source: JICA Survey Team

3-2 Recommendations

3-2-1 Problems and Recommendations

On the implementation of the Project, the Mongolian side is requested to execute the following matters at its own responsibility.

(1) Quality Security and Observance of Work Schedule

It has been agreed with the Mongolian side that construction of the distribution reservoir (excluding valves, flow meters and piping around the reservoir) and the operation bridge, fencing of the well pumping stations, connection of the electric power lines, and restoration of the North East Reservoir according to the water transmission will be borne by the Mongolian side (Implementing Agency: USUG; Responsible Agencies: Ulaanbaatar City and Ministry of Road, Transportation, Construction and Urban Development). Each work is required to satisfy, in quality, the technical specifications, and obey, without delay, the overall project implementation schedule.

(2) Monitoring concerning Environmental and Social Considerations

Prior to the commencement of the construction works of the transmission main pipes, USUG and Ulaanbaatar City are required to hold periodic meetings with the consultant to grasp the Gers affected by the construction work, to prevent and find out illegal actions such as building structures, and to execute proper negotiations and processes of compensation.

Prior to the commencement of the construction works, USUG and Ulaanbaatar City, along with the consultant, are required to hold explanatory meetings with the neighboring dwellers and businesses for having the works such as river closure, move of bus stops, traffic control, and opening of a complaint desk fully known in order not to inconvenience the progress of the construction works.

USUG is required, in the stage of construction, to make daily monitoring of the groundwater levels at the two (2) test wells (G-2 and G-3) and the private run water kiosk in Gachuurt. In the stage of operation, USUG is required to make daily monitoring of the groundwater levels at the twenty-one (21) proposed wells in addition to the said three (3) wells in order not to make the groundwater levels draw down over 2m.

Analysis by USUG of the chlorinated water sampled from the reservoirs of Gachuurt and North East, and the raw water sampled from the 21 proposed wells, is required in compliance with USUG's regulations for potable water quality. USUG is also required to inform the water users of the results of analysis through the proper manner.

USUG is required to submit, to the Japanese Government, the monitoring reports for two (2) years after the commencement of the operation of the facilities constructed by the Project.

(3) Impact Assessment for the Groundwater Quality and Strengthening of the Sewage Treatment

Survey of the situation and ability for sewage disposal (domestic wastewater and human excreta) in the beneficial Ger areas is required. An impact assessment of groundwater quality, according to augmentation of the quantity of water used in these areas, is required. When a negative impact is confirmed, countermeasures for strengthening the disposal capacity of the sewage are required.

(4) Secure Water Supply to the Beneficial Ger Areas

The water transmitted to the North East Reservoir is required to be supplied surely to the beneficial Ger areas upon completion of the Project. In the event that any inadequacy such as leakage in the pipe network is found, immediate repair is required.

(5) Smooth Operation of the Facilities with the Arrangement of Expert

USUG possesses similar facilities and equipment (well pumping stations, pipes, distribution reservoir, chlorination equipment and telemetry system) as those to be provided by the Project, and is currently operating them by assigning specialist. It is therefore required that the facilities and equipment provided by the Project will be smoothly operated by assigning specialists, or by sharing with newly assigned personnel the techniques, knowledge and the experience obtained by the specialists.

(6) Saving of Water Consumption and Planning of Medium/Long Term Water Resources Development

The project purpose is ”To improve the water supply condition to Ulaanbaatar residents by 2014,” and it is necessary to note that the Project will be implemented as an urgent countermeasure in response to the tight capacity of the existing water supply facilities.

To fulfill the project purpose, 25,200 m^3/day, which is the difference between the water supply and demand in 2014, will be covered by newly developing water sources in the Gachuurt area, which is expected to exploit 40,000 m^3/day of the potential groundwater between the Central and the Upstream Water Sources along the Tuul River based on the results of the past survey.

It has become clear that the population of Ulaanbaatar City keeps on growing even after 2014. On the other hand, there is no allowable exploitation within the existing water sources (Upstream, Central, Industrial and Meat-Complex) since groundwater exploitation have already reached 240,000 m^3/day in total. However, the remaining potential groundwater of Gachuurt will not be capable of covering 23,575 m^3/day (=288,775–240,000–25,200), which is the forecast difference between the water supply and demand in 2020.

USUG will be required to lower the water leakage by restoring the dilapidated waterworks, and to control water consumption in the apartment areas by promoting water-saving awareness and installation of water meters, and the implementation of a proper water charge system as well.

The related organizations in Mongolia will be required to establish a drastic water development and management plan in the medium/long term point of view, as an important national strategy, including development of the surface water. Moreover, it is then necessary to take careful prior coordination in order not to bring negative affects to the existing water sources.

3-2-2 Technical Cooperation and Coordination with Other Donors

(1) International Bank for Reconstruction and Development

The Ulaanbaatar Services Improvement Project 2 (USIP 2) financed by the International Bank for Reconstruction and Development is scheduled to complete the pipe network starting from the North East Reservoir to the Ger areas at the northeast of the city and water supply kiosks by the end of 2010. By the Project in cooperation with the USIP 2, a consistent waterwork, from the water source to the water supply kiosks, will be built minimizing the cost borne by the Japanese side. While waiting for the completion of the Project, the appearance of an efficient and immediate effect is expected since the water supply to the Ger areas is started.

(2) Holland

USUG is currently conducting a technical cooperation project, the Water Operators Partnerships (WOPs), in cooperation with VITENS of Holland.

The cooperation period is three (3) years from 1st November 2007 to 31st October 2010.

This technical cooperation is to provide assistance on water resources management including the enhancement of operation and maintenance capacity for the waterworks, strengthening of the financial base and demand control for the effective use of water resources.

The Project needs to keep on watching the outcome of this technical cooperation.

3-2-3 Relevance of the Project

(1) The reason for executing the Project coincides with the "Assistance for developing infrastructures for the promotion of economic activity," which is an important sector in the "Aid Plan to Mongolia" approved in 2014 by the Japanese Government.

(2) 390 thousand dwellers, in 2014, of the beneficiary Ger areas who can use no more than 7 ℓ/per capita per day of the water are expected to save time for obtaining water, and improvement of sanitary environment by better accessibility to nearby water supply kiosks is expected as well.

(3) It is possible to contribute to the promotion of economic activity in Ulaanbaatar City and effective use in communal facilities by unifying with the apartment areas and filling the water demand of enterprises, factories, and communal facilities supplying water to the Ger areas as the top priority.

(4) With prioritization of water supply to the Ger areas, the promotion of economic activities of Ulaanbaatar City and the effective use of public facilities is expected by satisfying the water demand of the apartment areas, firms, factories and public facilities.

(5) To respond to the water demand of the target year 2014, a new water source of 25,200 m^3/day is needed to be exploited immediately. There is however no allowable exploitation in the existing water sources: Upper, Central, Industrial and Meat-Complex. The new development of Gachuurt area is considered to be an optimal choice for the short-term countermeasures since Gachuurt area is designated as a water source protection area of Ulaanbaatar City and the development potential of 40,000 m^3/day is expected based on the result of the previous study.

(6) USUG will continue its management effort according to the financial plan submitted to International Bank for Reconstruction and Development as a condition of the loan for USIP 2. The Project will generate a great sales profit and strengthen the financial self-dependence of USUG.

(7) USUG has the technology and experience in supplying water without freezing from the water sources to the water supply kiosks or the faucets even in the coldest season that falls below minus 40°C. Therefore, the facilities constructed by the Project will be effectively operated throughout the year.

(8) USUG has become familiar with the grant-aid system of Japan through the implementation of the Phase 1 and Phase 2 projects. Therefore, smooth and timely performance of the obligations to be done by the Mongolian side can be expected.

3-2-4 Conclusion

The implementation of the Project is expected to bring a great effect as mentioned above, and at the same time, make a great contribution to the sound self-dependent growth of Ulaanbaatar City. Japan, as a top aid donor to Mongolia, has supported the movements for democratization and the market-oriented economic reform of Mongolia, and now the two counties are in an extremely excellent friendly relation. Further strengthening of the relationship between the two countries can be expected by executing the Project through the Japan's Grant Aid scheme.

APPENDICES

1. Member List of the Survey Team

(1) Basic Design Survey

No.	Name	Assignment	Affiliation
1	Mr. Shigeyuki MATSUMOTO	Team Leader	Advisor, Water Resources Management Division I, Water Resources and Disaster Management Group, Global Environment Dept., JICA
2	Mr. Yuji MARUO	Technical Advisor (Groundwater Development)	Senior Advisor, JICA
3	Mr. Akio ENDO	Planning Management Officer	Program Officer, Water Resources Management Division I, Water Resources and Disaster Management Group, Global Environment Dept., JICA
4	Mr. Yoshiharu MATSUMOTO	Chief Engineer	CTI Engineering International Co., Ltd.
5	Mr. Masaki ISHII	Deputy Chief Engineer/ Facility Designer 1	CTI Engineering International Co., Ltd.
6	Mr. Teruo TAHARA	Groundwater Development Engineer	CTI Engineering International Co., Ltd.
7	Mr. Manabu ATSUCHI	Water Supply Planner / Mechanical and Electrical Engineer	Daiwa Consultant Co., Ltd.
8	Ms. Kakiko IDE	Environmental Specialist	Polytech ADD Co., Ltd.
9	Mr. Yoshiaki ISHIZUKA	Water Supply Management Engineer	Institute of Project Economics, Inc.
10	Mr. Fumio KOSAKA	Construction Planner / Cost Estimator	CTI Engineering International Co., Ltd.
11	Mr. Hideki KONNO	Facility Designer 2 / Coordinator	CTI Engineering International Co., Ltd.
12	Mr. Toyohiro TAKAGI	Supporting Engineer (Facility Designer)	CTI Engineering International Co., Ltd.

(2) Explanation of Draft Report

No.	Name	Assignment	Affiliation
1	Mr. Yukio ISHIDA	Team Leader	Resident Representative, Mongolia Office, JICA
2	Mr. Akio ENDO	Planning Management Officer	Program Officer, Water Resources Management Division I, Water Resources and Disaster Management Group, Global Environment Dept., JICA
3	Mr. Yoshiharu MATSUMOTO	Chief Engineer	CTI Engineering International Co., Ltd.
4	Mr. Masaki ISHII	Deputy Chief Engineer/ Facility Designer 1	CTI Engineering International Co., Ltd.
5	Mr. Teruo TAHARA	Groundwater Development Engineer	CTI Engineering International Co., Ltd.
6	Mr. Hideki KONNO	Facility Designer 2 / Coordinator	CTI Engineering International Co., Ltd.

2. Survey Schedule

(1) Basic Design Survey

Date				Team Leader	Technical Advisor/ Groundwater Development	Planning Management Officer	Chief Engineer	Deputy Chief Engineer/ Facility Designer 1	Groundwater Development Planner	Water Supply Planner / Mechanical and Electrical Engineer	Environmental Specialist	Water Supply Management Specialist	Construction Planner / Cost Estimator (	Facility Designer 2 / Coordinator	Supporting Engineer (Facility Designer)
No.	Date			Mr. Shigeyuki MATSUMOTO	Mr. Yuji MARUO	Mr. Akio ENDO	Mr. Yoshiharu MATSUMOTO	Mr. Masaki ISHII	Mr. Teruo TAHARA	Mr. Manabu ATSUCHI	Ms. Kakiko IDE	Mr. Yoshiaki ISHIZUKA	Mr. Fumio KOSAKA	Mr. Hideki KONNO	Mr. Toyohiro TAKAGI
1		3	Mon	Tokyo(OM502/Dep 13:25)→ Ulaanbaatar(Arr 17:35)					Tokyo(OM502/Dep 13:25)→ Ulaanbaatar(Arr 17:35)	Miyazaki(JL3626/Dep 12:55) → Ulaanbaatar(Arr 22:40)		Tokyo(KE704/Dep 13:55)→ Ulaanbaatar(Arr 22:40)		Tokyo(OM502/Dep 13:25)→ Ulaanbaatar(Arr 17:35)	Tokyo(KE704/Dep 13:55)→ Ulaanbaatar(Arr 22:40)
2		4	Tue	Courtesy Call on JICA, EOF, USUG, MRTCUD, MNET, Explanation of IC/R					Courtesy Call on JICA, EOF, USUG, MRTCUD, MNET, Explanation of IC/R			Courtesy Call on JICA, EOF, USUG, MRTCUD, MNET, Explanation of IC/R		Courtesy Call on JICA, EOF, USUG, MRTCUD, MNET, Explanation of IC/R	
3		5	Wed	Field Reconnaissance/Gachuut Area, other water sources and water supply facilities					Field Reconnaissance/Gachuut Area			Field Reconnaissance/Gachuut Area		Field Reconnaissance/Gachuut Area	
4		6	Thu	Discussion about M/D with USUG, Courtesy Call on Ulaanbaatar City and OSNAAUG					Discussion about M/D with USUG, Courtesy Call on OSNAAUG			Discussion about M/D with USUG, Courtesy Call on OSNAAUG		Discussion about M/D with USUG, Courtesy Call on OSNAAUG	Technical Discussion with USUG
5		7	Fri	Signing of M/D by USUG, Report to JICA					Technical Discussion with USUG			Field Reconnaissance/Technical Discussion with USUG		Signing of M/D by USUG, Report to JICA	ditto
6		8	Sat	Ulaanbaatar(OM501/Dep 6:55)→Tokyo(Arr 12:30)					Field Reconnaissance/entrusted work	Data collection		ditto		Field Reconnaissance/entrusted work	ditto
7		9	Sun						Data Compilation			Data Compilation			Data Compilation
8		10	Mon						Field Reconnaissance/entrusted work	Field Reconnaissance/Technical Discussion with USUG		Field Reconnaissance/Technical Discussion with USUG		Field Reconnaissance/entrusted work	Technical Discussion with USUG
9		11	Tue						ditto	ditto		ditto		ditto	ditto
10		12	Wed						ditto	ditto		ditto		ditto	ditto
11		13	Thu						ditto	ditto		ditto		ditto	Ulaanbaatar(KE868/Dep 0:20) → Tokyo(Arr 11:30)
12	Aug.	14	Fri						ditto	ditto		ditto		ditto	
13		15	Sat						ditto	ditto		ditto		ditto	
14		16	Sun						Data Compilation			Data Compilation		Data Compilation	
15		17	Mon						Inspection: electric exploration	Field Reconnaissance/Technical Discussion with USUG		Field Reconnaissance/Technical Discussion with related agency		Field Reconnaissance/Technical Discussion with USUG	
16		18	Tue						ditto	ditto		ditto		ditto	
17		19	Wed					Tokyo(OM502/Dep 13:25)→ Ulaanbaatar(Arr 17:35)	data collection	Planning		ditto		ditto	
18		20	Thu					Field Reconnaissance/Technical Discussion with USUG	Field Reconnaissance	ditto		ditto		ditto	
19		21	Fri					ditto	ditto	ditto		ditto		ditto	
20		22	Sat					ditto	ditto	ditto		ditto		ditto	
21		23	Sun					Data Compilation				Data Compilation		Data Compilation	
22		24	Mon					Field Reconnaissance/Technical Discussion with USUG	Inspection: drilling work	Facility planning		Field Reconnaissance/Technical Discussion with USUG		Field Reconnaissance/Technical Discussion with USUG	
23		25	Tue					ditto	ditto	ditto		ditto		ditto	
24		26	Wed					ditto	Field Reconnaissance	ditto		Ulaanbaatar(KE868/Dep 0:20) → Tokyo(Arr 11:30)		ditto	
25		27	Thu					ditto	ditto	Facility planning (machinary)				ditto	
26		28	Fri					ditto	Inspection: drilling work	ditto				ditto	
27		29	Sat					ditto	Analysis of electric exploration	Facility planning (electric)	Tokyo(KE704/Dep 13:55)→ Ulaanbaatar(Arr 22:40)			ditto	
28		30	Sun					Data Compilation						Data Compilation	
29		31	Mon					Field Reconnaissance/Technical Discussion with USUG	Inspection: drilling work	Facility planning (electric)	Field Reconnaissance/Technical Discussion with USUG			Field Reconnaissance/Technical Discussion with USUG	
30		1	Tue					ditto	ditto	Ulaanbaatar(KE868/Dep 0:20) → Miyazaki(Arr 14:55)	ditto			ditto	
31		2	Wed					ditto	ditto		ditto			ditto	
32		3	Thu					ditto	ditto		ditto			ditto	
33		4	Fri					ditto	ditto		ditto			ditto	
34		5	Sat					ditto	ditto		ditto			ditto	
35		6	Sun					Data Compilation			Data Compilation			Data Compilation	
36		7	Mon					Data collection	Inspection: drilling work		Field Reconnaissance/Technical Discussion with MNET			Data collection	
37		8	Tue					ditto	ditto		ditto			ditto	
38		9	Wed					ditto	Data collection		Preparation of 1st Public Consultaion Meeting		Tokyo(KE704/Dep 13:55)→ Ulaanbaatar(Arr 22:40)	Preparatory of 1st Public Consultaion Meeting	
39		10	Thu					1st Public Consultaion Meeting			1st Public Consultaion Meeting		Field Reconnaissance/Technical Discussion with USUG	1st Public Consultaion Meeting	
40		11	Fri					Data collection	Inspection: drilling work		Field Reconnaissance/Technical Discussion with USUG		ditto	Data collection	

Date				Team Leader	Technical Advisor/ Groundwater Development	Planning Management Officer	Chief Engineer	Deputy Chief Engineer/ Facility Designer 1	Groundwater Development Planner	Water Supply Planner / Mechanical and Electrical Engineer	Environmental Specialist	Water Supply Management Specialist	Construction Planner / Cost Estimator (	Facility Designer 2 / Coordinator	Supporting Engineer (Facility Designer)
No.	Date			Mr. Shigeyuki MATSUMOTO	Mr. Yuji MARUO	Mr. Akio ENDO	Mr. Yoshiharu MATSUMOTO	Mr. Masaki ISHII	Mr. Teruo TAHARA	Mr. Manabu ATSUCHI	Ms. Kakiko IDE	Mr. Yoshiaki ISHIZUKA	Mr. Fumio KOSAKA	Mr. Hideki KONNO	Mr. Toyohiro TAKAGI
41		12	Sat					ditto	ditto		ditto		ditto	ditto	
42		13	Sun					Data Compilation			Data Compilation		Data Compilation		
43	Sep.	14	Mon					Facility planning	Inspection: drilling work		Field Reconnaissance/Technical Discussion with MNET		Field Reconnaissance/Technical Discussion with USUG	Field Reconnaissance/Technical Discussion with USUG	
44		15	Tue					ditto	ditto		Preparatory of 2nd Public Consultaion Meeting		ditto	Preparatory of 2nd Public Consultaion Meeting	
45		16	Wed					2nd Public Consultaion Meeting			2nd Public Consultaion Meeting		ditto	2nd Public Consultaion Meeting	
46		17	Thu					Facility planning	Inspection: drilling work		Field Reconnaissance		ditto	Facility planning	
47		18	Fri					ditto	ditto		ditto		ditto	ditto	
48		19	Sat					ditto	ditto		ditto		ditto	ditto	
49		20	Sun					Data Compilation			Data Compilation		Data Compilation		
50		21	Mon					Facility planning	Inspection: drilling work		Field Reconnaissance		Field Reconnaissance/Technical Discussion with USUG	Facility planning	
51		22	Tue					ditto	ditto		ditto		ditto	ditto	
52		23	Wed					Preparatory of Stakeholder Meeting			Preparatory of Stakeholder Meeting		ditto	Preparatory of Stakeholder Meeting	
53		24	Thu					Stakeholder Meeting			Stakeholder Meeting		Stakeholder Meeting	Stakeholder Meeting	
54		25	Fri					Facility planning	Inspection: drilling work		ditto		Field Reconnaissance/Technical Discussion with USUG	Reporting	
55		26	Sat					ditto	ditto		ditto		ditto	ditto	
56		27	Sun					Data Compilation			Ulaanbaatar(KE868/Dep 0:20) → Tokyo(Arr 11:30)		Data Compilation		
57		28	Mon					Facility planning	Inspection: drilling work				Field Reconnaissance/Technical Discussion with USUG	Compilation of Technical Note	
58		29	Tue					ditto	ditto				ditto	ditto	
59		30	Wed					ditto	ditto				ditto	ditto	
60		1	Thu					ditto	ditto				ditto	ditto	
61		2	Fri					ditto	ditto				ditto	ditto	
62		3	Sat					ditto	ditto				ditto	ditto	
63		4	Sun					Data Compilation					Data Compilation		
64		5	Mon				Tokyo(OM502/Dep 13:25)→ Ulaanbaatar(Arr 17:35)	Reporting	Inspection: drilling work	Miyazaki(JL3626/Dep 12:55) → Ulaanbaatar(Arr 22:40)			Field Reconnaissance/Technical Discussion with USUG	Compilation of Technical Note	
65		6	Tue				Technical Discussion with USUG	ditto	ditto	Field Reconnaissance of Central Water Source			ditto	ditto	
66		7	Wed				ditto	ditto	ditto	ditto			ditto	ditto	
67	Oct.	8	Thu				ditto	ditto	ditto	ditto			ditto	ditto	
68		9	Fri					Discussion of Technical Note					Discussion of Technical Note		
69		10	Sat				Discussion with USUG	Reporting	Reporting	Field Reconnaissance of Upper Water Source			Field Reconnaissance/Technical Discussion with USUG	Reporting	
70		11	Sun					Data Compilation					Data Compilation		
71		12	Mon				Discussion with USUG	Reporting	Reporting	Discussion with USUG			Field Reconnaissance/Technical Discussion with USUG	Reporting	
72		13	Tue				Preparation of Steering Committee Meeting			ditto			ditto	Preparation of Steering Committee Meeting	
73		14	Wed				Steering Committee Meeting						ditto	Steering Committee Meeting	
74		15	Thu				Courtesy Call on JICA, EOF						ditto	Courtesy Call on JICA, EOF	
75		16	Fri				Ulaanbaatar(KE868/Dep 0:20) → Tokyo(Arr 11:30)	Facility planning	Inspection: drilling work	Discussion with USUG			ditto	Reporting	
76		17	Sat					ditto	ditto	ditto			Ulaanbaatar(OM501/Dep 6:55)→Tokyo(Arr 12:30)	ditto	
77		18	Sun					Data Compilation		Ulaanbaatar(KE868/Dep 0:20) → Miyazaki(Arr 14:55)				Data Compilation	
78		19	Mon					Facility planning	Inspection: drilling work					Reporting	
79		20	Tue					ditto	ditto					ditto	
80		21	Wed					ditto	ditto					ditto	
81		22	Thu					ditto	ditto					ditto	
82		23	Fri					ditto	ditto					ditto	
83		24	Sat					ditto	Ulaanbaatar(OM501/Dep 6:55)→Tokyo(Arr 12:30)					ditto	
84		25	Sun					Data Compilation						Data Compilation	
85		26	Mon					Facility planning						Ulaanbaatar(OM501/Dep 6:55)→Tokyo(Arr 12:30)	
86		27	Tue					ditto							
87		28	Wed					ditto							
88		29	Thu					ditto							
89		30	Fri					ditto							
90		31	Sat					ditto							
91	Nov.	1	Sun					Data Compilation							
92		2	Mon					Ulaanbaatar(OM501/Dep 6:55)→Tokyo(Arr 12:30)							

Ulaanbaatar

Trip(Tokyo⇔Ulaanbaatar)

JICA : Japan International Cooperation Agency
USUG :Water Supply & Sewerage Authority of Ulaanbaatar City
OSNAAUG :Housing & Public Community Authority
MRTCUD: Ministry of Road, Transport, Construction and Urban Development
MNET: Ministry of Nature ,Environment and Tourism

EOJ : Embassy of Japan
IC/R : Inception Report
M/D : Minutes of Discussion

(2) Explanation of Draft Report

Date				Team Leader	Planning Management Officer	Chief Engineer	Deputy Chief Engineer/ Facility Designer 1	Groundwater Development Planner	Facility Designer 2 / Coordinator
No.	Date			Mr. Yukio ISHIDA	Mr. Akio ENDO	Mr. Yoshiharu MATSUMOTO	Mr. Masaki ISHII	Mr. Teruo TAHARA	Mr. Hideki KONNO
1	Feb.	21	Sun		Tokyo(JL951/Dep 9:50)→Ulaanbaatar(Arr 16:25)				
2		22	Mon	Courtesy Call on JICA, Discussion about the Steering Committee Meeting, Field Reconnaissance (Gachuut Area, Route of Transmission Main)					
3		23	Tue	Courtesy Call and Discussion with EOF & MNET, Field Reconnaissance (Route of Transmission Main)					
4		24	Wed	Steering Committee Meeting (Discussion on the M/D with USUG, Ulaanbaatar City, MRTCUD, Water Authority, MNET)					
5		25	Thu	Discussion with USIP2 & WOPs, Courtesy Call and Discussion with EOF, Discussion on the M/D					
6		26	Fri	Confirmation of contents of the M/D at MRTCUD and Signing, Reporting to EOJ and JICA Mongolia Office					
7		27	Sat		Ulaanbaatar(OM301/Dep 8:40)→Tokyo(Arr 20:15)				

Ulaanbaatar
Trip (Tokyo⇔Ulaanbaatar)

JICA : Japan International Cooperation Agency
USUG :Water Supply & Sewerage Authority of Ulaanbaatar City
MRTCUD: Ministry of Road, Transport, Construction and Urban Development

MNET : Ministry of Nature ,Environment and Tourism
EOJ : Embassy of Japan
M/D : Minutes of Discussion

3. List of Parties Concerned in the Recipient Country

Name	Position	Description
Municipality of Ulaanbaatar		
G. Munkhbayar	Mayor of Ulaanbaatar City	
Munkhbaatar Begzjav	Vice Mayor (In charge of construction, Urban Development and Infrastructure)	
Gankhuu Tsevelsodnom	Chief Engineer and Head of Engineering Facilities Division	
D. Ganbat	Officer of the Urban Development Policy Department	
Jargal Tsambajav	Consulting Engineer Engineering Facilities Division	
L. Altangerel	Urban Development Policy Department	
E. Jargalsaikhan	Officer of Environmental Protection Section	
L. Dashdorj	Specialized Inception Agency of the Ulaanbaatar City	
T. Soyolkhuu	Land Administration of UB city Municipality	
M. Nyamdorj	SSIA of UB city Municipality	
S. Bayarsaikhan	Power distribution Station of UB	
Ts. Regzmaa	UB city, Municipality	
B. Bayanjargal	UB city, Municipality	
Ch. Regzmaa	UB city, Municipality	
Water Supply & Sewerage authority of Ulaanbaatar city（USUG）		
B. Purevjav Msc	Director	
Baatarkhuyag Buyantogtokh	Deputy Director-Chief Engineer	
Yanjindulam Zagdaa	Officer of PIU of USUG	
SH. Ganzorig	Chief of the Industrial and Technology Sector	
N. Bayaraa	Chief of the Water Supply Office	
Ya. Erdenebat	Chief of the United office of the Branches	
P. Boldbaatar	Chief of the Central Cleaning Structure Office	
D. Tuyaa	Chief of the Customer's Sector	
S. Naran-Ochir	Chief of the Apartment Utilization Office	
U. Lkhamsuren	Chief of the Quick Coordination Office	
B. Bazargarid	Chief of the Monitoring and Appraisal Sector	
L. Lkhamaasuren	Chief Accountant Department	
G. Bazkhishig	Chief Electric Engineer	
N. Batsaikhan	Chief Engineer	
TS. Uranchimeg	Manager	
Falkert de Jaga	USUG, VEI	
Ch. Baasandorj	Engineer of the Investment, Supply and Service Sector	
Kh. Chimgee	Engineer of the Industrial and Technology Sector	
N. Narantuya	Engineer of the Industrial and Technology Sector	
B. Oyuun	Engineer of the Project Implementing Sector	
B. Urnaa	Engineer of the Project Implementing Sector	
A. Terbish	Electric Engineer	
M. Suren	Engineer of Estimation and Building	
T. Dagrasuren	Engineer of Pipeline	
G. Batkhishig	General Electrician	
B. Enkhtsetseg	Ecological Officer of the project of USUG	
S. Chuluunbat	GIS Engineer	
Odrhuu	Engineer	
Otgonsuren	Electric Engineer	
Orgilt	Engineer	
Byonbadran	Engineer	
Badran	Engineer	

Name	Position	Description
Ulaanbaatar City Government, Department of Statistics		
Batbayar Baasankhuu	Senior Statistician	
Ministry of Roads, Transport, Construction and Urban Development（MRTCUD）		
G. Myagmar	Deputy Director of Urban Development and Public Utilities Department	
Dashbaljir Nemekhbayar	Director, Finance and Investment Department	
Oyunchimeg		
Ministry of Nature, Environment and Tourism（MNET）		
D. Enkhbat	Director, Department of Environment and Natural Resource	
S. Bayartsetsgg	Expert of Environment	
D. Gantumur	Ministry of Environment and Tourism	
Ministry of Finance		
Dorjkhand Togmid	Deputy Director-General, Department of Development Financing and Cooperation	
Baajiikhuu Tuguldur	Department of Development Financing and Cooperation	
E. Purevjav	Department of Development Financing and Cooperation	
Water Authority		
P. Badamdorj	Head of the department, Water Authority	
Badamdorj Purev	Director, Water Utilization Department	
Tsedenbaljir Yadamtsoo	Head of Department Water Rcsources	
G. Batbayar	Water Authority	
Housing & Public Community Authority（OSNAAUG）		
Dashzeveg	Director	
World Bank（USIP）		
L. Badamkhorloo	Director, Funded Second Ulaanbaatar Services Improvement, Project Management Unit	
Enkhivvshin	Engineer	
Nyamdorj		
Bayanzurkh District		
D. Myagmar	Head of Land Administration of Bayanzurkh District	
A. Enkhmanlai	Land Administration of Bayanzurkh District	
N. Altansukh	Advisor of Bayanzurkh District Governor	
Governors of Khoroo		
C. Davaakhuu	Bayanzurkh District, 2nd Khoroo	
D. Batchimeg	Bayanzurkh District, 4th Khoroo	
Chimeddorj	Bayanzurkh District, 4th Khoroo	
G. Myadagmaa	Bayanzurkh District, 5th Khoroo	
Kh. Myadagmaa	Bayanzurkh District, 5th Khoroo	
Jargalsaikhan	Bayanzurkh District, 10th Khoroo	
Sh. Tsetseg	Bayanzurkh District, 17th Khoroo	
R. Zina	Bayanzurkh District, 17th Khoroo	
O. Munkherdene	Bayanzurkh District, 19th Khoroo	
G. Ganbold	Bayanzurkh District, 20th Khoroo	
U. Davaajav	Bayanzurkh District, 22th Khoroo	
Ts. Ouyn	Bayanzurkh District, 23th Khoroo	
B. Dagiikhuu	Bayanzurkh District, 24th Khoroo	
D. Otgonbaatar	Head of 124 Military Unit	
B. Idersaikhan	124th Military Unit	
Myagmartsooj	Deputy of 084 Military Unit	

Name	Position	Description
Battumur	Head of Peoples' Meeting of Gachuurt	
Embassy of Japan（EOJ）		
Takahiro ISHIZAKI	First Secretary	
Yoichi OKAWA	Second Secretary	
JICA Mongolia Office		
Yukio ISHIDA	Resident Representative	
Kazutoshi ONUKI	Senior Representative	
Toru OGURA	Project Formulation Adviser	
Ryuko HIRANO	Project Formulation Adviser	
E. Ankhtsetseg	Program Administrative Officer	
Other		
U. Tsedendamba	Land Relation, Construction and Geodesy Cartography Authority	
Folkert de Jager	VEI, Netherlands	
S. Rosenthar	The Asia Foundation	
Chimedochir		
S. Amarbayasgalan	Nature Friendly LLC	
T. Gantumur	Nature Friendly LLC	
G. Buyandelger	Nature Friendly LLC	
G. Myanganbayar	UBS TV-journalist	