2.7 ECOLOGY AND ENVIRONMENT

2.7.1 Mongolia

(1) Outline

No countries can be compared with Mongolia on the size, diversity, and the health of its natural ecosystems in the temperate zones of the Northern Hemisphere. Mongolia is located at the northern edge of Central Asian deserts and the southern edge of vast Siberian taiga. Its wide range of transitional ecosystems is reflected in the diversity of wild species. But these ecosystems are recently affected by some environmental factors, such as overgrazing and deforestation.
Mongolian Ministry for Nature and Environment revised the "Protected Area of Mongolia" in 1998 as shown in Figure 2.7.1.

(2) Fauna

Mongolia's fauna represents a mixture of species from the northern taiga of Siberia, the steppe, and the deserts of Central Asia. Fauna includes 136 species of mammals, 436 birds, 8 amphibians, 22 reptiles, 75 fish, and numerous invertebrates.

(3) Flora

Representative species of Siberia's coniferous taiga forest, Central Asia's steppe and desert, and the Altai and Sayan mountains all occur in Mongolia. More than 3000 species of vascular plants, 927 lichens, 437 mosses, 875 fungi, and numerous algae have been recorded. Mongolia's flora includes almost 150 endemic plants and nearly 100 relict species.

(4) Land Degradation

Much of Mongolia is pasture land. Grazing pressure is greatest near settlements and as a consequence these areas are most degraded. By all accounts the traditional methods of livestock management maintained most of Mongolia's pasture lands in relative good condition. In the last few years, however, there has been substantial increase in the number of herders. The effect of bringing many herders who are not familiar with the traditional grazing systems induces the land degradation.

Hydrologically, degrading grasslands lead to increased nutrient and sediment runoff from the bared soils. Without grass and organic materials the snow and moisture retention character of the soil degrades and seed germination and plant growth become more difficult each succeeding year.

2.7.2 Gobi-Altai Province

Gobi-Altai province has a variety of ecosystems, has five of six natural zones of Mongolia, such as high mountain, mountain forest steppe, steppe, desert steppe and desert, but doesn't have taiga forest zone.

- High mountain zone: climate in the high mountain zone is extreme, with high winds, extreme cold, and a short growing season. Relatively few species are adapted to these harsh conditions. Located above tree line, the zone is characterized by tundra, alpine-sedge meadows, highland swamps, and lichen-covered boulder fields (Khan Tayshirn mountains).
- Mountain forest steppe zone: mixed coniferous forest is found on cooler, moister northern slopes, while steppe vegetation predominant on other slopes (around Khan Tayshirn and Altai mountains).
- Steppe zone: the steppe zone provides many of the nation's most important grazing lands for domestic live-stock. The steppe is vulnerable to impacts from overgrazing, agriculture, roads and other human activities (North part of Khan Tayshirn mountains and areas between Khan Tayshirn mountains and Altai mountains).
- Desert steppe zone: the zone includes many low grasses and semi-shrub areas with salt pans, and small ponds. The climate is arid with frequent droughts and annual precipitation of 100-125 mm, and frequent strong winds and dust storms strongly influence the areas vegetation (the most part of northern Gobi-Altai province).
- Desert zone: Vegetation is sparse here. Climate is extreme. Precipitation may fall only once every two to three years, and averages less than 100 mm annually. Temperatures climb as high as 40℃ in summer, and fall as low as -40℃ in winter the most part of southern Gobi-Altai province).

The Study area is situated in the desert steppe zone.

2.7.3 Altai City

(1) Fauna

The development of Altai City has reduced the distribution of the large mammals near the city however some animals are still observed in the survey area. The dominant wild animals in the study area are shown in Figure 2.7.2. Common mammal species are Brandt's Vole, Tolai Hare, Siberian Marmot, Red Fox and Corsac Fox, and common bird species are Northern Wheatear, Arctic Warblar, Tree sparrow, White Wagtail, Horned Lark, Northern Raven and Rock Pigeon. Around Khadaasan river a variety of birds of prey were seen. In wet season (spring and summer), some waterfowls visit temporary wet lands. Common insects are arid steppe locusts and grasshoppers.

(2) Flora

A great part of the land near Altai City is used as pasture land. Overgrazing near the city and the present chaotic sprawl of roads have caused damage to the soil and vegetation.

The vegetation cover near Altai City can be divided into two types as follows:

Arid desert vegetation

- On the hilly and elevated terrain with small mounds and knolls stretching south-eastward from the north-west of Altai with clayey brown soils are abundant hillock plants with segmented stems, Shiveet Needlegrass, Motley Grass, and wild Leek.
- On the elevated places with pebbly soils grow small hillock plants with segmented stems.
- On the lowlands and valleys are recorded Feather Grass communities.
- The average plant height is 10 to 15 cm, approximately 10-12 species are to be observed at an area of 100 m^2, and the vegetation coverage makes up15-20%.

Desert steppe vegetation

- One of the characteristics of this type of vegetation is "arid clusters" where segmented small plants are dominating.
- In the brown soils of lower and middle mountain slopes, knolls, inter-mountain

hillocks and elevations around Altai City, some of the most widespread are typical plant species of the Mongolian desert steppe;

- Near Altai City, Gobian Needlegrass and Sandy Needleglass, Racemose Bluegrass, Pearl Russian Thistle, Common Russian Thistle, root onion species and Della Wormwood species are found; and
- The vegetation coverage is 10-15%, and 5-10 species of plants are to be recorded per 100 m^2.

2.7.4 Environment

This section describe the environmental law and organisation in Mongolia.

(1) Environmental Laws and Regulations

a) Mongolian Law on Land (date effective; April/1/1995)
b) Mongolian Law on Special Protected Areas (date effective; June/5/1995)
c) Mongolian Law on Environmental Protection (date effective; June/5/1995)
d) Mongolian Law on Air (date effective; June/5/1995)
e) Mongolian Law on Hunting (MLH) (date effective; June/5/1995)
f) Mongolian Law on Water (date effective; June/5/1995)
g) Mongolian Law on Forests (date effective; June/5/1995)
h) Mongolian Law on Natural Plants (MLNP) (date effective; June/5/1995)
i) Mongolian Law on Protection from Toxic Chemicals (date effective; June/5/1995)
j) Mongolian Law on Hunting Reserve Use Payments, and on Hunting and Trapping Authorization Fees (date effective; July/1/1995)
k) Mongolian Law on Water and Mineral Water Use Fees (date effective; July/1/1995)
l) Mongolia Law on Fees for Harvest of Forest Timber and Fuel Wood (date effective; July/1/1995)
m) Mongolian Law on Natural Plant Use Fees (date effective; July/1/1995)
n) Mongolian Law on Underground Resources (date effective; May/5/1996)
o) Mongolian Law on Mineral Resources (date effective; September/30/1994)
p) Mongolian Law on Protection from Forest and Steppe Fire (date effective; May/5/1996)
q) Mongolian Law on Environmental Impact Assessment (date effective; February/20/1998)
r) Mongolian Law on Hydro-meteorology (date effective; November/13/1997)
s) Land Fees Law of Mongolia (date effective; July/1/1997)

t) Mongolian Law on Buffer Zone of Strictly Protected Areas (date effective; October/23/1997)

(2) International Conventions and Treaties Related to Environment

Mongolia participates in the following conventions.

a) Convention on International Trade in Endangered Species of Wild Fauna and Flora (acceded in January/5/1995).
b) Montreal Protocol on Substances that Deplete the Ozone Layer (ratified in March/7/1996).
c) Vienna Convention for the Protection of the Ozone Layer (ratified in March/7/1996).
d) Convention on Biological Diversity (acceded in September/30/1993).
e) United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa (signed in 1994, ratified in September/3/1996).
f) UN Framework Convention on Climate Change (acceded in September/30/1993)
g) Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (ratified in April/15/1997).
h) Convention on Wetlands of International Importance Specially as Waterfowl Habitat (acceded in April/8/1998).
i) Convention on the Prohibition of the Development, Production, Stockpiling and the Use of Chemical Weapons and on their Destruction (ratified in January/7/1995, entry into force in April/29/1997).

(3) Executing Agency

Ministry for Nature and Environment (MNE) has the responsibility for investigation, monitoring, conservation, and protection of the natural and social environment.

(4) Initial Environment Examination (IEE)

In Mongolia, IEE is regarded as the General Environmental Screening Process in conformity with the Mongolian Law on Environmental Impact Assessment approved by the Parliament of Mongolia on January 22, 1998. For this project, it was carried out on May 22, 1998 by State Senior Inspector, Policy and Coordination Department of the Ministry for Nature and Environment.

(5) Mongolian Environmental Impact Assessment

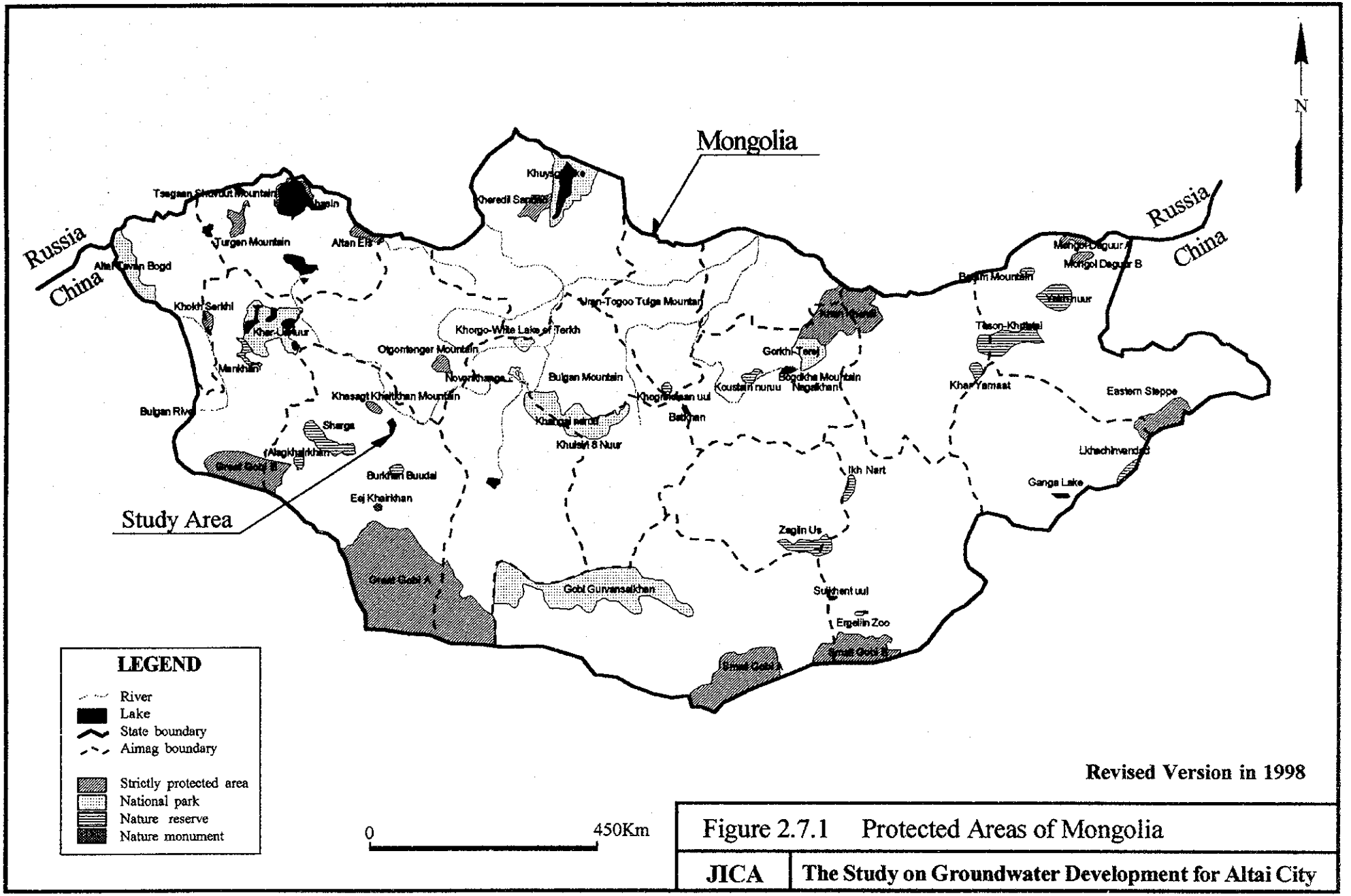
The following laws stipulate the Environmental Impact Assessment (EIA).

a) Mongolian Law on Environmental Impact Assessment (date effective; February/20/1998): the purpose of this law is the environmental protection, prevention from ecological imbalance, natural resource use management, environmental impact assessment of the projects and co-ordination any interrelations connected to the regulation on project implementation.
b) Annex of the Mongolian Law on Environmental Impact Assessment: the Criteria for application of projects to Environmental Impact Assessment.
c) Annex of decree No. 66 of 1998 of the Minister for Nature and Environment: the Manual for the Project screening of the Environmental Impact Assessment.
d) Annex 1 of decree No. 66 of 1998 of the Minister for Nature and Environment: the Manual for Project Description.
e) Annex 2 of decree No. 66 of 1998 of the Minister for Nature and Environment: the Mitigation Measures taken for environmental impacts.

EIA procedure is shown in Figure 2.7.3. Proponents of projects shall submit a project description to MNE and the local government before the implementation. MNE and the local government will conduct the screening and choose the required level of EIA study out of the following.

- No further study of EIA is required
- Item-wise EIA study is required
- Full scale study of EIA is required

If it is required, a licensed environment impact assessment company will conduct the EIA study for the project under the supervision of the government. The results of EIA study are made open to the public. The government makes a decision whether to implement the project or not on the basis of the results.



Revised Version in 1998

Figure 2.7.1 Protected Areas of Mongolia

JICA | The Study on Groundwater Development for Altai City

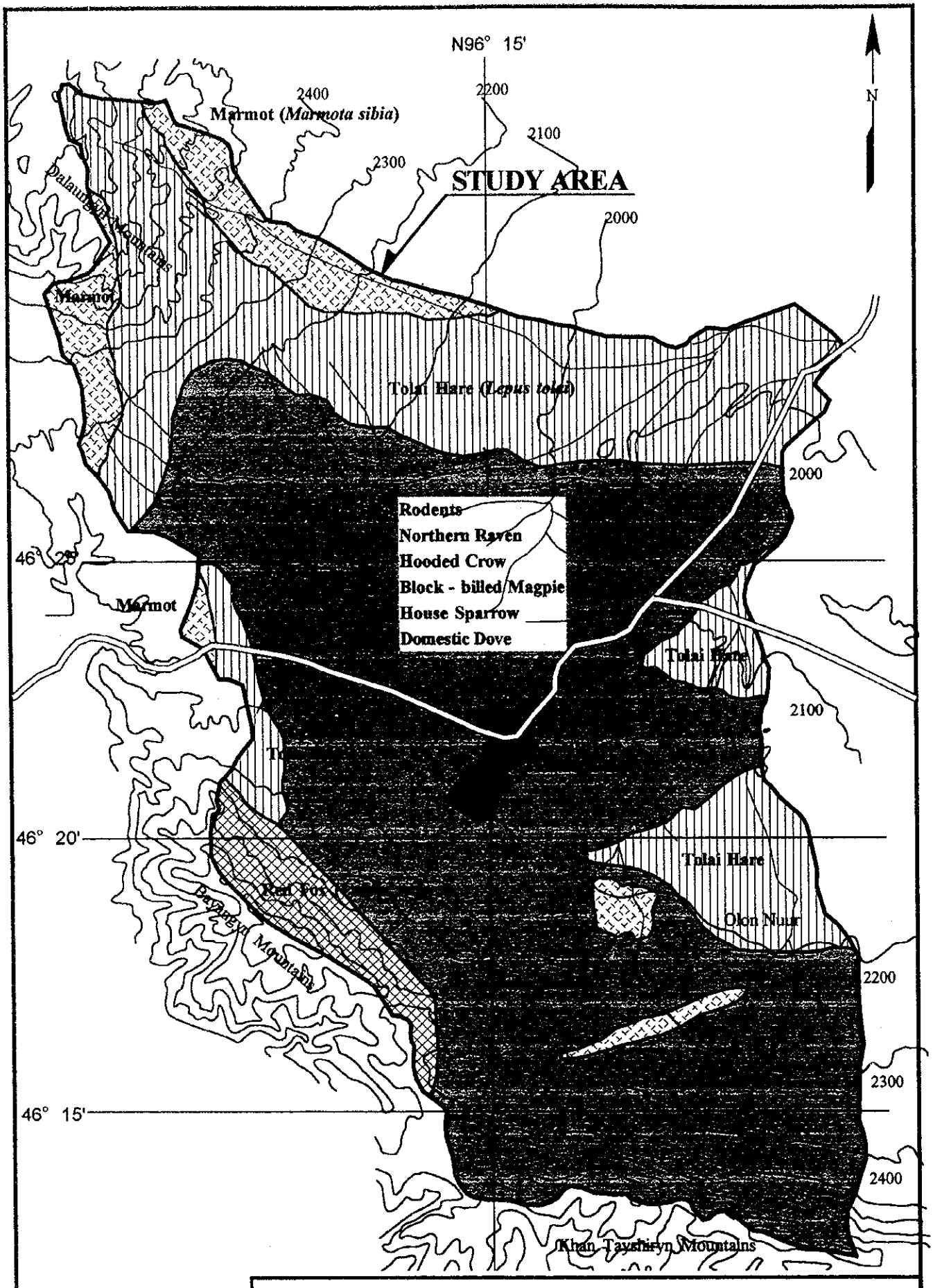


Figure 2.7.2 Distribution Map of Animals in the Study Area

JICA	The Study on Groundwater Development for Altai City

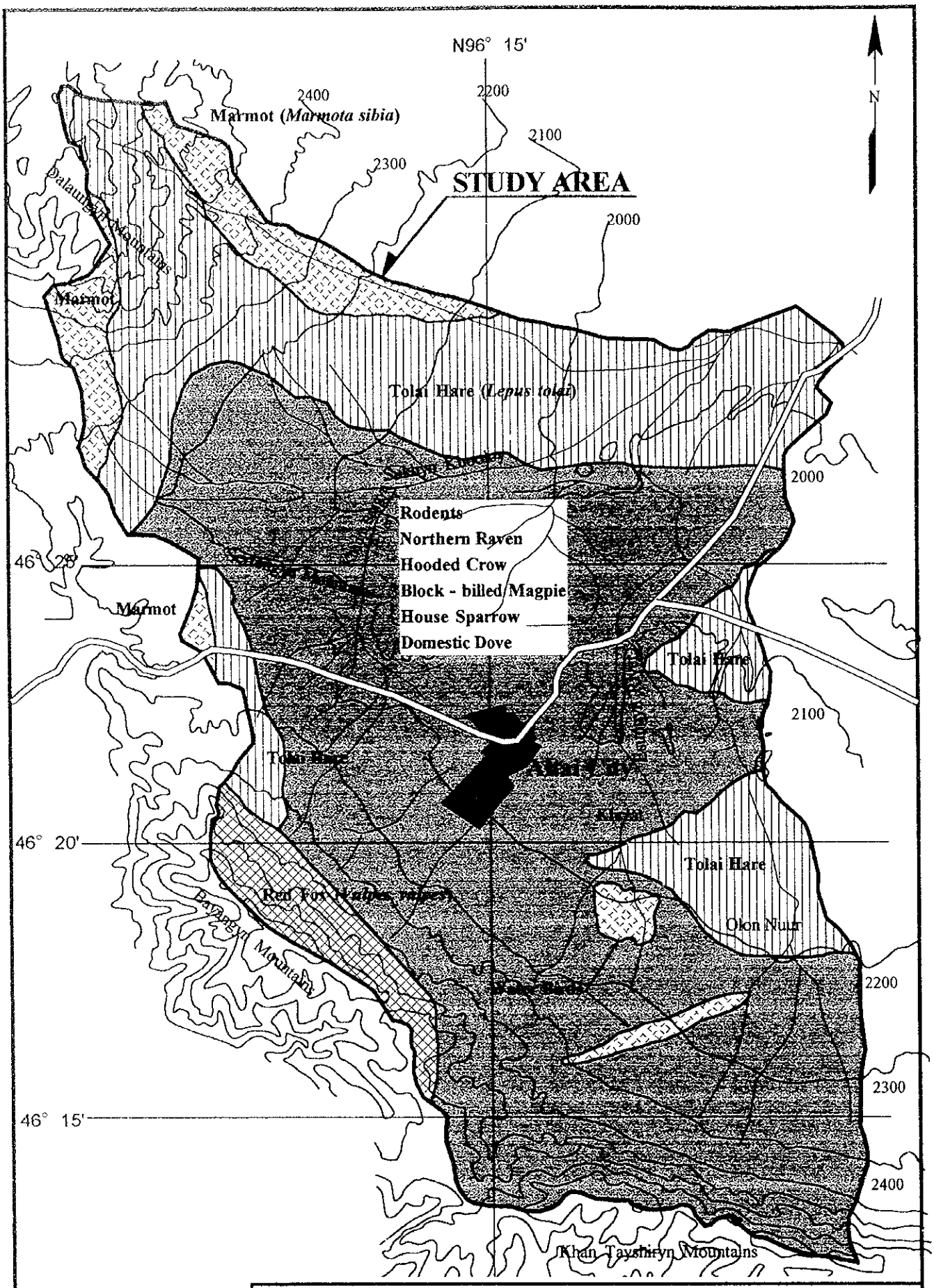


Figure 2.7.2 Distribution Map of Animals in the Study Area

JICA	The Study on Groundwater Development for Altai City

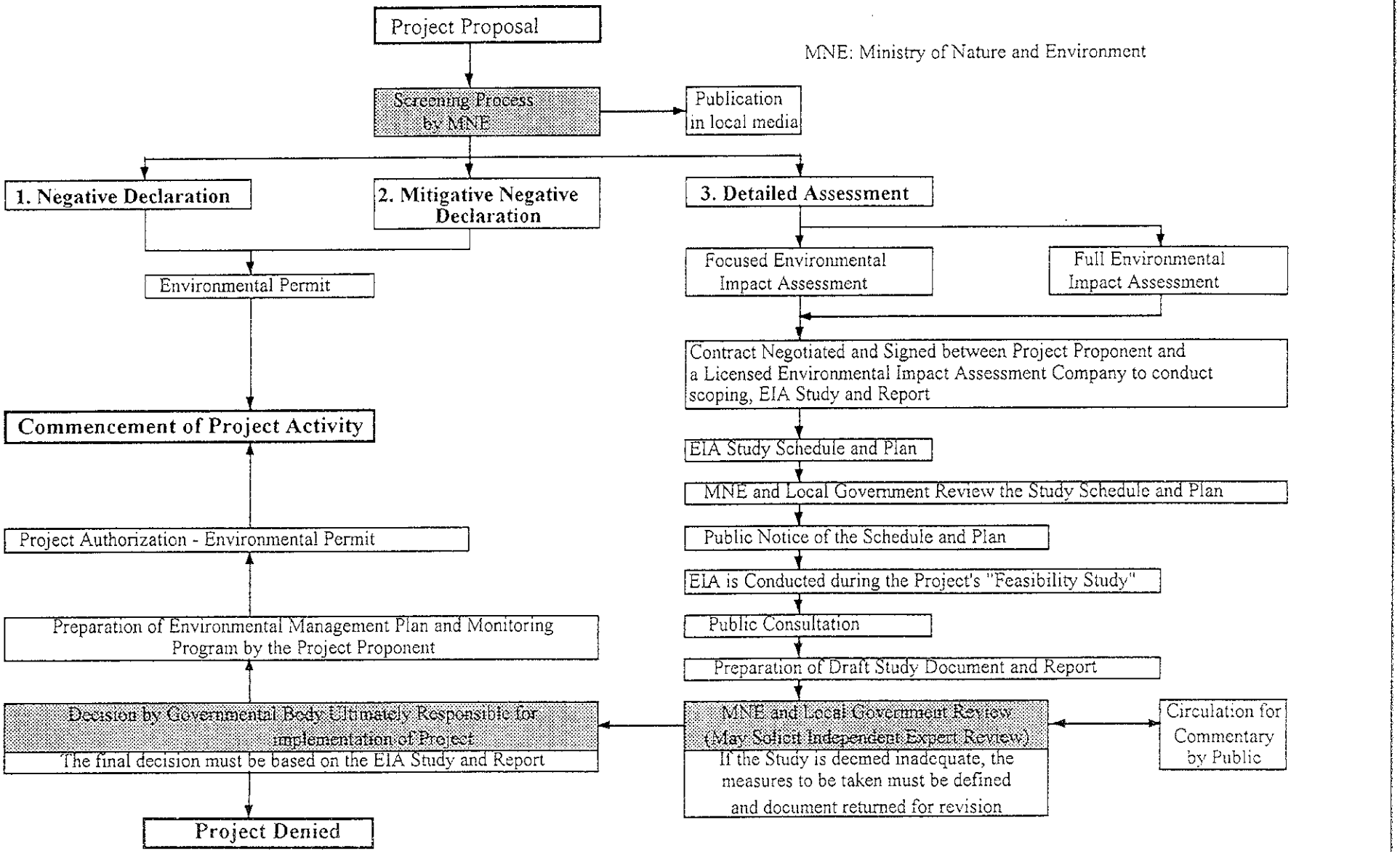


Figure 2.7.3 Mongolian Environmental Impact Assessment Procedure

2.8 WATER QUALITY

2.8.1 Objectives of Analysis

The Study Team conducted water quality analysis in 1997 and 1998. A part of the actual analysis was subcontracted to a local firm and the rest was carried out by some counterparts under the supervision of a member of the Study Team in Altai City.

The objectives of the water quality analysis are:

1) to investigate the groundwater characteristics and mechanism,
2) to clarify the condition of water supply system,
3) to clarify the condition of contamination of sewerage system, and
4) to clarify the condition of contamination of river.

2.8.2 Review of Previous Data

Water quality of drinking water in Gobi Altai Province has been monitored by Physicochemical and Bacteriological laboratories of Social Health Center in Gobi Altai Aimag in the past.
The recent results of analysis for drinking water of Villages in Gobi Altai Aimag are shown in Table 2.8.1. Water quality of the water supply system in Altai City is shown in Table 2.8.2. Some heavy metal parameters for the drinking water in Altai City was also studied (Table 2.8.3). The followings can be pointed out from the review of those data:

1) the magnesium ion concentration of drinking water in some Sum's (Khaliun, Bayan, Jargalan, Erdene, Tugrug, Khekhmorut, and Tsogt) and Altai City exceeds the Mongolian standard for drinking water (30 mg Mg/l),
2) the chloride ion concentration of drinking water in two Sum's, Bayan and Khekhmorut, exceeds the Mongolian standard for drinking water (350 mg Cl/l),
3) total bacteria number tends to increase in Altai City as the years go on, and
4) all heavy metallic parameters shown in Table 2.8.3 fulfill the Mongolian standard for drinking water.

2.8.3 Study Method

Water sampling and analysis were conducted in 1997 and 1998 at wells, rivers and water supply facilities in order to clarify some water related issues.

(1) Sampling

The summary of the sampling for the year 1997 and 1998 is presented below. The sampling locations are shown in Figure 2.8.1 and 2.8.2

Summary of Sampling in 1997:

Site	Site Names and Remarks
Existing Well	Total Number of sites: 8
	SW-1, SW-2, SW-3, SW-4, SW-5, SW-6, SW-7, SW-8 * SW-6 is the production well of APSD
Water Supply System	Total Number of sites: 14
	Reservoir at the pumping station: (DR-1 and DR-2)
	Tap water: Hospital (DT-1), Government Office (DT-2), Hotel (DT-3), High School (DT-4), Apartment (DT-5)
	Water wagons: (DW-1 and DW-2) at the station for water wagons.
	Water stored in Ger : (DG-1, DG-2, DG-3, DG-4, DG-5)
Sewerage System	Total Number of sites: 3
	at the new wastewater treatment plant (WWTP) (S-1)at the influent, (S-2) at the middle, (S-3)at the effluent * The old WWTP has no flow
River	Total Number of sites: 4
	Khadaasan (R-1), Mandaliin Aryn Am (R-2), Esuitiin Sair (R-3), and Hanginaagiin Hooloy (R-4) * The location of sampling are those where river cross sectional surveys were conducted in 1997. Some sampling were not carried out because of no stream.

The result of the analysis in 1997 revealed relatively high concentration of heavy minerals in waters of both well and water supply systems. Therefore the Study Team decided to carry out sampling at some of these sites to confirm this results. The detail will be discussed in the following section.

Summary of Sampling in 1998:

Site	Site Names and Remarks	
Existing Well (Reanalysis)	Total Number of sites	2 (4)
	SW-5, SW-6, SW-7, and SW-8 * Water sampling was planned at four existing wells (SW-5, SW-6, SW-7, and SW-8) in order to reanalyze heavy metal parameters (lead, cadmium and arsenic) but SW-5 well had been filled with stones, and SW-7 well was frozen. Therefore sampling could not be carried out for these two wells. The other wells (SW-1, SW-2, SW-3 and SW-4) were in very low water level and sampling could not be carried out for these four wells.	
Water Supply System (Reanalysis)	Total Number of sites	9
	DR-1, DR-2, DT-1, DT-2, DT-3, DT-4, DT-5, DW-1, and DW-2 * in order to reanalyze heavy metal parameters (lead, cadmium and arsenic).	
New Test Well	Total Number of sites	10
	A1, A2, A3, A4, B1, B2, B3, B4, B5, and B6 * The samplings were done when the pumping test of a new well was done.	

(2) Parameters and Method of Analysis

Forty eight (48) chemical parameters were analyzed with several different methods either in Altai City or in Ulaanbaatar. The detail of the methods are described in Chapter 7 of the supporting report.

The following parameters were measured in laboratory in Altai City:

pH, temperature, odor, taste, color, turbidity, conductivity, hardness, dry residue, COD ($KMnO_4$, alkali), nitrite, nitrate, ammonium, orthophosphate, bicarbonate, carbonate, chloride, sulfate, potassium, calcium, magnesium, copper, iron, manganese, chromium (VI), cyanide, fluoride, silica, aluminum, total coliforms, general bacteria, residual chlorine, SS, alkalinity, acidity

The following parameters were measured in Ulaanbaatar:

chloride, sulfate, sodium, potassium, calcium, copper, iron, manganese, zinc, lead, chromium, cadmium, arsenic, mercury, molybdenum, beryllium, sulfur, chlorine(element), nickel, selenium, bromine, strontium, BOD, COD.

Some parameters were also measured in Japan for verification.

2.8.4 Analysis Results

Existing Wells and New Test Wells

The results of the analysis are summarized in Table 2.8.4 for existing wells (including calculated values of magnesium and hardness from the charge balance of major ions) and Table 2.8.5 for new test wells. The reanalyzed data of heavy metal (lead, cadmium, arsenic and total chromium) for SW-6 and SW-8 is also shown in Table 2.8.6. These values are compared with Mongolian Standards and the findings are as follows.

1. The water from all the existing wells except SW-6 is not good for drinking because the hardness, magnesium, and sulfate concentration are very high.
2. The water from all the new test wells except B5 and B6 is not good for drinking, because the hardness, magnesium, and sulfate concentration are very high.

Water Supply Facilities

The results of water quality analysis for 1997 are summarized in Table 2.8.7. The calculated values of magnesium ion, hardness and dry residue from the charge balance of major ions are shown in Table 2.8.8. The reanalyzed data for 1998 for lead, cadmium, arsenic and total chromium are shown in Table 2.8.9. It was confirmed that the reanalysis values for all the heavy metals fulfilled the Mongolian standard values.

Rivers

Water quality for rivers are shown in Table 2.8.10. Khadaasan river (R-1)'s water has high concentration of sulfate, chloride, calcium, magnesium and strontium. All these rivers are microbiologically contaminated.

Sewerage System

Water quality for the sewerage system is shown in Table 2.8.11 and 2.8.12. The result of water quality analysis of the effluent (S - 3) is that :

a) ammonia exceeds this limit of 10 mg N/l,
b) SS exceeds this limit of 30 mg/l,
c) BOD is within or is slightly over this limit of 20 mg/l.

This treatment water may affect on pasture.

2.8.5 Evaluation of Drinking Water Quality

Water Quality was evaluated according to Mongolian standards or WHO guidelines. The results are shown in Table 2.8.13 for existing wells and water supply system, and new test wells.

Existing Wells and New Test Wells

Kharzat well (SW-6) is the best of all analyzed existing wells for a drinking water source, though its magnesium concentration exceeds slightly the Mongolian standard of 30 mg/l and the total coliform number is high.
B5 and B6 of the new test wells are better than any other new test wells for a drinking water, though magnesium concentration exceeds the Mongolian standard and total coliform is very high.
Considering all the analysis results, SW-6 (Kharzat well) is the best choice as water supply source among all the existing wells and new test wells. B5 and B6 can also be used in the future. B5 is better than B6, because the magnesium concentration in B5's water is lower than that in B6.

Water Supply Facilities

All the parameters except for the magnesium concentration and microbiological parameters (total coliforms and general bacteria) of the water supply facilities are acceptable. Water stored in Ger (DG) is microbiologically more contaminated than other samples of the water supply facilities.

Table 2.8.1 Water Quality for Drinking Water in Gobi Altai Province

Sum name	year	season	odor	taste	temp	trans-parency	color	pH	hardnes	Ca	Mg	NH_4	NO_2	NO_2	chloride	Fe	PO_4	F	SO_4	acidity	alkalinity	residual chlorine	bacterium	coliform
					°C	cm			meq/l	mg Ca/	mg Mg/l	mg N/l	mg N/l	mg N/l	mg Cl/l	mg Fe/l	mg PO_4/l	mg F/l	mg SO_4/l	meq/l	meq/l	mg Cl_2/l	number/ml	number/l
Kharzat	1985	av. of 4 time	1	2	6.0	>30	5	6.8	4.4	39	40	0.06	0.01	0.90	21	0.00				0.30	3.6		38	3
(Altai City)	1986	av. of 4 time	1	2	6.0	>30	5	8.0	4.5	30	35	0.01	0.01	1.00	28	0.00				0.20	4.0		35	3
	1987	av. of 4 time	1	2	7.6	>30	5	7.5	4.7	31	35	0.01	0.01	1.50	28	0.00				0.30	3.8		7	3
	1988	av. of 4 time	1	2	8.2	>30	5	7.2	4.6	32	36	0.10	0.03	1.30	27	0.30				0.30	4.0		31	3
	1989	av. of 4 time	1	2	8.5	>30	5	7.2	4.8	34	37	0.10	0.03	1.10	28	0.30		0.46		0.30	3.9		18	3
	1990	av. of 4 time	1	2	9.0	>30	5	7.2	5.0	36	38	0.09	0.03	1.00	28	0.30		0.44		0.30	4.0		47	3
	1991	av. of 4 time	1	2	9.0	>30	5	8.0	4.9	32	39	0.10	0.05	0.05	155	0.30	0.030	0.70		0.30	4.1	0.35	99	3
	1992	av. of 4 time	1	2	9.0	>30	5	8.0	4.8	34	39	0.10	0.05	0.30	181	0.23	0.050	0.52		0.25	4.3	0.40	105	3
	1993	av. of 4 time	1	2	8.5	>30	5	8.0	4.9	34	40	0.09	0.03	0.30	59	0.17	0.150	0.56		0.25	4.0	0.38	134	3
	1994	av. of 4 time	1	2	8.7	>30	5	8.0	4.8	32	39	0.15	0.07	0.03	27	0.40	0.098	0.46		0.23	4.1	0.50	318	5
	1995	av. of 4 time	1	2	8.6	>30	5	8.0	4.8	32	37	0.15	0.09	0.10	29	0.10	0.085	0.64		0.28	3.8	0.35	117	3.5
Sharga	1993	av. of 4 time	1	1		>30	5	7.0	4.2	46	23	0.20	0.01	1.00	25	0.00				0.03	4.0			
	1994	av. of 4 time	1	1	4.0	>30	5	7.0	4.0	40	24	0.01	0.01	1.00	25	0.00				0.30	4.0			
	1995	av. of 4 time	2	2				6.0	4.0	50	15	0.23	0.05		58	0.10				0.20	2.9			
Khaliun	1993	av. of 4 time	1	1	6.0		5	7.4	5.4	56	31	0.10	0.03	1.50	21	0.00				0.30	3.8			
	1994	av. of 4 time	1	1	10.0		5	7.0	5.2	52	31	0.10	0.04	1.00	37	0.30				0.30	4.6			
	1995	av. of 4 time	2	2		>30	5	7.0	5.3	58	29	0.20	0.11	0.75	60	0.08					3.7			
Taishir	1993	av. of 4 time	1	1	7.0		5	7.0	2.8	38	11	0.01	0.01	1.00	28	0.00				0.30	4.0		52	9
	1994	av. of 4 time	1	1	4.0		5	7.0	2.0	28	72	0.01	0.01	1.00	24	0.00				0.30	4.0			
	1995	av. of 4 time	1	1			5	7.0	2.6	28	15	0.01	0.01	1.50	25	0.00				0.30	3.8			
Delger	1993	av. of 4 time	1	1	5.0	28	5	6.8	3.6	38	20	0.00	0.03		37	0.50				0.30	2.7			
	1994	av. of 4 time	1	1	3.0	>30	5	6.8	4.6	46	28	0.10	0.01	1.50	49	0.50				0.20	3.0			
	1995	av. of 4 time	1	1		>30	5		3.9	40	19	0.10	0.01	1.00	26	0.30				0.30	3.5		91	3
Bungat	1994	II	2	2		>30	5	6.0	3.9	52	16	0.20	0.15		36					0.10	2.7			
Tseel	1994	II	1	1		>30	5		8.1	95	24	0.10	0.01	1.00	60	0.30				0.20	4.3			
Bayan	1994	II	2	2		>30	5	4.0	8.2	88	46	0.10	0.03	0.14	462	0.20				0.20	3.9			
Chandmana	1994	II	4	1		>30		7.0	3.3	46	16		0.05		26	0.10				0.30	4.2			
Jargalan	1994	II	2	2	3.0	>30	5	4.0	5.2	44	36	0.23	0.10	0.04	60	0.15				0.20	4.0			
Erdene	1994	II	2	2		>30	5	6.5	6.1	50	43	0.20	0.05		18	0.10				0.30	3.8			
Tugrug	1994	II	2	2		>30		7.0	8.2	88	46	0.20	0.25		52	0.10				0.40	2.9			
Khekhmorut	1994	II	2	2		>30	5	8.0	6.5	79	31	0.20	1.50	0.10	354	0.10				0.30	3.1			
Bigar	1994	II	1	1		>30		7.0	3.2	36	17	0.20	0.10		19	0.10	0.005	0.60		0.10	2.7			
Tsogt	1994	II	2	2		>30	5	7.0	8.2	76	53				55					0.20	4.6			
Tonkhil	1994	II	2	2			5	6.1	5.6	71	28	0.10	0.01	0.80	23	0.30				0.20	4.0			
Darvi	1994	II	2	2		>30	5	7.0	2.7	30	14				18					1.50	0.3			
Altai	1994	II	2	2		>30	5	5.0	4.5	58	19	0.15	0.44	0.03	17	0.07	0.025	0.50		0.30	3.0			
Standard for drinkng water			≦2	≦2		>30	≦20	6.5-8.5		≦100	≦30			≦10	≦350	≦0.3	≦3.5	0.7-1.5	≦500					≦3

Table 2.8.2 Water Quality for Drinking Water in Kharzat (Altai City) and Zavkhan River

Sampling Point	year	odor	taste	transparency cm	color	pH	hardness meq/l	Ca mg Ca/l	Mg mg Mg/l	NH4 mg N/l	NO_2 mg N/l	NO_3 mg N/l	chloride mg Cl/l	Fe mg Fe/l	PO_4 mg P/l	F mg F/l	acidity meq/l	alkalinity meq/l	residual chlorine mg Cl2/l
Reservoir (before chlorination)	1993	2	2	>30	5	7.6	4.9	32	36	0.02	0.04	0.35	47	0.10	0.035	0.50	0.20	3.8	0.00
	1994																		
	1995	2	2	>30	5	7.0	4.8	32	39	0.80	0.28	0.04	23	0.20	0.140	0.60	0.20	3.8	0.00
	1996	2	2	>30	5	7.5	4.9	50	41	0.30	0.20	0.01	23	0.20	0.060	1.10	0.30	3.7	0.00
Reservoir (after chlorination)	1993	2	2	>30	5	7.8	5.0	35	38	0.20	0.04	0.16	60	0.20	0.080	0.40	0.30	4.0	0.60
	1994	2	2	>30	5	7.0	4.7	32	32	0.10	0.02	0.04	21	0.18	0.130	0.40	0.30	4.0	0.68
	1995	2	2	>30	5	7.0	4.8	32	39	0.12	0.13	0.03	23	0.18	0.080	0.45	0.30	4.0	0.35
	1996	2	2	>30	5	8.0	4.8	39	40	0.20	0.10	0.20	23	0.10	0.200	1.00	0.30	4.0	0.00
Tap Water	1993	2	2	>30	5	7.0	5.2				0.05	0.04	23	0.20			0.30	4.0	0.30
	1994	2	2	>30	5	7.0	4.7	31	37		0.03	0.05	23	0.20		0.40	0.30		0.30
	1995																		
	1996	2	2	>30	5	8.0	4.8	36						0.20	0.040		0.30	3.8	0.00
Water Wagon	1993	2	2	>30	5	7.0	5.4	40	42		0.08	0.04	23	0.21	0.030	0.70	0.30	4.0	0.25
	1994	2	2	>30	5	7.0	4.8			0.12	0.04	0.05	23	0.20	0.100	0.80	0.30		0.27
	1995	2	2	>30	5		4.7	30	39					0.20		0.80	0.30	4.0	0.29
	1996	2	2	>30	5	8.0	4.8	36	31					0.28			0.30	4.0	
Zavkhan River																			
(Guulin)	1991	2	2	>30	5	7.5	2.1	26	10				14	0.10	0.120		0.20	2.8	
(Guulin)	1996	2	2	>30	5	7.5	1.8	30	6				8	0.10	0.130		0.20	2.8	
(Taishir)	1996	2	2	>30	5	7.5	2.4	36	7				16	0.10	0.300		0.20	3.0	
Standard for drinking water		≦2	≦2	>30	≦20	6.5-8.5		≦100	≦30			≦10	≦350	≦0.3	≦3.5	0.7-1.5			

Table 2.8.3 Heavy Metal Parameters in Drinking Water of Altai City in 1991

Heavy Metal	Sampling Number	Unit	Average Concentration	Mongolian Standard for drinking water
Copper	3	micro-g CU/l	5.38	≦1000
Silver	3	micro-g Ag/l	0.85	≦50
Zinc	3	micro-g Zn/l	42.96	≦5000
Cadmium	3	micro-g Cd/l	0.86	≦10
Lead	3	micro-g Pb/l	5.84	≦30
Vanadium	3	micro-g V/l	4.90	—
Chromium	3	micro-g Cr/l	12.36	≦50
Molybdenum	3	micro-g Mo/l	3.64	≦250
Manganese	3	micro-g Mn/l	3.62	≦100
Iron	3	micro-g Fe/l	275.70	≦300
Cobalt	3	micro-g Co/l	0.40	—
Nickel	3	micro-g Ni/l	7.90	—
Aluminum	3	micro-g Al/l	50.66	≦500
Cesium	3	micro-g Cs/l	0.70	—

Table 2.8.4 Water Quality of Existing Wells

Item			well water								Mongolian
No.	Item	Unit	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	Standard
1	pH		7.4-7.9	7.4-8.1	7.7-7.9	8-8.1	7.6-8.4	8.3-8.6	8.1-8.5	7.6-7.9	6.5-8.5
2	Temperature	°C	4.5-7.0	(-2)-6	(-5.5)-7	(-4.5)-5	3.5-4	(-3)-2.5	(-3.5)-3.5	4-8	
3	Odor	dilution factor	-	<1	<1	<1	<1	<1	1	<1	≦2
4	Taste	dilution factor	-	-	-						≦2
5	Color	mg/l Pt scale	4-20	2-6	2-10	6-20	4-20	10-20	20	5-20	≦15$
6	Turbidity	kaolin (JIS)	1-5	1-2	<1	3-15	0.5-10	3-5	3-15	0.5-5	
7	Conductivity	mS/m(at 25°C)	276-436	100-186.7	238-360	288-450	143-224	46-91.3	71.7-524	83-134.7	
8	Hardness	mg$CaCO_3$/l	1375-2500	370-575	690-1625	690-3375	178-550	200-300	793-1150	220-1850	≦350
8	Hardness###	mg$CaCO_3$/l	1400-1770	400-540	800-970	690-1140	300-510	116-210	1110-1790	340-410	≦350
9	Dry Residue###	mg/l	1796-2257	574-746	1047-1338	1025-1402	498-685	270-396	1296-1981	495-563	≦1000
10	COD($KMnO_4$, alkali)	mg O_2/l	6	4.8	6.2	1.5	5.1-7	2-4	2-6.7	4-8	
11	Nitrite	mg NO_2/l	0.06-0.24	0.01-0.5	0.01-0.25	0-0.34	0.02-0.05	0.05-0.3	0.01-0.17	0.03-2	
12	Nitrate	mg NO_3/l	5.5-9.6	5.4-9.8	4.1-9.6	3.9-28	0.5-1	2-5.6	4-6	0.21-0.6	≦44.3
13	Ammonium	mg NH_4/l	0.43-0.6	0.2-0.4	0.24-0.35	0.24-0.38	<0.2-1.2	0.24-0.45	0.28-0.45	1.2-1.6	
14	Orthophosphate	mg $P0_4$/l	0.14-0.3	0.05-0.15	0.03-0.1	0.07-0.1	0.04-0.5	<0.05	0.18-0.38	0.12-0.41	≦3.5
15	Bicarbonate	mg HCO_3/l	305-427	220-281	244-281	311-354	0-70	207-214	403-1007	397-470	
16	Carbonate	mg CO_3/l	0.27-0.66	0.16-0.89	0.35-0.52	0.89-1.08	0.18-0.96	1.04-2.14	2.33-3.20	0.4-0.86	
17	Chloride*	mg Cl/l	14-28	10-36	58-138	139-140	18-25	6-19	57-236	17-35	≦350
18	Sulfate#	mg SO_4/l	1170-1430	280-380	540-670	401-730	270-380	57-140	520-720	80-130	≦500
19	Sodium***	mg Na/l	49.0-49.3	47	54.0-54.6	52-52.3	54.2-54.8	56-56.2	53.1-53.6	52-52.2	
20	Potassium*	mg K/l	13.2-16	3.7-6	7	9-12.2	3.1-8.6	2.5-5	19.4-31	6.7-17	
21	Calcium	mg Ca/l	100-236	45-67	96-260	28-60	19-26	22-27	27-42	25-80	≦100
22	Magnesium	mg Mg/l	188-540	62-96	139-234	146-774	27-116	33-56	174-251	38-396	≦30
22	Magnesium##	mg Mg/l	250-282	68-97	77-188	146-257	61-110	13-38	249-405	34-77	≦30
23	Copper*	mg Cu/l	0.04-0.12	0.05-0.13	0.05-0.07	<0.05	<0.04-0.11	0.03-0.15	0.05-0.08	0.02-0.24	≦1
24	Iron	mg Fe/l	0.09-0.30	0.04-0.2	0.06-0.14	0.05-0.35	0.06-0.14	0.06-0.10	0.03-0.10	0.02-0.11	≦0.3
25	Manganese*	mg Mn/l	0.07-0.13	<0.1	<0.08	0.08	0.54-0.61	0.19-0.43	0.04-0.14	0.73-0.84	≦0.1
26	Zinc*	mg Zn/l	0.21-0.48	0.16-0.58	0.14-0.37	0.32-0.9	0.06-0.28	0.33-0.6	0.23-0.48	0.7-1.25	≦5
27	Lead**	mg Pb/l	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.02	≦0.03
28	Chromium(VI)	mg Cr(VI)/l	0.01	0.01-0.05	<0.02	<0.01-0.02	0.01-0.04	0.03	0.01-0.02	<0.01	
	Chromium**	mg Cr/l	0.03	0.05	0.05	0.02	0.04	0.02	0.03	0.02	≦0.05
29	Cadmium**	mg Cd/l	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.02	≦0.01
30	Arsenic*	mg As/l	<0.1								≦0.05
	Arsenic**	mg As/l	0.02	0.01	0.03	0.01	0.02	0.01	0.02	0.01	
31	Cyanide	mg CN/l	<0.01-0.5	0.01-0.04	<0.01-0.1	<0.01-0.1	0.09-2.5	0.02-0.05	0.01-0.05	0.06	≦0.1
33	Fluoride	mg F/l	0.04	0.01-0.04	0.05	<0.01-0.02	0.06-0.3	0.01-0.4	0.01-0.7	0.01-0.62	0.7-1.5
34	Silica	mg SiO_2/l	2.3-14	5.2-14	3.5-12	5.2-13	1.1-1.3	5.4-9	5.2-11	2.7-15	
35	Molybdenum**	mg Mo/l	0.02-0.03	0.03	0.05	0.03	0.04	0.02	0.03	0.03	≦0.25
36	Beryllium**	mg Be/l	nd	nd	0.003	0.026	0.003	nd	nd	0.0042	≦0.0002 $$
37	Aluminum	mg Al/l	0.01-0.1	0.01	<0.01-0.08	0.02-0.03	0.02-0.1	0.01-0.03	0.01-0.11	0.01-0.02	≦0.5
38	Total Coliforms	No. in 1l	2380	180-960	180-2380	23-2380	94-2380	9-23	23-960	10-960	(<3 in 1l)
43	Acidity	mg $CaCO_3$/l	90-125	45-100	55-125	50-130	0-57.5	92.5-95	70-205	90-160	
44	Alkalinity	mg $CaCO_3$/l	250-350	210-230	200-230	255-290	115-240	170-175	330-825	325-385	
	Nickel*	mg Ni/l	<0.07	<0.04-0.08	<0.07	<0.05-0.07	<0.07	0.02-0.07	0.02-0.12	0.03-0.08	
	Selenium*	mg Se/l	<0.08	<0.07	<0.06	<0.06	<0.1	<0.03	<0.055	<0.04	≦0.001 $$$
	Strontium*	mg Sr/l	3.68-4.17	0.92-1.1	5.27-6.17	2.8-3	0.4-0.51	0.5-0.89	0.43-0.57	0.53-0.69	≦2
	Bromine*	mg Br/l	0.37-0.46	0.08-0.48	0.31-0.69	0.68-0.7	0.14-1.51	0.05-0.45	0.56-1.81	0.12-0.42	

nd not detected
* ED-TRXRF
** Colorimetry in Ulaanbaatar
*** Flame emission spectrometric method
\# Calculated from the correlation between results from gravimetric method and from ED-TRXRF method
\## Calculated from charge balance
\### Calculated value
$ WHO guideline
$$ 0.004 (mg/l) as maximum contaminant level (MCL) for the Primary Regulation of USA
$$$ 0.05 (mg/l) as maximum contaminant level (MCL) for the Primary Regulation of USA

Table 2.8.5 Analysis for Water Quality of New Test Well in Altai City

	Parameter	Unit	Mongolian	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6
	Sampling date		Standard	8th Sep	6th Aug	13th Oct.	5th Oct.	17th Sep	15th Aug	6th July	2nd July	19th July	24th Sep.
1	pH			7.7	7.2	7.2	6.5	8.1	7.8	7.56	7.8	8	8.36
2	Temparature	Deg. C		4.2	9.1	2.2	1.8	4.2	7.2	7.8	4	3.5	2.2
3	Odor		2	1	4	1	1	1	1	2	2	1	1
4	Taste		2	2	2	1	1	2	2	2	2	1	1
5	Color	Pt-unit	15#			2	2	2	2			2	1.5
6	Turbidity	NTU	5#	0.5	1.5	1	0.5	0.5	1.5	1	1	1.5	0.5
7	Conductivity	ms/m		213	470	164.3	350	159.2	214	156.7	(58)	44.3	59.9
8	Dry Residue	mg/l	1000									400	800
9	COD			-	-	-	-	-	-	-	-	-	-
10	Nitrite Ion	mg/l		0.03	0.003	0.006	0.008	0.05	0.007	0.003	0.005	0.002	0.005
11	Nitrate Ion	mg/l	44.3	0.3	10	8	0.1	0.8	0.1	1.5	6	4	0.1
12	Ammonium Ion	mg/l		1.5	0.7	0.6	0.3	1	0.7	0.2	0.15	0.3	1.2
13	Orthophosphate	mg/l	3.5	0.05	0	0.3	0.06	0.6	0.75	0.2	0.05	0.2	0.25
14	Cyanide	mg/l	0.1	0.008	0.01	0.01	0.02	nd		0.04		nd	nd
15	Biocarbonate Ion	mg/l		134	420	232	265	135	200	135	160	147	200
16	Carbonate Ion	mg/l		0.3	0.3	0.2	0.0	0.9	0.6	0.2	0.5	0.7	0.2
17	Hardness	mg $CaCO_3$/l	350									225	257.5
18	Chloride Ion*	mg/l	350	200		240		235				110	95
19	Sulfate Ion*	mg/l	500	316		336	331	303				42.5	59
20	Sodium Ion**	mg/l		68.9	69	83.1	75.3	69.1	71.2	68.3	57.3	59.5	55.9
21	Potassium Ion**	mg/l		6	2.8	6.5	7	4.5	6.8	7	6	1.7	4
22	Calcium Ion	mg/l	100	20		24	80	60	40			12	6
23	Magnesium Ion	mg/l	30										
24	Copper***	mg/l	1	0.02	0.01	0.01	0.01	0.1	0.2	0.002	0.001	0.1	nd
25	Iron	mg/l	0.3	0.3		0.1	0.25	0.05	0.2	0.03	0.15	0.05	0.2
26	Manganese***	mg/l	0.1	nd		nd	nd	nd	nd		nd	nd	nd
27	Zinc***	mg/l	5	0.37	0.59	0.32	0.73	0.18	0.63	1.45	0.32	0.13	nd
28	Lead****	mg/l	0.03	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
29	Chromium(VI)	mg/l		0.04	0.03	0.02	0.04	0.03	0.01	0.04	0.004	0.01	0.03
30	Cadmium****	mg/l	0.01	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
31	Arsenic**	mg/l	0.05	0.012	0.035	0.01	0.012	0.02	0.015	0.01	0.01	0.015	0.021
32	Mercury			-	-	-	-	-	-	-	-	-	-
33	Fluoride	mg/l	0.7-1.5			0.8		0.7		0.75			0.8
34	Silica	mg/l		2.9	3	2.2	2.5	2	3	2.9	3	2.7	0.5
35	Molybdenum**	mg/l	0.25	0.035	0.024	0.03	0.038	0.029	0.03	0.02	0.04	0.03	0.02
36	Beryllium**	mg/l	0.0002 $	<0.005	<0.003	<0.003	<0.004	<0.005	<0.004	<0.003	<0.003	<0.003	<0.004
37	Aluminum	mg/l	0.5	nd	0.03	0.01	0.01	0.02	nd	0.01	nd	0.25	nd
38	Total Coliforms	no/l	3										
39	General Bacteria			-	-	-	-	-	-	-	-	-	-
40	Residual Chlorine	mg/l		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
41	BOD			-	-	-	-	-	-	-	-	-	-
42	SS			-	-	-	-	-	-	-	-	-	-
43	Acidity	mg $CaCO_3$/l		275	250	225	240	175	155	960	27	210	225
44	Alkalinity	mg $CaCO_3$/l		100	325	175	200	100	150	100	120	110	150
	Nickel*	mg Ni/l		1.3	0.17	0.13	0.08	nd	0.08	0.15	nd	nd	nd
	Selenium*	mg Se/l		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	Strontium*	mg Sr/l		0.7	11.1	0.6	nd	1	2.1	11.8	5.9	0.5	nd
	Bromine*	mg Br/l		0.3	2	nd	0.2	nd	0.6	2.1	0.9	0.1	0.3

nd: not detected

#: WHO guideline

*: Central Laboratory of Drinking Water and Food Products

**: Institute Chemistry and Chemical Technology of Mongolian Academy of Science

***: Nuclear Physic Research Center

****: Central Laboratory of Geology

$ 0.004 (mg/l) as maximum contaminant level (MCL) for the Primary Regulation of USA

Table 2.8.5 Analysis for Water Quality of New Test Well in Altai City

	Parameter	Unit	Mongolian	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6
	Sampling date		Standard	8th Sep	6th Aug	13th Oct.	5th Oct.	17th Sep	15th Aug	6th July	2nd July	19th July	24th Sep.
1	pH			7.7	7.2	7.2	6.5	8.1	7.8	7.56	7.8	8	8.36
2	Temparature	Deg. C		4.2	9.1	2.2	1.8	4.2	7.2	7.8	4	3.5	2.2
3	Odor		2	1	4	1	1	1	1	2	2	1	1
4	Taste		2	2	2	1	1	2	2	2	2	1	1
5	Color	Pt-unit	15#	20#	50#	2	2	2	2	50#	50#	2	1.5
6	Turbidity	NTU	5#	0.5	1.5	1	0.5	0.5	1.5	1	1	1.5	0.5
7	Conductivity	ms/m		213	470	164.3	350	159.2	214	156.7	(58)	44.3	59.9
8	Dry Residue	mg/l	1000	2000#	7600#	1200#	2400#	1400#	2100#	2800#	2400#	400	800
9	COD			-	-	-	-	-	-	-	-	-	-
10	Nitrite Ion	mg/l		0.03	0.003	0.006	0.008	0.05	0.007	0.003	0.005	0.002	0.005
11	Nitrate Ion	mg/l	44.3	0.3	10	8	0.1	0.8	0.1	1.5	6	4	0.1
12	Ammonium Ion	mg/l		1.5	0.7	0.6	0.3	1	0.7	0.2	0.15	0.3	1.2
13	Orthophosphate	mg/l	3.5	0.05	0	0.3	0.06	0.6	0.75	0.2	0.05	0.2	0.25
14	Cyanide	mg/l	0.1	0.008	0.01	0.01	0.02	nd	0.015	0.04	0.1	nd	nd
15	Biocarbonate Ion	mg/l		134	420	232	265	135	200	135	160	147	200
16	Carbonate Ion	mg/l		0.3	0.3	0.2	0.0	0.9	0.6	0.2	0.5	0.7	0.2
17	Hardness	mg $CaCO_3$/l	350	1000#	3725#	362.5#	1875#	875#	845#	1950#	900#	225	257.5
18	Chloride Ion*	mg/l	350	200	2200#	240	476#	235	1000#	1750#	1500#	110	95
19	Sulfate Ion*	mg/l	500	316	2813#	336	331	303	1158#	1306#	913#	42.5	59
20	Sodium Ion**	mg/l		68.9	69	83.1	75.3	69.1	71.2	68.3	57.3	59.5	55.9
21	Potassium Ion**	mg/l		6	2.8	6.5	7	4.5	6.8	7	6	1.7	4
22	Calcium Ion	mg/l	100	20	232#	24	80	60	40	385#	100#	12	6
23	Magnesium Ion	mg/l	30	228#	730#	97#	302#	174#	179#	237#	156#	147#	45#
24	Copper***	mg/l	1	0.02	0.01	0.01	0.01	0.1	0.2	0.002	0.001	0.1	nd
25	Iron	mg/l	0.3	0.3	2.4#	0.1	0.25	0.05	0.2	0.03	0.15	0.05	0.2
26	Manganese***	mg/l	0.1	nd	0.36#	nd	nd	nd	nd	0.051#	nd	nd	nd
27	Zinc***	mg/l	5	0.37	0.59	0.32	0.73	0.18	0.63	1.45	0.32	0.13	nd
28	Lead****	mg/l	0.03	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
29	Chromium(VI)	mg/l		0.04	0.03	0.02	0.04	0.03	0.01	0.04	0.004	0.01	0.03
30	Cadmium****	mg/l	0.01	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
31	Arseme**	mg/l	0.05	0.012	0.035	0.01	0.012	0.02	0.015	0.01	0.01	0.015	0.021
32	Mercury			-	-	-	-	-	-	-	-	-	-
33	Fluoride	mg/l	0.7-1.5	1.7	1.7	0.8	1.7	0.7	1.8	0.75	1.8	1.8	0.8
34	Silica	mg/l		2.9	3	2.2	2.5	2	3	2.9	3	2.7	0.5
35	Molybdenum**	mg/l	0.25	0.035	0.024	0.03	0.038	0.029	0.03	0.02	0.04	0.03	0.02
36	Beryllium**	mg/l	0.0002 $	<0.005	<0.003	<0.003	<0.004	<0.005	<0.004	<0.003	<0.003	<0.003	<0.004
37	Aluminum	mg/l	0.5	nd	0.03	0.01	0.01	0.02	nd	0.01	nd	0.25	nd
38	Total Coliforms	no/l	3	92	23	27	10	27	27	960	90	21	10
39	General Bacteria			-	-	-	-	-	-	-	-	-	-
40	Residual Chlorine	mg/l		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
41	BOD			-	-	-	-	-	-	-	-	-	-
42	SS			-	-	-	-	-	-	-	-	-	-
43	Acidity	mg $CaCO_3$/l		275	250	225	240	175	155	960	27	210	225
44	Alkalinity	mg $CaCO_3$/l		100	325	175	200	100	150	100	120	110	150
	Nickel*	mg Ni/l		1.3	0.17	0.13	0.08	nd	0.08	0.15	nd	nd	nd
	Selenium*	mg Se/l		nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	Strontium*	mg Sr/l		0.7	11.1	0.6	nd	1	2.1	11.8	5.9	0.5	nd
	Bromine*	mg Br/l		0.3	2	nd	0.2	nd	0.6	2.1	0.9	0.1	0.3

nd: not detected

: WHO guideline

*: Central Laboratory of Drinking Water and Food Products

**: Institute Chemistry and Chemical Technology of Mongolian Academy of Science

***: Nuclear Physic Research Center

****: Central Laboratory of Geology

$: 0.004 (mg/l) as maximum contaminant level (MCL) for the Primary Regulation of USA

Table 2.8.6 Reanalyses of Heavy Metals in Well Water of Altai City

Item	Laboratory	Unit	Mongolian Standard	Samples (Sampling:May 30th 1998)	
				SW-6 Kharzat well	SW-8 school well
Lead	#	mg/l	0.03	0.0006	0.0004
	##	mg/l		<0.005	-
Cadmium	#	mg/l	0.01	0.0024	not detected
	##	mg/l		<0.001	-
Arsenic	###	mg/l	0.05	0.009	0.025
	##	mg/l		<0.005	-
Total Chromium	##	mg/l	0.05	<0.004	-

#: Central Laboratory of Environmental Monitoring (Atomic Absorption Spectroscopy (Graphite Furnace))
##: Shizukan Kensa Center (Japan: Analysis Method of Drinking Water in Japan)
###: Institute Chemistry and Chemical Technology of Mongolian Academy of Science (Colorimetry)

Table 2.8.7 Water Quality for Water Supply Facilities

Item No.	Item	Unit	Reservoir water		Tap water					Water wagon		Stored water in ger					Mongolian Standard
			DR-1	DR-2	DT-1	DT-2	DT-3	DT-4	DT-5	DW-1	DW-2	DG-1	DG-2	DG-3	DG-4	DG-5	
1	pH		8.2-8.3	8.2-8.3	8.1-8.3	8.2-8.4	7.9-8.2	8.0-8.1	8.2	8.2-9.1	8.3-8.5	8.2	8.0-8.3	7.8-8.3	8.3	8.3	6.5-8.5
2	Temperature	℃	3.0-5.2	4.0-5.2	12.0-20.0	5.0-20.0	7.0-18.0	9.0-10.0	5.7-14.5	5.0-9.0	7.0-9.0	8.0-19.0	9.4-19.4	11.6-19.7	9.8-19.7	16.0-19.4	
3	Odor	dilution factor	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	1	1	1	≦2
4	Taste	dilution factor	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	1	1	<1	≦2
5	Color	mg/l Pt scale	<1-4	<1-4	<1-2	<1-6	<1-2	<1-20	<1-2	2.0-5.0	<1-4	2.0-4.0	2.0-4.0	<1-5	<1-20	<1-2	≦15$
6	Turbidity	kaolin (JIS)	<1-2	<1	<1	<1	<1	<1-5	<1-6	<1	<1	<1-2	<1-2	<1-1	<1-3	<1	
7	Conductivity	mS/m(at 25℃)	58-89	54-93	54-68	57-93	54-82	54-68	56-86	58-94	58-85	55-86	56-73	58-69	54-75	53-64	
8	Hardness	mg $CaCO_3$/l	265-310	240-300	220-288	188-250	220-300	210-450	230-450	240-313	238-300	230-250	225-300	230-375	285-320	220-275	≦350
10	COD($KMnO_4$, alkali)	mg O_2/l	<1-2	<1	1.0-2.0	1.0-2.0	<1-3.0	<1-2	<1-1.5	<1-2.2	<1-2	<1-3	<1-3	<1-2	1.0-3.5	<1-2.8	
11	Nitrite	mg NO_2/l	<0.01	<0.01	0.01-0.03	<0.01-0.13	0.01	<0.01	<0.01-0.02	<0.01	0.01	<0.01-0.02	<0.01	<0.01-0.5	<0.01-0.25	<0.01	
12	Nitrate	mg NO_3/l	4.0-7.4	3.1-8.6	0.4-7.0	4.6-7.0	4.7-8.0	0.4-9.0	4.1-8.2	4.2-9.2	3.0-5.0	4.0-8.0	4.0-8.2	4.1-9.4	4.9-7.0	2.0-9.0	≦44.3
15	Bicarbonate	mg HCO_3/l	217-244	232-250	214-275	232-250	220-244	220-262	177-275	244-366	214-266	238-275	214-256	226-305	220-275	214-275	
16	Carbonate	mg CO_3/l	0.86-1.22	1.00-1.25	1.00-1.73	0.97-2.50	0.77-1.39	0.69-0.97	1.12-1.38	1.09-11.57	1.35-2.68	0.87-1.50	0.89-2.03	0.77-1.79	1.73-1.99	1.70-2.18	
21	Calcium	mg Ca/l	24-30	21-30	23-30	22-26	25-29	26-38	22-27	20-40	26-70	24-44	11-28	23-52	25-32	24-27	≦100
22	Magnesium	mg Mg/l	49-70	45-66	35-53	25-47	37-55	36-97	39-95	46-58	38-46	34-46	43-59	41-59	52-62	38-42	≦30
22	Magnesium#	mg Mg/l	37							36							≦30
22	Magnesium##	mg Mg/l	31														≦30
23	Copper*	mg Cu/l	0.04-0.14	0.04-0.13	0.06-0.2	0.05-0.4	<0.04-0.05	0.05-0.09	<0.03	<0.04-0.16	<0.06	<0.05-0.08	<0.03-0.05	0.04-0.05	0.03-0.06	<0.05-0.31	≦1
24	Iron	mg Fe/l	0.09-0.12	0.10-0.15	0.08-0.10	0.10-0.12	0.06-0.25	0.05-0.10	0.04-0.10	0.06-0.13	0.03-0.91	0.03-0.2	0.05-0.21	0.04-0.30	0.01-0.3	0.02-0.10	≦0.3
25	Manganese*	mg Mn/l	<0.06	0.1-0.42	<0.07	<0.05	<0.04	<0.02-0.04	<0.06	<0.04	<0.02	<0.06	<0.04-0.06	<0.05	<0.06	<0.02-0.04	≦0.1
26	Zinc*	mg Zn/l	0.11-0.48	0.14-0.27	0.21-0.28	0.2-1.28	0.29-0.43	0.21-0.7	0.1-0.37	0.25-0.43	0.11-0.21	0.17-0.35	0.06-0.26	0.12-0.57	0.23-0.41	0.07-0.26	≦5
27	Lead**	mg Pb/l		0.05		0.04				-	-		0.041				≦0.03
28	Chromium(VI)	mg Cr(VI)/l	0.01-0.04	0.02-0.03	0.02-0.03	0.01-0.02	0.02-0.05	0.02-0.03	0.02-0.03	0.02-0.03	0.01-0.02	0.02-0.04	0.02-0.03	0.01-0.02	0.02	0.01-0.04	
	Chromium**	mg Cr/l		0.10		0.01				-	-	-	-	-	-	-	≦0.05
29	Cadmium**	mg Cd/l		0.03-0.04		0.028-0.03				-	-		0.026				≦0.01
30	Arsenic**	mg As/l		0.03		0.03-0.035		<0.06	<0.02	-	-		0.024				≦0.05
31	Cyanide	mg CN/l	0.04-0.06	0.03-0.05	0.03-0.05	0.03-0.05	0.03-0.05	0.03-0.06	0.03-0.05	0.03-0.05	0.03-0.06	0.02-0.75	0.03-0.05	0.03-0.05	0.04-0.06	0.02-0.05	≦0.1
33	Fluoride	mg F/l	0.05-0.2	<0.05	0.05-0.54	<0.05-0.52	<0.05-0.82	<0.05-0.88	<0.05-0.62	<0.05	<0.05	<0.05-0.74	<0.05-0.7	<0.05-0.69	<0.05-0.61	<0.05	0.7-1.5
38	Total Coliforms	No. in 1l	7-39	4.0-21	3.0-7.0	<3-4	3	<3-4	3.0-4.0	7.0-14	11	3.0-11	4.0-28	11-460	3.0-21.0	3.0-43	(<3 in 1l)
39	General Bacteria	No. in 1 ml	143-1000	102-700	42-500	250-580	30	300-350	22-150	200-720	300	102-300	240-1000	100-950	345-780	143-850	
40	Residual Chlorine	mg ClO/l	0.02-0.7	0.02-0.1	<0.1	<0.1	<0.1	<0.02-0.1	<0.1	0.03-0.1	<0.02-0.1	<0.02-0.1	<0.02-0.2	<0.02-0.2	<0.02-0.2	<0.02-0.2	
43	Acidity	mg $CaCO_3$/l	35-65	35-50	35-100	28-85	43-78	63-85	35-100	30-80	35-80	30-65	50-60	40-65	50-60	30-60	
44	Alkalinity	mg $CaCO_3$/l	178-200	190-205	175-225	190-205	180-200	180-215	145-225	200-300	175-220	195-225	175-210	185-250	180-225	175-225	
	Nickel*	mg Ni/l	<0.06	<0.05	<0.09	0.03-0.05	<0.04	<0.05	<0.03	<0.02-0.03	<0.05	<0.05	<0.04	<0.05	<0.04	<0.02-0.03	
	Selenium*	mg Se/l	<0.03	<0.06	<0.05	<0.03	<0.03	<0.04	<0.02	<0.04	<0.07	<0.07	<0.05	<0.04	<0.05	<0.04	0.001 $$
	Strontium*	mg Sr/l	0.54-0.61	0.53-0.59	0.52-0.58	0.52-0.55	0.62-0.63	0.42-0.56	0.51-0.52	0.58-0.60	0.53-0.64	0.58-0.61	0.19-0.63	0.27-0.58	0.45-0.59	0.42-0.63	≦2
	Bromine*	mg Br/l	0.12-0.15	0.14-0.23	0.14-0.34	0.09-0.14	0.14-0.3	0.1-0.17	0.11-0.17	0.11-0.25	0.12	0.13-0.3	0.12-0.14	0.13-0.15	0.07-0.12	0.07-0.28	

* ED-TRXRF
** Colorimetry in Ulaanbaatar
# Analyzed in Japan: the test method for tap water
Calculated from the charge balance
$ WHO guideline
$$ 0.05 (mg/l) as maximum contaminant level (MCL) for the Primary Regulation of USA

Table 2.8.8 Average Concentrations of Major Ions and Average Physical Parameters for the Water Supply System

Item No.	Item	Unit	Average	Mongolian Standard	WHO	
					(health)	(complain)
7	Conductivity	mS/m(at 25℃)	63.5			
8	Hardness#	mg$CaCO_3$/l	199	≦350		
9	Dry Residue#	mg/l	344	≦1000		≦1000
12	Nitrate	mg NO_3/l	5.4	≦44.3	≦50	
15	Bicarbonate	mg HCO_3/l	247			
16	Carbonate	mg CO_3/l	1.65			
17	Chloride*	mg Cl/l	29	≦350		≦250
18	Sulfate**	mg SO_4/l	68	≦500		≦250
19	Sodium***	mg Na/l	56			
20	Potassium****	mg K/l	3.3			
21	Calcium	mg Ca/l	28	≦100		
22	Magnesium##	mg Mg/l	31	≦30		

* Titration method
** Gravimetric method
*** Flame emission spectrometric method (using data from SW-6)
**** ED-TRXRF method
# Calculated from calcium and magnesium concentration
Calculated from the charge balance

Table 2.8.9 Reanalyses of Heavy Metals in Drinking Water of Altai City

Item	Laboratory	Unit	Mongolian Standard	Samples (Sampling:May 30th 1998)				
				DT-1 hospital	DT-2 government house	DT-3 apartment near hotel	DT-4 high school	DT-5 apartment (Ms. Tunga)
Lead	#	mg/l	0.03	0.0001	0.0004	not detected	not detected	not detected
	##	mg/l		<0.005	-	<0.005	-	-
Cadmium	#	mg/l	0.01	not detected	not detected	not detected	not detected	not detected
	##	mg/l		<0.001	-	<0.001	-	-
Arsenic	###	mg/l	0.05	0.03	0.01	not detected	0.01	0.02
	##	mg/l		<0.005	-	<0.005	-	-
Total Chromium	##	mg/l	0.05	<0.004	-	<0.004	-	-

Item	Laboratory	Unit	Mongolian Standard	Samples (Sampling:May 30th 1998)			
				DR-1 reservoir	DR-2 reservoir	DW-1 water wagon	DW-2 water wagon
Lead	#	mg/l	0.03	0.0002	not detected	0.0001	not detected
	##	mg/l		<0.005	-	-	<0.005
Cadmium	#	mg/l	0.01	not detected	not detected	not detected	not detected
	##	mg/l		<0.001	-	-	<0.001
Arsenic	###	mg/l	0.05	0.015	0.02	0.03	0.02
	##	mg/l		<0.005	-	-	<0.005
Total Chromium	##	mg/l	0.05	<0.004	-	-	<0.004

#: Central Laboratory of Environmental Monitoring (Atomic Absorption Spectroscopy (Graphite Furnace))
##: Shizukan Kensa Center (Japan: Analysis Methods of Drinking Water in Japan)
###: Institute Chemistry and Chemical Technology of Mongolian Academy of Science (Colorimetry)

Table 2.8.10 Water Quality of Rivers

Item No.	Item	Unit	R-1			R-3	R-4		
			27-Jun-97	18-Jul-97	24-Jul-97	27-Jun-97	27-Jun-97	18-Jul-97	24-Jul-97
1	pH		8.4	8.9	8.7	8.6	9.3	8.7	8.1
2	Temperature	°C	14	15	22	12.5	2	10	8.5
3	Odor	dilution factor	-		<1	-	-		1
5	Color	mg/l Pt scale	20	20	5	10		5	6
6	Turbidity	kaolin (JIS)	10	5	<1	<1	10	1	1
7	Conductivity	mS/m(at 25°C)	1999	1830	1746	528	128	102	141
8	Hardness	mg$CaCO_3$/l	300	6875	8195	445	450	410	425
10	COD	mg O_2/l	-	-	-	4	-	-	-
11	Nitrite	mg NO_2/l	0.01	0.02	<0.01	0.01	<0.01	0.01	<0.01
12	Nitrate	mg NO_3/l	0.2	0.5	0.7	0.3	0.2	5.6	9.6
13	Ammonium	mg NH_4/l			0.4		0.34		0.23
15	Bicarbonate	mg HCO_3/l	345	329	238	1098		403	458
16	Carbonate	mg CO_3/l	3.45	10.41	4.73	13.82		6.38	1.82
17	Chloride*	mg Cl/l	10100	5420	4770	1120	303	160	152
18	Sulfate*	mg SO_4/l	5350-10700	2865-5730	2660-5320	1110-2220	206-412	158-316	143-286
20	Potassium*	mg K/l	29	17	17	20	17	7.3	8.6
21	Calcium*	mg Ca/l	548	312	305	58	48	49	48
22	Magnesium	mg Mg/l	72	1650	1789	95	92	85	67
23	Copper*	mg Cu/l	<0.15	<0.13	<0.12	<0.09	0.06	0.05	<0.05
24	Iron	mg Fe/l	0.19	0.13	0.09	0.06	0.05	0.42	0.07
25	Manganese*	mg Mn/l	<0.31	<0.17	<0.14	<0.08	0.1	<0.05	<0.07
26	Zinc	mg Zn/l	<0.23	0.43	<0.13	0.12	0.15	0.17	0.18
28	Chromium(VI)	mg Cr(VI)/l	0.01	0.03	0.02	0.01		0.01	0.001
31	Cyanide	mg CN/l	0.06	0.5	0.8	0.09	0.8	0.05	0.01
33	Fluolide	mg F/l	0.22	<0.05	0.05	0.19		0.05	0.04
38	Total Coliforms	No. in 1l	960	2380	2380	>2380		960	>2380
43	Acidity	mg $CaCO_3$/l	40	95	80	750		160	78
44	Alkalinity	mg $CaCO_3$/l	283	270	195	900		330	375
	Nickel*	mg Ni/l	<0.14	<0.11	<0.13		<0.05	<0.03	<0.06
	Seleni8m*	mg Se/l	<0.3	<0.2	<0.17		<0.04	<0.03	<0.04
	Strontium*	mg St/l	27.8	19.2	16.7		1.25	0.93	0.87
	Bromine*	mg Br/l	5.85	3.3	3		0.53	0.21	0.21

* ED-TRXRF

Table 2.8.11 Water Quality of Sewerage System

Item No.	Item	Unit	S-1			S-2			S-3			Maxmum Quality limit (in Oman)#
			26-Jun-97	18-Jul-97	24-Jul-97	26-Jun-97	18-Jul-97	24-Jul-97	26-Jun-97	18-Jul-97	24-Jul-97	
1	pH		8.4	8.4	8.6	8.3	8.1	9	8.9	8.7	9.3	
2	Temperature	℃	5.5	7	7	9	11	15	15	12.5	16	
3	Odor	dilution factor			16			4			4	
5	Color	mg/l Pt scale	60	60	50	20	20	100	20	40	140	
6	Turbidity	kaolin (JIS)	30	10	40	5	10	80	20	10	80	
7	Conductivity	mS/m(at 25℃)	130	109	155	102	80	114	100	84	108	270
8	Hardness	mg$CaCO_3$/l	170	270	475	163	270	350	175	270	425	
9	Dry Residue	mg/l	1486		2800	4120		3200	412		2000	2000
10	COD ($K_2Cr_2O_7$)	mg O_2/l	161.4	102.7	163	112.2	113.8	115	138	139.9	144	200
11	Nitrite	mg NO_2/l	0.02	0.01	0.01	0.38	0.35	0.3	0.07	0.3	0.28	
12	Nitrate	mg NO_3/l	0.07	0.2	<0.1	2.6	3.8	2.8	0.08	2.4	2.1	50
13	Ammonium	mg NH_4/l										10
14	Orthophosphate	mg $P0_4$/l			1.55			1.8			1.7	
17	Chloride*	mg Cl/l	261	265	195	228	160	197	212	173	195	650
20	Potassium*	mg K/l	18	16	11.3	20	8.1	12.5	20	7.6	9.1	
21	Calcium	mg Ca/l	28	33	48	34	27	37	37	30	40	
	Calcium*	mg Ca/l	40	41	39	43	33	36	43	30	40	
22	Magnesium	mg Mg/l	24	45	85	18.6	49	62	19.8	47	78	
23	Copper*	mg Cu/l	<0.05	0.11	0.17	0.05	0.05	<0.05	0.04	0.04	0.08	1
24	Iron	mg Fe/l	0.25	0.36	0.15	0.29	0.25	0.21	0.34	0.26	0.17	5
25	Manganese*	mg Mn/l	0.08	<0.07	0.04	0.09	0.07	<0.08	0.09	<0.03	<0.06	
26	Zinc*	mg Zn/l	0.13	0.19	0.54	0.14	0.1	0.23	0.17	0.12	0.27	5
28	Chromium(VI)	mg Cr(VI)/l	0.01	0.03	0.03	0.01	<0.01	0.03	0.03	<0.01	0.01	total 0.05
31	Cyanide	mg CN/l	0.08	0.28	0.06	0.07	0.07	0.05	0.09	0.09	0.05	0.1
33	Fluolide	mg F/l	0.2		0.04	0.16		0.03	0.18		0.03	2
38	Total Coliforms	No. in 1l	100000	1000000	1000000	100000	1000000	1000000	10000	100000	100000	Fecal 1000
39	General Bacteria	No. in 1 ml	600000			200000			60000			
41	BOD	mg O_2/l	20	20.5	21	21.4	22.8	23.5	20.5	22.3	2.5	20
42	SS	mg SS/l	708	247	211	572	283	444	424	255	171	30
43	Acidity	mg $CaCO_3$/l	140	180		170	75		210	105		
44	Alkalinity	mg $CaCO_3$/l	270	400		355	250		330	325		
	Nickel*	mg Ni/l	<0.03	<0.04	<0.06	<0.04	<0.03	0.04	<0.04	<0.04	<0.05	
	Selenium*	mg Se/l	<0.04	<0.03	<0.05	<0.03	<0.03	<0.05	<0.03	<0.02	<0.05	
	Strontium*	mg St/l	0.83	0.7	0.79	0.82	0.52	0.64	0.94	0.53	0.71	
	Bromine*	mg Br/l	0.3	0.12	0.27	0.12	0.12	0.22	0.15	0.07	0.28	

*ED-TRXRF

Donald R. Rowe and Isam Mohammed Abdel-Magid, Handbook of Wastewater Reclamation and Reuse (1995), CRC Press Inc.

Table 2.8.12 Analysis Results for Sewerage System (Phase 4)

Item	28-Jul-97				
No.	Item	Unit	S-1	S-2	S-3
10	COD($KMn0_4$ Alkali)	mg O_2/l	80	60	25
13	Ammonium	mg NH_4/l	100	45	18
Item	30-Jul-97				
No.	Item	Unit	S-1	S-2	S-3
10	COD($KMn0_4$ Alkali)	mg O_2/l	27	17	21
13	Ammonium	mg NH_4/l	70	45	40

Table 2.8.13 Evaluation of Water Quality for Water of Wells and Water Supply Facilities

Item	Existing Wells								New Test Wells										Water Supply System			
	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6	DR	DT	DW	DG
Color*	B	A	A	B	B	B	C	B	C	D	A	A	A	A	D	D	A	A	A	A	A	A
Hardness	D	C	D	D	C	A	D	B	D	D	B	D	D	D	D	D	A	A	A			
Dry Residue	C	A	C	C	A	A	C	A	D	D	C	D	C	D	D	D	A	A	A			
Chloride	A	A	A	A	A	A	A	A	A	D	A	C	A	D	D	D	A	A	A			
Sulfate	D	A	C	C	A	A	C	A	A	D	A	A	A	D	D	C	A	A	A			
Calcium	C	A	B	A	A	A	A	A	A	D	A	A	A	A	D	B	A	A	A			
Magnesium	D	D	D	D	D	B	D	D	D	D	D	D	D	D	D	D	C	C	C	C	C	C
Strontium	C	A	D	C	A	A	A	A	A	D	A	A	A	B	D	D	A	A	A	A	A	A
Iron	A	A	A	B	A	A	A	A	B	D	A	A	A	A	A	A	A	A	A	A	A	A
Manganese	B	A	A	A	D	D	B	D	A	D	A	A	A	A	D	A	A	A	A	A	A	A
Lead	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	?
Chromium	A	?	?	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Cadmium	?	?	?	?	?	A	?	A	A	A	A	A	A	A	A	A	A	A	A	A	A	?
Arsenic	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Total coliform**	D	D	D	D	D	C	D	D	D	D	D	D	D	D	D	D	D	D	C	B	C	D

* WHO guidelines

** Guidelines

A: good, below the standard

B: fair, around the standard

C: bad, exceed the standard

D: very bad, more than double the standard

?: inconclusive

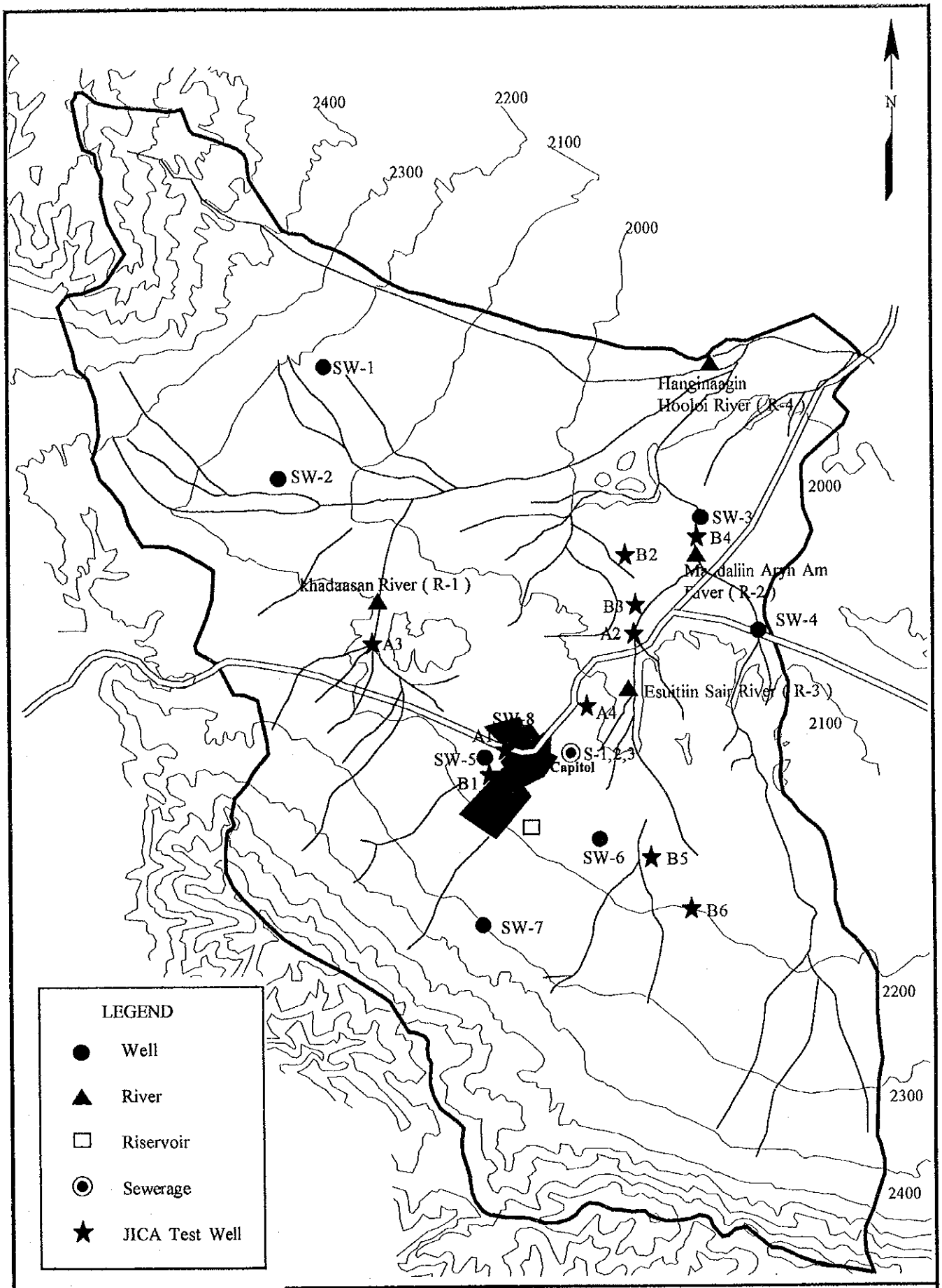


Figure 2.8.1 Sampling Points for Water Quality Analysis (Existng Well)

JICA	The Study on Groundwater Development for Altai City

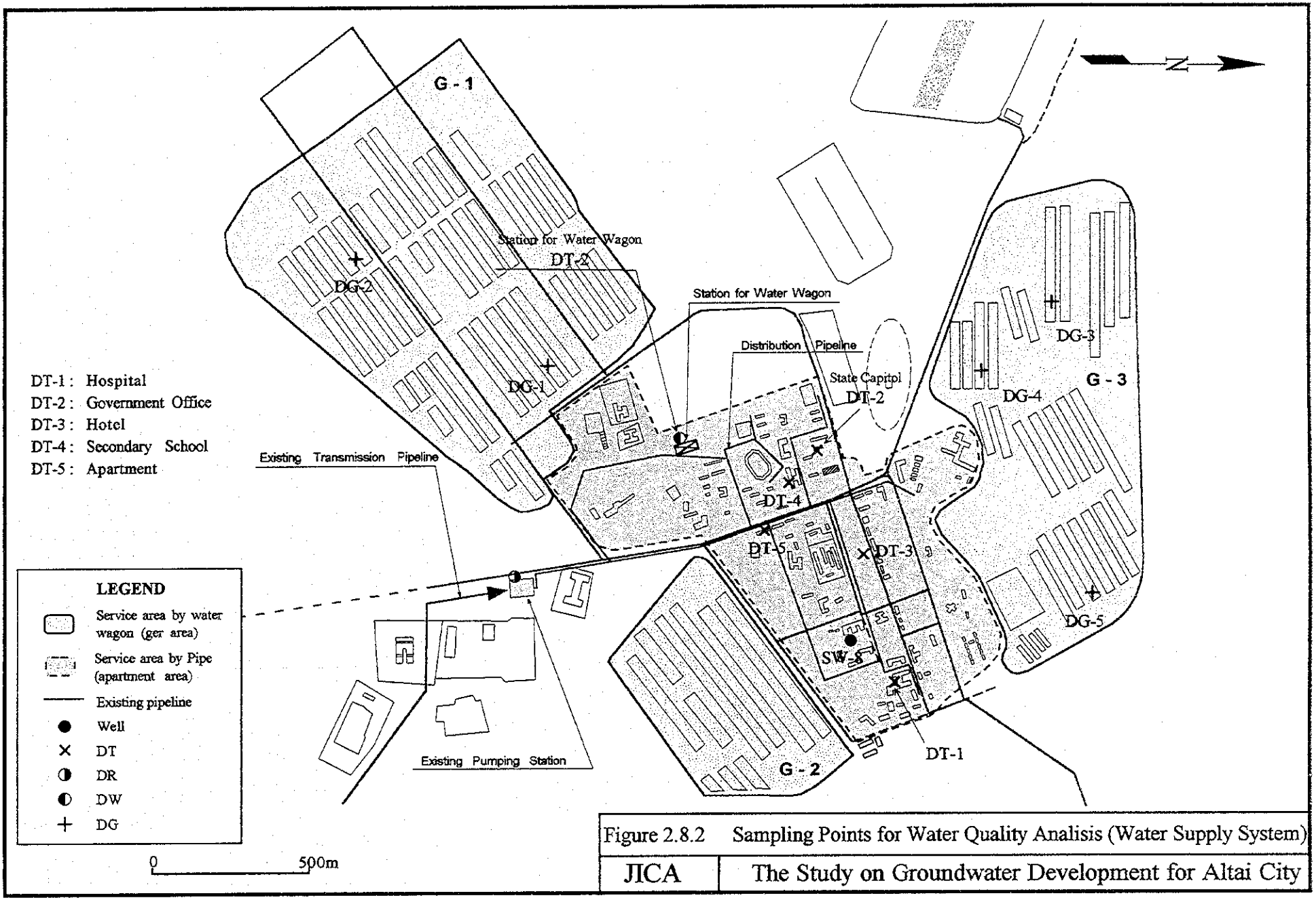


Figure 2.8.2 Sampling Points for Water Quality Analisis (Water Supply System)

JICA	The Study on Groundwater Development for Altai City

2.9 WATER SUPPLY FACILITIES

2.9.1 Objectives and Scope of the Survey

The objectives and scope of survey are as follows.

1) To clarify the conditions of water supply service
2) To clarify the conditions of water supply facilities
3) To clarify the actual amount of supplied water, water consumption and leakage
4) To realize the problem of operation and maintenance
5) To estimate the water demand in each category

2.9.2 Service Condition

(1) Service Area

The service area covered by public water supply is ascertained as shown in Figure 2.9.1. The domestic water is supplied to the central apartment area (approximately 90 ha) by pipe net work system and to ger area (approximately 224 ha) by water wagon transportation system.

(2) Population in Service Area

Population of Altai City is about 17,800 in the year of 1997. People live in the apartment buildings in the central area and in ger houses in the surroundings of the central area. Population of those areas is shown in the following table.

Category	Population	Number of household	Family size
Apartment Dwellers	3,245	488	6.6
Ger Dwellers	14,516	2,661	5.5
Total	17,761	3,149	5.6

2.9.3 Present Water Supply System

(1) Outline of the system

Public water supply system in Altai City shown in Figure 2.9.2 has been basically the same since the start of water supply service of Altai City. The system is operated and

managed by **Altai Public Service Department (APSD)** which controls water supply and sewerage works.

Raw groundwater is first pumped up at the intake wells in Kharzat and transported to the distribution pumping station through pipeline, where it is reserved in the storage reservoir. Finally the water is supplied to consumers, after chlorination at the storage reservoir. Water is supplied through pressured pipelines to apartment buildings, institutions, and some of industries with individual service pipe connection.

Buildings are also supplied with hot water during the cold season from the communal heating center (CHC; eight CHC exist in the city, one of them holds public bath in addition to it's regular service) where some parts of cold water from distribution pipelines is heated. Therefore these buildings are supplied with two types of water through dual service pipes. APSD is responsible for supplying water up to the entrance of the CHC.

In ger area, water is supplied by four water wagons every day with a tank capacity of 4 m^3 to 4.75 m^3. People in ger area have to go to buy water with water vessels (20 to 60 liters of volume) to delivery point, where water wagon comes to supply the water every day.

(2) Water Source

Altai City depends solely on groundwater as the source for public water supply. There are four intake wells in Kharzat area located at the southern part of the city. This includes one well with a lift pump under repair.

Intake water is transmitted to storage reservoir at distribution pumping station from two wells out of three, which are operated by turns every day. The specifications of the intake wells are outlined in Table 2.9.1.

(3) Water Supply Facilities

The following tables are references for the present water supply facilities.

A. Intake Pump

	Item	Specification, Remarks
1	Number of pumps	4wells: dia.8" x 25 m^3/h /unit x (80m-100m) x 4 units (CK4923;1979, CK4924;1979, CK8761;1986 under repair, CK8850;1995)
2	Daily intake quantity	25m^3/h.unit x 2 units x (18~24 hrs/d) =900~1200 m^3/d
3	Point at issue	- the operating condition; pump do not function properly. - spare parts for repair are always in short supply - some of the pumps has been deteriorating

B. Transmission Pipe

	Item	Specification, Remarks
1	Length of pipes	dia150mm x 3.4km x 2 lines (in parallel) = 6.8 km
2	Pipe material	Steel pipe coated outside with coal tar and joined by welding
3	Depth of pipe	Thickness of soil cover : 3.6meters
4	Point at issue	- Pipes have been deteriorating - Reconstruction was requested to GIAUS

C. Distribution Facilities

	Item	Specification, Remarks
1	Storage reservoir	- 1,000m^3/unit x 2 units =2,000m^3 - Two rectangular reservoirs of the same size made of reinforced concrete.
2	Chlorination	Liquid chlorine is added to the inlet pipe of raw water at the reservoir for thirty minutes a day when reservoir is nearly full. Dosage is not well controlled.
3	Distribution pump Number of pump Dairy quantity	- Dia.8" x 90 m^3/h .unit x 35^m x 3 Units - Only one unit is usually operated. - 90 m^3/h x 1 unit x (18-24 hrs/d) = 2160 m^3/d Practically the water of 800(summer)~1200 (winter) m^3/d is distributed.
4	Point at issue	- Pressure gauge on the delivery pipe of the pump indicated 4.6 kg/cm^2 which is higher than the designed pressure of 3.5 kg/cm^2. - Pump capacity is too large for present water demand.

D. Distribution Pipe

	Item	Specification, Remarks
1	Length of pipes	dia.200mm x 5600 m (Approximately) dia.125mm x 135 m Total 5735 m (Approximately)
2	Pipe material	Steel pipe coated outside with coal tar and joined by welding
3	Depth of pipe	Depth of soil covering : 3.6 meter
4	Point at issue	- It is necessary for reduction of water leakage to control the water pressure of pipes by handling valve for low ground level area. - Service of pipeline network is not enough to supply the water easily.

E. Water Supply for Ger

	Item	Specification, Remarks
1	Water wagon	4 m^3 of capacity : 3 vehicles 4.75 m^3 of capacity : 1 vehicle Total : 4 vehicles
2	Dairy delivery quantity	Mean : 64 m^3/day Maximum : 78 m^3/day On weekly data at the beginning of Oct.1998
3	Point at issue	- People in ger area suffer inconvenience in getting potable water in terms of quantity and accessibility. - Carrying filled vessels to home is a heavy burden on women and children.

2.9.4 Water Supply Amount

Flow rate measurements were carried out to clarify the actual water supply amount in summer season (June and July, 1997) and winter season (October, 1998) at the distribution pumping station with the use of ultrasonic flow meter. The following are the findings.

Summer season

- Supply amount to service area is about 860 m^3 /day in average.
- Even late in the night considerable amount of water (6.5m^3 hourly) is distributed after pump stop caused by electric power cut.

Winter season

- Supply amount to service area is about 1,060 m^3 /day in average.
- Daily consumption in a week day (Friday) and in weekend (Saturday) is almost the same.
- Peak-flow appears around 9:00-10:00AM on Friday and at 10:00-11.00 AM on Saturday.
- Even late in the night considerable amount of water (35 to 38 m^3 hourly) is distributed.

2.9.5 Water Consumption

(1) Domestic Use

According to the data on the water tariff of APSD, water consumption of domestic users was estimated and shown in the following table for the consecutive 12 months until the end of September, 1998.

(unit: m^3)

Type of Dweller	Monthly Consumption (1997-1998)												Annual Amount
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
Apart.	4950	4950	4950	5202	5202	5202	5202	5202	5202	5202	5202	5202	61,668
Ger	940	980	988	1194	1301	1331	1108	1259	1663	1378	1213	1734	15,089

Apartment : daily mean : 169.0 m^3 , daily max. 185.3 m^3
Ger : daily mean : 41.3 m^3 , daily max. 57.8 m^3

Apartment Dweller

According to the data of the water tariff in 1997, 1650 persons of all apartment dwellers were registered to APSD as water consumers and water charges were collected from them. Water consumption (monthly 4,950m^3) of apartment dwellers is calculated on the basis of unit water demand to be 100 l/c/d and on the number users. It is expressed as follows. Water consumption

1650 persons x 100 l/c/d x 30 days/month x 10^{-3} = 4950 m^3/month.

It is difficult to accurately calculate the actual water consumption for the apartment dwellers because there are not any water meter in apartment buildings.

Actual measurement

Amount of water consumption for domestic use was measured in July 1997 and October 1998 at two apartment buildings (No 17 and No 20).

The following table shows the summary of the flow rate measurement at the apartment buildings in winter season.

Summary of the flow rate measurement

Apartment No	Supplied Amount (m^3/d)	Number of Families	Number of Dwellers	Unit Consumption (l /c/d)	Remark
17	22	27	78	282	measured about 1.0m^3/h in midnight
20	22	37	125	176	ditto

(*) Average consumption per capita: 217 l/c.d = (22 + 22) m^3/day (78+125) person

Unit consumption can be calculated to be 217 l/c/d in average for 203 persons living in 64 dwellings in two apartment buildings.

The flowrate at the same building for summer season is calculated to be 28.8 m^3/d based on the measured result in June, July 1997 and the unit consumption can be calculated to be 220 l/c/d in average for 130 persons living in 29 dwellings in No.20 apartment building.

Ger dwellers

Ger dwellers are estimated to consume 58 m^3/d in average of monthly maximum on the basis of the data from APSD. On the other hand, the consumption in winter season for ger dwellers was examined on the water delivery data by wagon. Ger dwellers require about 80 m^3/d in daily maximum of winter season at present. It means that its unit water

demand can be estimated at more than 5.5 l/c/d if all the ger dwellers are covered. These data are considered reliable because water quantity to fill the wagon tank is measured by water meter set at transfer station to ger area since May 1997.

(2) Institutional and Industrial Use

At present there are 31 institutions and 3 industrial buildings supplied with the water from pipeline network of APSD and the number of institutions are increasing year by year. Monthly water consumption in institutions and industrial buildings is shown in Table 2.9.2 for this one year (Oct 1997~ Sept. 1998) on the basis of the data from APSD.

Water consumption of institutions and industrial buildings is 145.2 m^3 in annual daily average. However there is much difference in water consumption of summer and winter as shown in the following table.

This reflects the fact that CHCs (Communal Heating Center) need water in cold season for heating.

Summary of Water Consumption of Institution and Industries

(unit : m^3/day)

Categories	Annual Average Consumption		Monthly Maximum Consumption (representing winter system)		Monthly Minimum Consumption (representing summer season)	
1. Total Institution	136	93.8%	229	94.2 %	44	86.3%
CHC	(16)	(42.0)%	(140)	(57.6)%	(6)	(11.8%)
2. Total Industries	9	6.2%	14	5.8%	7	13.7%
Grand Total	145	100%	243	100%	51	100%

Oct.1997~Sep.1998

2.9.6 Organization for Water Supply Works

APSD is one of the departments of the municipality. APSD takes care of water supply and sewerage works in Altai City. APSD has been financially independent from municipality since 1996. The name of the organization was changed to Public Service Department (Company) instead of Water Supply Department. Organization chart of APSD is shown in Figure 2.9.3 with the number of employee of each division in each department. The total number of employee of APSD is 45 at present including the director.

2.9.7 Operation and Maintenance

(1) Operation of pump facilities

There are three members of staff for operation of intake pumps at the intake well sites. They operate the pumps in response to phone call from the distribution reservoir site. According to an interview to a staff member, the intake pumps could be operated automatically. However, the automatic operation system has been broken.
Distribution pumps are operated manually, the daily operation time is 24 hours in cold season and 16~18 hours in warm season. So when the distribution pump stops, water supply is suspended.

(2) Operation of Chlorination

Chlorine is added to the inletpipe at the reservoir for thirty minutes a day when the water in the reservoir is nearly full. One staff is in charge of chlorination. The laboratory is located in a premise of the distribution reservoir, three staff members are working at the laboratory. Judging from the appearance, the equipment in the laboratory is definitely insufficient. According to the data of water quality of residual chlorine at the reservoir and tap in this Study is nearly zero (refer to Section 2.8 of this report). Reliability of chlorination should be raised to the point where a little amount of chlorine should remain in water at taps.

(3) Maintenance

Maintenance of the water at the storage reservoir and supply facilities should be conducted periodically so as to keep the facilities in good condition as long as possible. At the same time, daily inspection of the facilities is required.
In APSD maintenance staff is not sufficient in number. Moreover, shortage of equipment, devices, materials, and so on is the most crucial matter in executing sufficient maintenance. Existing spare parts of major equipment based on the interview to APSD, are described as follows.

- Submersible pump for installation of a intake well: 25 m^3/hx100m; 1 set
- Centrifugal pump for distribution: 90 m^3/hx80m; 1 set
- Injection equipment for chlorination: 1 set
- Fan for exhaust gas at chlorination room: 1 set
- Tees for accessory of chlorination injection: D 25 ; 3 pipes

- Valve : D 25 ; n = 10
- Valve : D 150 ; n = 10

2.9.8 Water Tariff

(1) Profit and Loss Statement

The following table shows the profit and loss statement of APSD for the past five years from 1997. The largest revenue is water tariff from consumers, accounting for 69% of the total income in 1997. On the other hand, the largest spending is on power accounting for 48.6% in 1997.
The balance in the year of 1997 shows a profit of Tg. 11.2 million.

Profit and Loss Statement of APSD

unit (Tg1000)

Year	1993	1994	1995	1996	1997	1997 (%)
1. Revenue						
Tariff	22,501.8	21,636.6	17,964.4	52,198.6	72,349.1	69.0
Piping Service	8,786.2	9,487.6	6,860.6	20,659.4	25,668.6	24.5
Other Service	1,193.4	2,886.8	3,193.1	3,514.4	6,781.5	6.5
Total	32,481.4	34,011.0	28,018.1	76,372.4	104,799.2	100.0
2. Expenditure						
Raw Material	120.1	320.5	1,600.0	228.2	1,471.4	1.6
Coal/ Wood	31.3	155.1	140.0	--	98.6	--
Fuel	6,166.1	8,097.1	9,000.0	6,851.1	7,632.2	8.2
Parts	793.2	1,231.3	1,156.0	2,535.1	3,932.2	4.2
Power	9,017.5	8,396.2	9,001.0	40,692.5	45,476.3	48.6
Heating	705.4	1,120.8	1,427.5	1,796.3	2,744.9	2.9
Expendable	49.1	442.2	662.0	351.2	902.9	1.0
Communication	223.5	235.9	267.1	465.7	793.7	0.8
Repair	5,332.5	5,314.9	5,320.0	5,316.0	10,100.4	10.8
Salary	3,381.5	6,990.4	8,251.2	9,142.2	11,126.5	11.9
Tax	456.5	943.7	1,402.7	693.3	2,300	2.5
Other	585.2	1,772.0	1,347.5	3,011.3	7,004.0	7.5
Total	26,862.2	35,019.7	39,575.0	71,081.9	93,583.3	100.0
3. Balance	5,619.2	-1,008.7	-11,556.9	5,289.5	11,215.9	

(2) Water Tariff

The following table shows the present water tariff. The tariff is collected as follows:

- APSD delivers an invoice to consumers

- Consumers receive the invoice and pay the charge at the bank.

According to APSD, about 99% of water tariff was collected.

Water Tariff set by APSD for 1997 (Tg)

Consumer	Unit	Water supply	Sewerage	Total
Industry, Enterprise	Tg/m^3	900	900	1800
Apartment	Tg/month/cap.	250	240	490
Ger	Tg/m^3	1250	-	1250

Apartment dwellers pay only a fixed amount of Tg250 monthly. On the other hand, ger dwellers pay Tg1,250 for coupon tickets to buy one cubic meter of potable water.

2.9.9 Sewerage System

(1) Outline of Sewerage System

Altai City has a sewerage system managed by APSD. Only the wastewater from urban area (apartment, commercial, and institutional areas) is collected by sewer. No roadside ditch and sewer for stormwater are present in the city.

In the ger areas, each ger has its own latrine. Sediments in the latrine is desludged about once a year. The sludge is conveyed to the new wastewater treatment plant site.

Collected wastewater is discharged to two wastewater treatment plants with stabilization pond and the treated water is discharged to the swamp next to the plants. There are two waster water treatment plant; old and new. (The location is shown in Figure 2.9.4.)

(2) Collecting System

The collecting system by sewer covers almost all of the apartment area in Altai City. The sewer route is shown in Figure 2.9.4. Diameter of the sewers range from 125 mm to 350 mm, the sewers are made of reinforced concrete.

Two main sewers exist because of existence of two wastewater treatment plants. Their flow rates are roughly estimated to be 400 m^3/d and 600 m^3/d, however some portion of the flow leaks and discharges to Esuitiin Sair River.

Manholes are located at sewer intersections, changes in alignment, changes in sewer size and also at regular intervals where alignment remained unchanged.

(3) Treatment System

The Old Wastewater Treatment Plant

APSD operates the old wastewater treatment plant (WWTP) and the new one. Both plants are working at present. The old plant is located at the southeast of the city center. Influent flow at the old one is much bigger than that of new one. Treatment process uses a stabilization pond with four cells. However all of the influent wastewater percolates downward through the bottom or evaporates. That means there is little effluent wastewater. The area of old plant site is about 10 ha based on GPS survey.

The New Wastewater Treatment Plant

The new WWTP is located at the east of the city center. The treatment process uses a stabilization pond with six cells. However all of influent wastewater percolates downward through the bottom or evaporates and little effluent water except leakage from collecting sewer is discharged at side. However in the coldest season, some of the treated wastewater discharges to the outside according to the interview with APSD. The area of the new WWTP site is about 12 ha based on GPS survey.

The confluence of leaked wastewater and Esuitiin Sair River is 3 km away from the old treatment plant. The leaked wastewater near the confluence looks as clear as the treated wastewater. However the quality of wastewater before the confluence point should be analyzed as effluent wastewater quality of WWTP.

2.9.10 Solid Waste Management

The Urban and Road Department of Altai City is responsible for solid waste management in Altai City. This department has four vehicles for conveying solid waste and five staffs.

The disposal site is located in the northeastern part of the city and the distance from the city center is approximately 6 km. Collected solid wastes are leveled by a bulldozer without any soil cover.

Table 2.9.1 Features of Intake Wells

	Item		Unit	Intake well				
1	Well code			CK-4923	CK-4924	CK-8761	CK-2 (8850)	CK-22
2	Construction year			1979	1979	1986	1995	1986
3	Depth of Well		m	39	62	30	52	45
4	Depth of Installed Pump		m	37.5	22	29	33	42
5	Pumping Rate		l/s	7.5	9.5	6.0	7	7.6
6	Statistic Water Level		m	GL-5.0	GL-7	GL-6	GL-7	GL -8
7	Dynamic Water Level		m	GL-9.0	GL-11	GL-10	GL-13	GL -18
8	Drawdown (SWL - DWL)		m	4	4	4	6	10
9	Specification of Pump			$8x25m^3/hx80m$	$8x25m^3x100$	$8x25m^3x180$	$8x25m^3x100$	
10	Depth to Aquifer	Upper	m	GL-10	GL-11	GL-18	GL-14	GL-12
		Lower	m	GL-24	GL-25	GL-28	GL-47	GL-20
Comment						under repair		abandoned

Table 2.9.2 Water Consumption in Institutional and Industrial Facilities

unit : m^3

Facilities			Monthly Consumption (1997 - 1998)												Anual Consumption
			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	
1	Communial Heating Center	No.1	134	118	45	74	98	87	645						1,201
		No.2	1,263	997	951	1,500	1,643	2,151	285						8,790
		No.3	257	299	325	253	217	380	536						2,267
		No.4	265	119	110	119	138	149	153						1,053
		No.5	70	188	159	239	152	128	158						1,094
		No.6	300	593	428	424	645	835	624						3,849
		No.7	125	104	84	110	131	297	272						1,123
		No.8	240	185	264	264	334	307	344	173	294		198	281	2,884
	Sub-total		2,654	2,603	2,366	2,983	3,358	4,334	3,017	173	294	-	198	281	22,261
2	Provincial Hospital		1,698	869	1,074	1,040	1,181	1,120	1,320	1,249	1,409	1,150	860	806	13,776
3	School No.1		876	876	876	876	876	876	876	310	240				6,682
4	No.3		7	7	7	10	8	8	8	8			8	8	79
5	Kindergarden No.1		57	45	13	22	11	8	27	11					194
6	No.2						5							27	32
7	No.3		5	7	6	11	11	6	4	6	18			120	194
8	No.4					8		8	4	4					24
9	Governor's office		160	160	160	417	291	190	160	160	195	190	196	190	2,469
10	Police office		25	25	25			34	32	32	77	74	47		371
11	Post office		28	28	28	28	28	28	28	28	28	20	56	56	384
12	Public Health Center		5	1	1	2	2	2	2	2	2	2	2	2	24
13	Radio Broadcasting St.					40	48	10	25	77					200
14	Earthquake St.									2					2
15	Oil Supply Company							82	4						86
16	Airport					28	39	70	33	5				23	198
17	Medical Collage Dormitory		114	110	90	150	150	200	940					555	2,309
18	Laundry		39	27	15										81
19	Hair Dresser		2	2	2	1	2	1	1	1	2	2	2	2	20
20	Baby Nursery										5			16	21
21	Chemist (Shop)									5					5
22	Nursery for Elder People						6	12	8		10	12			49
23	Agricultural Stock-exchange					48	39	96	6						189
A: Sub-total Institution (1 - 23)			5,670	4,760	4,663	5,664	6,055	7,085	6,495	2,074	2,280	1,450	1,369	2,086	49,650
1	Mandal Co.		41	103	98	93	85	64	81	31	70	100	65	39	870
2	Entum Co.		104	164	45	91	260	260	260	75	55	35	55	85	1,489
3	Tulga Altai Co.		100	100	100	100	100	100		100	100	100	100		1,000
B: Sub-total Industry (1 - 3)			245	367	243	284	445	424	341	206	225	235	220	124	3,359

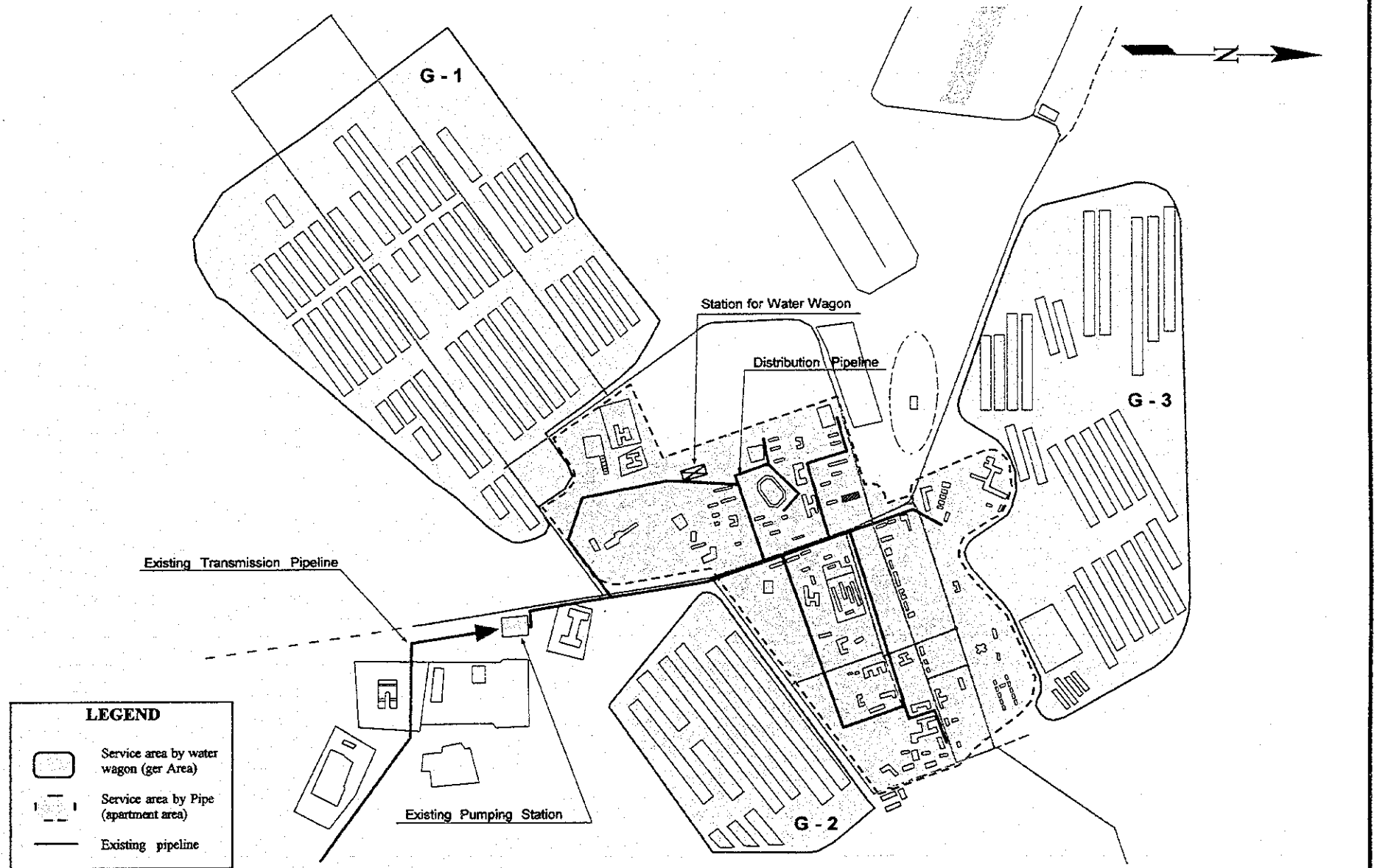


Figure 2.9.1 Existing Pipeline and Service Area

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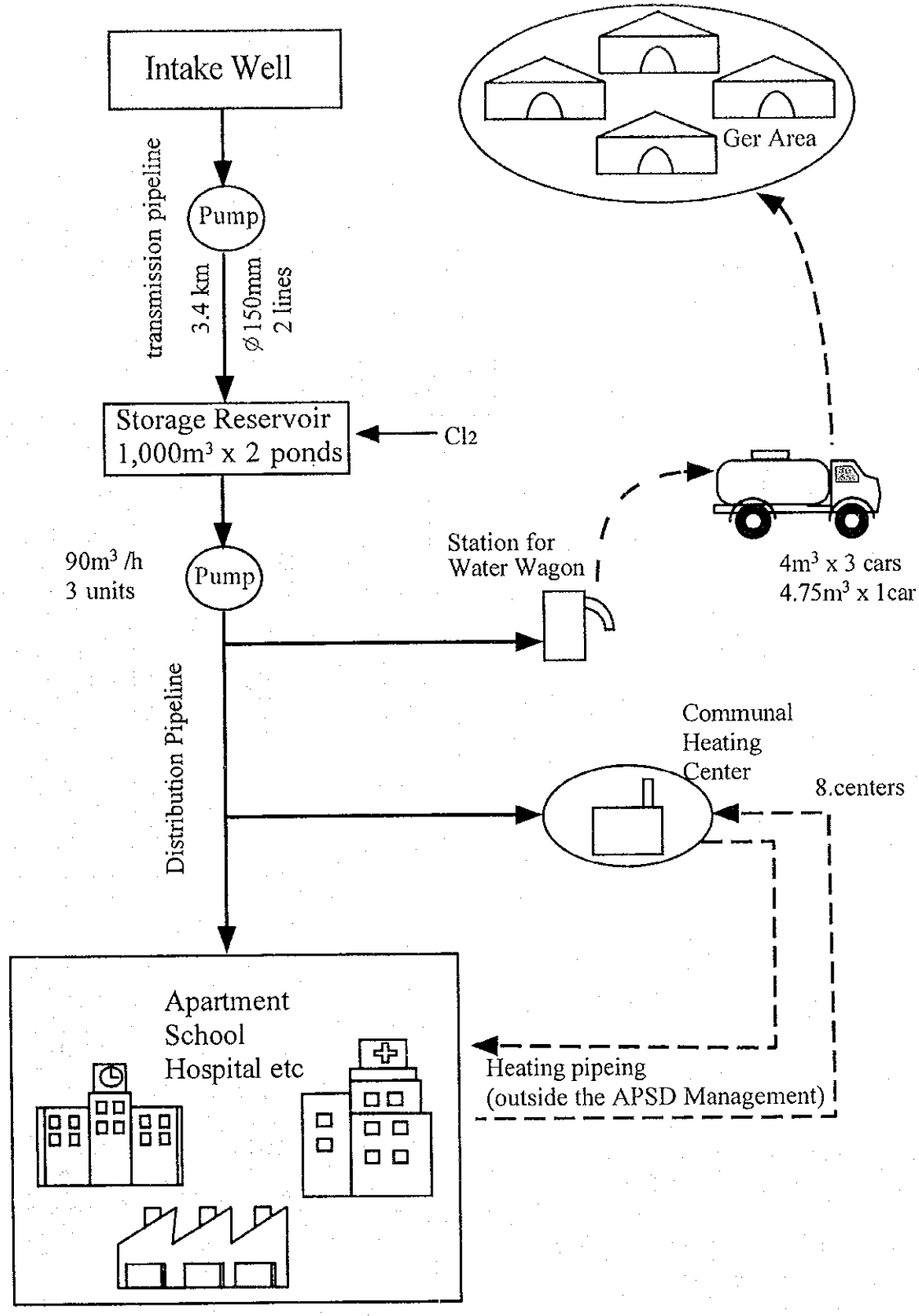

Figure 2.9.2 Water Supply System of Altai City

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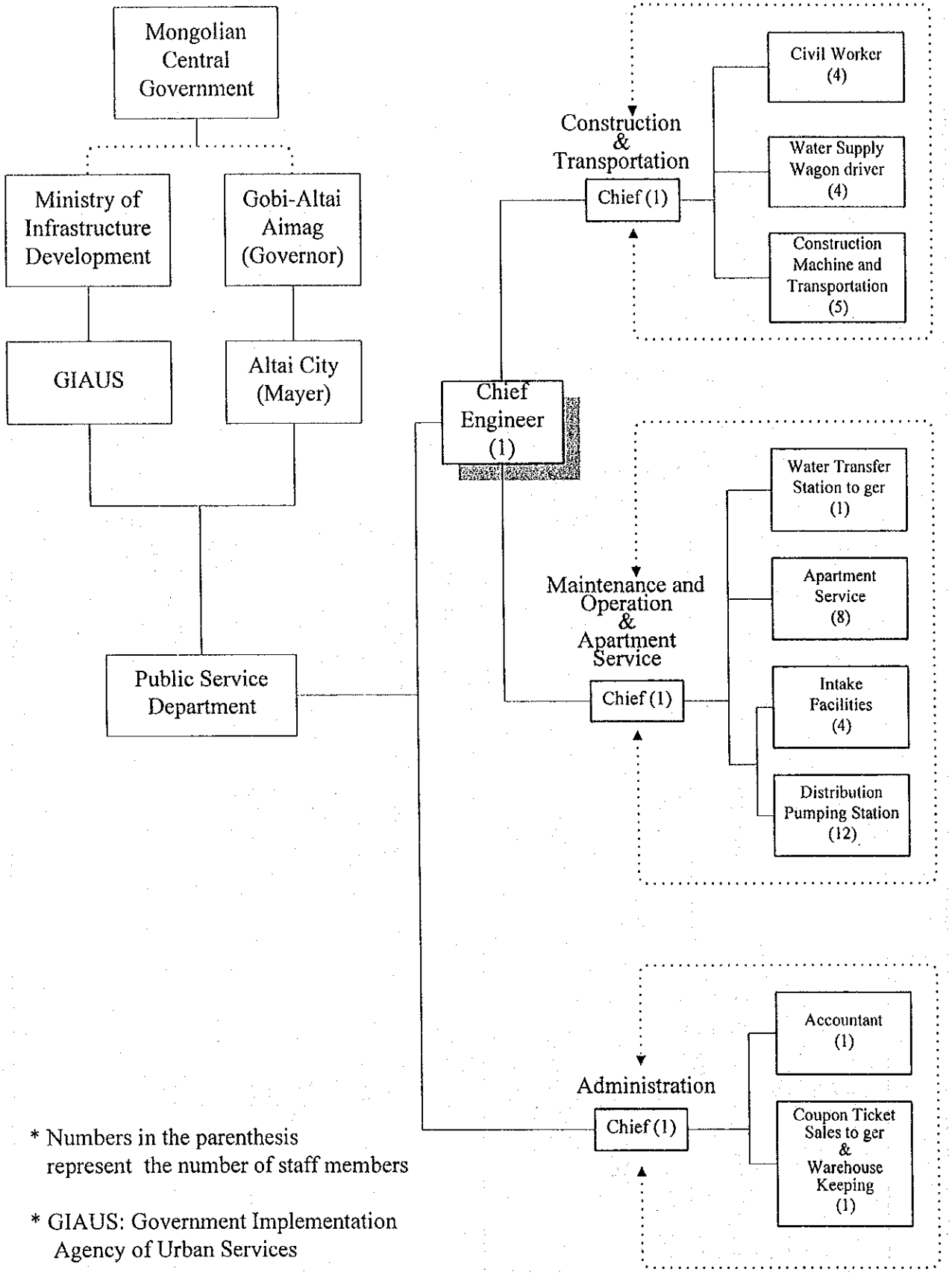

* Numbers in the parenthesis represent the number of staff members

* GIAUS: Government Implementation Agency of Urban Services

Figure 2.9.3 Organization Chart of Water Supply Works in Altai City

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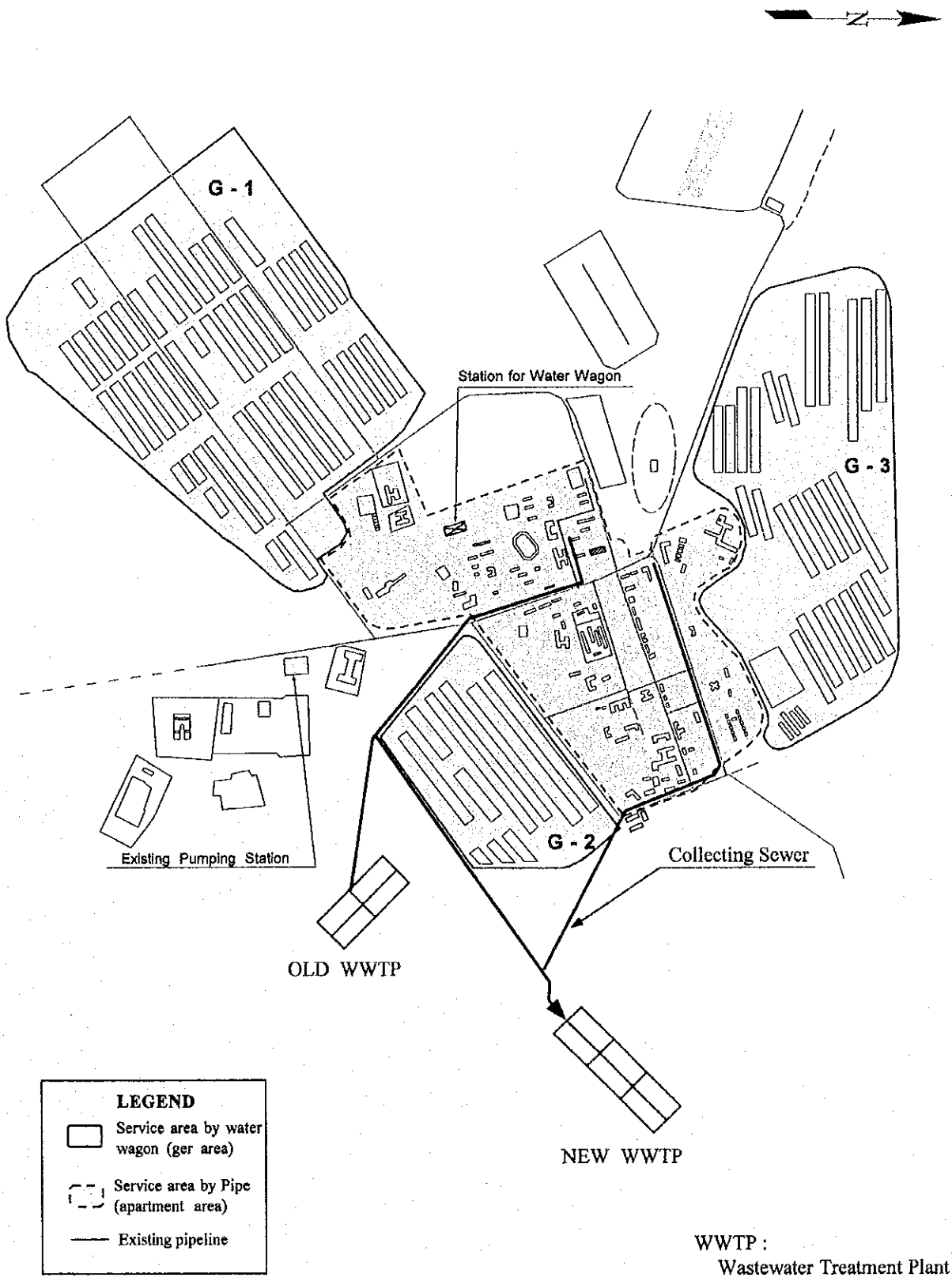

Figure 2.9.4 Sewerage System in Altai City

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