4.10 PROJECT EVALUATION

4.10.1 Economic Analysis

Economic feasibility of the proposed priority project was confirmed by deriving economic internal rate of return (EIRR), benefit-cost ratio (B/C) and net present value (NPV) for the standard case and alternative cases based on the assumptions same as those for the master plan. The following are the values specific to the priority project.

Economic Benefit in 2005

Item	Unit	Minimum Requirement	Commercial good
Value of water	Tg/m^3	1,875	67
	$\$/m^3$	2.11	0.08
Net water use in 2005			
Apartment	Lcd	10.6	139.4
Ger	Lcd	10.6	0
Population in 2005			
Apartment	No.	3,433	
Ger	No.	15,357	
Economic benefit in 2005 and thereafter			
Domestic water	10^3 \$/year	153	13
Industrial and institutional water	10^3 \$/year	112	

The following table summarizes the result.

Result of Economic Evaluation of Priority Project

Case	EIRR (%)	B/C	NPV ($\$10^3$)
Standard	16.3	1.38	532
Cost 10% up	14.3	1.25	391
Benefit 10% down	114.1	1.24	337
Cost 10% up plus benefit 10% down	12.3	1.13	196

The EIRR for the standard case was derived at 16.3% indicating high economic return of the priority project, compared with an opportunity cost of capital or cut-off EIRR at 10%. The same assumptions for the analysis on the master plan were also employed. The following are the used values and the estimated economic benefit.

4.10.2 Financial Analysis

A financial analysis for the priority projected was carried out in the same way as for the master plan. The following are the derived water charges for the priority project.

- Ger : Tg 556/m^3
- Apartment : Tg 64/m^3
- Industry/Institution : Tg 900/m^3

Under these water charges, operation and maintenance cost can be recovered as well as they are affordable for the residents. A financial internal rate of return (FIRR is derived at 4.6%, indicating the possibility that the fund for implementing the priority project could be procured at an interest of less than 4.6% per year as shown in Table 4.2.

4.10.3 Social Evaluation

Proposed project on water supply system mainly focused on the improvement of water supply in the ger area by increasing chances of water availability. Although the residents of ger area cited yard connection as a preferable choice, it is not technically feasible. As mentioned in social analysis, no negative impact on the proposed project is recognized in terms of religion and social custom, acquisition of land for the project, and water seller.

4.10.4 Analysis for the Beneficiaries

While the higher income group of non-piped households approved 161% of increase, the lower income group of non-piped households approved 80% of increase to the current tariff level. As indicated in the result of the household survey, the lower income group of non-piped household consumes less volume of water per day per person than the higher income group. However even the volume used by the higher income group is insufficient for required volume of consumption. It is recommended that exemption system of water charge for lower income group - unemployed and single female headed households should be revised periodically in accordance with local poverty assessment.

The proposed program for water supply system, which plans the installation of kiosk type water delivery points in the ger area, will give the residents access to the water

whenever necessary for them. This also will lead to the increase of water consumption for non-piped households. The frequent supply of water is expected to reduce the habit of stock water and bring about less opportunity of contamination.

However, 20% of non-piped households will not gain the intended benefit of kiosk type of water supply since a fixed single kiosk is designed to cover a radius of 250m. Therefore the use of water carriers as proposed in the previous chapter will be especially important for these households.

4.10.5 Environmental Impact Assessment (EIA)

(1) General Description

This section is written based mainly on the Environmental Impact Assessment report for the project conducted by an approved Mongolian EIA Company. The contents of the report is summarized in the following.

(2) Activities of the Project

Construction Phase

① Drilling of test wells
② Construction of production wells
③ Construction of distribution pipelines (about four kilometers) for Ger areas

Operation Phase

① Production of water from the production wells
② Chlorinating

(3) Environmental Impacts

Expected Impacts in the Construction Phase

① Impacts from drilling wells

Item	Judgement
Noise for human being (including livestock) and fauna (especially in breeding season).	small negative impact
Degradation of vegetation and subsoil, small area (10-30 m^2)	small negative impact
Employment	small positive impact

② Impacts from the Construction of Water Supply Facilities

Item	judgement
Degradation of vegetation and subsoil - distribution pipelines (30 m x 3.9 km, affected area 12 ha)	large negative impact
Employment	small impact
if construction workers are locally employed,	positive impact
if construction workers are employed from other places,	negative impact

③ Impacts in Operation Phase

Item	judgement
Stable water supply, especially for Ger areas	large positive impact
Degradation of groundwater, wetland, vegetation and subsoil if overusing the groundwater	large negative impact
Employment (changing types of job)	small impact

(4) Mitigation of Impacts

Although there are not many serious impacts expected in this project, proper measures should be taken to minimize the impacts.

1) Informing for the construction detail before the construction
2) Preventing for the degradation of vegetation and subsoil from the construction work. The following steps should be taken:

   ① to survey rare plant species and breeding sites of rare animal species in the affected area around the construction of facilities, and they take a protection action for these rare species if necessary;
   ② to preserve subsoil from the affected area;
   ③ to construct the facility;
   ④ to return subsoil in the affected area; and
   ⑤ to monitor fauna and flora in the affected area.

3) Prevention the degradation of groundwater from overusing
   The following measures should be taken :

   ① to educate people on proper water use;
   ② to reduce the leakage of water; and
   ③ to monitor water level and quality of groundwater, vegetation and subsoil.

4) Hygiene

① The following sanitary zonation scheme should be established to protect the sources of domestic water.

I - (100 m) strictly prohibited zone.

Prohibit to setting up of any sources of possible pollution in the I-zone.

II - (300 m) zone under protection.

III - (1,000 m) monitoring zone.

② Bacteriological and chemical analyses should be monitored in these zones.

(5) Monitoring and Management

1) Construction Phase

After the construction of a facility, vegetation and subsoil in the affected area should be monitored, and if necessary, some measure should be taken to restore them.

2) Operation Phase

Water level and quality of groundwater, vegetation, and subsoil should be monitored, and if necessary some measures should be taken to improve the situation.

Table 4.1 Economic Evaluation of Priority Project

(Unit : $)

No.	Year	Cost				Benefit			Balance
		Invest-ment	OM	Replace-ment	Total	Domestic	Industrial & institutional	Total	
1	2000	10,418	44,113	0	54,531	0	0	0	-54,531
2	2001	232,134	48,710	0	280,844	1,739	3,007	4,746	-276,098
3	2002	293,869	52,245	0	346,114	40,495	6,326	46,821	-299,293
4	2003	282,859	48,108	0	330,967	89,557	9,887	99,445	-231,522
5	2004	177,080	52,433	0	229,513	136,782	13,166	149,948	-79,565
6	2005	0	55,967	0	55,967	166,346	112,102	278,447	222,480
7	2006	0	55,967	0	55,967	166,346	112,102	278,447	222,480
8	2007	0	55,967	0	55,967	166,346	112,102	278,447	222,480
9	2008	0	55,967	0	55,967	166,346	112,102	278,447	222,480
10	2009	0	55,967	0	55,967	166,346	112,102	278,447	222,480
11	2010	0	55,967	0	55,967	166,346	112,102	278,447	222,480
12	2011	0	55,967	0	55,967	166,346	112,102	278,447	222,480
13	2012	0	55,967	0	55,967	166,346	112,102	278,447	222,480
14	2013	0	55,967	0	55,967	166,346	112,102	278,447	222,480
15	2014	0	55,967	0	55,967	166,346	112,102	278,447	222,480
16	2015	0	55,967	0	55,967	166,346	112,102	278,447	222,480
17	2016	0	55,967	0	55,967	166,346	112,102	278,447	222,480
18	2017	0	55,967	0	55,967	166,346	112,102	278,447	222,480
19	2018	0	55,967	0	55,967	166,346	112,102	278,447	222,480
20	2019	0	55,967	404,081	460,048	166,346	112,102	278,447	-181,601
21	2020	0	55,967	0	55,967	166,346	112,102	278,447	222,480
22	2021	0	55,967	0	55,967	166,346	112,102	278,447	222,480
23	2022	0	55,967	0	55,967	166,346	112,102	278,447	222,480
24	2023	0	55,967	0	55,967	166,346	112,102	278,447	222,480
25	2024	0	55,967	0	55,967	166,346	112,102	278,447	222,480
26	2025	0	55,967	0	55,967	166,346	112,102	278,447	222,480
27	2026	0	55,967	0	55,967	166,346	112,102	278,447	222,480
28	2027	0	55,967	0	55,967	166,346	112,102	278,447	222,480
29	2028	0	55,967	0	55,967	166,346	112,102	278,447	222,480
30	2029	0	55,967	0	55,967	166,346	112,102	278,447	222,480
	Total	996,360	1,644,784	404,081	3,045,225	4,427,220	2,834,926	7,262,146	4,216,921

Sensitivity Analysis

Case	EIRR (%)	B/C	B-C ($)
Standard	16.3%	1.38	532,082
Cost 10% up	14.3%	1.25	390,646
Benefit 10% down	14.1%	1.24	337,438
Cost 10% up and benefit 10% dow	12.3%	1.13	196,001

Table 4.2 Financial Internal Rate of Return of Priority Project

(Under the revised water tariff for OM cost recovery)

FIRR = 4.6% (Unit : $)

Year	Cost				Revenue			Balance
	Invest-ment	OM	Replace-ment	Total	Domestic	Industrial & instiuturional	Total	
2000	10,418	44,113	0	54,531	0	0	0	-54,531
2001	232,134	48,710	0	280,844	536	977	1,513	-279,331
2002	293,869	52,245	0	346,114	12,489	22,741	35,230	-310,884
2003	282,859	48,108	0	330,967	27,620	50,294	77,914	-253,053
2004	177,080	52,433	0	229,513	42,184	76,815	118,999	-110,514
2005	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2006	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2007	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2008	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2009	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2010	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2011	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2012	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2013	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2014	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2015	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2016	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2017	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2018	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2019	0	55,967	404,081	460,048	51,302	93,418	144,720	-315,328
2020	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2021	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2022	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2023	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2024	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2025	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2026	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2027	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2028	0	55,967	0	55,967	51,302	93,418	144,720	88,753
2029	0	55,967	0	55,967	51,302	93,418	144,720	88,753
Total	996,360	1,644,784	404,081	3,045,225	1,365,381	2,486,273	3,851,654	806,429

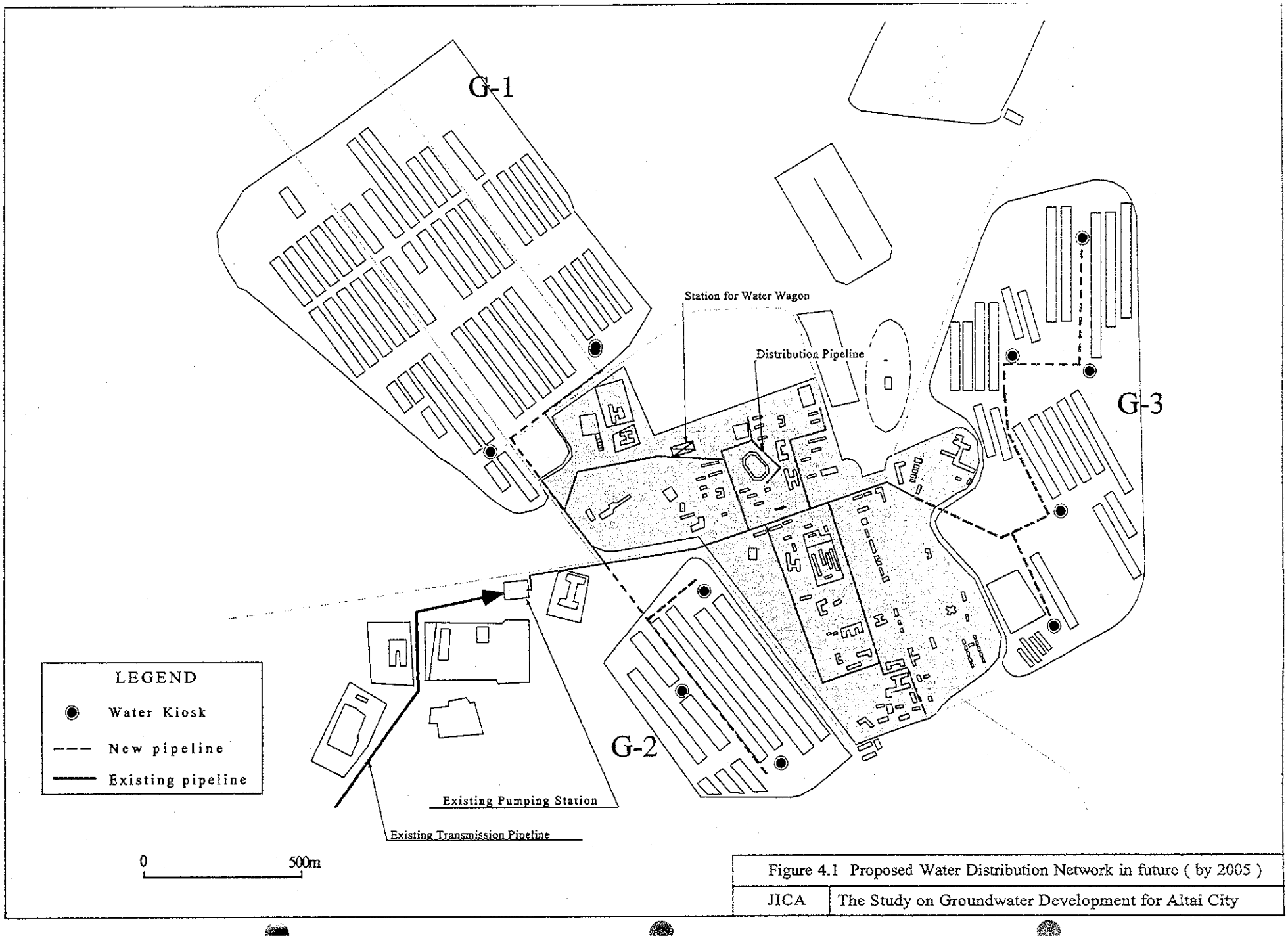


Figure 4.1 Proposed Water Distribution Network in future (by 2005)

JICA	The Study on Groundwater Development for Altai City

5 CONCLUSION AND RECOMMENDATION

5. CONCLUSION AND RECOMMENDATION

Conclusion

The project evaluation revealed that both the master plan and priority project were feasible, therefore worth promoting to the implementation stage. The project would contribute to the improvement of the living standard of Altai people and support economic development in the city. An appropriate financial arrangement would be needed considering the low financial return of the project. No adverse impacts are envisaged in the environmental and social aspects.

Recommendation

(1) At present ger dwellers have great disadvantage in that water wagons deliver water a couple of times a week for them, while apartment dwellers get water by taps any time. Ger dwellers cannot get water whenever they want. Therefore, improvement of water supply service for ger dwellers shall be given priority.

(2) Disparity of water tariff between apartment dwellers and ger dwellers shall be revised. To start with, the fact should be opened to the public.

(3) People have to change the awareness for water quality that high mineral concentrations in water affect their health. Actually, the chemical contents are below the Mongolian standards except magnesium. The problem is the total coliform in water, especially in the stored water in gers. Water in Altai City is not as bad as they claim, considering the water quality analysis result and especially when it is compared with water quality and standard of some other countries. Hygiene education for the public shall be conducted through radio, television, by the public health center and school with following objections:

- increase of awareness on hygiene practice and water consumption,
- proper management of stock water and water consumption, and
- water and health.

(4) Epidemiological survey, that started from 1998, shall be continued to clarify the cause of chronic diseases.

(5) The drawdown in operation of wells should be kept around four to six meters to conserve the limited natural resources of groundwater.

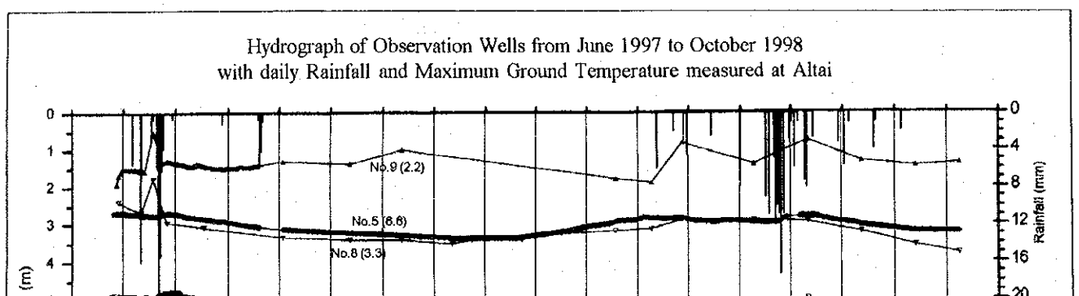
(6) The loss ratio of leakage should be improved step-wise. Water meters shall be installed at the pumping station, apartment buildings, public buildings, and in each apartment. APSD has to inspect meters and find the point of leakage in order to

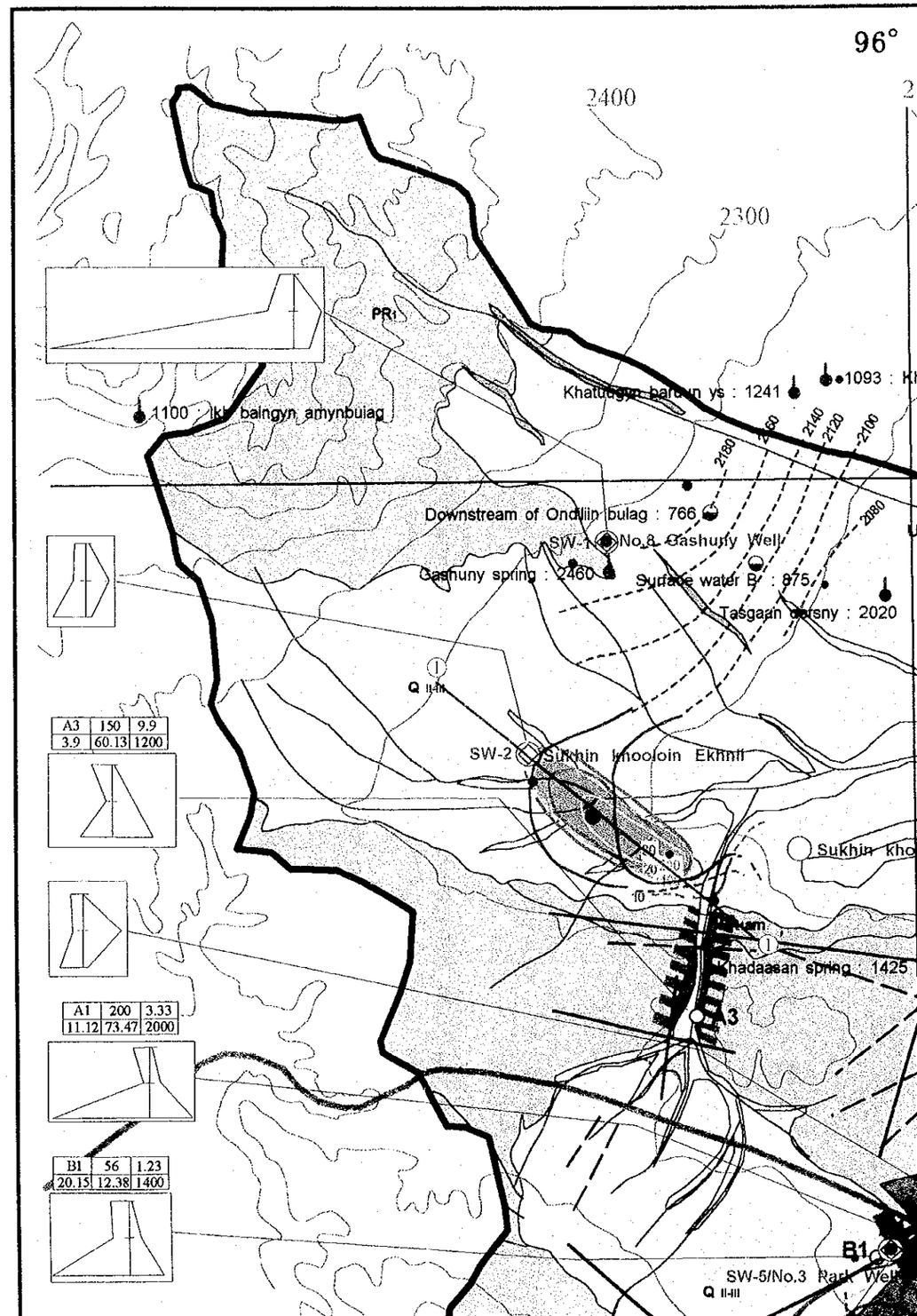
improve the water supply facilities. Inspection staff in APSD should be strengthened.

(7) All information shall be opened to the public to improve the people's awareness for saving water, preservation of the environment to spread the idea that groundwater is limited natural resources.

Hydrogeological Description of Formations in the Study Area

Era / Period	System	Maximum thickness (m)	Explanation
CENOZOIC QUATERNARY Q_{IV}	Upper Quaternary Recent river deposits	>20	Distributed in river and stream bed. Mainly sandy loam and loam. And sand, clay, gravel. A scattered and limited aquifer in Sukhin Khooloi.
Q_{II-III}	Middle and Upper Quaternary Fan and talus deposits	>100	Distributed widely in the area. Gravel, sandy gravel, sand. Most exploitable aquifer occurs in Olon Nuul, where the deposit is thick.
TERTIARY N_{2al}	Neogene System	>100	Mainly covered by Quaternary sediments in the area. Unconsolidated generally. Very low productive aquifer in Sukhin Hooloi and Olon Nuul. Reddish clay with sand and gravel.
PALEOZOIC DEVONIAN D_{1-2}	Lower and Middle Devonian series	>1000	Distributed in the limited area. Sandstone and conglomerate. No aquifer in Study Area.
CAMBRIAN Lower and Middle E_{1-2}	Tsagaan Olom Series	>1000	Distributed in the south end of Study Area. Mainly carbonate rocks.
PRECAMBRIAN PROTEROZOIC V_{ht}	Vend Series Khantaishir Series		Limited distribution in the mountain range on the south of Study Area.
R_{1-3gb}	Upper-Lower Rephean Series		Distributed in the southwest mountain range of Altai City. Mainly Dunite and Serpentine, Peridotite. Springs occur in places along faults.
PR_1 PR_{1am}	Gobi Al Ulaantolgoy S	2950	Distributed widely in the northwest and central mountainous region in Study Area. Fractured aquifers occur in Kharzat and Sukhin Hooloi.
PROTERPZOIC γR_{2-3}	Intrusive Rock of Riphean Series		Limited distribution in the eastern area.





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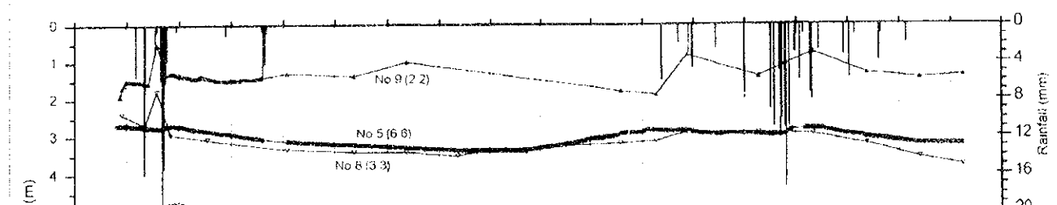
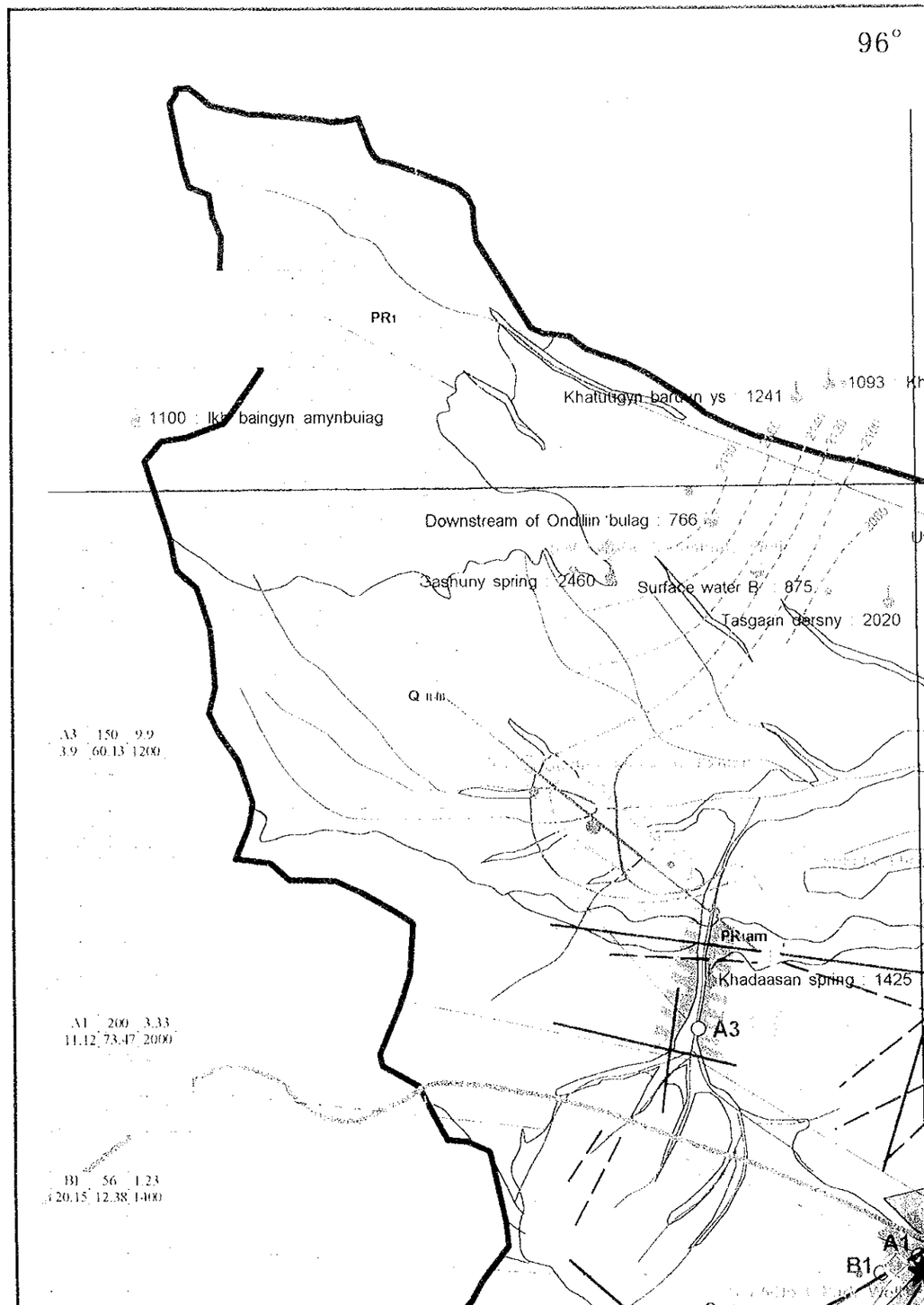
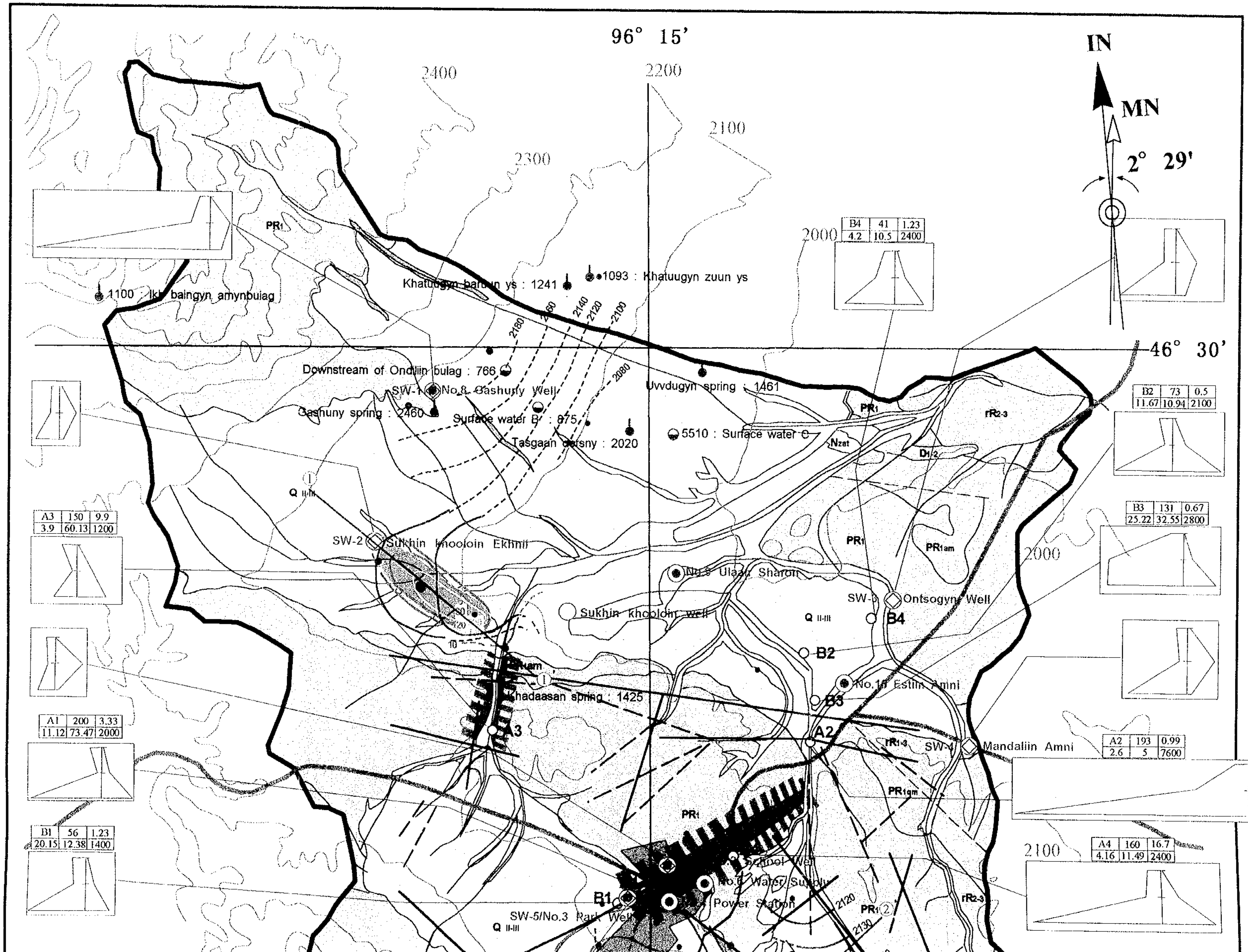
Q_{II-III}	Middle and Upper Quaternary Fan and talus deposits	>100	Distributed widely in the area. Gravel sandy gravel, sand. Most exploitable aquifer occurs in Olon Nuul, where the deposit is thick.
TERTIARY N_{2a}	Neogene System	>100	Mainly covered by Quaternary sediments in the area. Unconsolidated generally. Very low productive aquifer in Sukhin Hooloi and Olon Nuul. Reddish clay with sand and gravel.
PALEOZOIC DEVONIAN D_{1-2}	Lower and Middle Devonian series	>1000	Distributed in the limited area Sandstone and conglomerate. No aquifer in Study Area.
CAMBRIAN Lower and Middle E_{1-2}	Tsagaan Olom Series	>1000	Distributed in the south end of Study Area. Mainly carbonate rocks.
PRECAMBRIAN PROTEROZOIC V_{ht}	Vend Series Khantaishir Series		Limited distribution in the mountain range on the south of Study Area.
R_{1-3gb}	Upper-Lower Rephean Series		Distributed in the southwest mountain range of Altai City. Mainly Dunite and Serpentine. Peridotite. Springs occur in places along faults
PR_1 PR_{1am}	Gobi Altai and Ulaantolgoy Series	29-50	Distributed widely in the northwest and central mountainous region in Study Area. Fractured aquifers occur in Kharzat and Sukhin Hooloi.
PROTERIPZOIC γR_{2-3}	Intrusive Rock of Riphean Series		Limited distribution in the eastern area.

Hydrograph of Observation Wells from June 1997 to October 1998
with daily Rainfall and Maximum Ground Temperature measured at Altai






96° 15'
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2200
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1100 : Ikh baingyn amynbulag
Khatuugyn baruun ys : 1241
1093 : Khatuugyn zuun ys
Downstream of Ondliin bulag : 766
SW-1 No.8 Gashuny Well
Gashuny spring : 2460
Surface water B : 875
Tasgaan dersny : 2020
Uvvdugyn spring : 1461
5510 : Surface water C
Nzat
D1-2
rR2-3
B4 | 41 | 1.23
4.2 | 10.5 | 2400
B2 | 73 | 0.5
11.67 | 10.94 | 2100
B3 | 131 | 0.67
25.22 | 32.55 | 2800
A3 | 150 | 9.9
3.9 | 60.13 | 1200
A1 | 200 | 3.33
11.12 | 73.47 | 2000
B1 | 56 | 1.23
20.15 | 12.38 | 1400
A2 | 193 | 0.99
2.6 | 5 | 7600
A4 | 160 | 16.7
4.16 | 11.49 | 2400
Q II-III
SW-2 Sukhin khooloin Ekhnii
No.5 Ulaan Sharoi
Sukhin khooloin well
SW-3 Ontsogyn Well
B4
B2
No.10 Estiin Amni
B3
PR1
PR1am
Khadaasan spring : 1425
A3
A2
SW-4 Mandaliin Amni
PR1am
PR1
School Well
No.2 Water Supply
Power Station
B1
SW-5/No.3 Park Well
rR2-3
2120
2130
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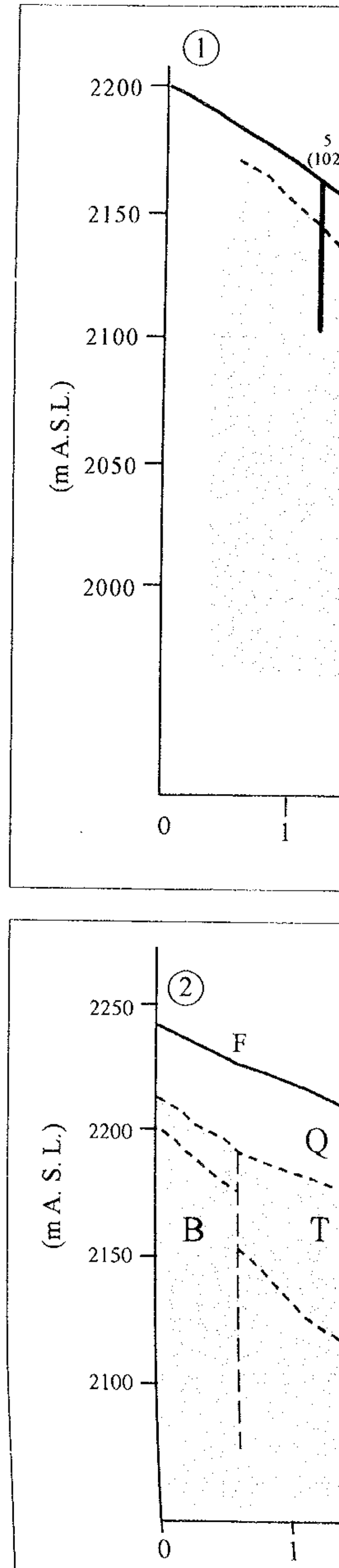
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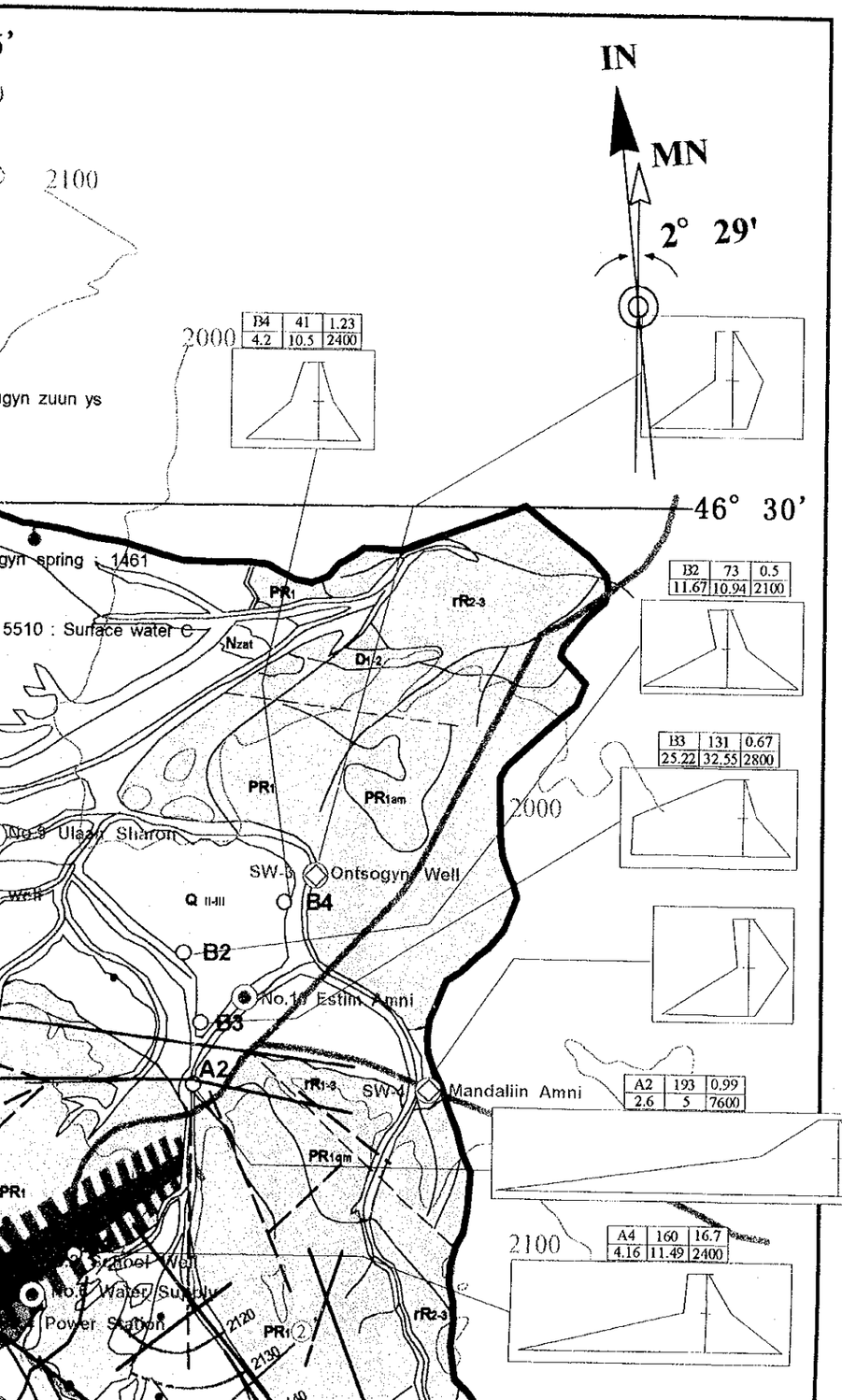
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2° 29'
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4.2 10.5 2400
B2 73 0.5
11.67 10.94 2100
B3 131 0.67
25.22 32.55 2800
A2 193 0.99
2.6 5 7600
A4 160 16.7
4.16 11.49 2400
gyn spring : 1461
5510 : Surface water C
PR1
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PR1am
No.9 Ulaan Sharon
Well
SW-5
Ontsogyn Well
Q II-III
B4
B2
No.10 Estim Amni
B3
A2
rR1-3
SW-4
Mandaliin Amni
PR1qm
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Power Station
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PR1(2)
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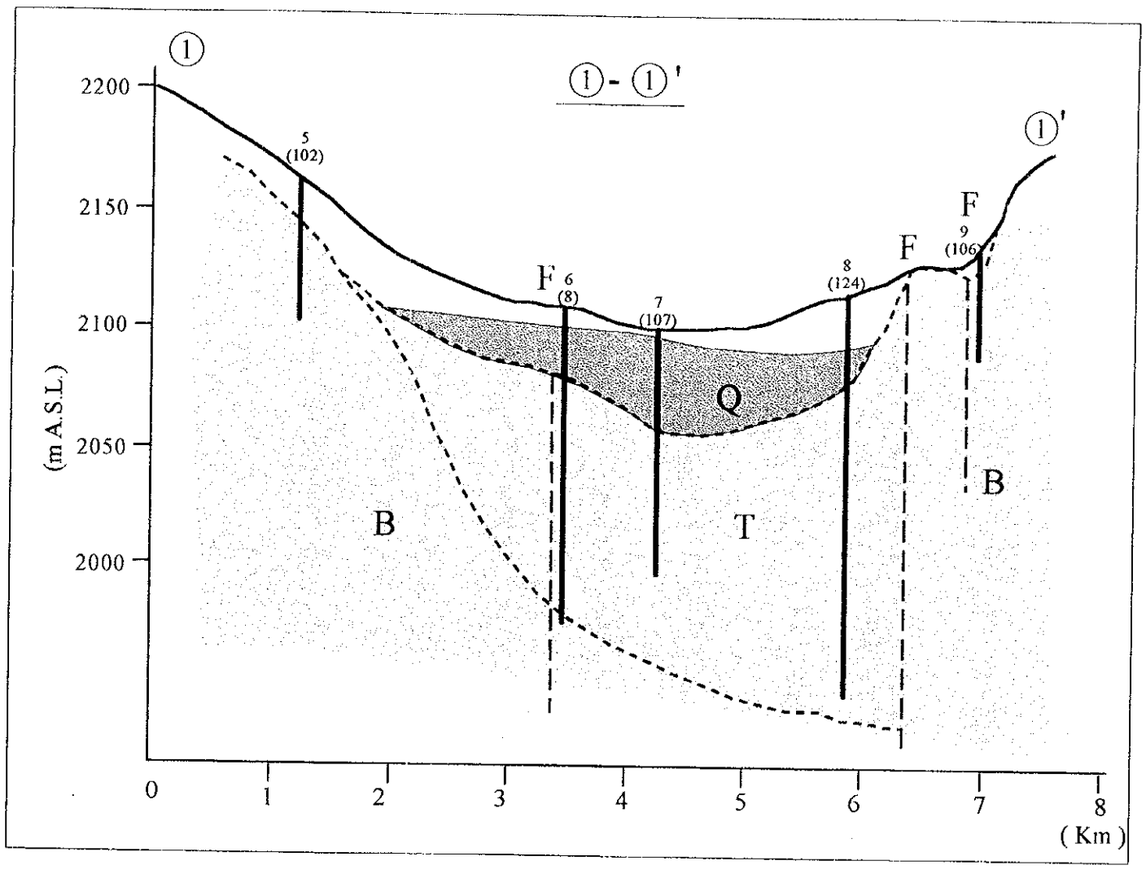
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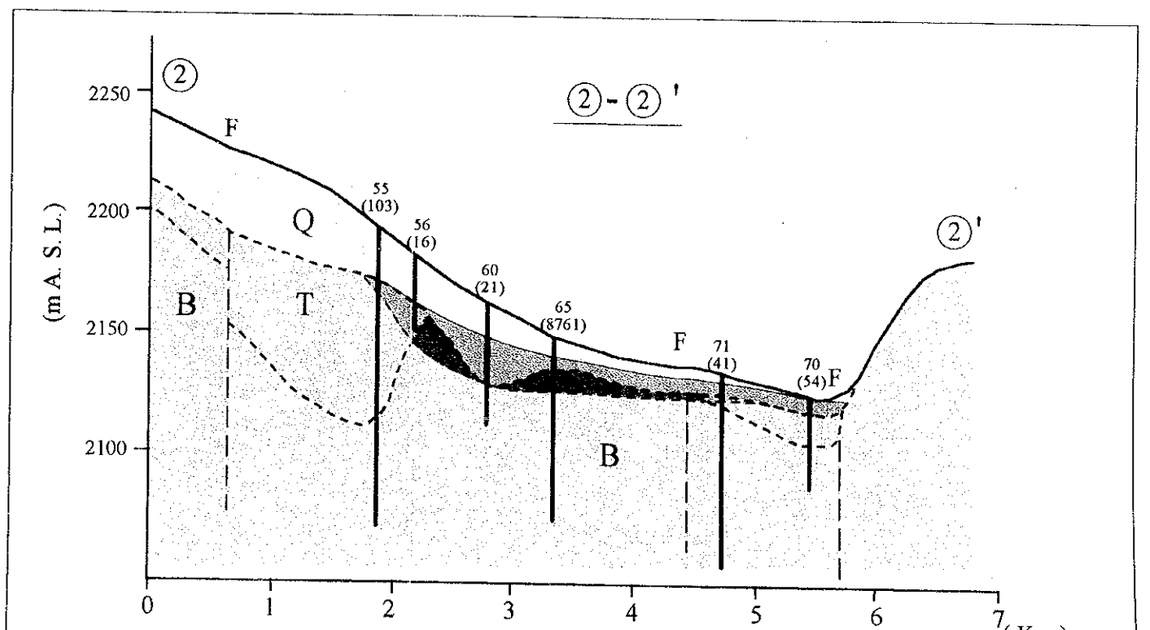
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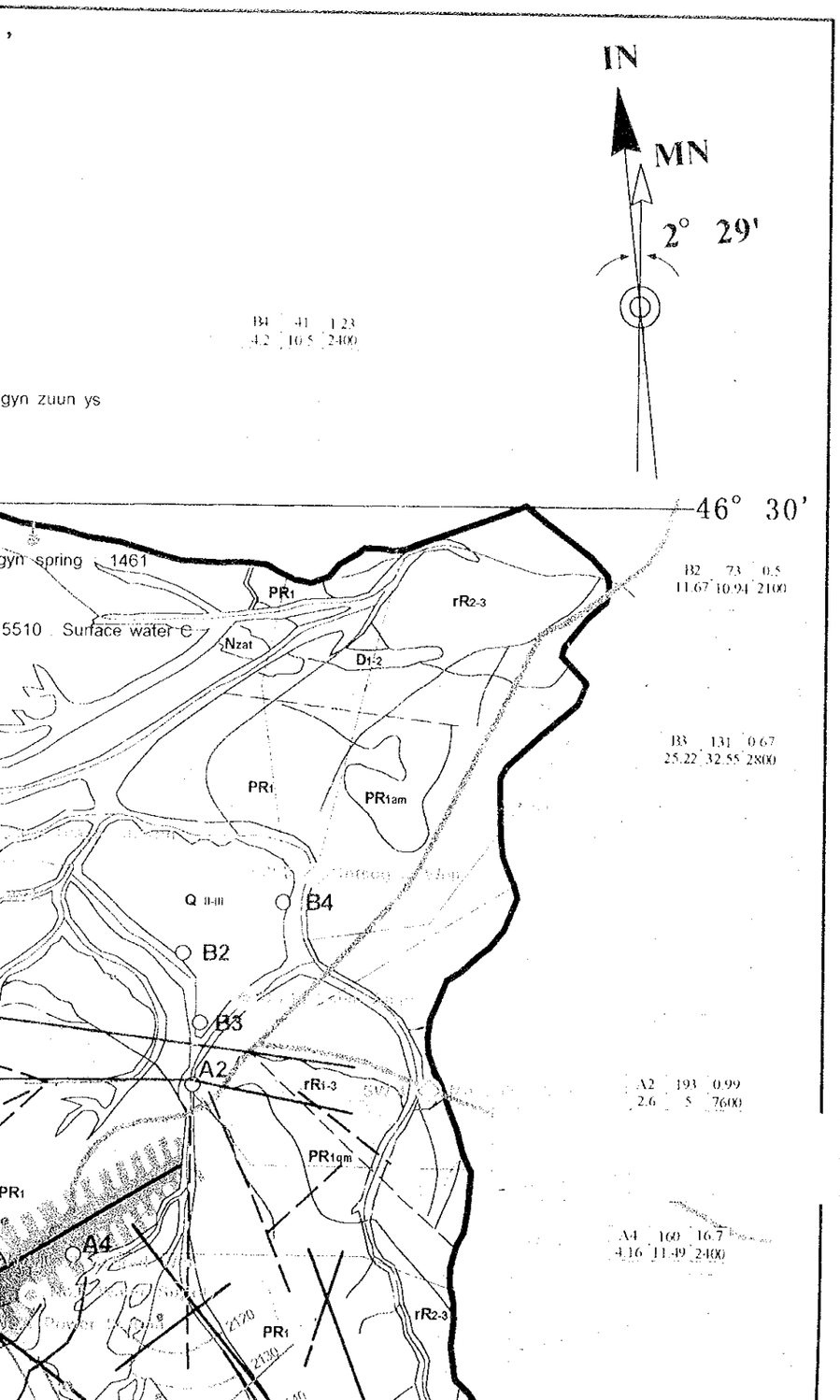
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2° 29'
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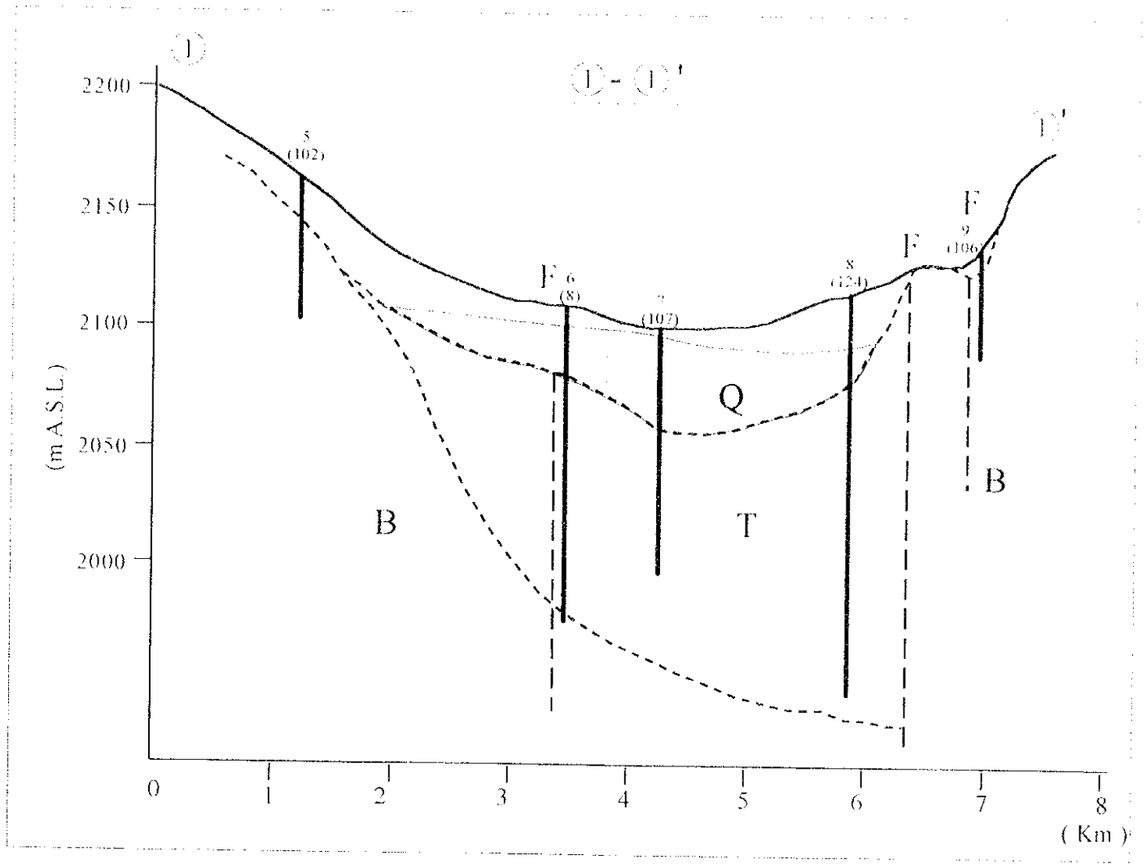
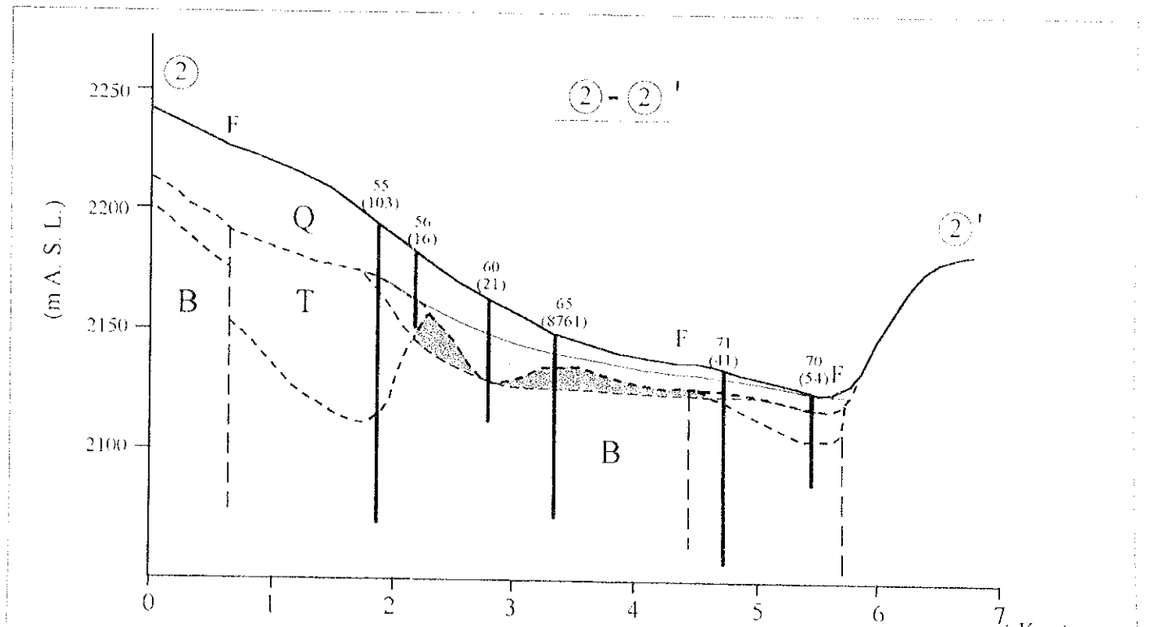
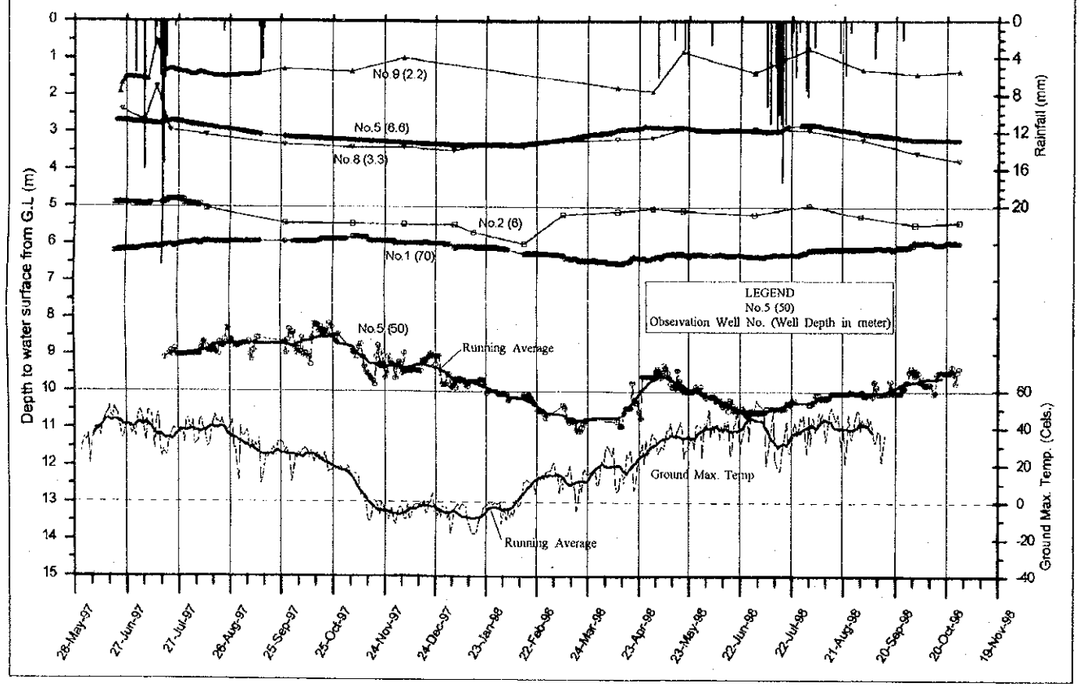
46° 30'
gyn spring 1461
B2 73 0.5
11.67 10.94 2100
5510 Surface water
PR1
rR2-3
Nzat
D1-2
B3 131 0.67
25.22 32.55 2800
PR1am
Q II-III
B4
B2
B3
A2
A2 193 0.99
2.6 5 7600
rR1-3
PR1qm
PR1
A4
A4 160 16.7
4.16 11.49 2400
2170
2130


1 - 1'
1
1'
2200
2150
2100
2050
2000
(m.A.S.L)
5 (102)
F 6 (8)
7 (107)
8 (124)
F
F 9 (106)
Q
B
T
B
0
1
2
3
4
5
6
7
8
(Km)

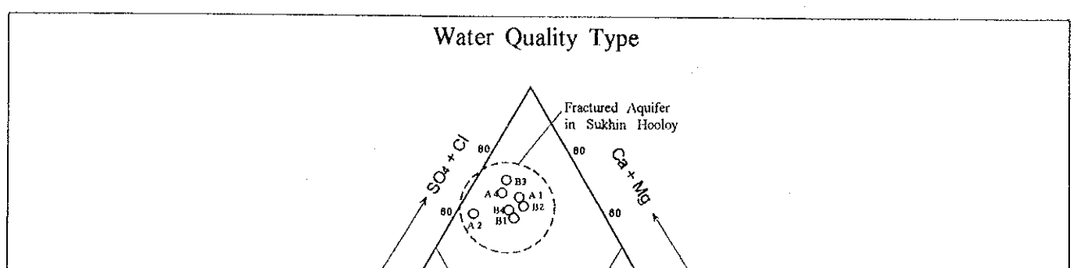

2 - 2'
2
2'
2250
2200
2150
2100
(m A. S. L.)
F
Q
B
T
55 (103)
56 (16)
60 (21)
65 (8761)
F
71 (41)
70 (54) F
B
0
1
2
3
4
5
6
7

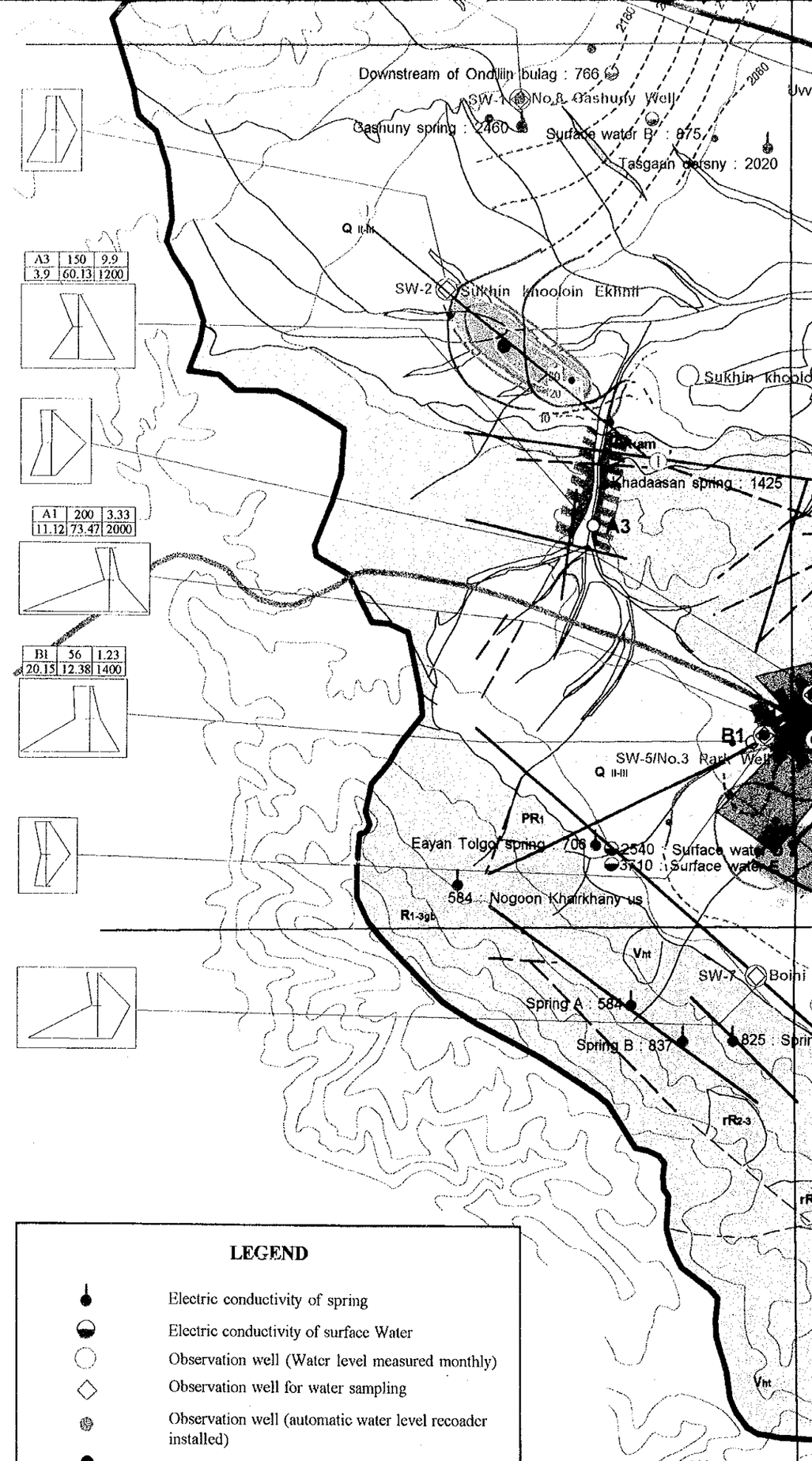
PALEOZOIC DEVONIAN D_{1-2} CAMBRIAN Lower and Middle E_{1-2}	Lower and Middle Devonian series	>1000	Distributed in the limited area. Sandstone and conglomerate. No aquifer in Study Area.
	Tsagaan Olom Series	>1000	Distributed in the south end of Study Area. Mainly carbonate rocks.
PRECAMBRIAN PROTEROZOIC V_{ht}	Vend Series Khantaishir Series		Limited distribution in the mountain range on the south of Study Area.
R_{1-3gb}	Upper-Lower Rephean Series		Distributed in the southwest mountain range of Altai City. Mainly Dunite and Serpentine, Peridotite. Springs occur in places along faults.
PR_1 PR_{1am}	Gobi Al[redacted] Ulaantolgoy S[redacted]	2950	Distributed widely in the northwest and central mountainous region in Study Area. Fractured aquifers occur in Kharzat and Sukhin Hooloi.
PROTERPZOIC γR_{2-3}	Intrusive Rock of Riphean Series		Limited distribution in the eastern area.

Hydrograph of Observation Wells from June 1997 to October 1998
with daily Rainfall and Maximum Ground Temperature measured at Altai



Water Quality Type



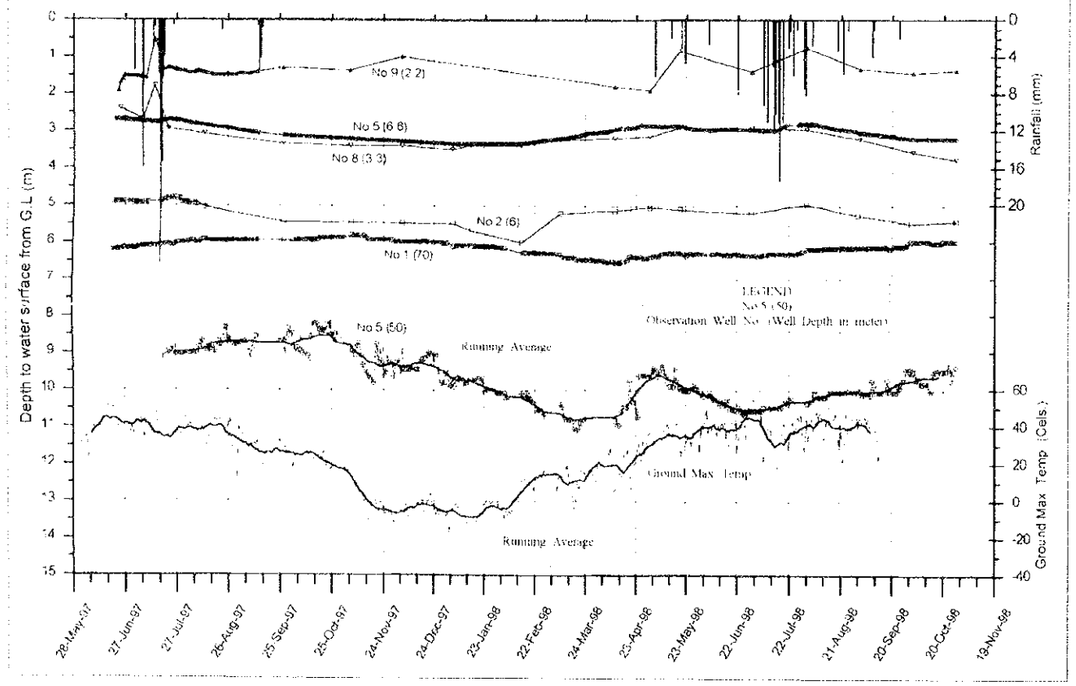


LEGEND

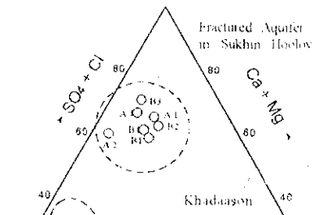
- Electric conductivity of spring
- Electric conductivity of surface Water
- Observation well (Water level measured monthly)
- Observation well for water sampling
- Observation well (automatic water level recoader installed)
- 7 < Pumping rate of well (litter/sec)

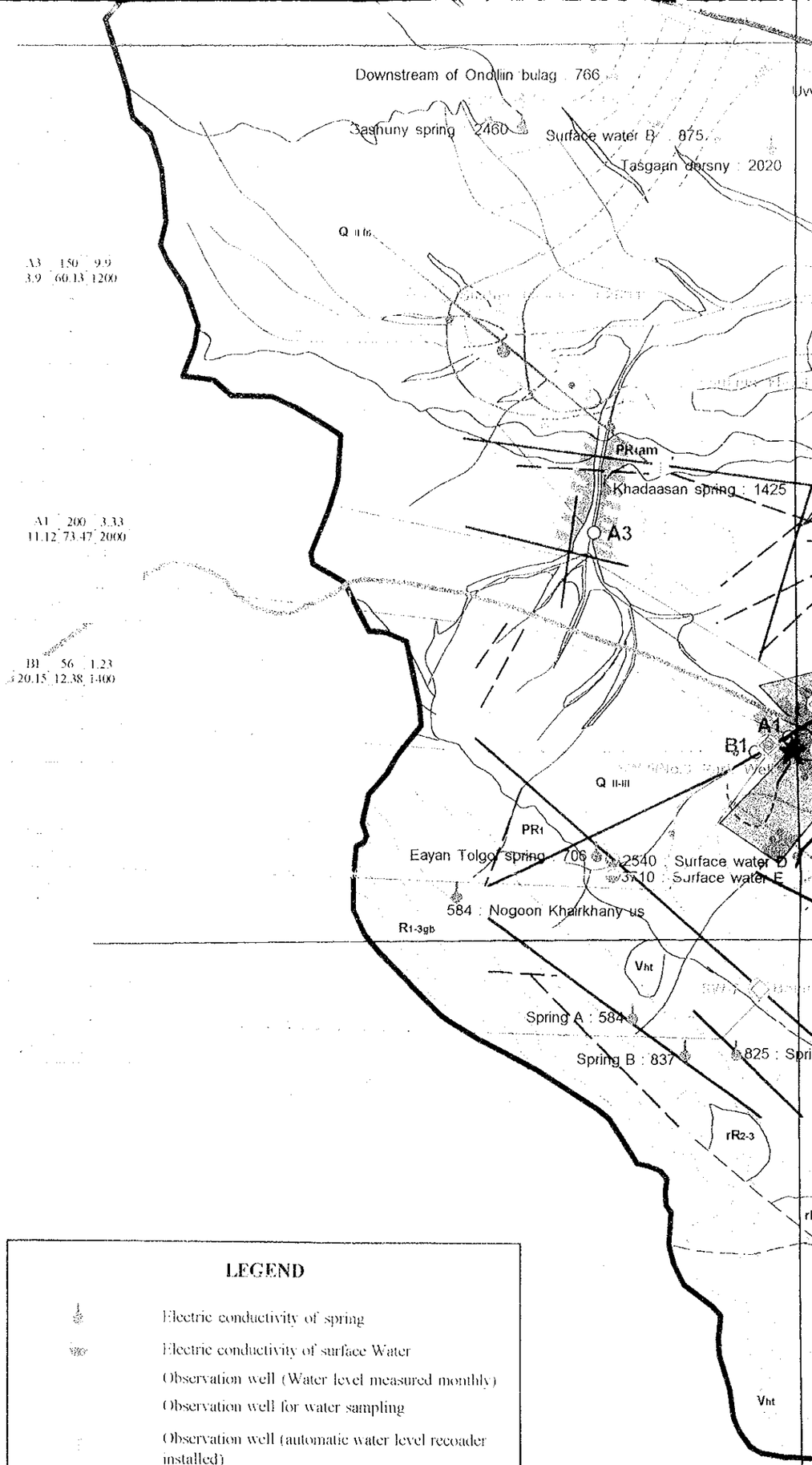
PALEOZOIC DEVONIAN D_{1-2}	Lower and Middle Devonian series	>1000	Distributed in the limited area. Sandstone and conglomerate. No aquifer in Study Area.
CAMBRIAN Lower and Middle E_{1-2}	Tsagaan Olom Series	>1000	Distributed in the south end of Study Area. Mainly carbonate rocks
PRECAMBRIAN PROTEROZOIC V_{ht}	Vend Series Khantaishir Series		Limited distribution in the mountain range on the south of Study Area.
R_{1-3gb}	Upper-Lower Rephean Series		Distributed in the southwest mountain range of Altai City. Mainly Dunite and Serpentine. Peridotite. Springs occur in places along faults
PR_1 PR_{1am}	Gobi Altai and Ulaantolgoy Series	2950	Distributed widely in the northwest and central mountainous region in Study Area. Fractured aquifers occur in Kharzat and Sukhin Hooloi.
PROTERPZOIC γR_{2-3}	Intrusive Rock of Riphean Series		Limited distribution in the eastern area.

Hydrograph of Observation Wells from June 1997 to October 1998
with daily Rainfall and Maximum Ground Temperature measured at Altai



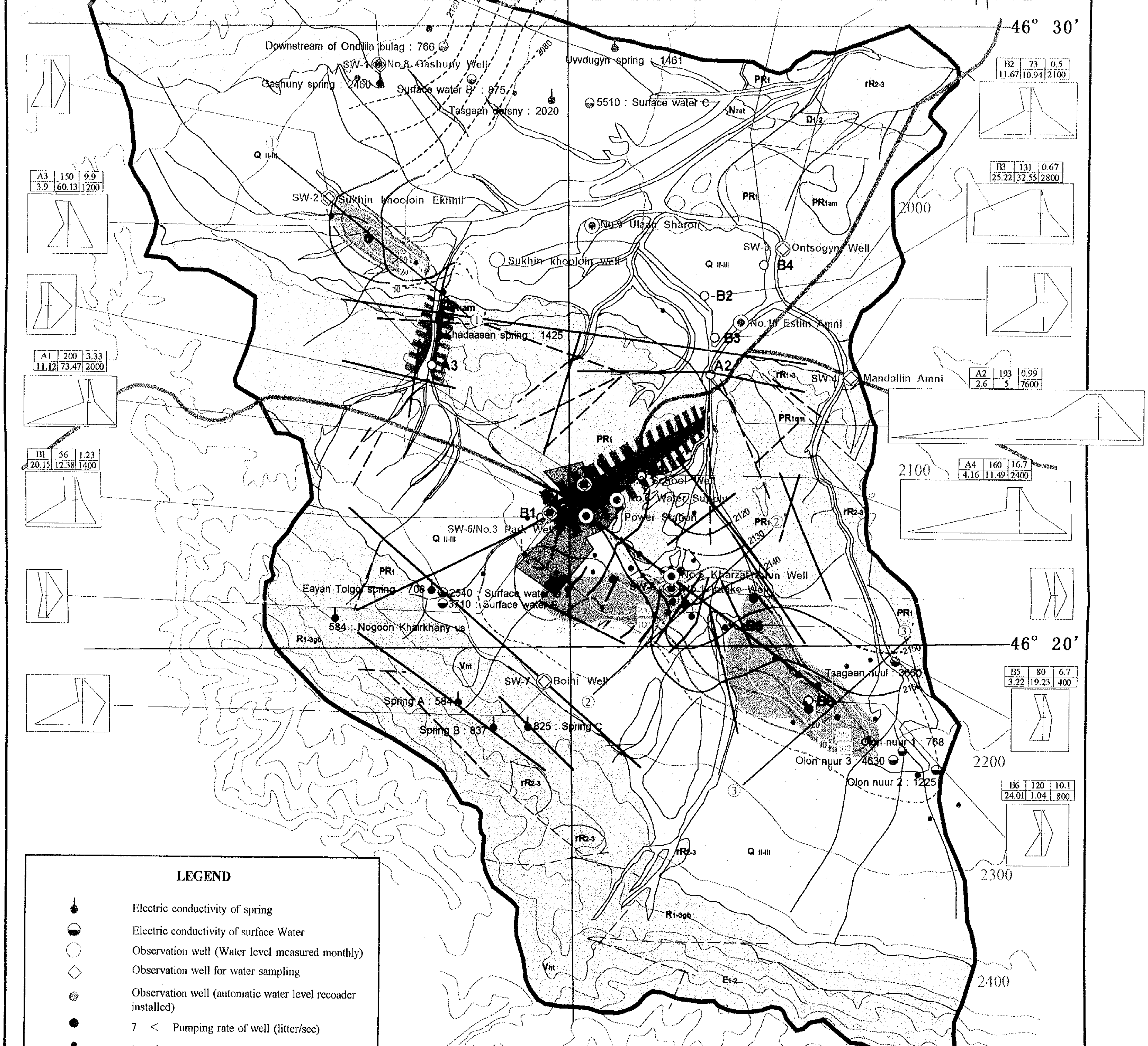
Water Quality Type

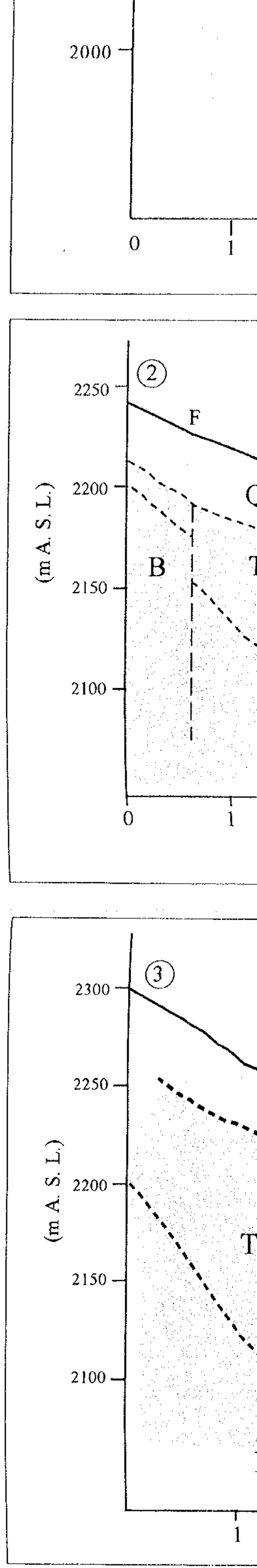




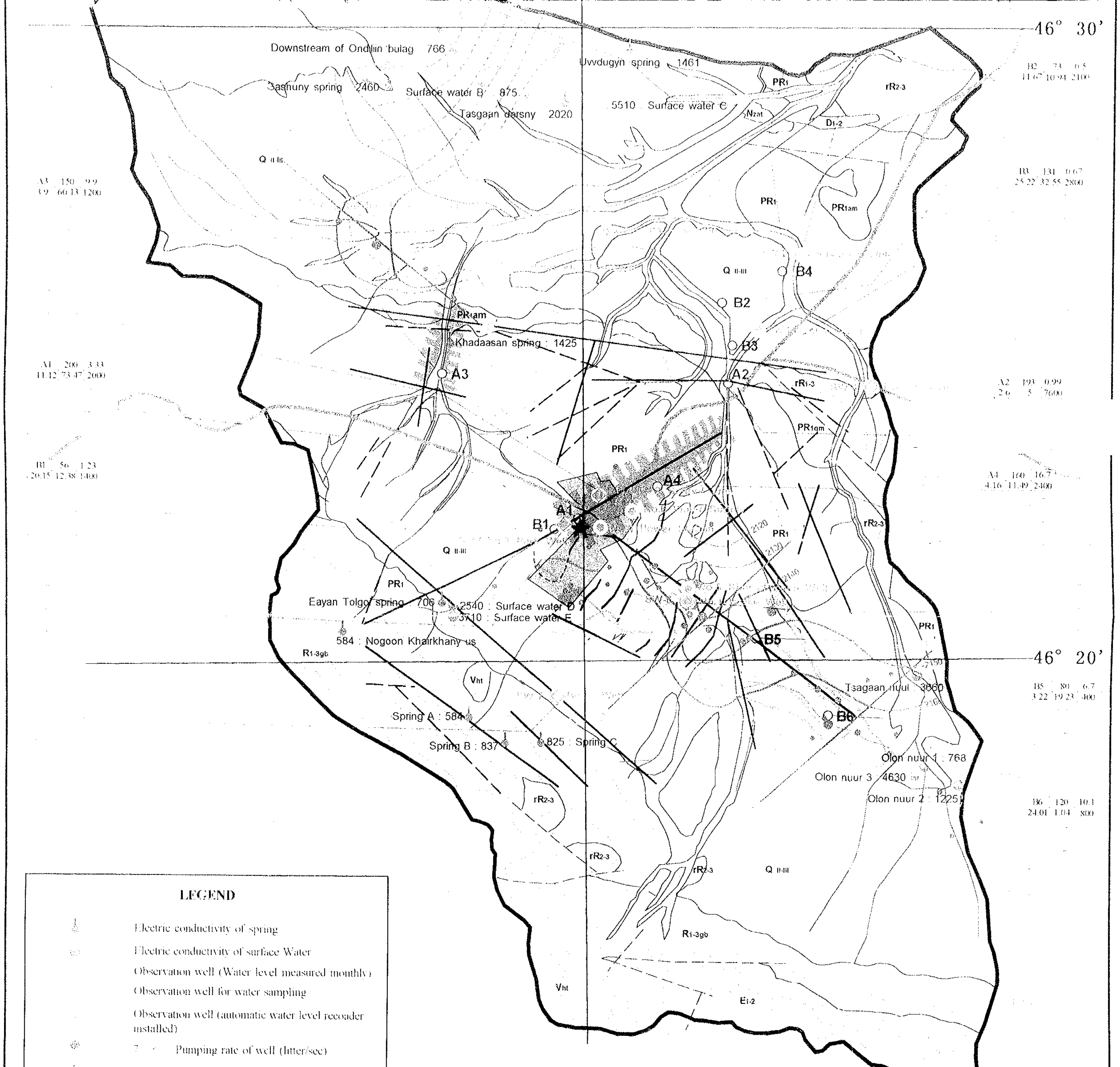
LEGEND

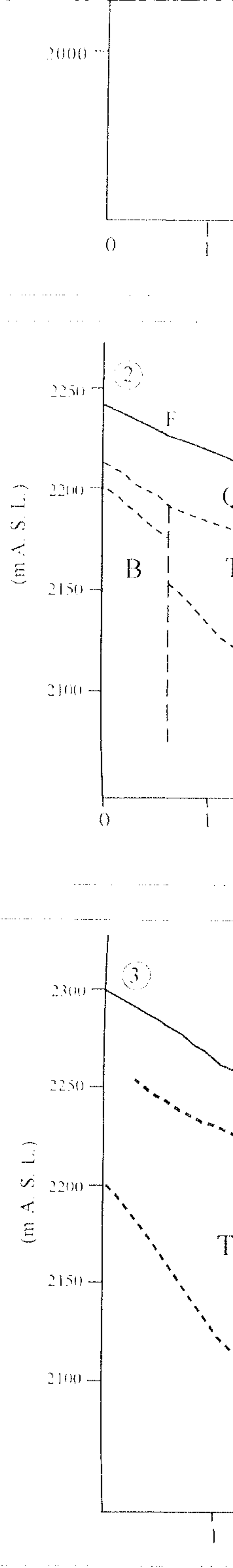
- Electric conductivity of spring
- Electric conductivity of surface Water
- Observation well (Water level measured monthly)
- Observation well for water sampling
- Observation well (automatic water level recoader installed)
- 7 — Pumping rate of well (litter/sec)

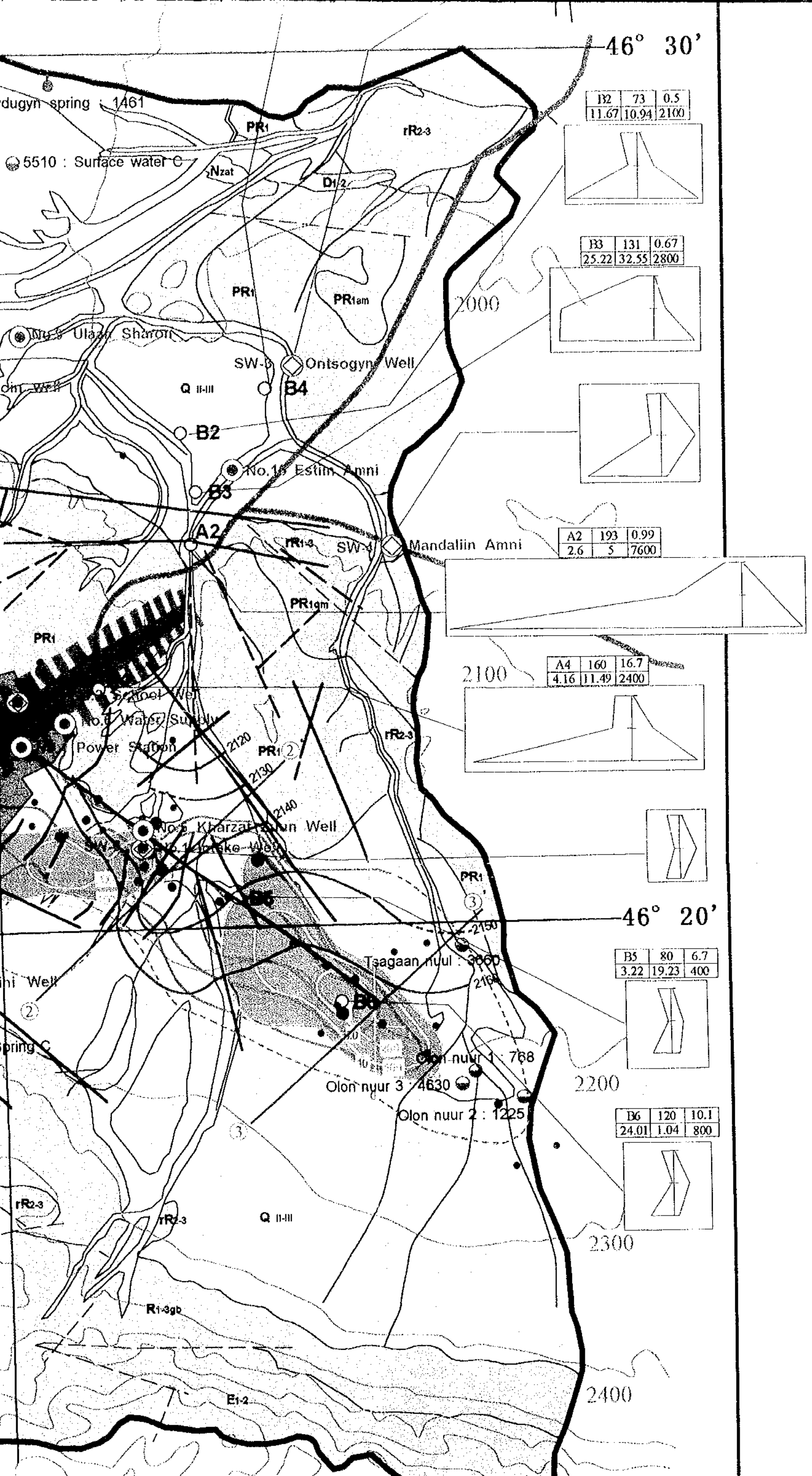

46° 30'
46° 20'
Downstream of Ondliin bulag : 766
SW-1 No.8 Gashuny Well
Gashuny spring : 2460
Surface water B : 875
Uvvdugyn spring : 1461
Tasgaan dersny : 2020
5510 : Surface water C
SW-2 Sukhin khooloin Ekhhil
No.9 Ulaan Sharoit
SW-6 Ontsogyn Well
Sukhin khooloin Well
B4
B2
No.10 Estiin Amni
Khadaasan spring : 1425
B3
A3
A2
SW-4 Mandaliin Amni
School Well
No.6 Water Supply
Power Station
B1
SW-5/No.3 Park Well
No.5 Kharzat... Well
Eayan Tolgo spring : 706
2540 : Surface water
3710 : Surface water
584 : Nogoon Khairkhany us
SW-7 Boini Well
Spring A : 584
Spring B : 837
825 : Spring C
Tsagaan nuul : 3660
B6
Olon nuur 1 : 768
Olon nuur 3 : 4630
Olon nuur 2 : 1225
2000
2100
2200
2300
2400
A3	150	9.9
3.9	60.13	1200
A1	200	3.33
11.12	73.47	2000
B1	56	1.23
20.15	12.38	1400
B2	73	0.5
11.67	10.94	2100
B3	131	0.67
25.22	32.55	2800
A2	193	0.99
2.6	5	7600
A4	160	16.7
4.16	11.49	2400
B5	80	6.7
3.22	19.23	400
B6	120	10.1
24.01	1.04	800
LEGEND
Electric conductivity of spring
Electric conductivity of surface Water
Observation well (Water level measured monthly)
Observation well for water sampling
Observation well (automatic water level recoader installed)
7 < Pumping rate of well (litter/sec)

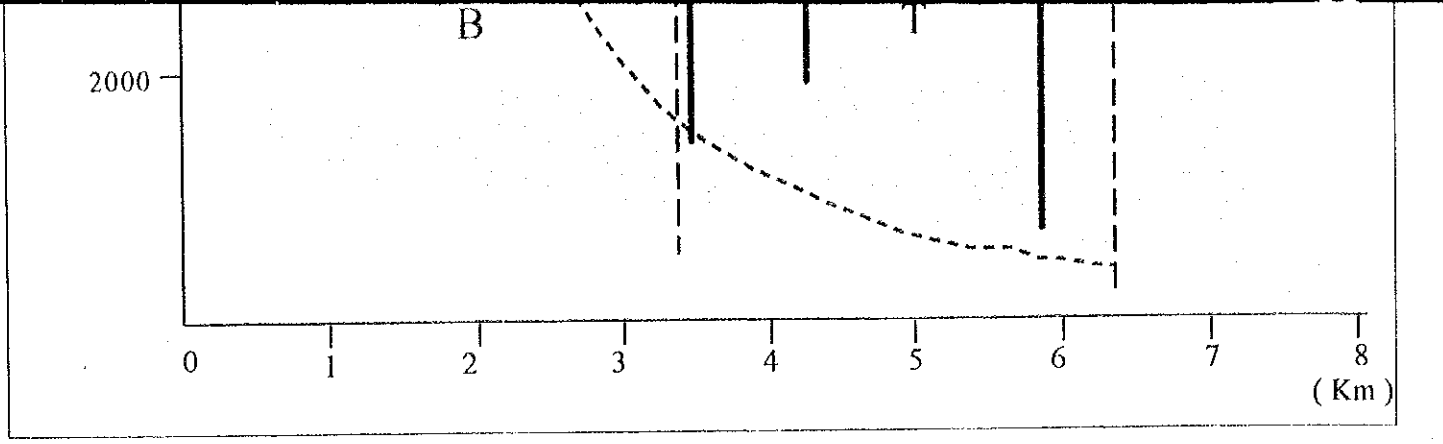

2000
0
1
2250
2200
2150
2100
(m A. S. L.)
F
B
0
1
2300
2250
2200
2150
2100
(m A. S. L.)
1

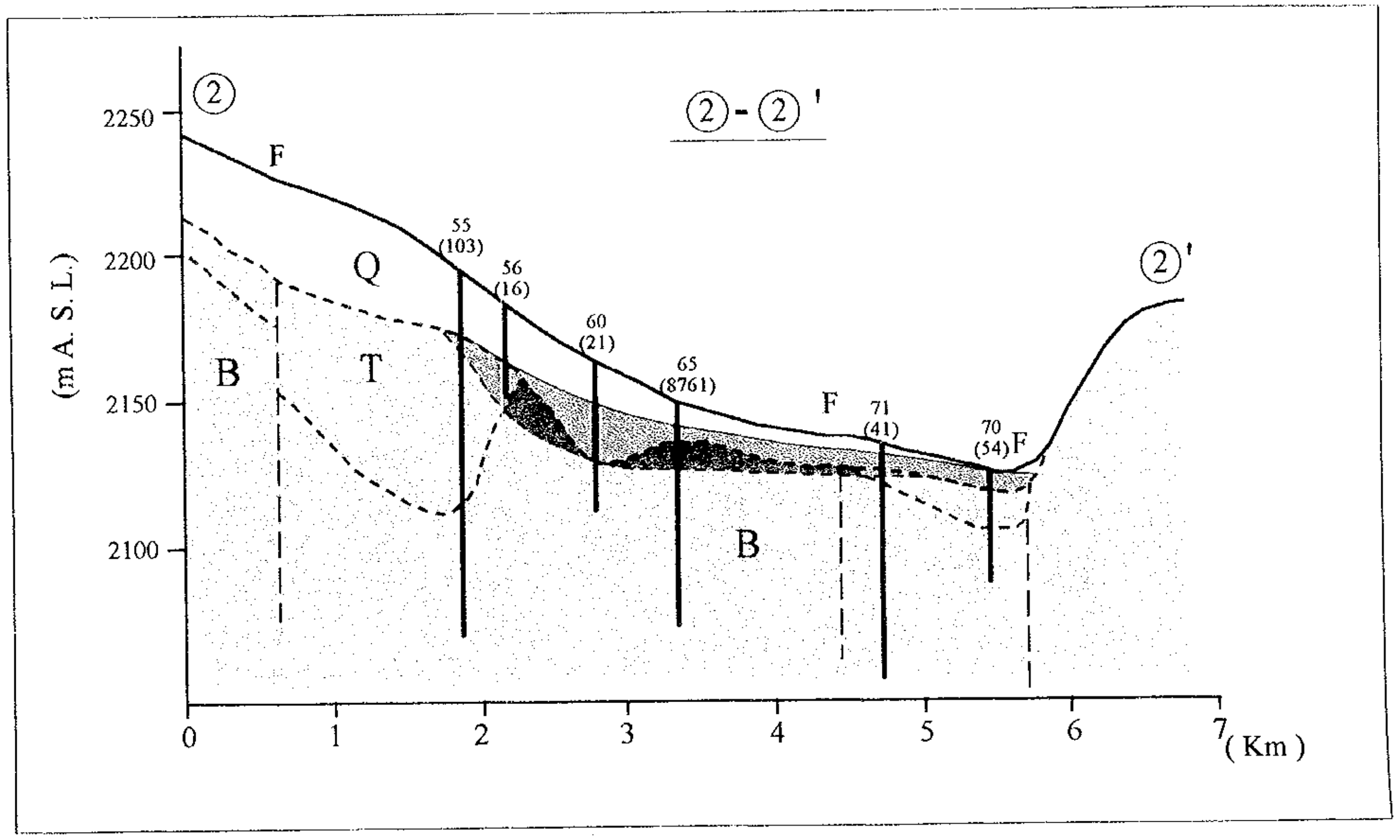

Rainfall (mm)
Ground Max. Temp. (Cels.)

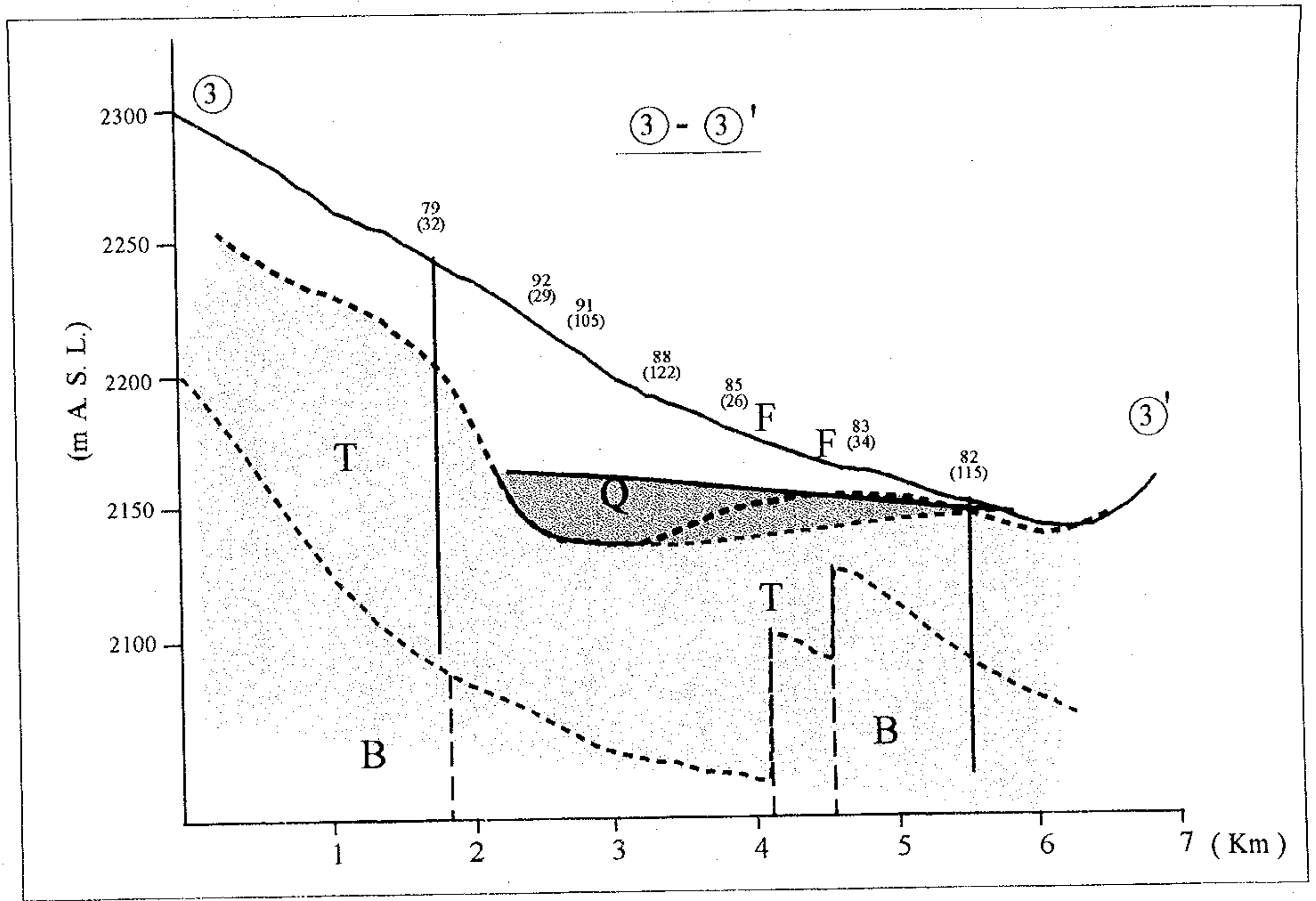

46° 30'
46° 20'
Downstream of Ondiliin bulag 766
Uvdugyn spring 1461
Sashuny spring 2460
Surface water B 875
Tasgaan dersny 2020
5510 Surface water C
Khadaasan spring 1425
Eayan Tolgo spring 706
2540 : Surface water D
3710 : Surface water E
584 : Nogoon Khairkhany us
Spring A : 584
Spring B : 837
825 : Spring C
Tsagaan nuul : 3660
Olon nuur 1 : 768
Olon nuur 3 : 4630
Olon nuur 2 : 1225
A1
A2
A3
A4
B1
B2
B3
B4
B5
B6
PR1
PR1am
rR2-3
rR1-3
R1-3gb
Q II-III
Vht
Nzat
D1-2
E1-2
A3 150 9.9
3.9 60.13 1200
A1 200 3.33
11.42 73.47 2000
B1 56 1.23
20.15 12.38 1400
B2 73 0.5
11.67 10.94 2100
B3 131 0.67
25.22 32.55 2800
A2 193 0.99
2.6 5 7600
A4 100 16.7
4.16 11.49 2400
B5 80 6.7
3.22 19.23 400
B6 120 10.1
24.01 1.04 800
LEGEND
Electric conductivity of spring
Electric conductivity of surface Water
Observation well (Water level measured monthly)
Observation well for water sampling
Observation well (automatic water level recoader installed)
7 Pumping rate of well (litter/sec)

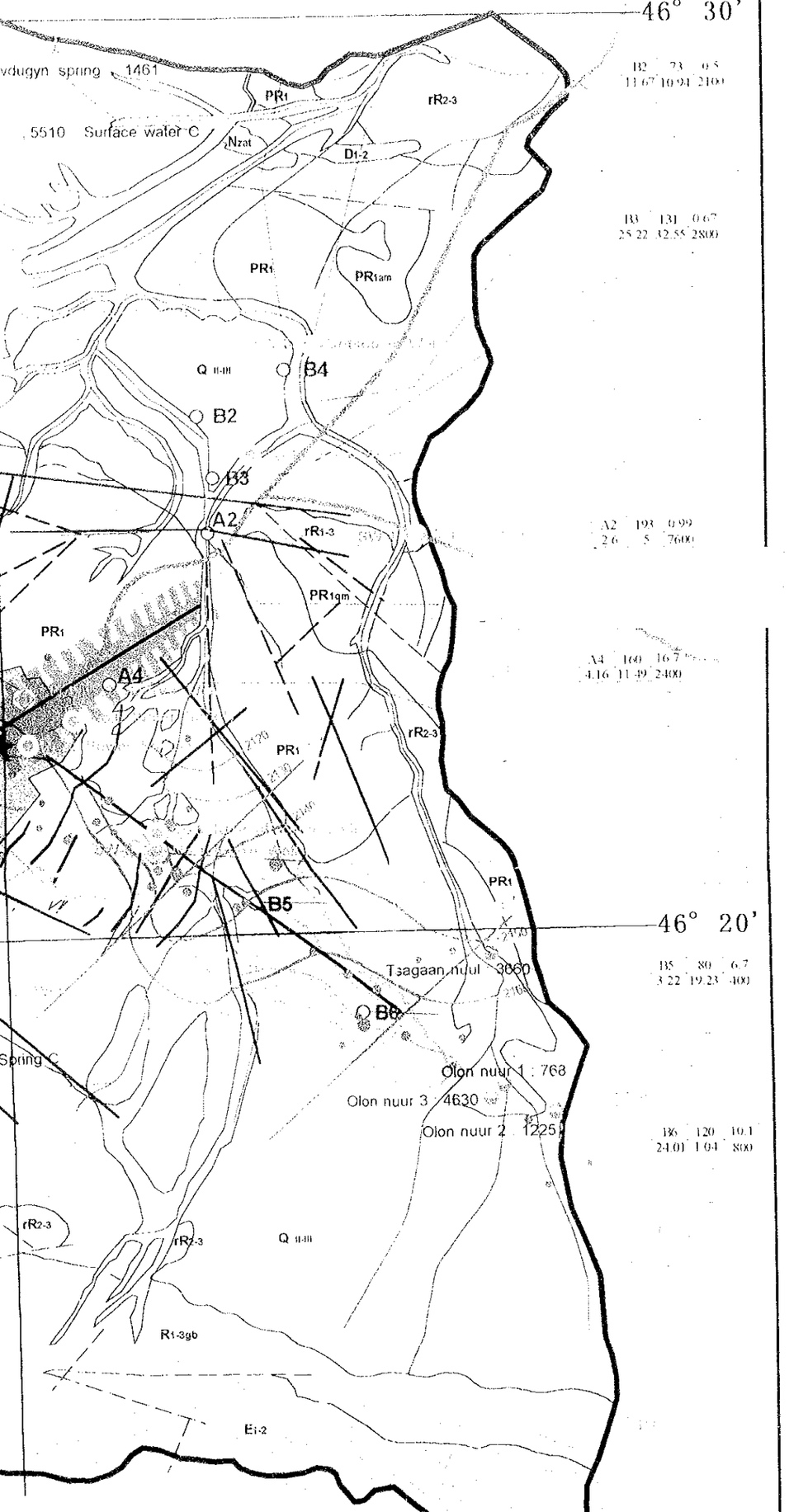

2000
2250
2200
2150
2100
2300
(m A. S. L.)
F
B
T
②
③
0
1

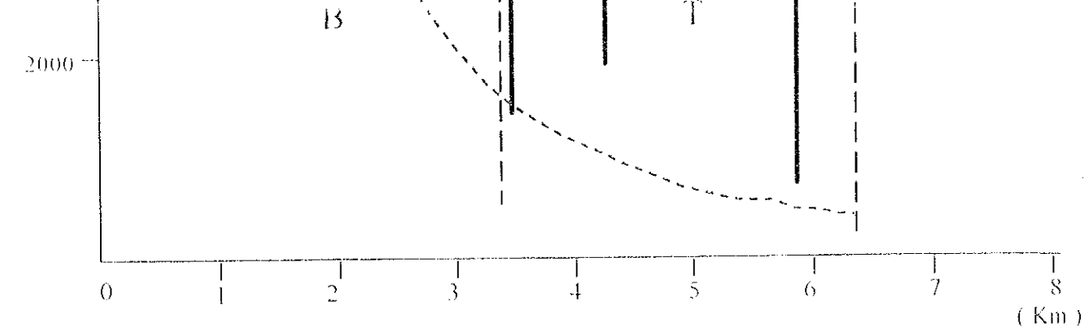

46° 30'
46° 20'
rdugyn spring : 1461
5510 : Surface water C
Ontsogyn Well
Q II-III
B4
B2
B3
No.14 Estin Amni
A2
SW-4
Mandaliin Amni
PR1
PR1am
rR2-3
D1-2
Nzat
School Well
No.2 Water Supply
Power Station
No.5 Kharzat Usun Well
B5
B6
Tsagaan nuur : 3660
Olon nuur 1 : 768
Olon nuur 3 : 4630
Olon nuur 2 : 1225
R1-3gb
E1-2
2000
2100
2200
2300
2400
2120
2130
2140
2150
B2 | 73 | 0.5
11.67 | 10.94 | 2100
B3 | 131 | 0.67
25.22 | 32.55 | 2800
A2 | 193 | 0.99
2.6 | 5 | 7600
A4 | 160 | 16.7
4.16 | 11.49 | 2400
B5 | 80 | 6.7
3.22 | 19.23 | 400
B6 | 120 | 10.1
24.01 | 1.04 | 800

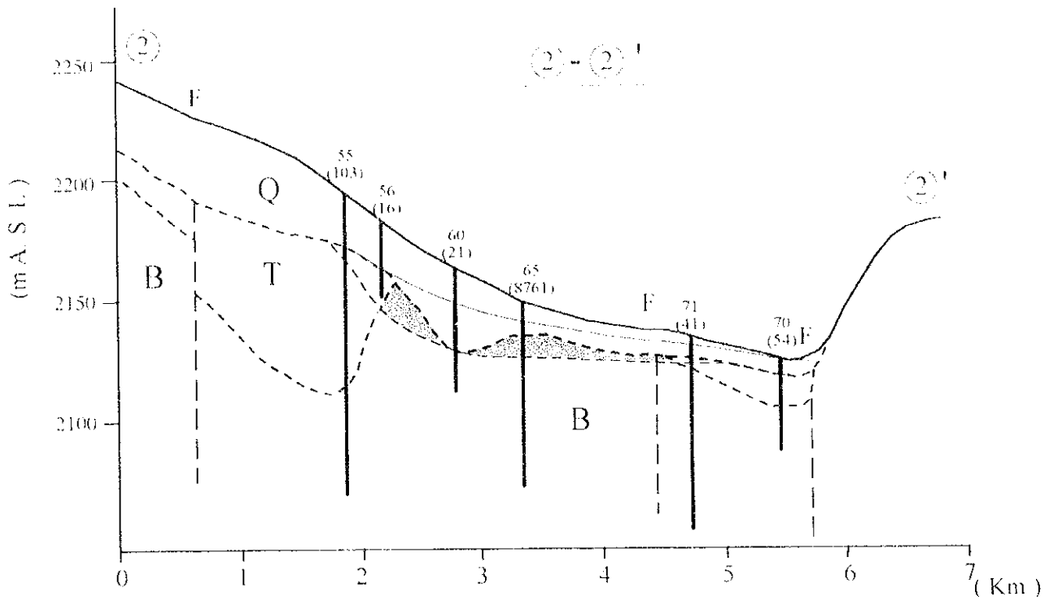

B
T
2000
0
1
2
3
4
5
6
7
8
(Km)

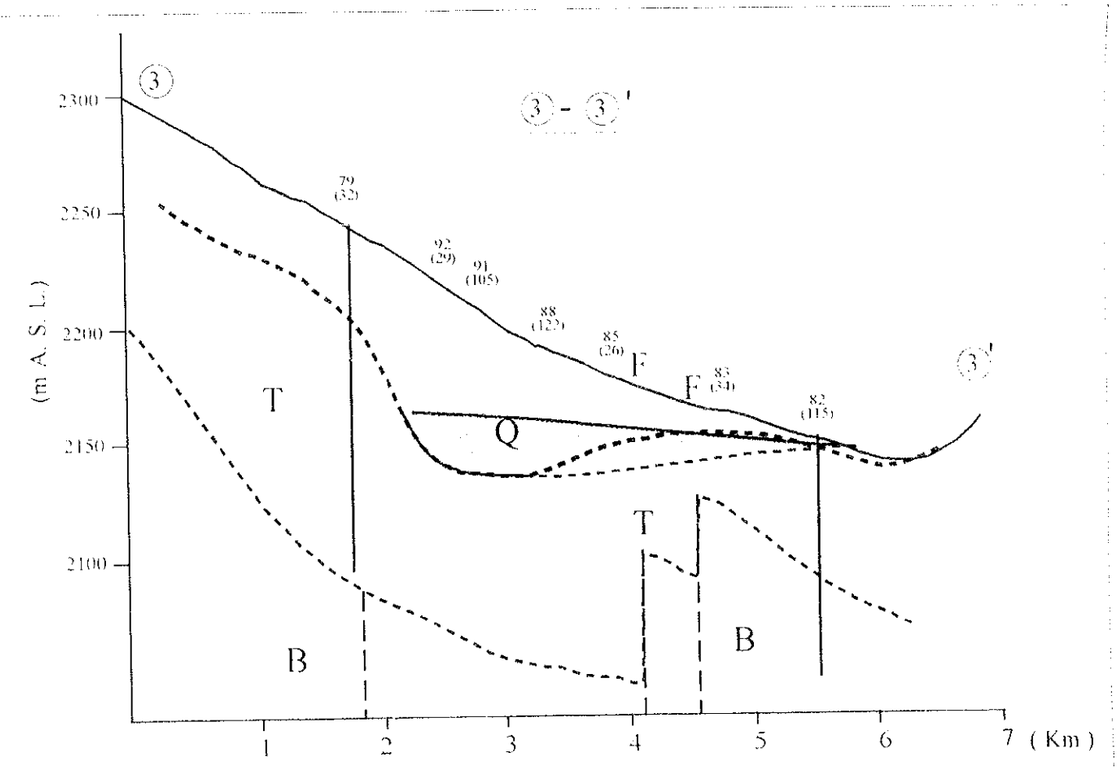

② - ②'
(m A. S. L.)
2250
2200
2150
2100
F
Q
B
T
55 (103)
56 (16)
60 (21)
65 (8761)
71 (41)
70 (54)
0
1
2
3
4
5
6
7 (Km)

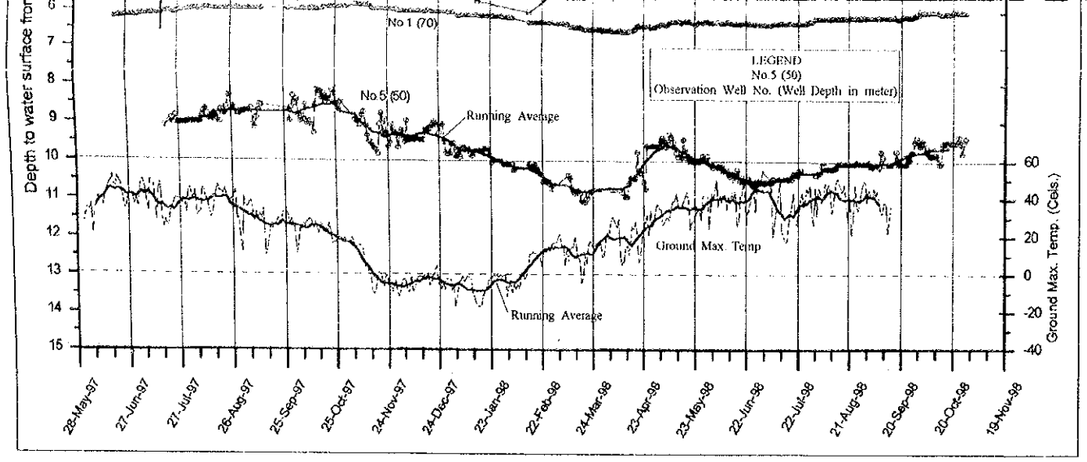

③ - ③'
(m A. S. L.)
2300
2250
2200
2150
2100
T
Q
B
F
79 (32)
92 (29)
91 (105)
88 (122)
85 (26)
83 (34)
82 (115)
1
2
3
4
5
6
7 (Km)


46° 30'
vdugyn spring 1461
5510 Surface water C
PR1
rR2-3
Nzat
D1-2
PR1am
Q II-III
B4
B2
B3
A2
rR1-3
PR1gm
A4
B5
46° 20'
Tsagaan nuur 3060
B6
Olon nuur 1 1768
Olon nuur 3 4630
Olon nuur 2 1225
Spring C
Q II-III
R1-3gb
Ei-2
B2 23 0.5
11.67 10.91 2100
B3 131 0.67
25.22 12.55 2800
A2 193 0.99
2.6 5 7600
A4 160 16.7
4.16 11.49 2400
B5 80 6.7
3.22 19.23 400
B6 120 10.1
24.01 1.04 800

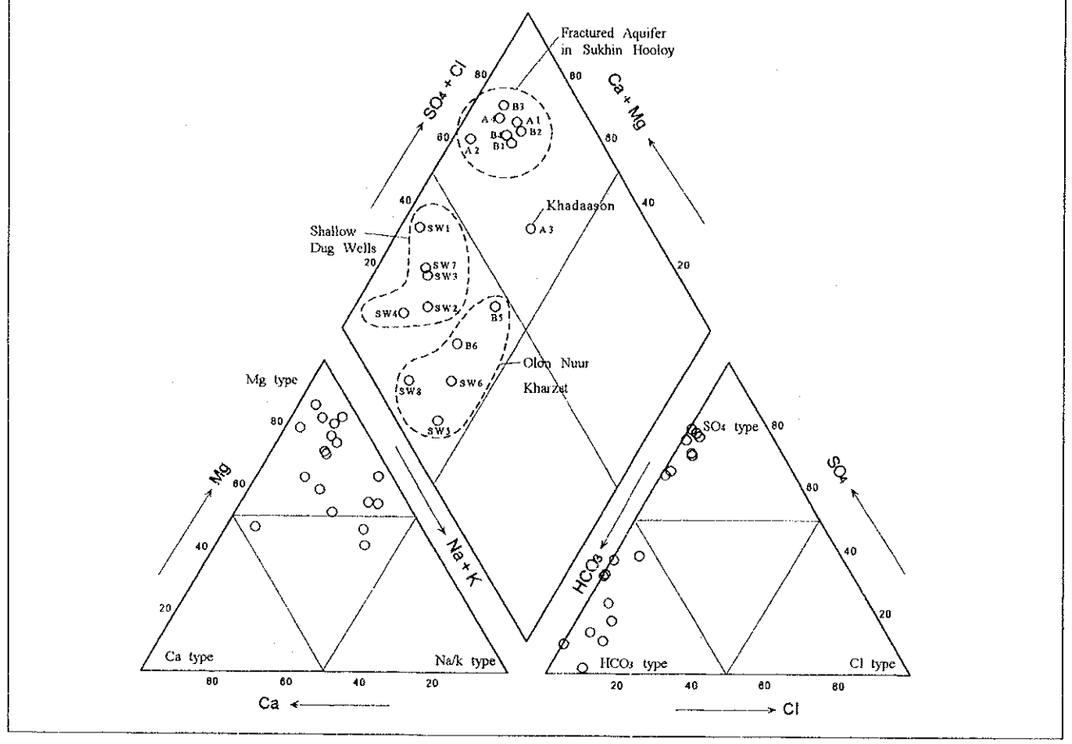

2000
B
T
0
1
2
3
4
5
6
7
8
(Km)

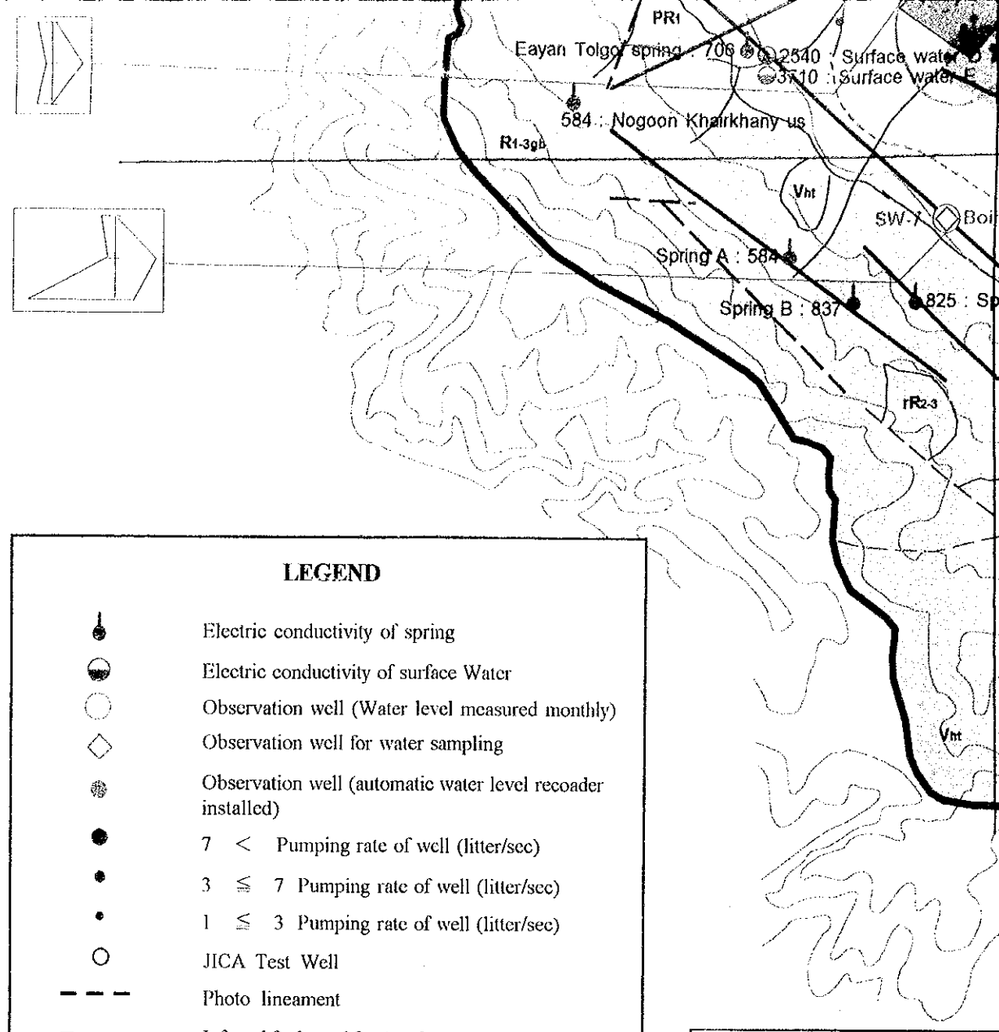

2
2'
2 - 2'
2250
2200
2150
2100
(m A S L)
F
Q
B
T
55 (103)
56 (161)
60 (21)
65 (876)
71 (41)
70 (54)
F
B
0
1
2
3
4
5
6
7
(Km)


3
3'
3 - 3'
2300
2250
2200
2150
2100
(m A. S. L.)
79 (52)
92 (29)
91 (105)
88 (122)
85 (26)
F
F
83 (54)
82 (115)
Q
T
B
T
B
1
2
3
4
5
6
7
(Km)



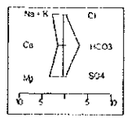
Water Quality Type





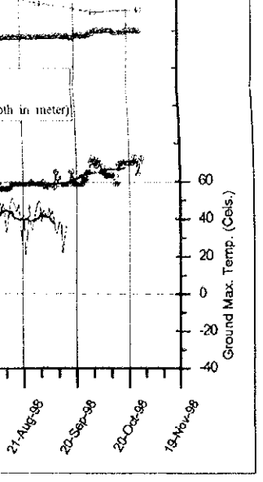
LEGEND

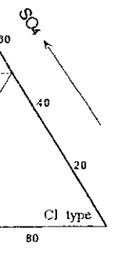
- Electric conductivity of spring
- Electric conductivity of surface Water
- Observation well (Water level measured monthly)
- Observation well for water sampling
- Observation well (automatic water level recoader installed)
- 7 < Pumping rate of well (litter/sec)
- 3 ≦ 7 Pumping rate of well (litter/sec)
- 1 ≦ 3 Pumping rate of well (litter/sec)
- JICA Test Well
- Photo lineament
- Inferred faults and fractured zone
- 2120 Water Table Contour (m ASL)
- 10 Isopach of Main Aquifer (m)
- Isoline of Transmissivity (m²/day)

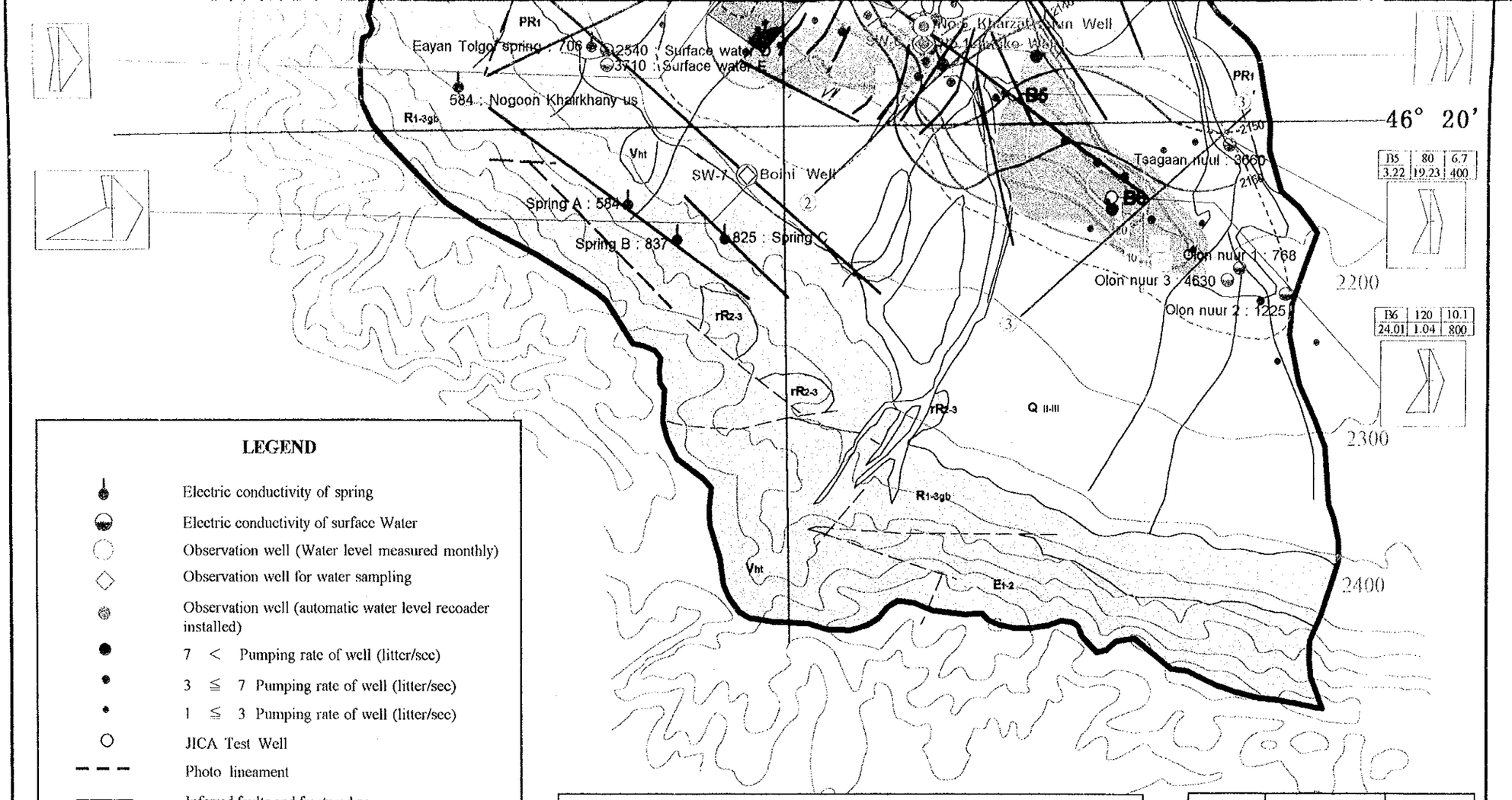


Granular Aquifer

- Highly productive aquife
- Locally important aquife
- Local and low productiv aquifers

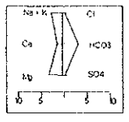






LEGEND

- Electric conductivity of spring
- Electric conductivity of surface Water
- Observation well (Water level measured monthly)
- Observation well for water sampling
- Observation well (automatic water level recoader installed)
- 7 < Pumping rate of well (litter/sec)
- 3 ≦ 7 Pumping rate of well (litter/sec)
- 1 ≦ 3 Pumping rate of well (litter/sec)
- JICA Test Well
- Photo lineament
- Inferred faults and fractured zone
- 2120 Water Table Contour (m ASL)
- 10 Isopach of Main Aquifer (m)
- Isoline of Transmissivity (m^2/day)



Granular Aquifer

- Highly productive aquifers Locally important aquifers
- Local and low productive aquifers

Fissured Aquifer

- Productive aquifers (not extensive)

Insignificant Aquifer

- Minor aquifers with local and limited groundwater resources

Well No.	Depth	Q (l/s)
S.W.L	Drawdown (m)	TDS (mg/l)

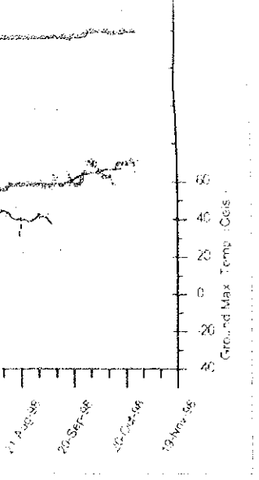
1 : 100,000

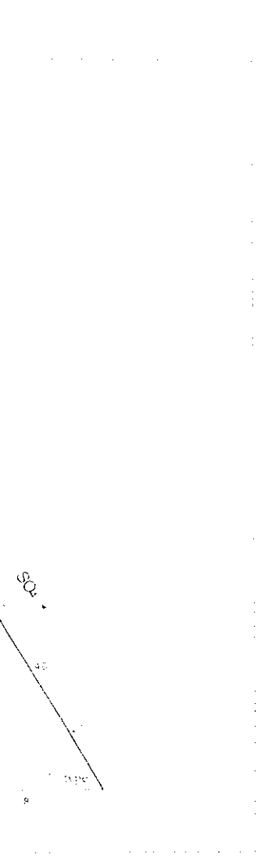
0 1 2 3 4 5Km

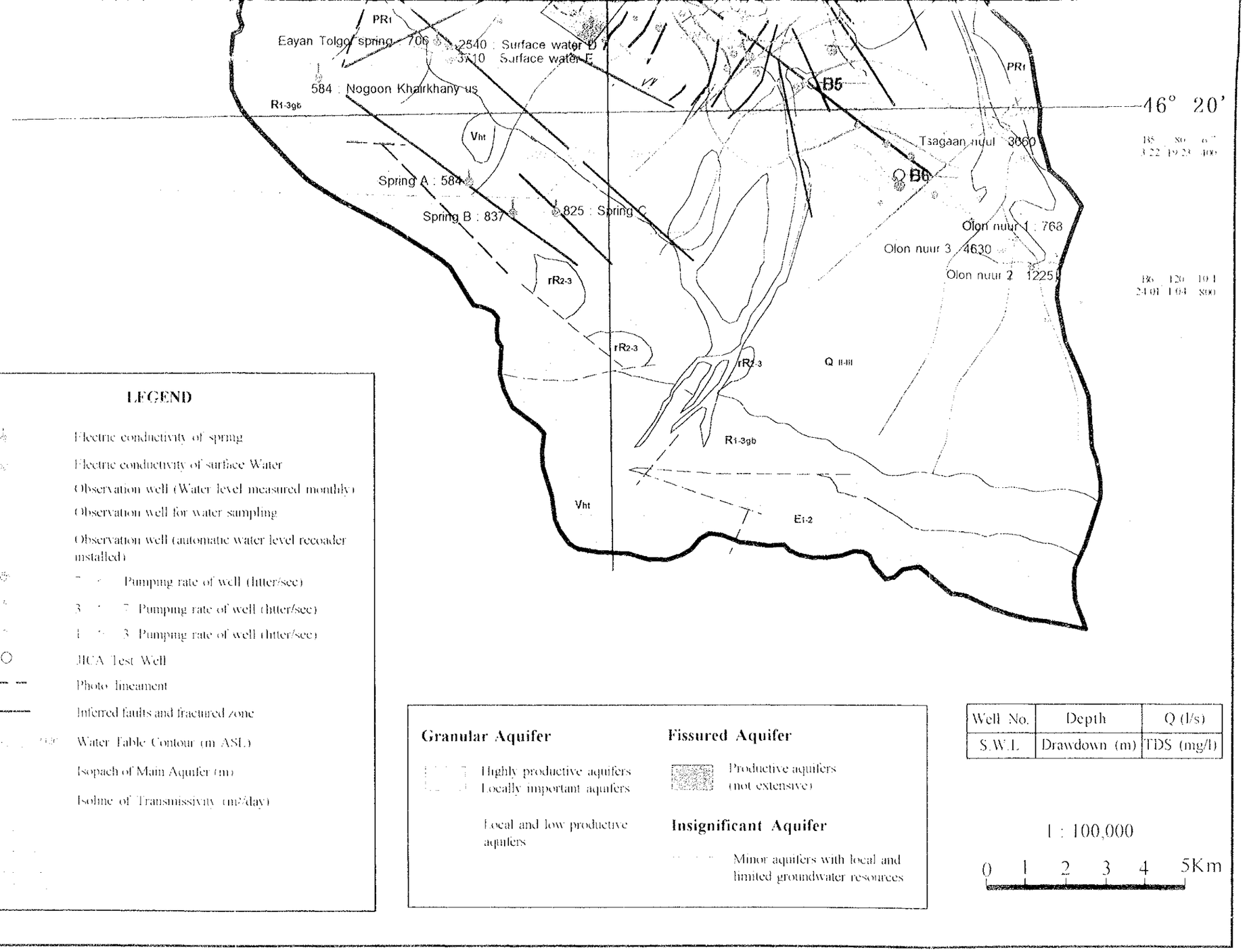
(m A. S. L.)

23
22
21
210

JICA







LEGEND

- Electric conductivity of spring
- Electric conductivity of surface Water
- Observation well (Water level measured monthly)
- Observation well for water sampling
- Observation well (automatic water level recoader installed)
- Pumping rate of well (liter/sec)
- Pumping rate of well (liter/sec)
- Pumping rate of well (liter/sec)
- JICA Test Well
- Photo lineament
- Inferred faults and fractured zone
- Water Table Contour (m ASL)
- Isopach of Main Aquifer (m)
- Isolne of Transmissivity (m²/day)

Granular Aquifer

- Highly productive aquifers / Locally important aquifers
- Local and low productive aquifers

Fissured Aquifer

- Productive aquifers (not extensive)

Insignificant Aquifer

- Minor aquifers with local and limited groundwater resources

Well No.	Depth	Q (l/s)
S.W.L	Drawdown (m)	TDS (mg/l)

1 : 100,000

0 1 2 3 4 5Km

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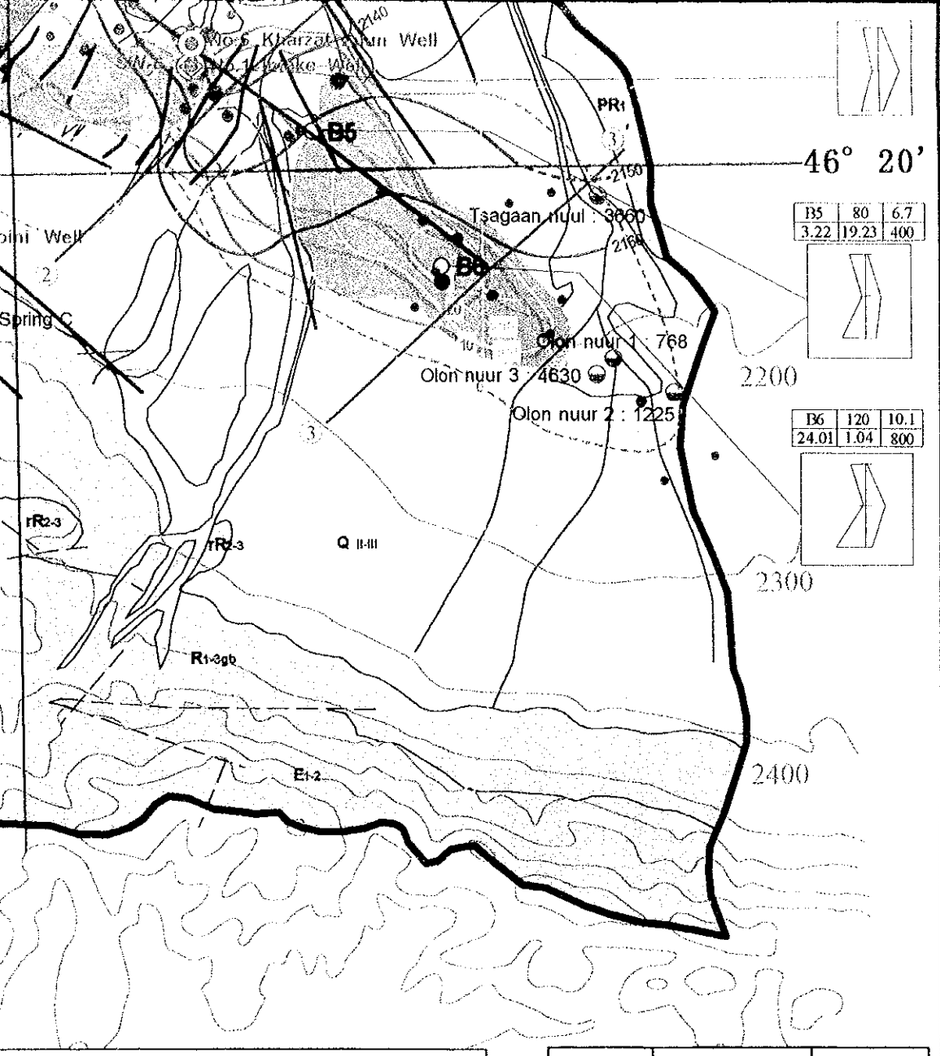

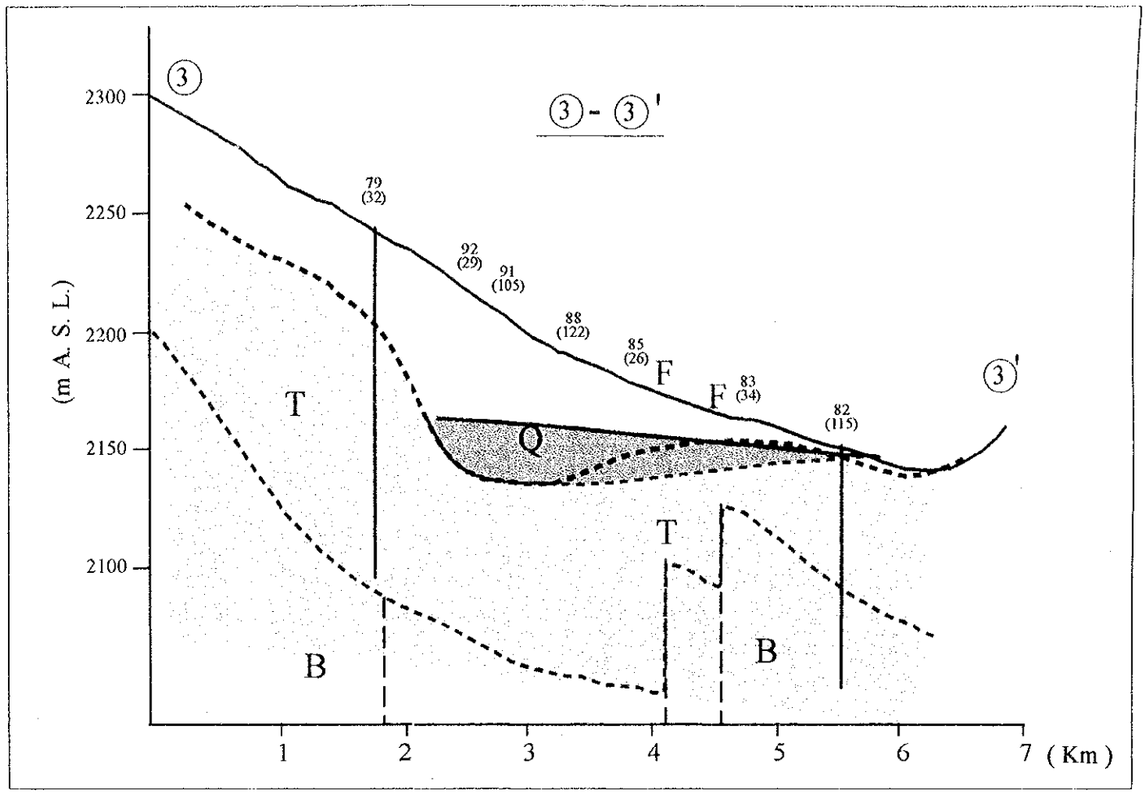

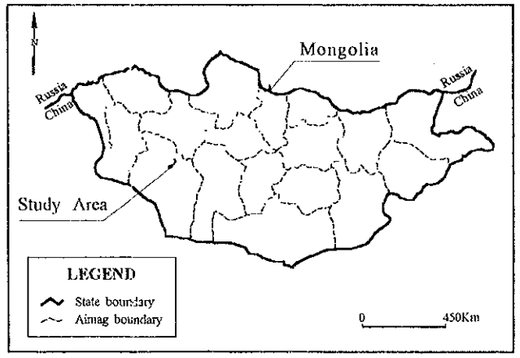

Fissured Aquifer

Productive aquifers (not extensive)

Insignificant Aquifer

Minor aquifers with local and limited groundwater resources

Well No.	Depth	Q (l/s)
S.W.L	Drawdown (m)	TDS (mg/l)

1 : 100,000

0 1 2 3 4 5Km

January, 1999

HYDROGEOLOGICAL MAP

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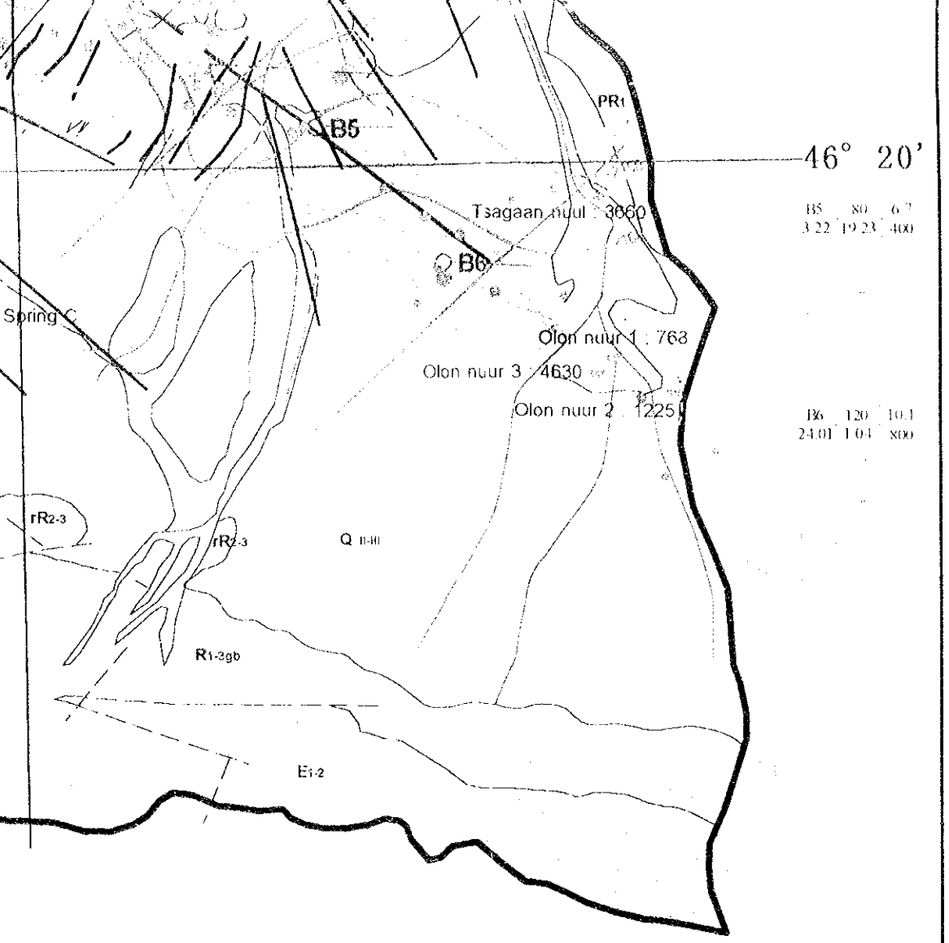

B5 80 6.7
3.22 19.23 400

B6 120 10.1
24.01 1.04 800

Well No.	Depth	Q (l/s)
S.W.L	Drawdown (m)	TDS (mg/l)

1 : 100,000

0 1 2 3 4 5Km

Fissured Aquifer

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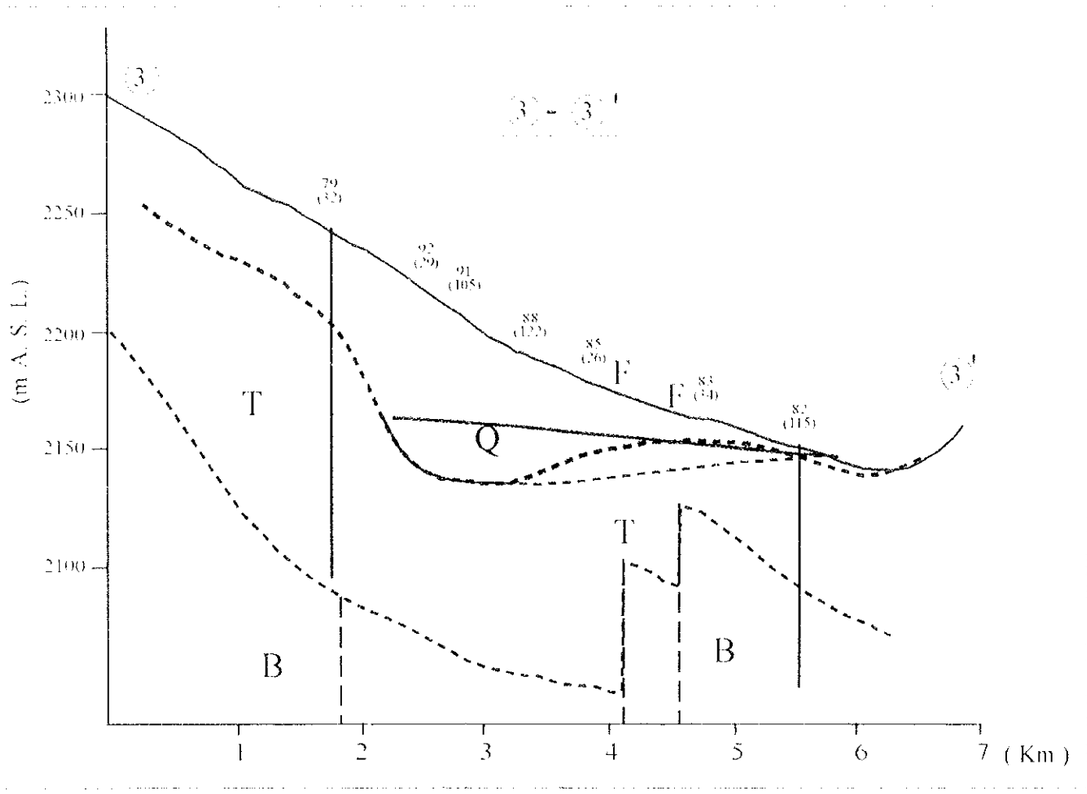

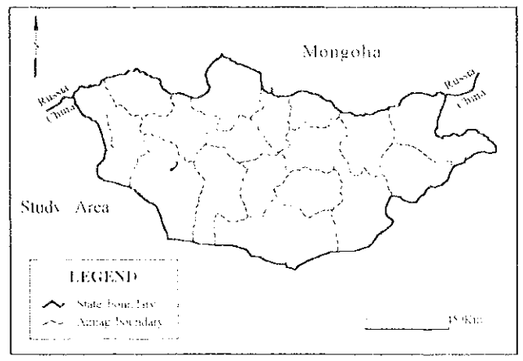

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HYDROGEOLOGICAL MAP

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