Chapter 6 Environmental Assessment and Environmental Protection Measures

6.1 Summary

(1) Present Environmental Conditions

1) Ambient air

(a) With emission from Borsod Power Plant, SO_2 exceeds the environmental criteria.

(b) The situation of air pollution has not been improved since 1993 when the air pollution control study by JICA was conducted in Sajo valley area.

2) Groundwater

(a) The groundwater pollution by Borsod Power Plant is limited to ions and arsenic (As) contaminations. The As concentration is high only near the sludge storage.

(b) Yearly changes in the quality of the groundwater around the wells for water supply show decrease in NO_3^- and NH_4^+, and increase in conductivity, Cl^- and Na^+. The pH values is decreasing. SO_4^{2-} values vary depending on the wells.

(c) High concentrations of ions including SO_4^{2-} and Cl- are found in Borsodszirak I/A. Further deterioration in the quality of water in the future may occur.

3) River water

(a) The water quality of Sajo river has been rapidly improved from the serious contamination in the past. The concentrations of the both heavy metals and ions are low. The water quality of Bodva river is better than that of Sajo river .

(b) No serious contamination is found in the sediment of Sajo river.

(c) As and ions concentrations in Holt-Szuha River are affected by leachate from the sludge storage areas.

(d) In Sajo River, the problem of thermal efferent from the cooling system is evident.

4) Soil

(a) Heavy metal contaminations in soil are found around the waste dumping and storage sites. Heavy metal pollution by Borsod Power Plant is limited to As contamination.

(b) In the floodplain of Sajo river, the concentrations of heavy metals are high, affected by the previous industrial pollution of Sajo river.

(c) At several points near Borsod Power Plant, the As concentration in soil exceeds the limit value specified in the soil and groundwater protection regulation.

5) Natural environment

(a) Due to social and economic activities, many of natural plants and animals in this area have disappeared.

(b) Species sensitive to environmental pollution have disappeared, and precious species can be no longer found in this area.

(c) Aquatic life in Sajo river are gradually recovering.

(d) Emissions from Borsod Power Plant and other sources are affecting national parks and nature conservation areas.

(2) Environmental Impact Assessment

1) Ambient air

(a) According to the short-term (30 minutes) prediction, even though the emission standards to be enforced on January 1, 2005 are met by Borsod Power Plant, the SO_2 concentration will exceed the environmental quality standards for protected areas II (400 μ/m^3 or 150 ppb) in some cases, if domestic coal or mixed coal with imported coal is used.

(b) According to the prediction of the heating reason average pollutant concentrations, SO_2 concentration will exceed the environmental standard for protected areas I (70 $\mu g/m^3$ or 26 ppb) in large areas even when the planned protection measures are taken in the Power Plant. The NOx concentrations will meet the standard for protected areas I (100 $\mu g/m^3$ or 52 ppb). For SO_2, it is necessary to take measures for other sources than Borsod Power Plant.

(c) The results of downwash analysis suggest that the height of newly constructed chimneys should be 130 m.

(d) Stagnation modeling analyses were made for the case where a CFBC boiler is used for the new 150 MW unit and the existing boilers are converted to the natural gas firing type. The contribution of Borsod Power Plant to the SO_2 concentration at the maximum point is 32 ppb under the full load operation. The contribution is substantially reduced from the present. The maximum 30-minute SO_2 concentration satisfies the standard for protected areas II (400μg/m^3 or 150 ppb), but the background concentration itself exceeds the standard for protected areas I (250 μg/m^3 or 94 ppb).

2) Groundwater

(a) Actual flow velocity of groundwater is 0.42 m/day. It will take about 40 years for the whole presently contaminated water to move to the source wells of water supply in Borsodszirak I/A.

(b) It is estimated to take about 50 years for the groundwater quality to recover to conform the protection criteria for drinking water even though complete measures for preventing the groundwater are put into practice.

3) Soil

(a) It is important to take measures for preventing new contamination from occurring. Except for several sites with high concentration, there is no practical measures for clean-up. The situation will improve gradually over the years by natural remediation process.

(b) The remediation of high concentration sites helps the recovery of the groundwater quality.

4) Natural environment

(a) It is necessary to take measures for creating better environment as well as environmental protection measures.

(b) A large amount of waste from Borsod Power Plant shall be treated not to damage the natural environment.

(3) Environmental Protection Measures

For protecting environment, the following measures are recommended.

1) Ambient air

(a) To apply the CFBC technology to the boiler of the new unit and to convert the existing boilers to the natural gas firing type.

(b) The height of the stack originally planned to be 125 m should be changed to 130 m to prevent the down wash phenomenon.

(c) For preventing coal ash scattering from sludge storage, soil coverage and planting are proposed.

2) Groundwater and soil

(a) For sludge handling, a thick sludge transport system where sludge is transported through pipes should be used. Sludge should be stored inside impermeable sheets for preventing groundwater contamination. (The use of thick sludge transport system only can not prevent groundwater contamination.)

(b) The wastewater from the deminalitation plant is temporarily stored, after neutralization, in reservoirs with impermeable sheets and discharged with other effluent. The study team recommends a discharge system where waste liquids are discharged according to the conditions of Sajo river and the sewerage system.

(c) Strict control of illegal waste dumping

3) River water

Closed cooling water system should be employed to minimize the effect of thermal effluent.

4) Vegetation

(a) The above measures for air, groundwater, soil and river water should be strictly implemented.

(b) It is recommended to construct wetland between Holt-Szuha River and the sludge storage area to create semi-natural vegetation.

5) Environmental protection during construction

(a) Prevention of water pollution in Sajo River caused by construction works

(b) Observation of the rules and regulations applicable in Hungary

(4) Environmental Monitoring Plan

Environment monitoring should be performed as follows.

1) Environment monitoring during construction

Environmental impacts of the construction should be properly monitored in conformity with the present rules and regulations in order to minimize the impacts.

2) Environment monitoring after commissioning

(a) Flue gas monitoring
(b) Ambient air pollutant concentration monitoring
(c) Establishment of a continuous monitoring network by combining (a) and (b) above
(d) Groundwater monitoring
(e) Periodical monitoring of wastewater, noise, and traffic volume

6.2 Environmental Quality Standards and Emission Standards

Various environmental standards are established in Hungary. In regards to the emission standards of exhaust gas, the new standards will take effects on January 1, 2005.

The outline of major environment and emission standards are as follows.

(1) Ambient Air Quality

Emission Limit Values in Hungary is shown in Tables 6.2.1 and 6.2.2. Environmental standard of ambient air quality is shown in Table 6.2.3.

Table 6.2.1 Proposed Emission Standards concerning New Firing Equipment Operated with Solid Fuel

Input heat Load : P_{th} (MW_{th})

Air Pollutant	Emission Limit Value (mg/m^3)(4)		
	15-100 MW	100-500 MW	>500 MW
Solid Material	100	50	50
CO	250	250	250
NOx (given in NO_2)	600 (1)	400 (1)	400 (1)
SO_2 and SO_3 (given in SO_2)	2000 (2)	2400-4xP_{th} (3)	400
Chlorides (given in HCl)	200	100	100
Fluorides	30	15	15

Notes :

(1) In case of domestic lignite maximum 300 mg/m^3 (calorific value: <7000kJ/kg≒1700 kcal/kg), 200 mg/m^3 for fluidized bed combustion.

(2) In case of firing domestic coal 2,000 mg/m^3, or at least 60 % Desulphurating efficiency

(3) Limit value except for the following conditions is obtained by interpolating interval between the value for [15-100 MW] and that for [>500 MW]

- In case of firing domestic brown coal and lignite, at least 90% desulphurating efficiency.
- In case of firing imported coal maximum 400 mg/m^3.
- In case of Fluidized Bed Combustion Boiler using domestic coal, at least 85% desulphurating efficiency.

Concentration given in mg/m^3 refer to dry smoke-gas with 6% O_2 content at a normal state (273 °K, 101.3 kPa)

Table 6.2.2 Proposed Emission Standards for New Firing Equipment Operated with Gaseous Fuel

Input heat Load: P_{th} (MW_{th})

Air Pollutant	Emission Limit Value (mg/m^3) >15MW
Solid Material	5
CO	100
Nox (given in NO_2)	200
SO_2 and SO_3 (given in SO_2)	35

Note : Concentration given in mg/m^3 refer to dry smoke-gas with 3% O_2 Content at normal state (273K,101.3kPa).

Table 6.2.3 Standard of Ambient Air Quality in Hungary

Air Pollutant	Concentration (mg/m^3) [(ppm 20℃)]		
	Specially Protected Area	Protected Area I	Protected Area II
SO_2			
- Annual average	0.030 [0.011]	0.070 [0.026]	0.100 [0.038]
- 24-hours average	0.100 [0.038]	0.150 [0.056]	0.300 [0.113]
- 30-minutes value	0.150 [0.056]	0.250 [0.094]	0.400 [0.150]
NO_2			
- Annual average	0.030 [0.016]	0.070 [0.037]	0.120 [0.063]
- 24-hours average	0.070 [0.037]	0.085 [0.044]	0.150 [0.078]
- 30-minutes value	0.085 [0.044]	0.100 [0.052]	0.200 [0.105]
NOx			
- Annual average	0.030 [0.016]	0.100 [0.052]	0.150 [0.078]
- 24-hours average	0.070 [0.037]	0.150 [0.078]	0.200 [0.105]
- 30-minutes value	0.085 [0.044]	0.200 [0.105]	0.400 [0.209]
SPM			
- Annual average	0.030	0.050	0.100
- 24-hours average	0.060	0.100	0.200
- 30-minutes value	0.100	0.200	0.300
Dust			
- Monthly total(g/m^2/30days)	12	16	21
- Annual total(g/m^2/year)	100	120	150

(2) Soil, Groundwater and Drinking Water

Soil and groundwater quality criteria are shown in Table 6.2.4. Limit Values for Toxicological Substances in Drinking Water is shown in Tables 6.2.5 and 6.2.6.

Table 6.2.4 Soil and Groundwater Quality Criteria

(unit : mg/kg)

Parameter	A	B	C_1	C_2	C_3	Prohibited Material
Chromium	30	100	150	400	800	T2
Copper	30	100	200	300	400	T2
Zinc	100	250	500	1000	2000	T2
Arsenic	10	15	30	40	60	T2
Cadmium	0.5	1	2	5	10	T1
Mercury	0.15	0.5	1	3	10	T1
Lead	25	70	100	500	600	T2

Table 6.2.5 Drinking Water Standard (Toxic Substances)

Parameter	Unit	Limit Values	
		Adequate	Tolerable
Specific electric conductivity	μ s/cm	1350	1600
pH	pH	7.0～8.0	6.8～8.5
Total dissolved substance	mg/l	1000	1200
Sulphate	mg/l	200	300
Iron	mg/l	0.2	0.3
Copper	mg/l	0.2	1.0
Zinc	mg/l	0.2	1.0
Natrium	mg/l	200	—
Arsenic	μ g/l	50	
Total mercury	μ g/l	1	
Cadmium	μ g/l	5	
Total Chromium	μ g/l	50	
Lead	μ g/l	50	

Table 6.2.6 Drinking Water Standards for Groundwater

Parameter	Unit	Adequate	Tolerable
COD	mg/l	2.5	3.5
Chlorides	mg/l	80	100
Ammonium	mg/l	0.1	0.2
Nitrite	mg/l	0.1	0.3
Nitrate	mg/l	20	40

6.3 Present Environmental Conditions

(1) Geographical Background and Other Conditions

1) Study Area

Borsod Power Plant is located in one of the major industrial areas, but there are densely populated housing areas nearby. This study area has been developed until today without sufficient consideration for the environmental protection. Figure 6.3.1 shows the land use in central Sajo valley at present.

2) Geological conditions

The foundations in this area consist of the cumulus deposits in the Carboniferous period and the Triassic period. The Sajo valley is formed at both side of Sajo river with a width of 3 to 6 km and with a length of 35 to 40 km.

3) Rivers

The Sajo river, the most important river in this area, is originated in Slovakia. Borsod Power Plant is located at a distance of 81 km from its origin. Power plants used the water from Sajo river and Bodva river.

4) Soil

On the flood-plain of Sajo river, typical flood soil can be observed. The soil in this area has medium to low productivity and substantially high water capacity. The water-bearing layer is of gravel.

5) Land Use

A quarter of this area is used for housing or industries, a half is cultivated and remaining quarter is forests or semi-natural grass fields.

6) Industries

The industries in Sajo valley have been developed over several centuries due to the mineral resources and favorable geographical conditions. Heavy industries including chemical, metallurgic, mining industries and power generation form the core of the industrial structure in this area.

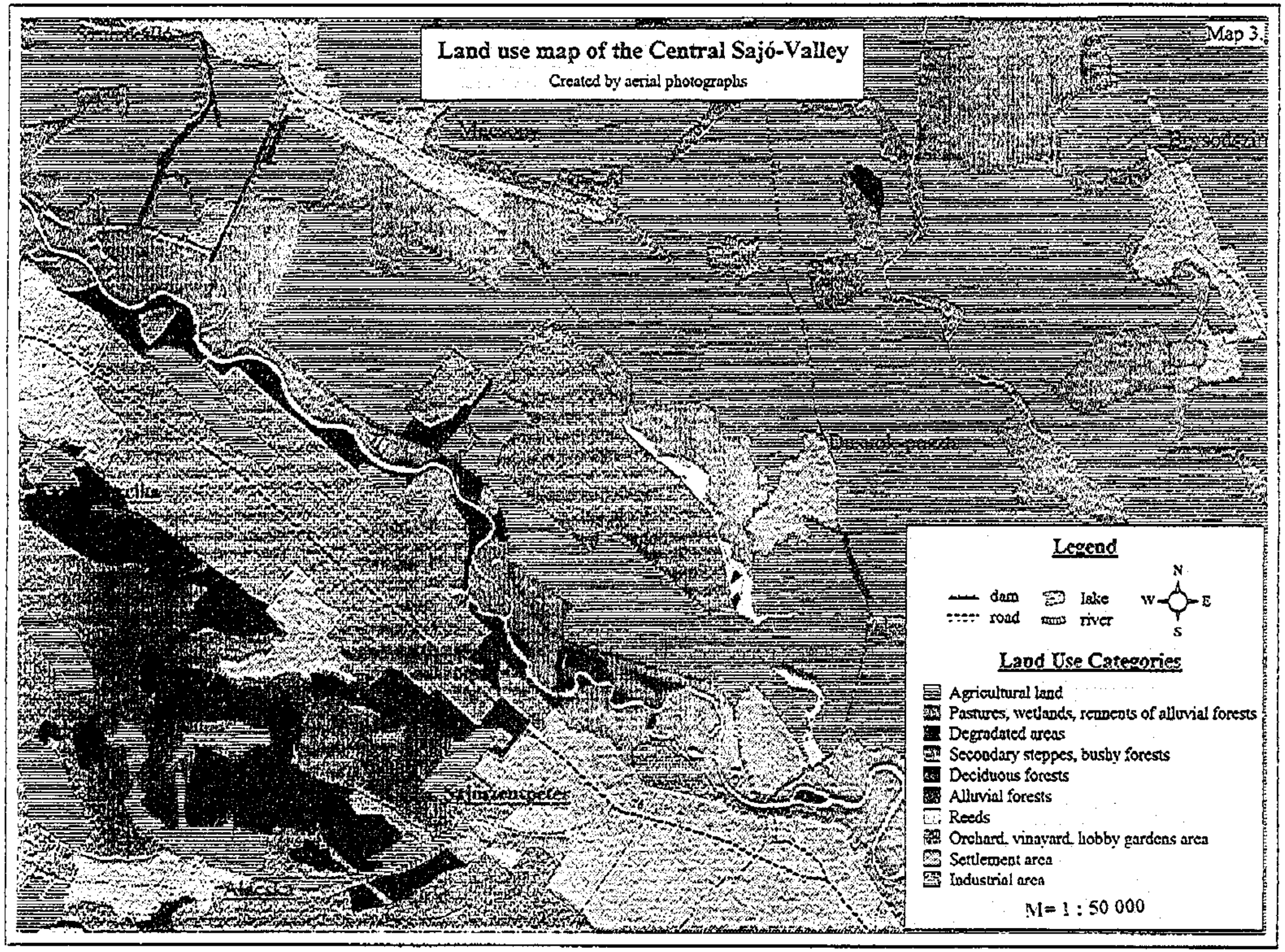


Figure 6.3.1 Land-use Map of the Central Sajo-Valley

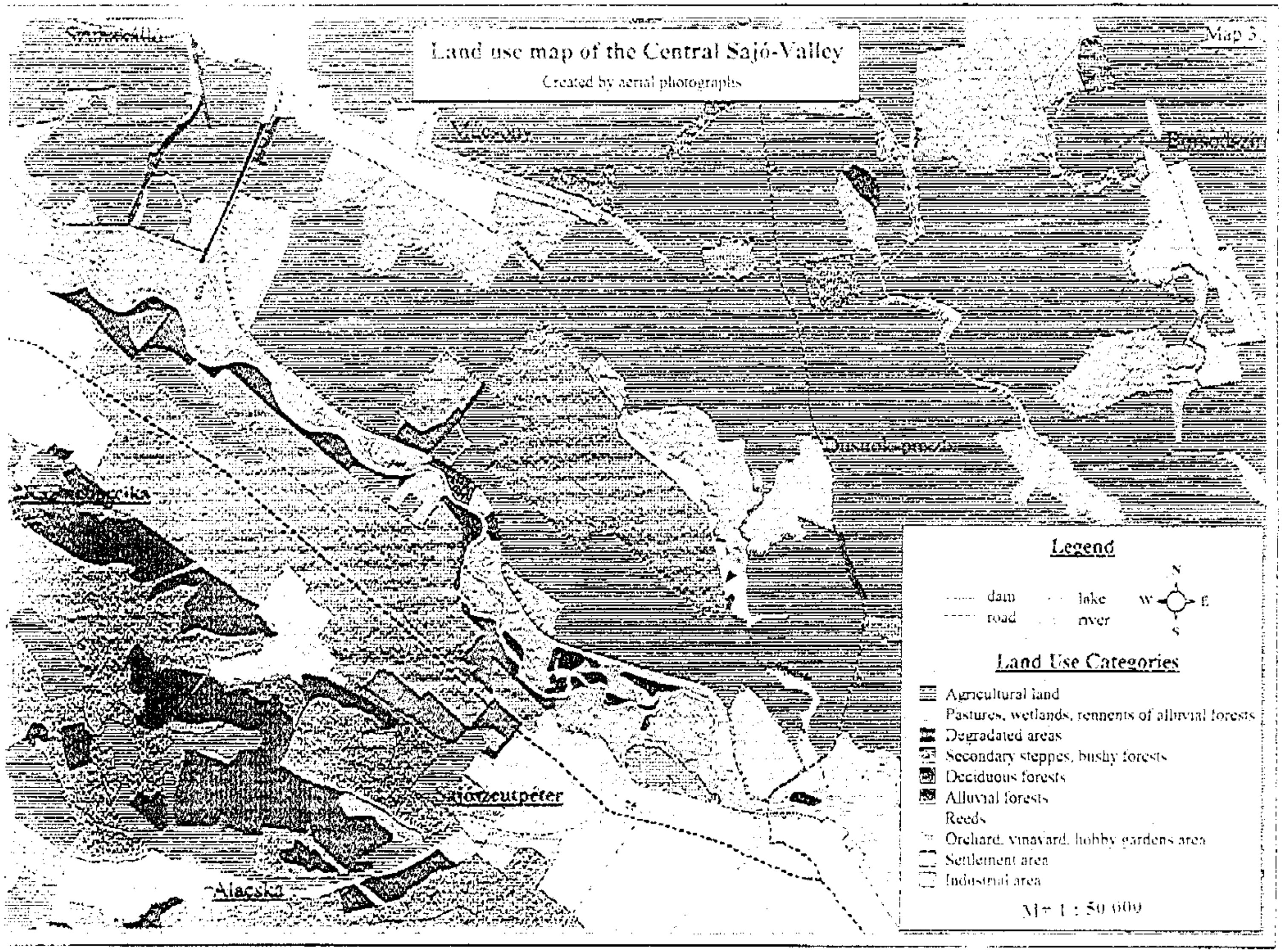
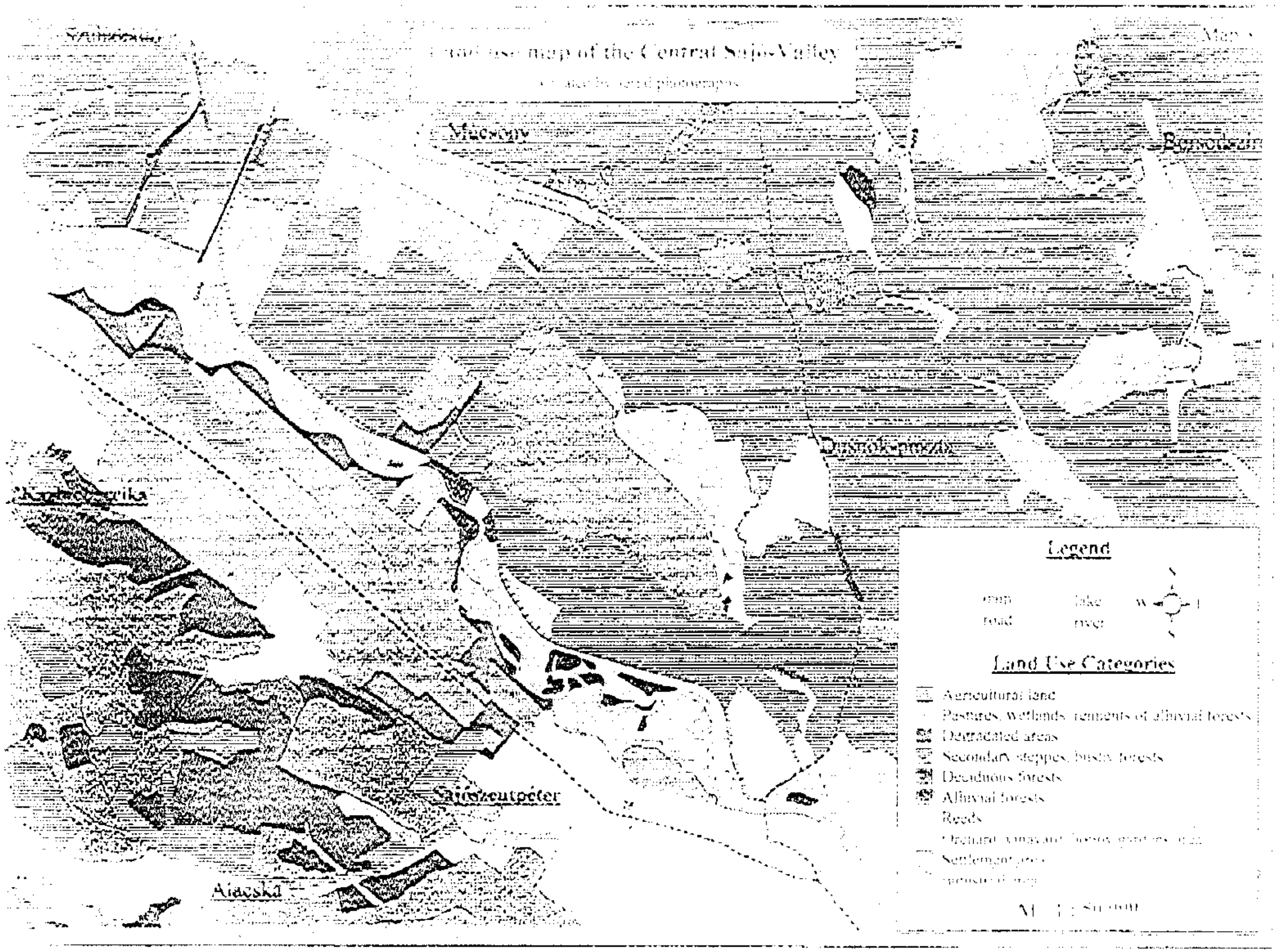


Figure 6.3.1 Land-use Map of the Central Sajó-Valley


map of the Central Sajo-Valley
Mucsony
Sajószentpéter
Alacska
Legend
road
lake
river
W
Land Use Categories
Agricultural land
Pastures, wetlands, remnants of alluvial forests
Degradated areas
Secondary steppes, bushy forests
Deciduous forests
Alluvial forests
Reeds

7) Around Borsod Power Plant, there is no specifically designated area including nature conservation area.

8) There is neither precious species nor endemic animal in this area. At present, environmental destruction is in progress.

9) Near Borsod Power Plant, there are water purification plants, Borsodszirak I and I/A, that use the ground water as the source.

10) Environmental pollution concerning the air, soil, ground water and plants has been observed.

(2) Meteorology

The yearly average precipitation, temperature and humidity are about 650 mm, 8～9℃ and 70～75% respectively. The prevailing winds which have an effect on direction of pollutant dispersion are NNW, NW～N and SSE～S. In winter, the temperature inversion layer is formed and fog is observed frequently.

(3) Air Pollution Analysis

1) Outline of analysis

Air pollution analysis is performed twice, in autumn and winter. The existing air pollution data were collected and reviewed. Heavy metal contents of suspended particulate matter (SPM) and falling dust are also analyzed. Figure 6.3.2 shows locations of automatic ambient air quality measuring stations and sampling points of falling dust analysis.

2) Result of analysis

(a) An example of the chronological transition of the automatic measurement data is shown in Figure 6.3.3. It shows that SO_2 values exceed air quality standard value under the influence of Borsod Power Plant emission.

(b) The air quality standard for SO_2 is shown in Table 6.3.1. The summary of automatically measurement results of SO_2 is shown in Tables 6.3.2 and 6.3.3. The results show that the maximum value of 30 minutes average exceeds the air quality standard value at every monitoring station in each year.

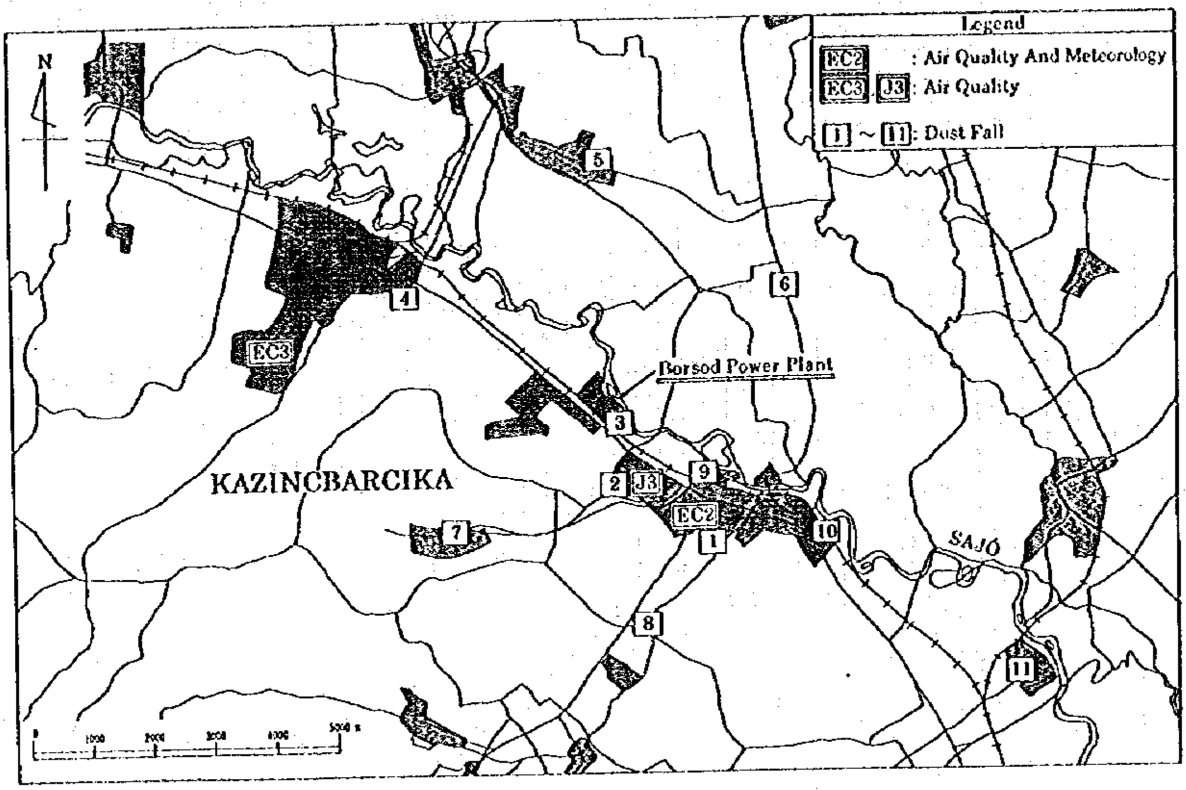


Figure 6.3.2 Location of Ambient Air and Dust Fall Monitoring Stations

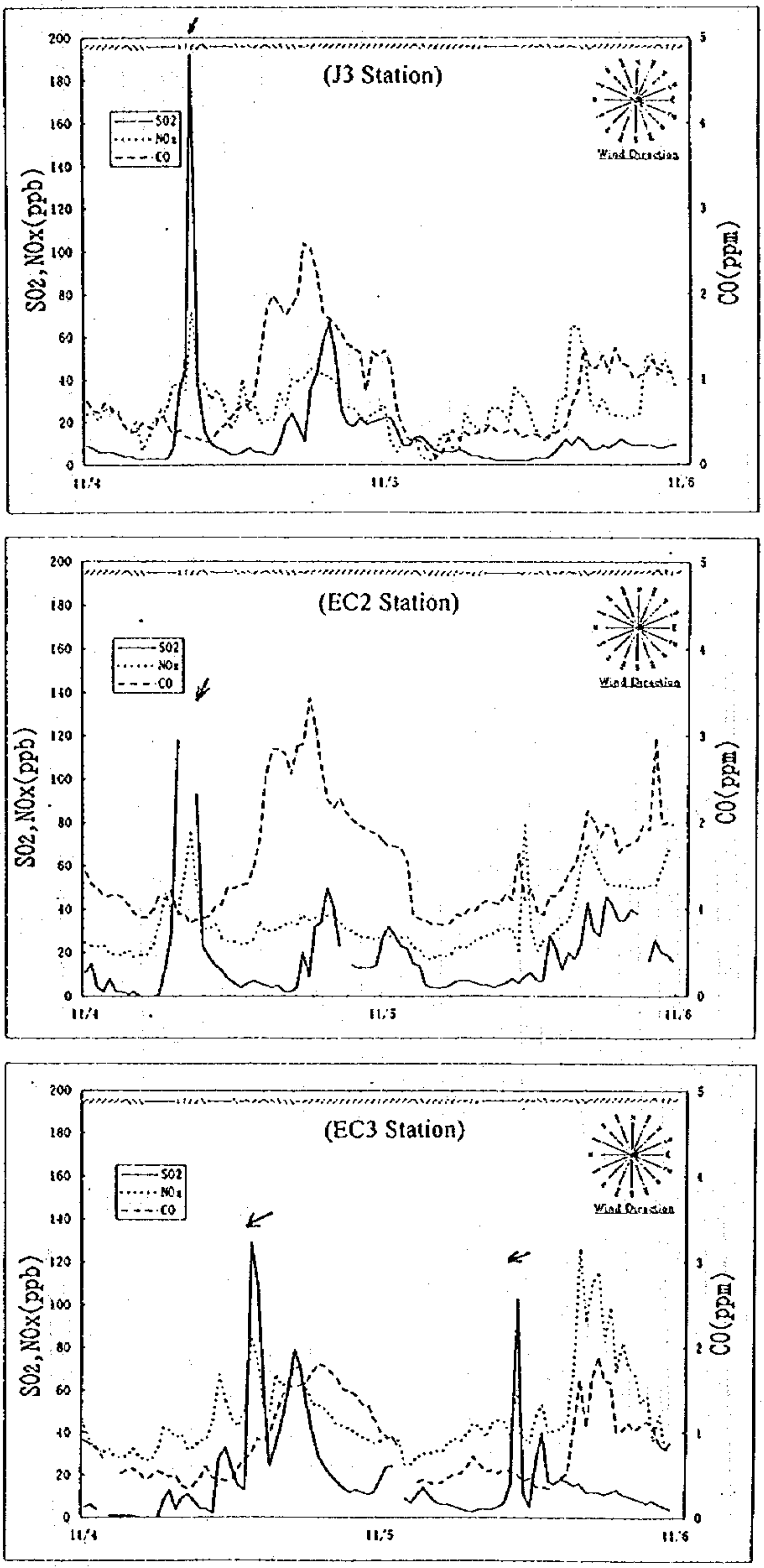


Figure. 6.3.3 The Chronological Transition of the Automatic Measurement Data of Each Air Pollutant in Autumn

(c) Ambient air pollution level is high in winter due to meteorological condition as well as household heating.

(d) No noticeable improvement has been found in the air pollution by SO_2 NO, NO_2, NOx since the JICA master plan survey for Sajo valley area.

(e) High concentration of arsenic in falling dust is caused by high level emission from Borsod Power Plant.

Table 6.3.1 Ambient Air Quality Standard of SO_2

unit : ppb

	Protected Area I (J1)	Protected Area II (J2, J3, EC2, EC3)
30 minutes average	94	150
24 hours average	56	113
Annual average	26	38

Table 6.3.2 Summary of Measured Results of SO_2 (30 Minutes Average)

unit : ppb

Protected Area		I	II			
Station		J1	J2	J3	EC2	EC3
1993 (May - Dec)	98%	36	108	94		
	Max	200	501	467		
	The Number of Data	10413	11002	10937		
1994	98%	41	132	95	112	75
	Max	178	498	500	604	532
	The Number of Data	8561	12206	13500	7615	8777
1995	98%	27	124	52	96	73
	Max	154	453	309	482	376
	The Number of Data	3336	16783	7449	15133	16731
1996 (Jan - Nov)	98%	***	101	42	98	64
	Max	***	396	74	611	267
	The Number of Data	0	12301	2161	6723	11675
All	98%	38	119	84	99	70
	Max	200	501	500	611	532
	The Number of Data	22310	52292	34047	29471	37183

[shaded box] : exceeding ambient air quality standard

Table 6.3.3 Summary of Measured Results of SO2 (24 Hour Average)

unit : ppb

Protected Area		I	II			
Station		J1	J2	J3	EC2	EC3
1993 (May - Dec)	98%	30	74	60		
	Max	55	212	200		
	The Number of Data	217	230	227		
1994	98%	28	70	60	71	53
	Max	32	138	179	162	80
	The Number of Data	180	279	313	168	186
1995	98%	23	75	34	64	47
	Max	119	120	48	90	87
	The Number of Data	74	353	157	312	357
1996 (Jan - Nov)	98%	-	76	-	65	45
	Max	-	132	22	131	55
	The Number of Data	-	265	46	149	262
All	98%	28	75	58	69	46
	Max	119	212	200	162	87
	The Number of Data	471	1127	743	629	805

(shaded) : exceeding ambient air quality standard

(4) Groundwater and Surface Water Analysis

1) Outline of analysis

The location of sampling points for ground and surface water are shown in Figure 6.3.4.

A total of 74 samples (61 ground water samples from monitoring wells, 12 surface water samples, 1 sediment sample of Sajo river) were collected at the same time for analyses of heavy metal, ions, etc.. In addition, hydrodynamics of groundwater was studied. Collected existing data were also used for analysis.

2) Result of analysis

(a) The contour lines of ground water level are shown in Figure 6.3.5. The ground water level shows that ground water flows from North-West to South-East. The impact of the sludge storage and other disposal sites on the service water source, Borsodszirak I/A, requires further study. Groundwater level and lines of equal water level are seasonally or yearly variable.

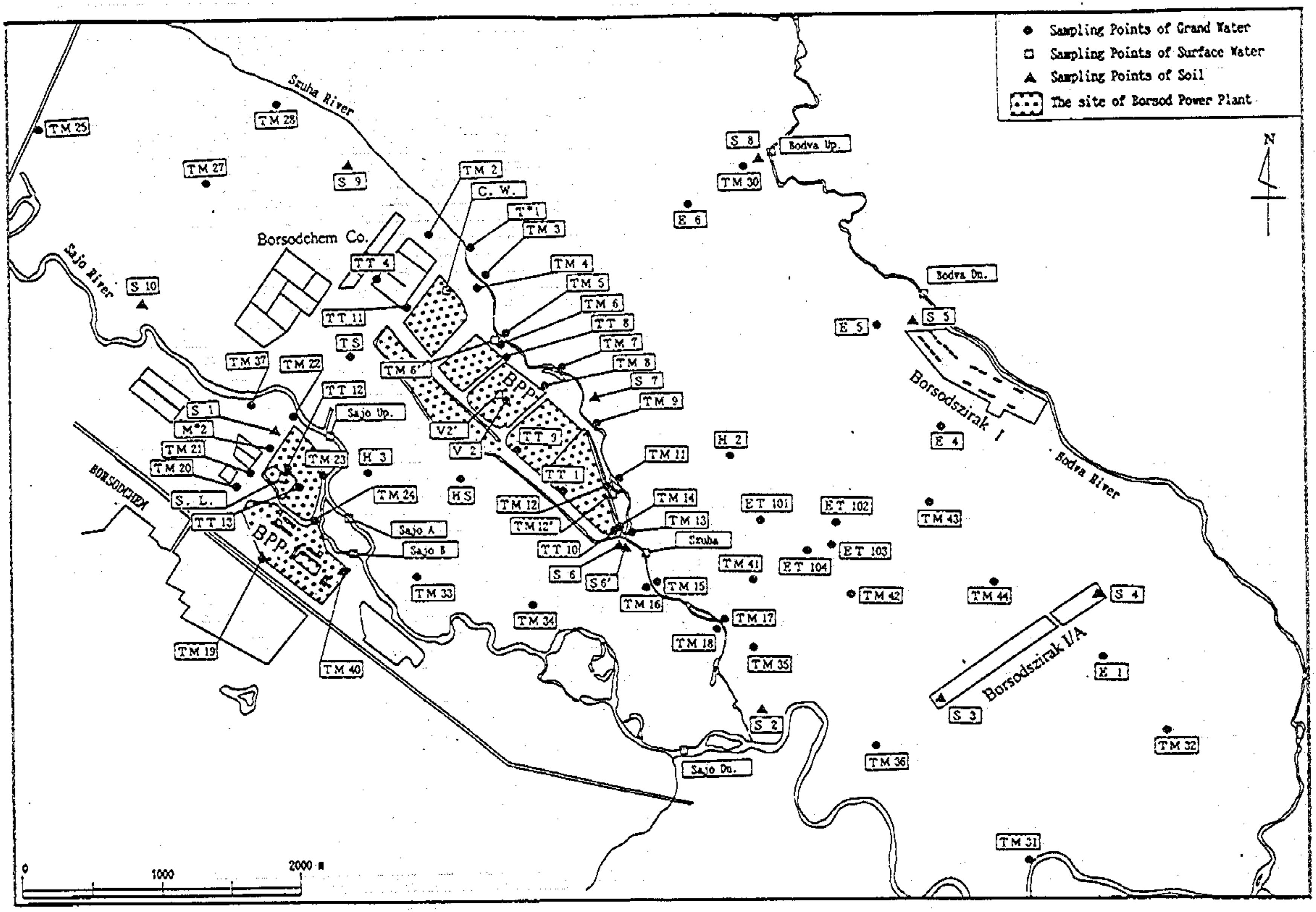


Figure 6.3.4. Sampling Points of Ground Water and Surface Water

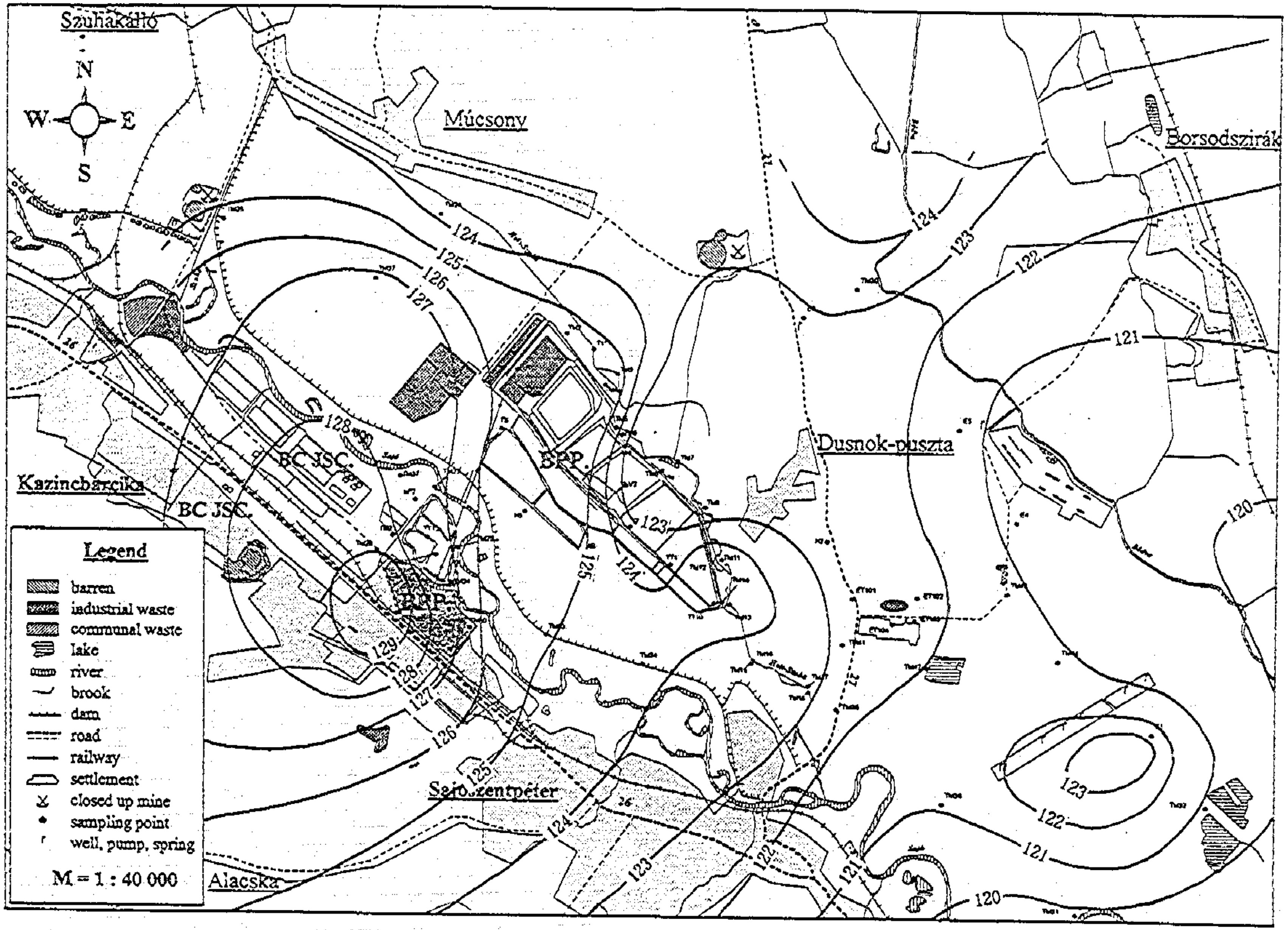


Figure 6.3.5 Isopleth of Ground Water Level

(b) Figure 6.3.6 shows equal concentration lines of As in ground water.

i) As is the only heavy metals contaminant discharged from Borsod Power Plant which may harm human health. High concentration of As is observed around sludge storage and waste water reservoir. For water supply, ions, pH values and electric conductivity are causing problems at present rather than heavy metals.

ii) Concerning the contamination by ions, high concentration appears around the pond of standby storage place and coal washing sludge, and the abandoned waste storage of Borsodchem Co.. Several other spots also show high concentration depending on the type of contaminants. This suggests the existence of many waste dumping sites.

(c) Overall trend of water quality in the observation wells No.1-No.6 at Borsodszirak I/A is summarized as follows:

i) SO_4^{2-} : Level has declined in recent years.

ii) Cl^- : Level has increased since 1985.

iii) NO_3^- : Level has shown wide fluctuation.

iv) NH_4^+ : Level used to show wide fluctuation. Level has drastically declined since 1989, probably due to the use of fertilizer in the farming land.

v) pH : Level has been declined.

(d) Figures 6.3.7 shows an example of SO_4^{2-} distribution in surface water.

i) Concerning surface water, the concentration of SO_4^{2-}, dissolved solids and electric conductivity is high in coal ash sludge storage area and the waste water reservoir. On the other hand, high concentration of Cl^- and NO_3 is observed in the waste water reservoir. This high concentration water causes the pollution of ground water. High concentration of SO_4^{2-} and NH_4^+ was found in the side drains located near sludge storage.

ii) Although arsenic is hardly detected in the waste reservoir, it is necessary to pay attention to the followings.

- The ground water in the area of the nearest standby sludge storage is polluted with As.

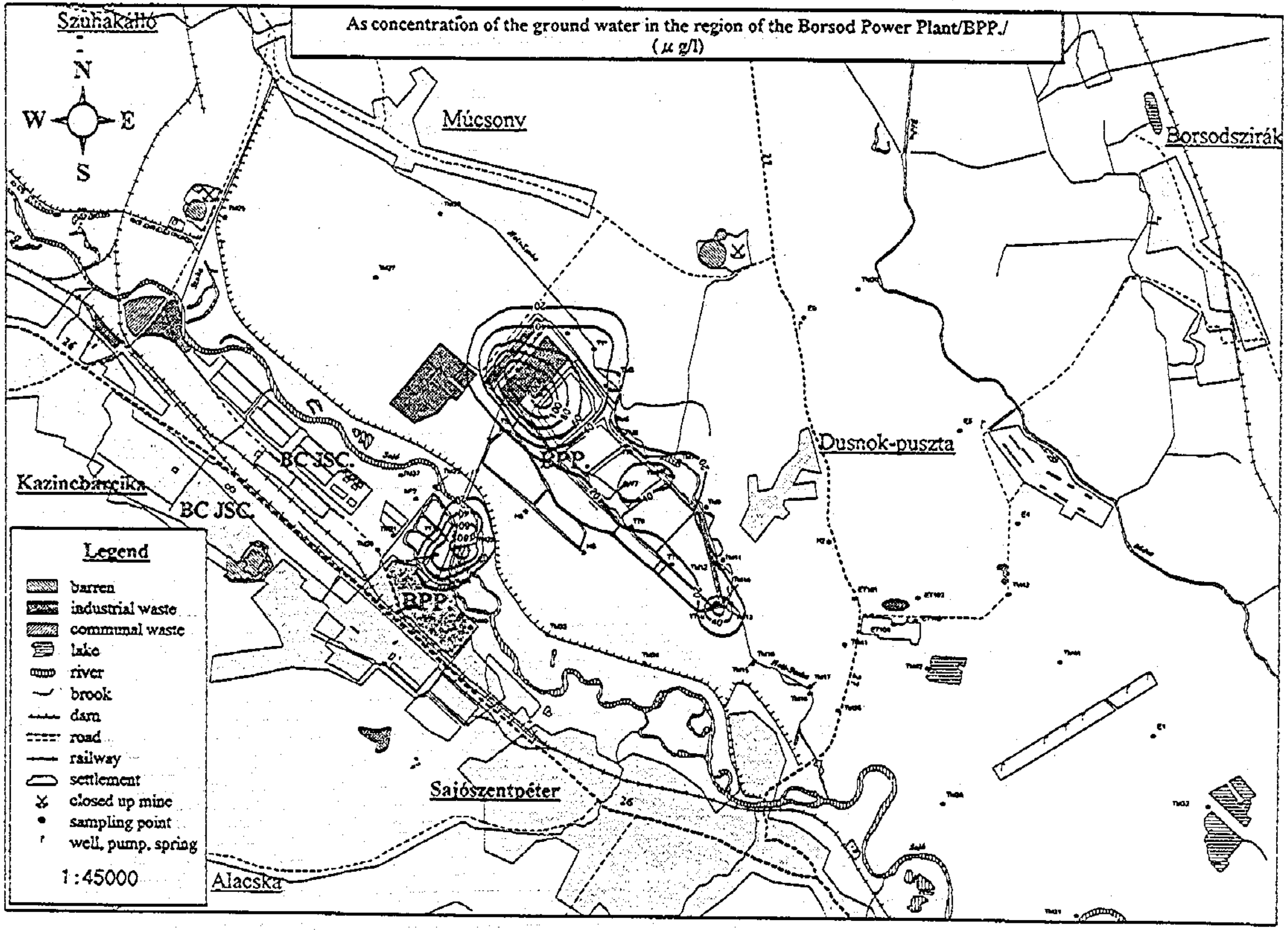


Figure 6.3.6 As Concentration of the Ground Water in the Surroundings of Borsod Power Plant

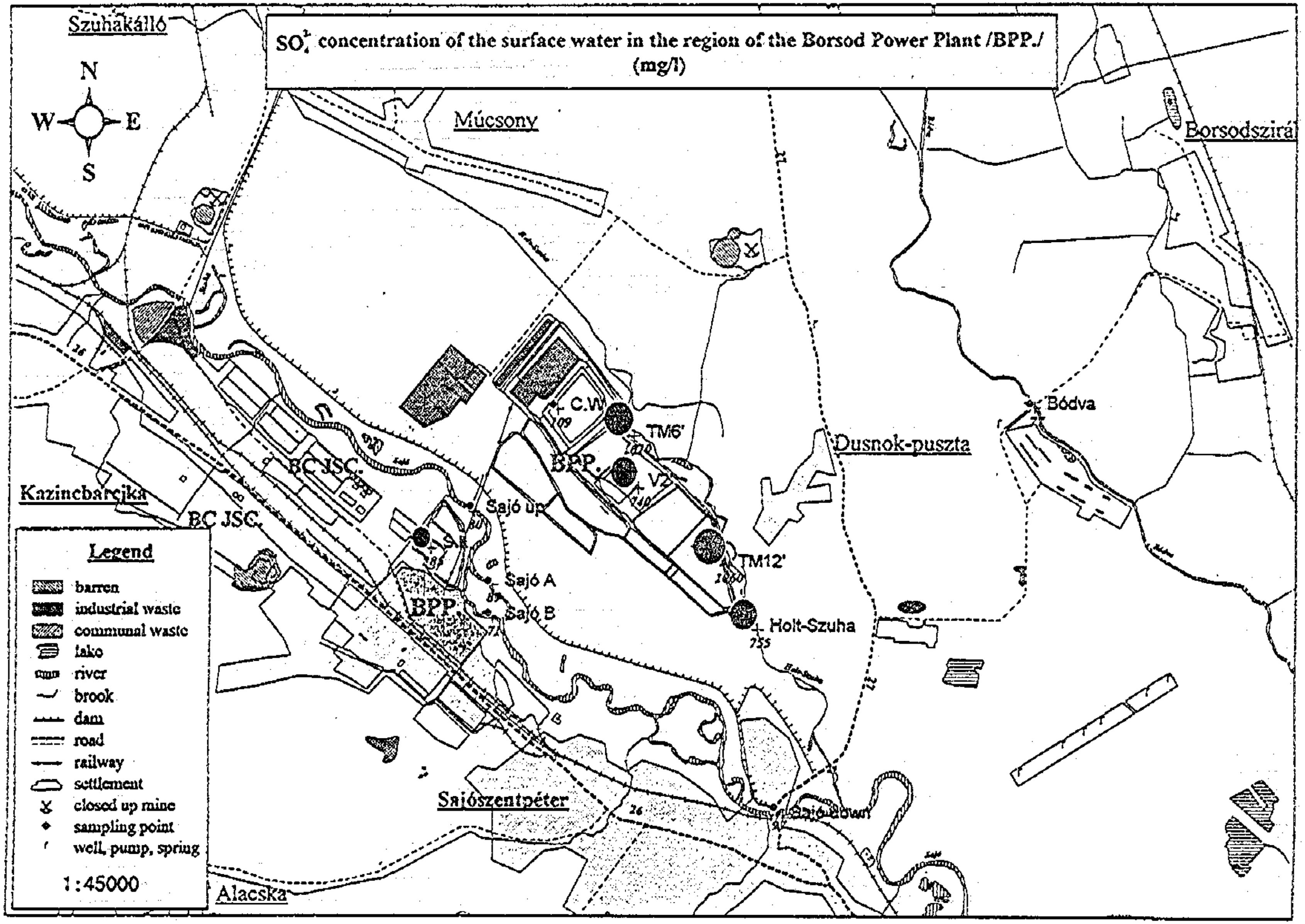


Figure 6.3.7 SO_4^{2-} Concentration of the Surface Water in the Surroundings of Borsod Power Plant

- High concentration of As was found in the side drains located along the coal washing sludge storage.

(5) Quality of River Water

The Sajo river running through the tract of Kazincbarcika was extremely polluted with heavy metals and organic matter in the past, where aquatic life died out completely to such an extend that river was called a river of death. The water quality has been improved in recent years due to recognition of importance of environmental protection, stagnant industrial activities in the river basin and the closing of the pulp plants in Slovakia. This enables aquatic life to recover.

The present condition of the rivers is as follows.

(a) Concerning the quality of water in Sajo river and Bodva river, the concentration of both heavy metals and ions is low. High concentration has not been detected.

(b) The bottom sediment of the Sajo river which was polluted with heavy metals in the past has been substantially improved. As a result, the improvement of the bottom sediment quality has contributed remarkably to the improvement of the water quality.

(c) Holt-Szuha river which flows near sludge storage is still polluted by As and ions due to the leachate from sludge storage.

(6) Changes of Water Temperature in Sajo River

Although the quality of water in the Sajo river has been improved, the problem of discharge of heated cooling water is still present. Especially in summer when the water level is low, the water temperature in Sajo river rises from 25 °C to 33 °C.

(7) Soil Contamination Analysis

1) Outline of analysis

There is concern about heavy metal contamination such as As due to flue dust from the Borsod Power Plants and dust from the sludge storage. Illegal disposal of waste and industrial waste disposal sites of the other companies, cause the contamination of soil and ground water.

Samples are taken at 22 points in autumn and winter. Result of the analysis was used to evaluate the data from JICA master plan study in 1994. The samples for heavy metal analysis were prepared by the following three methods.

- 2M-acid extraction
- Water extraction
- Acid decomposition

2) Result of analysis

(a) An example (As) of heavy metal (As, Cd, Hg, Pb) analysis results using 2M-acid extraction method is shown in Figure 6.3.8.

i) As shows high concentration near the Borsod Power Plant, but the other heavy metals including Cd, Hg, Pb, Zn, show low concentration. Therefore, the soil pollutant deriving from Borsod Power Plant is limited to As.

ii) The lot S-12 where Cd, Pb, Zn, etc. show high concentration is positioned on the flood plain of Sajo river. The lot S-12 seems to be affected by the industrial pollution in Sajo river occurred in the past.

(b) The result of water extraction method heavy metal analysis shows that only sampling points have high As content are near Borsod Power Plant.

(c) The result of acid decomposition method heavy metal analysis shows that As content of several samples taken near Borsod Power Plant exceeded criteria values. But other samples do not show high heavy metal contents.

(d) Evaluation of existing data

Distribution maps of heavy metal contamination in the soil, which uses acid decomposition method heavy metal analysis, are prepared based on the data from the Survey of Environmental Pollution in the Sajo Valley Area [Regional Environmental Center for Central and Eastern Europe (1994)]. Arsenic distribution is shown in Figure 6.3.9.

i) Level of As contamination was relatively high (5 mg/kg) in Kazincbarcika and Mucsony. Only the sample taken from the dumping site such as sludge storage had an extremely high level of As contamination.

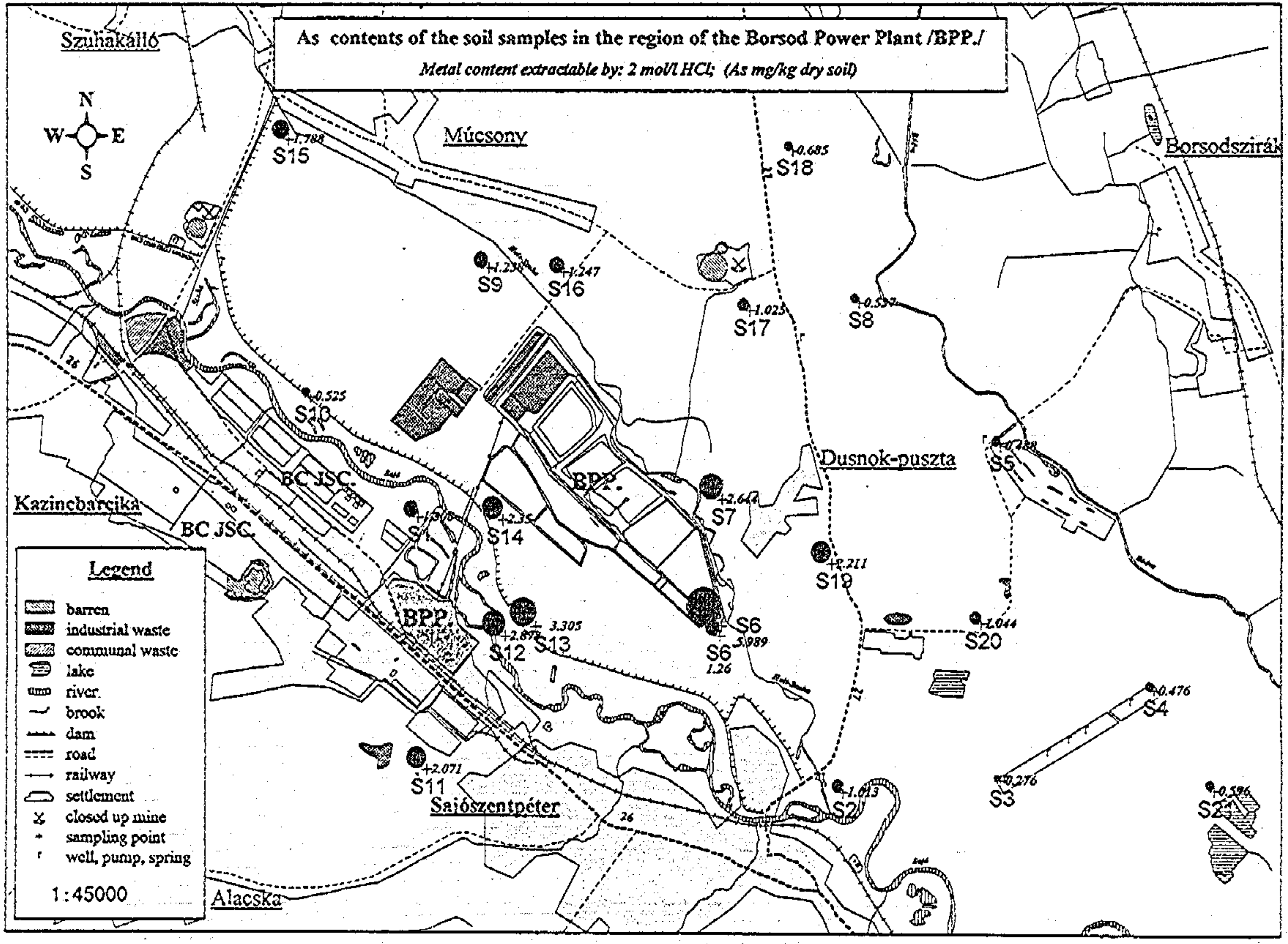


Figure 6.3.8 As Contents of the Soil Samples in the Surroundings of Borsod Power Plant

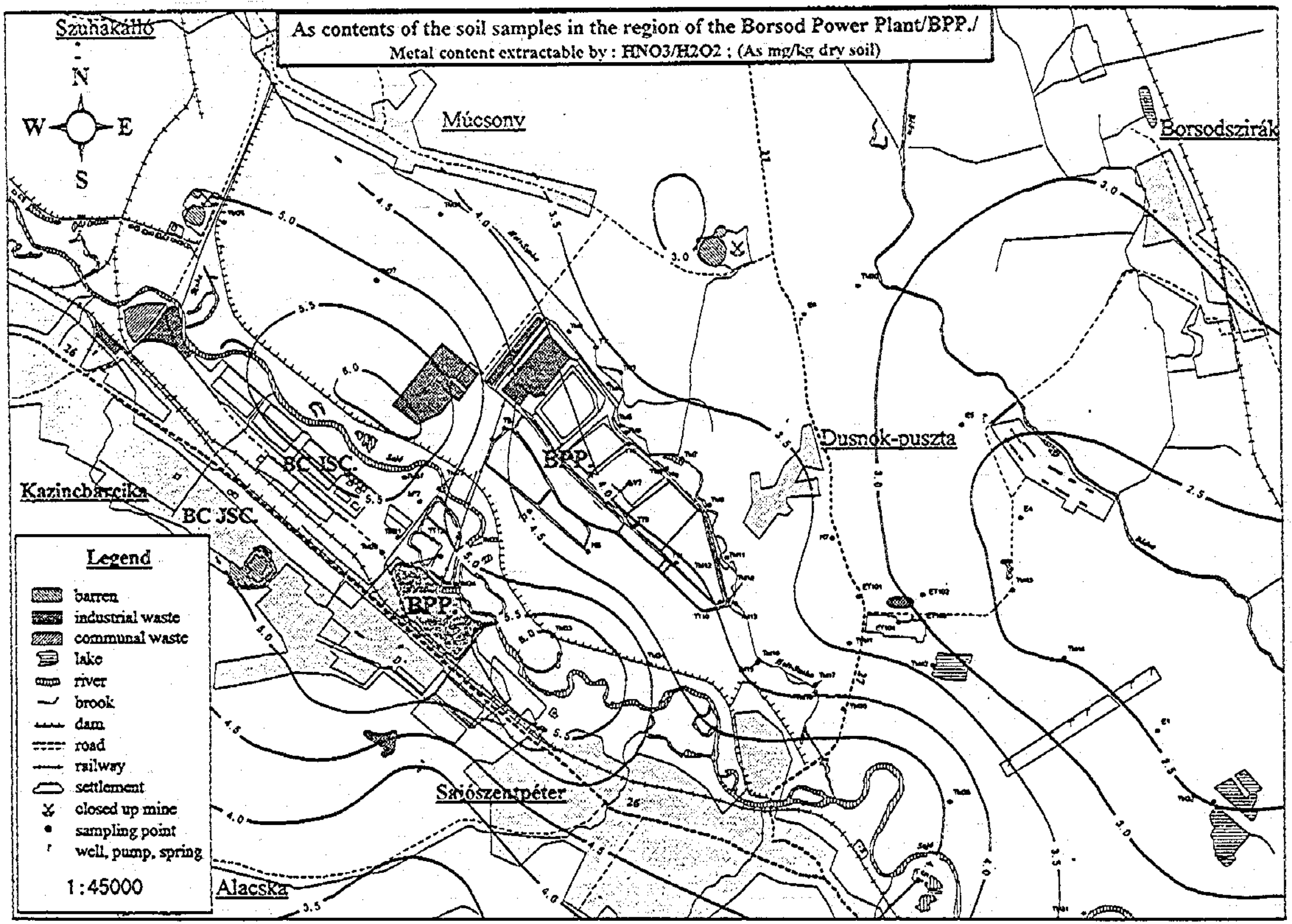


Figure 6.3.9 As Contents of the Soil Samples in the Surroundings of Borsod Power Plant

ii) According to the distribution of Hg contamination, the pollution source is most likely Kazincbarcika.

iii) Ca, Pb and other heavy metal contamination is derived from industrial waste dumping and industrial activities other than Borsod Power Plant. This supports the result of this study.

iv) Comparing the above data with the data measured by the study team, the study team data indicate Cd content lower, and As, Cu and Zn content higher while indicating Hg Mn and Pb content nearly equal. These differences may be caused by difference in analytical methods. It is necessary to take into account these tendencies.

(8) Flora, Precious Species and Endemic Animals

1) Outline of survey

For the evaluation of influence of Borsod Power Plant on natural environment, changes from the past and present environmental situation were surveyed in the central part of Sajo valley. Necessary actions to recover and create nature from the viewpoint of nature protection are proposed.

The survey was based on the field exploration, data collection, hearing and discussions with local specialists.

2) Influence of Borsod Power Plant on natural environment

The past, present and future influence of Borsod Power Plant on the natural environment in the area including vegetation are estimated as follows.

(a) Construction of Borsod Power Plant

For constructing this Plant, extensive farming land, flood plains along the Sajo river and shrubs were destroyed.

(b) Inside and outside coal ash storage areas

Inside coal ash storage areas were mainly farming land and wet land. Outside coal ash storage areas were the farming land along Szuha river which had rapid flow before the plant construction. The installation of coal ash storage has had serious effects on the vegetation in the vicinity.

(c) Coal mining

The brown coal consumed in Borsod Power Plant has been furnished from the mines located in the same area. The strip mining of the brown coal seriously destroyed the vegetation.

(d) Air pollution

Borsod Power Plant, one of the most serious sources of air pollution in these areas, has seriously destroyed the vegetation so far. Until the beginning of the eighties, there were no electric dust collectors installed in the Plant and annual discharge of particulate matter and SO_2 was 40,000-60,000 tons and 50,000-

60,000 tons respectively. Although the discharges has decreased to 1,000-2,000 tons and about 40,000 tons respectively, it still has bad effects on environment.

(e) Influence on Sajo river

The dam was constructed in the Sajo river for cooling water intake. Heated cooling water at a temperature of 30-40 °C is returned to the Sajo river, which is seriously affecting aquatic plants and animals especially when river flow is small.

(f) Outside sludge storage

The leachate containing As, SO_4^{2-}, NH_4^+, etc. flows into the Sajo river through Holt-Szuha river. It affects the vegetation along Holt-Szuha river.

3) Present condition of plants

(a) Figure 6.3.10 shows the habitats of remaining plants around Borsod Power Plant. This shows the seriousness of the environmental destruction by the development.

(b) Endemic plants and animals in this area have almost disappeared.

4) Present condition of animals

(a) As a result of the destruction of the animal habitats the villages and industrial areas located in the valley can be called a barren land from zoological point of view.

(b) The species susceptible to environmental pollution have disappeared and precious species can be no longer observed in these areas.

(c) The land animals visually observed by the study team are mammals (foxes and rabbits), amphibians and some species of birds. In Hungary, all these species including insects are under the protection of the law.

(d) Sajo river became " a river of death" in the past by violent industrial pollution and the aquatic life almost disappeared. However, the quality of water has been improved since the beginning of the nineties, and the aquatic life is recovered gradually.

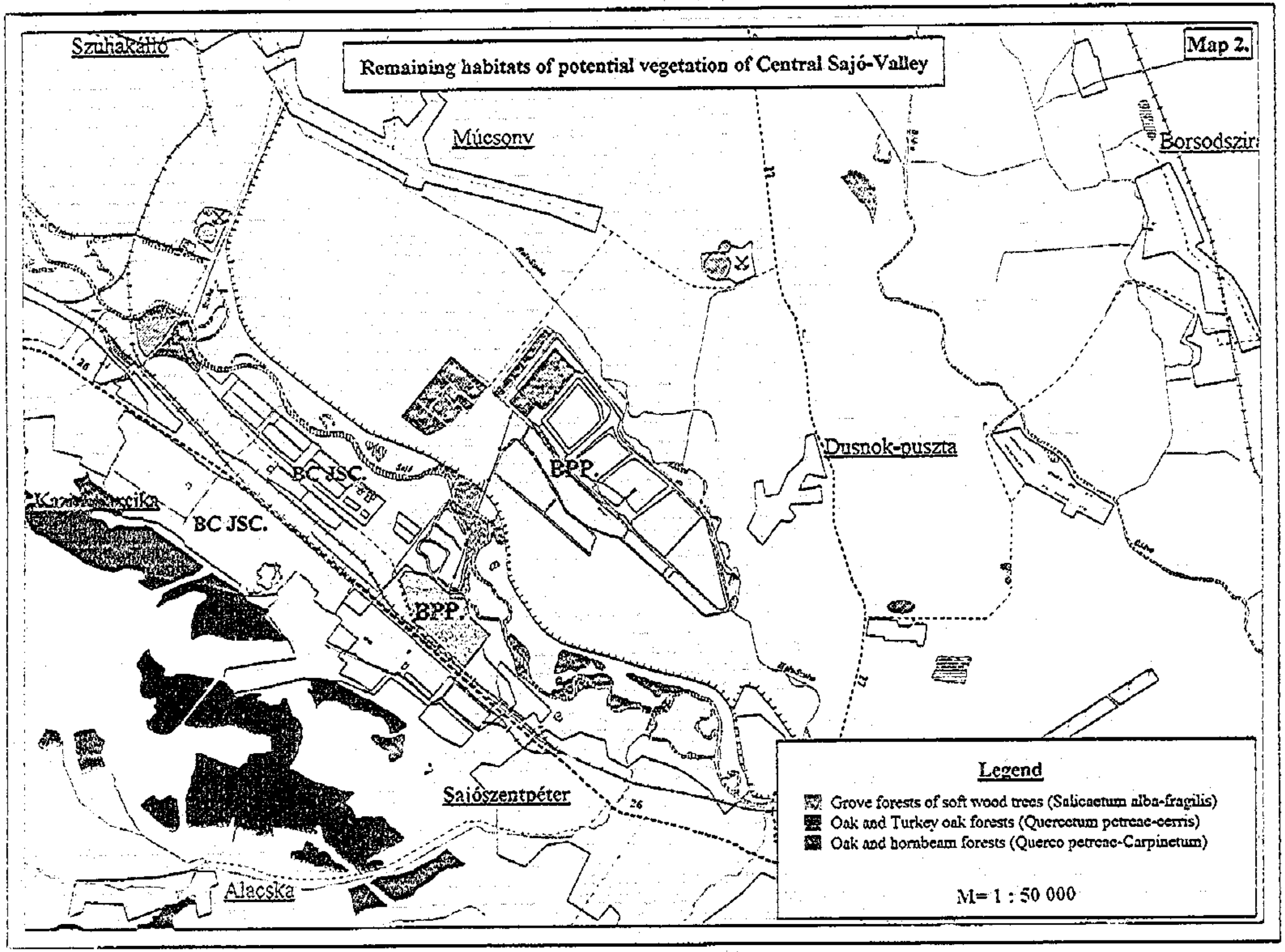


Figure 6.3.10 Remaining Habitats of Potential Vegetation of Central Sajo-Valley

5) Influence on nature protection areas

There are two national parks, twenty protection areas and hundred nature conservation areas within the 25 km radius from Borsod Power Plant, but no area around the Plant is under special protection.

Together with other sources, emission of Borsod Power Plant is affecting Aggtelek National Park, Bukk National Park and nature conservation areas.

(9) Noise

The noise levels measured in the vicinity of Borsod Power Plant meet applicable environmental standards. Northern Hungarian Supervisory Authority of Environmental Protection laid down the allowable limits of the noise originated from Borsod Power Plant by the law No. 16.632-2/ 1993. The noise levels and allowable limits in relation to the buildings concerned are as follows.

Measuring point	Noise level(dB)		Limit value(dB)	
	day	night	day	night
The house of power plant's guard	44	42	57	47
The power plant's employee lodgings	46	45	55	45
The reformatory	45	44	55	45

(10) Vibration

Any pollution caused by the vibration from Borsod Power Plant has not been reported. Vibration is expected during construction works.

(11) Air Pollution Sources

1) Stationary sources

Based on the discharge of air pollutants from the stationary sources located within a 20 km radius from Borsod Power Plant, the followings are observed.

(a) SO_2 emission from Borsod Power Plant comprises 95 % of total SO_2 emission from stationary sources.

(b) Comparing annual discharges in 1993 and 1995, the discharges of both SO_2 and NOx from Borsod Power Plant increased. Particularly, the increase of NOx is remarkable. On the other hand, the trends in other sources show that SO_2 was on the same level, and NOx decreased. However, by examining the data, the study team estimated that both SO2 and NOx emissions remained on the same levels.

2) Automobiles

(a) For the traffic on the national roads, the number of trucks decreased from 1990 to 1995, but the total volume of traffic remained in the same level.

(b) Concerning the number of automobiles registered, the number of automobiles with larger emission factors decreased and that with smaller emission factors increased. The total number of automobiles registered is increasing.

(c) Dieselization of small-sized automobiles is in rapid progress in recent years. The total discharge from automobiles remains in the same level.

3) Non-point sources

Non-point sources include domestic heating, small point sources and traffic on narrow streets.

(a) Gas is replacing solid fuels as a domestic heating fuel.
(b) It is estimated that the present discharge of SO_2 and NOx emitted from small-scale stationary sources and traffic on narrow streets remains same compared to that in 1993.

4) Emissions from the Borsod Power Plants

Emission analysis was carried out twice during ambient air quality analysis. In addition, special pollutants in the fallen dust and gaseous Hg and As in the flue gas were studied.

(a) Comparison of the result of this emission analysis and data in 1993 shows that volume and level of emission from each boiler are almost same in both study.

(b) Most of Hg in the flue gas turned into fume, so Hg content of the dust is low. Contrary to Hg, most of As is contained in the dust. Gaseous As is negligible.

(c) Levels of chlorides and fluorides were sufficiently lower than the emission standard (Hcl $\leq$ 200 mg/m^3, F $\leq$ 30 mg/m^3).

(d) The As contents of EF flyash was several times higher than that of slug or economizer flyash.

6.4 Initial Environmental Examinaiton

The study team collected and reviewed past environmental examination results for the study of the influences of the proposed project on the environment.

With additional exsting data and the result of on-site surveys, environmental impacts of the proposed project were carefully studied.

The important environmental items for the initial environmental examinaiton (IEE) are shown in Table 6.4.1.

Table6.4.1 Important Environmental Items Selected in IEE (1/2)

Item of environment		Cause	Present situation, affect on environment and assessment	Decision	Ground of decision	Cautions
Social condition		Reconstruction of a power plant	Accepted due to the location in an industrial area	×	The power plant was constructed in designated industrial area in earlier stage, and the influence on the social condition is negligibly small.	Take necessary consideration for the influences on the traffic during construction
Natural environment	Precious species and inherent animals	Gas exhausted from flues	Affected by atmospheric pollution	×	It is not said that special species or inherent animals are present in the neighborhood	-
	Flora	Gas exhausted from flues or sludge storage places	Affected. Countermeasures should be taken	Δ	Soil and ground water polluted by thermal effluent, As and ions	Also take care of National Parks
	Pollution of ground water	Sludge storage places or waste water reservoirs	Pollution is in progress in ground water	○	It is necessary to prevent the influence on the tap water sources and agricultural land	Take into consideration the wells used by the residents as well as other sources of pollution
	Changes in flow and levels in water areas	Water from Sajo River is used as coolant	Plants living alongside the river are being affected	Δ	The influence will not disappear unless necessary countermeasures are taken.It is absolutely required to take necessary countermeasures	-
	Changes in water temperature in water areas	Ditto	River plants are affected by thermal effluent	Δ	Ditto	-
	Air pollution	Gas exhausted from flues Sludge storage places	Obvious influence of As, SO_2, Nox and SPM on the environment	○	It is necessary to propose the countermeasures to avoid the influence on the environment	Fume mercury should be also taken into consideration
	Water pollution	Water leaking from rainwater piping or sludge storage places	Causing water pollution in Sajo River but light	Δ	Drainage from rainwater piping must be partially improved Leakage of water can be solved by preparing sludge storage places	-

Table6.4.1 Important Environmental Items Selected in IEE (2/2)

Item of environment		Cause	Present situation, affect on environment and assessment	Decision	Ground of decision	Cautions
Natural environment	Soil pollution	Ashes splashing in flues and sludge storage places	Some areas are polluted by As	O	It is necessary to propose the countermeasures to prevent the pollution	Take into consideration the pollution by the heavy metals from the sources other than those from power stations
	Noise	Noise caused by facilities and works in during construction	Present noise does not exceed the limit	×	It is possible to take the countermeasures to prevent the occurrence of noises	The noise arising when boilers are blown off must be re-examined
	Vibration	Vibration cause by facilities and works in during constriction	Ditto	×	It is possible to take the countermeasures to prevent the occurrence of vibrations.	The occurrence of vibration must be avoided in particular during construction
	Odor	Combustion of coal	Bad smell caused by the power plant has not invited any serious problem	×	It is unnecessary to take any countermeasure	—

Note: O Detailed survey of environmental influences and proposal of countermeasures are necessary.

△ It is necessary to examine the measures taken for mitigating the influences on the environment.

× It is necessary to take these facts into consideration but the effect on the environment is negligibly small.

6.5 Environmental Impact Assessment

(1) Ambient Air Quality

The following four predictions and analyses were made.

- Prediction of short-term concentration using plume model (Pre-analysis)
- Prediction of long-term average concentration of SO_2 using a simulation model
- Analysis of down-wash
- Modeling of stagnation (at calm and stagnated high concentration)

1) Prediction of short-term concentration using plume model

Effects on SO_2 and Nox concentration of ambient air on down wind ground-level from Borsod Power Plant were predicted with plume model according to the condition of emission and the weather. 30 minutes average was used as evaluation time. Other emission sources are ignored in this prediction.

Figure 6.5.1 shows the attenuation of SO_2 and NOx concentration on the down wind principal axis according to the fuel type and the operation conditions of the plant in Table 6.5.1.

Table 6.5.1 Emission Conditions from Borsod Power Plant on Calculation for Prediction

Case	Boiler Condition	New (150 MW) (H=125 m)	Existing 4 Boilers (H=101 m)
1	Full Operation	SO_2=400 mg/m^3	Domestic Coal
2	Full Operation	SO_2=400 mg/m^3	Mixture Coal
3	Full Operation	SO_2=400 mg/m^3	Oil
4	75 % Operation	Desulfurization 85 %	Mixture Coal
5	75 % Operation	SO_2=400 mg/m^3	Mixture Coal
6	75 % Operation	SO_2=400 mg/m^3	Oil
7	75 % Operation	SO_2=400 mg/m^3	Gas

From the results of calculation, the cases that ambient air quality exceeds the Environmental Protection Standards II are as follows.

Environmental Protection Standards II (value in 30 minutes)

SO_2 : 0.40 mg/m^3
NOx : 0.20 mg/m^3

(大気安定度：A)

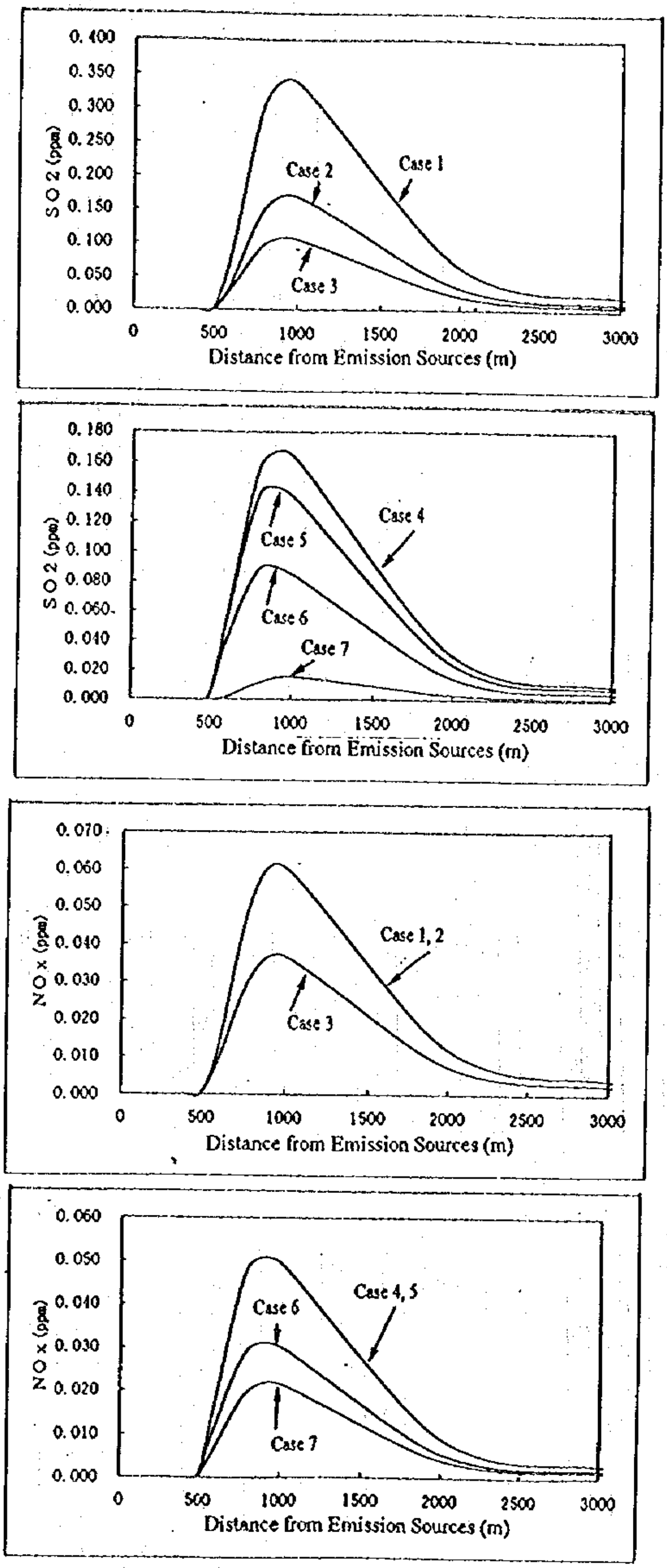


Figure 6.5.1 Attenuation of SO_2 and NOx Concentration on Principal Axis by Fuel Kind (Atmospheric Stability: A)

<SO_2>

a) Atmospheric stability A, wind speed 1 m/s : case 1,2,4

b) Atmospheric stability B, wind speed 1 m/s : case 1

<NOx>

The concentration of NOx is 0.116 $\mu g/m^3$ with the atmospheric stability A and wind speed of 1 m/s, which does not exceed the environmental protection standards.

As mentioned above, emission standards of SO_2 applicable to each type of fuels can be satisfied, but ambient air quality fails to satisfy the environmental protection standards in some cases. As the background concentration is added actual concentration becomes higher. From the viewpoint of environmental protection, it is insufficient only to satisfy the emission standards required for the Borsod Power Plant. Further reduction of emission is required.

2) Prediction of long-term average concentration using a simulation model

Prediction is based on the model used in " Study on an Integrated Air Pollution Control Plan for Sajo Valley Area (M/P Study) between 1992 and 1994". The same conditions in the above study are used for prediction besides conditions of Borsod Power Plant operation.

The simulation of SO_2 concentration in winter under the conditions below is shown in Figure 6.5.2.

- New boiler: 75 % load, CFBC
- Existing boiler: fuel = natural gas

The simulation of Nox concentration in winter under the conditions below is shown in Figure 6.5.3.

- New boiler: 100 % load, CFBC
- Existing boiler: fuel = domestic coal

Air quality environmental standards for the yearly average of SO_2 and NOx are as follows.

(Unit : mg/m^3)

Parameter	Protected Area	
	I	II
SO_2	0.070	0.100
NOx	0.100	0.150

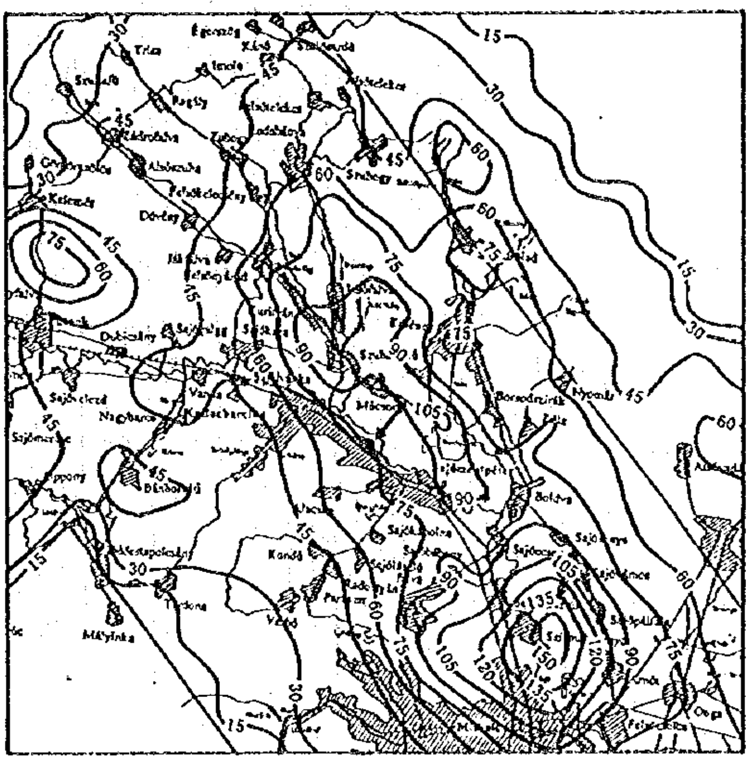


Table 6.5.2 Isopleth for SO_2 in Heating Season

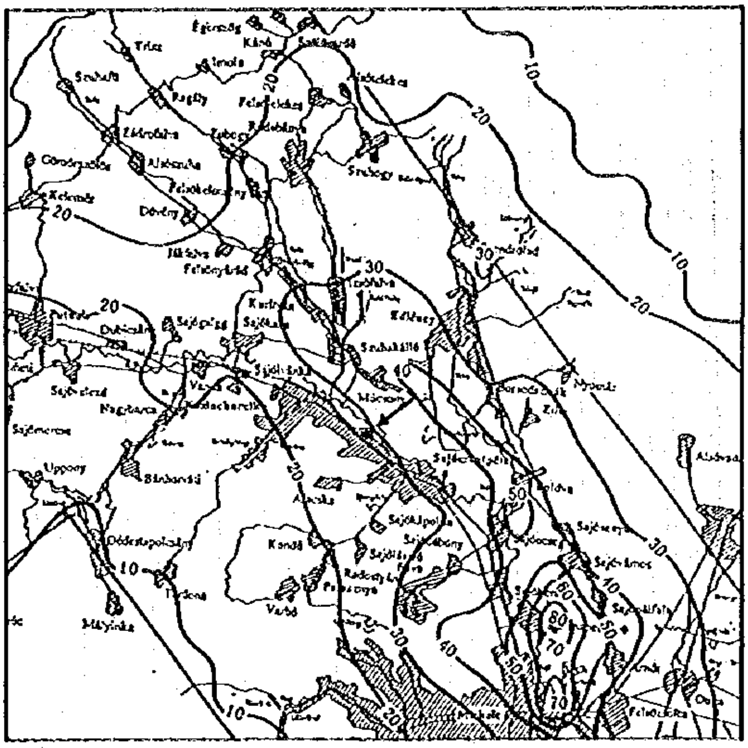


Figure 6.5.3 Isopleth for NOx in Heating Season

(a) Even if using natural gas, the cleanest fuel, for the existing boiler, SO_2 in winter exceeds the " air quality standard I for residential areas" in the vast area including the cities of Kazincbarcika, Sajoszentpeter and Miskolc. Even the Environmental Standard II applicable to industrial areas has not been met in Miskolc.

(b) NOx in winter with the full load operation, which is the worst condition, has cleared the air quality standard I in all areas.

(c) This indicates that, although the air control preventive measures at Borsod Power Plant is contributing to lower the local SO_2 concentration level, there still remains a large impact mainly from non-point sources. In order to clear the environmental protection standard in winter, it is necessary to take pollution control measures for other sources than the Borsod Power Plant.

(d) In order to meet a new SO_2 emission standard which comes into effect on Jan 1, 2005, following conditions should be satisfied.

- The emission standard for other stationary sources is strictly enforced.
- The fuel conversion from solid fuel to natural gas for the residential areas is steadily implemented.

3) Downwash analysis

GEP stack height was calculated using BPIP (Building Profile Input Program) (1993) prepared by the US EPA.

For the new stack, with the proposed stack height of 125 m by the feasibility study, downwash is observed in case of ENE or WSW winds under the influence of boiler house. In order to prevent the downwash, either the new stack height is to be increased or the new stack to be built on the other location. The study team recommend that the height of stack is to be increased to 130 m.

4) Stagnation (stagnated high-concentration) modeling

Stagnated high-concentration pollution has been observed mainly in winter several times at the JICA M/P study in Sajo Valley Area. Figure 6.5.4 (top) shows the concentration diagram of SO_2 at 12:00 ~ 13:00 on Nov. 23, 1993.

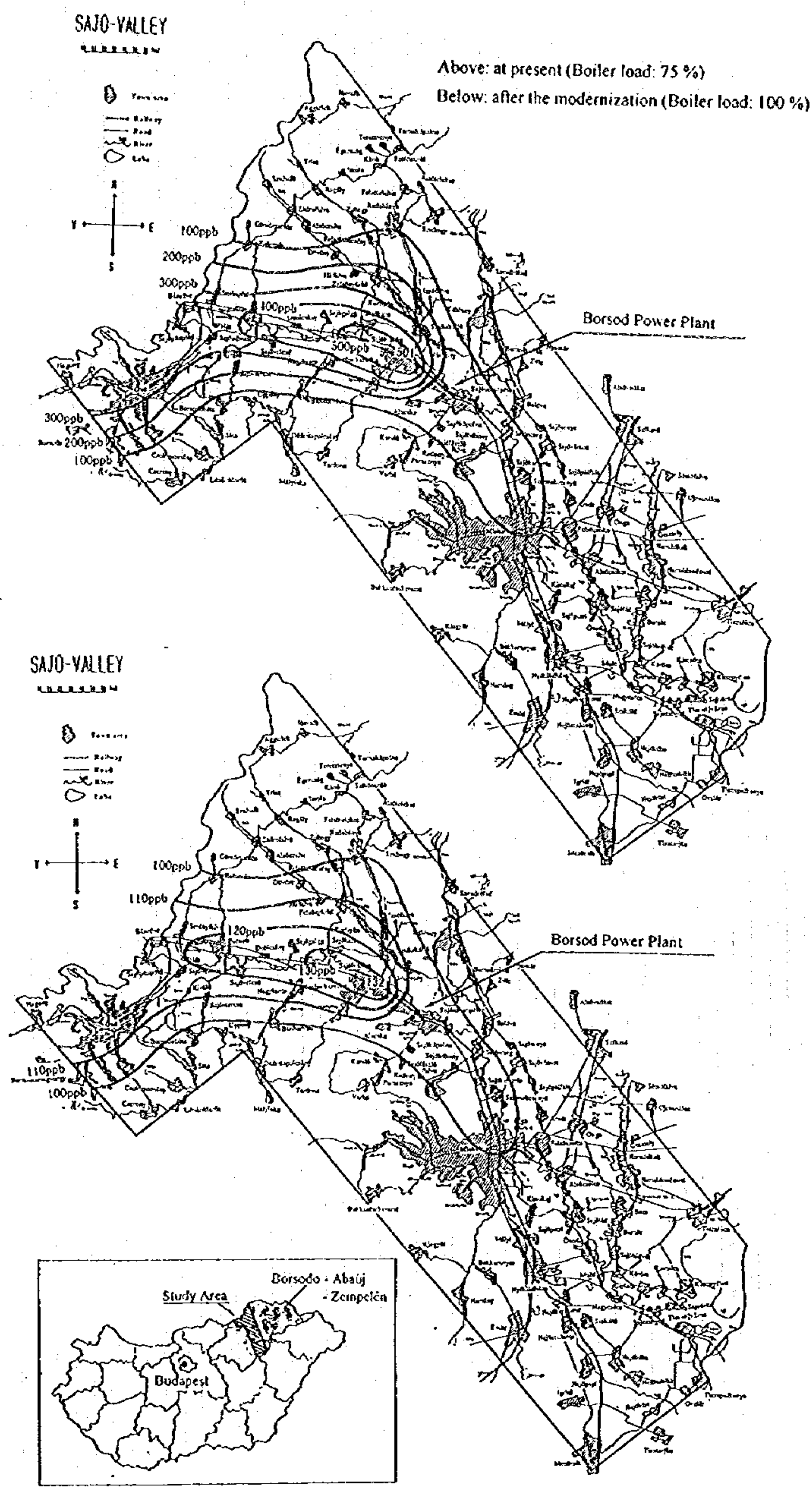


Figure 6.5.4 Isopleth for SO_2 at Stagnant Weather Condition by All Types of Sources

The weather condition on the ground level at this occasion was with 0.9m/s ESE wind. A high concentration of SO_2 (0.5ppm) was detected at 5-6 km from Borsod Power Plant, but the highest concentration is estimated to be about 0.6 ppm. The operating condition of Borsod Power Plant at this occasion was that four 100t/h boilers, No.5, 6, 7 and 8, were operated at 70-80% load. The background concentration is estimated around 100ppb.

Assuming 100% load operations for the newly installed boiler and the existing boilers using natural gas as fuel, the predictive calculation is made based on the same conditions as in the above occasion. The result is shown in Figure 6.5.4 (bottom).

In the case that proposed measures are implemented, Air Quality Environmental Standard II for SO_2 0.40mg/m^3 (150ppb) applicable to factory areas is satisfied, but the Standard I 0.25mg/m^3 (94ppb) applicable to residential areas is already exceeded by the background concentration. The contribution by Borsod Power Plant is maximum 32ppb with the newly installed stack height of 130m, and 35ppb even with the stack height of 125m, which is much lower than the present level. Therefore, it is necessary to control other sources.

According to the plan of the local gas supply company covering the whole study area, fuel conversion to natural gas is in progress and users are expected to increase to 154,445 in 2001 from 138,192 in 1996. Regarding stationary sources, North Hungarian Environmental Agency (EKF) is expected to have a stricter control over emissions. As environmental protection measures are sufficiently implemented by Borsod Power Plant, it will be possible to meet the SO_2 Standard I in the near future even under a specific weather conditions such as stagnation.

(2) Ground water

Ground water contaminations mainly by ions are observed in the study area. Pollution control measures should be taken to prevent further contamination by the Borsod Power Plant. Even if contamination by the power plant is prevented thoroughly by proposed measures, it will take forty years for ground water quality to meet drinking water standards. For the improvement of the groundwater quality, pollution control measures should be applied to other pollution sources such as the waste storage of Borsodchem Co. The followings are the summary of EIA.

1) The groundwater flow is 2,350 m^3/d which is only about 1/ 1000 of that of River Sajo.

2) The horizontal velocity of groundwater flow is only 0.42 m/day and it takes about 40 years for pollutants from the salt water evaporating plant at Borsodchem Co. to reach Borsodszirak I/A water service source.

3) Table 6.5.2 shows that estimated total contaminants discharged from Borsod power plant in the past, present and future average concentration of contaminants in the study area by simulation calculation and analysis of samples taken from the sites. For the simulation calculation of the contaminants concentration after 50 years, the following assumptions are used:

- Groundwater contamination by Borsod Power Plant is thoroughly prevented with pollution control measures such as impermeable sheets etc.
- Groundwater contamination from other sources besides Borsod Power Plant remains in the same level.

Table 6.5.2 Prediction Calculation of Groundwater Quality

Parameter	Total Pollutant Discharged (ton)	Background level (mg/l)	Average concentration concentration (mg/l)		
			Corrected calculation	Analysis result	Prediction (after 50 yrs)
SO_4^{2-}	35,180	92	541	559	110
Cl^-	16,000	26	246	310	90
Na^+	9,200	52	142	178	88
Ca^{2+}	11,020	94	170	170	94
As	-	<0.0006	-	0.018	<0.0006

Simulation results are calibrated using the analysis result of Ca^{2+} concentration which is regarded mainly from Borsod Power Plant. The simulation result for future average concentration shows that concentration of contaminants will go down to the background level if contamination from Borsodchem Co., which is main contamination source of Cl^-, and other sources take necessary pollution control measures.

4) Drinking water standards (MSZ 450/1-1989) regarding chemical parameters are shown in the table below. If necessary groundwater pollution control measures are taken by Borsod Power Plant and Borsodchem Co., groundwater quality in Borsodszirak I/A would satisfy the drinking water standards.

Parameter	Qualified value	Permissible limit
SO_4^{2-}	200	300
Cl^-	80	100
Na^+	200	--
As	--	0.05

5) Measures to drinking water sources in Borsodszirak I/A and I

The following two measures are considered.

a) Pollution control measures for polluters (passive measures)
b) Direct measures for ground water clean-up (positive measures)

As show in the above result of ground water simulation calculation, about 50 years are required for ground water quality to meet drinking water standards by the above a). In case that ground water demand for drinking water is increased, use of Borsodszirak I/A should be resumed. Even though bad quality water from Borsodszirak I/A is mixed with water from source I, water quality would be degraded.

By the above b) measures, surface water from Bodva river will be used to recharge ground water and improve the quality of ground water immediately. For the source I/A, Bodva river water is to be injected and stored in aquifer. For the source I, the present ground water recharge facility is to be expanded with Bodva river water. Until the ground water quality is improved sufficiently to meet drinking water standard, b) measures are recommended.

(3) Soil

1) Proposed measures

Considering the soil contamination by Borsod Power Plant, control measures are divided into the following four.

(a) Removal of dust in the flue gas (As etc.)
(b) Prevention of coal ash from flying in sludge storage areas (As etc.)
(c) Prevention of acid/alkali waste liquid from permeating into soil (ions)
(d) Soil, water and air pollution control during construction.

Possible measures are as follows.

(a) Improvement of flue gas dust collection efficiency
(b) Soil cover, planting and other preventive measures for flying coal ash
(c) Thick sludge system and solidification of coal ash
(d) Conversion of existing boiler fuel to natural gas free from dust (As etc.)
(e) Stopping waste acid/alkali liquids used for ion exchange resins to flow in the waste reservoir
(f) Implementation of pollution control measures during construction

As soil pollution often leads to groundwater contamination, some of the above measures are related to groundwater pollution control measures.

2) Evaluation of environmental impact

The environmental protection goal is to meet the Hungary environmental standards on soil and groundwater. Minimization of environmental impact by Borsod Power Plant is possible by implementing the above proposed measures 1). Any further soil contamination is prevented by these measures and natural purifying process will enable gradual recovery of polluted areas in the future.

(4) Vegetation

Proposed environmental protection measures can alleviate the environmental impact on vegetation to gain the following objectives.

(a) Maintenance and improvement of remaining semi-natural vegetation
(b) Recovery of lost vegetation

For vegetation protection in the future, positive environment creation is necessary as well as pollution control measures.

Proposed protection measures are as follows.

(a) Measures to meet the new discharge standards to be enforced on Jan. 1, 2005

(b) Prevention of warm wastewater discharge by a closed cooling water circulation system

(c) Use of thick sludge system for coal ash and impermeable sheet system for waste storage

(d) Creation of better environment with soil cover and planting for the abandoned sludge storage areas

(e) Construction of wet land between Holt-Szuha river and sludge storage area to creating a semi-natural environment.

(f) Appropriate disposal and treatment of wastes from construction works of Borsod Power Plant.

6.6 Environmental Protection Measures

(1) Environmental Protection Measures

Environmental protection measures for major items are shown in Table 6.6.1.

Table 6.6.1 Environmental Protection Measures for Major Items

Item		Measures	
Air	SO_2, NOx	Combustion facility	Fluidized bed boiler, Reduction of SO_2 by desulfurization in combustion chamber and control of generation of NOx by the firing characteristics. Various types of BFBC, CFBC, HFBC, ICFB, PFBC, etc.
	SO_2	FGD	Semi-dry type of GSA and spray dryer, and wet type of limestone-gypsum process.
	NOx	Denitrizer	SCR method is in common use at coal-fired power plant.
	SO_2, NOx	Conversion to NG	No SO_2 generation. Low-NOx burner and EGR as measures against NOx.
	Dust	EP	Dry type EP is generally installed at coal-fired power plant.
	Downwash	Higher stack, increase in effluent velocity and modification of shape of stack. It is possible to predict the concentration caused by downwash with GEP of EPA in USA.	
Water	Intake, discharge, thermal effluent	Installation of closed system cooling tower, bottom water intake, application of curtain wall, condensate by-passing, and discharging effluent in the water.	
	Waste water	Integrated waste water treatment facility for plant waste water, purifying tank for domestic sewage, and physical and chemical treatment for leachate from ash dumping area.	
Soil Ground water	Combustion residue	Thick sludge technology	System to transport sludge at the mixing ratio of water less than 1 and mitigate groundwater pollution by decreasing leachate from ash dumping area.
		Impermeable sheet	Method to construct water intercepting basin with impermeable sheet and contain the polluted soil in the basin. This construction method is for general waste.
		Vertical sealing works	Method to construct water intercepting basin with steel sheet pile/clay and ground continuous concrete wall/impermeable sheet and contain the polluted soil in the basin. This construction method is for general waste.
		Sealed concrete reservoir	Method to contain the polluted soil in the concrete reservoir. This construction method is for the waste containing harmful substances such as Cd, Pb, Cr^{6+}, As, CN, PCB, etc.
	Existing soil and groundwater pollution	Method to remove pollutant by pumping polluted groundwater or soil excavating.	
		Method to prevent polluted groundwater from dispersing by installing impermeable wall.	
	Dispersion of pollutant	Soil coverage, planting, water sprinkling, coverage with waterproof sheet, wind break netting, etc.	
	Others	Selling to recycling dealer. Harmful substances should be treated by proper dealer with permission.	

(2) Evaluation of Environmental Protection Measures

1) Air pollution control measures

The CFB technology will be adopted for the new unit as a measure to control emissions of SO_2 and NOx. Concentrations of SO_2 and NOx to be emitted will be 400 mg/Nm^3 and 200 mg/Nm^3, respectively, and satisfy the emission standards to be introduced in 2005 Height of the stack will be 130 m as a measure against downwash.

The air pollution control measure for the existing units against SO_2 and NOx is the change of fuel from coal to natural gas. No SO_2 will be generated and the concentration of NOx will be 200 mg/Nm^3. Accordingly, the emission standards to be introduced in 2005 will be satisfied.

2) Water quality protection measures

The operation of the new unit in the condensing mode requires the cooling facility. As measures against changes in flowrate and water level and increase of water temperature due to thermal effluent, the cooling tower of the closed system which enables to recycle the water will be adopted, thus mitigating impacts on Sajó River.

Oil in wastewater discharged from storages of turbine and transformer oil, garages, and car washes is being collected by oil trap pits before the wastewater is discharged to the stormwater drainage system. But the capacity of the oil trap pits should be expanded.

Overflow from the sludge storage area should be prevented from entering rivers by laying impermeable sheets at the bottom of the sludge storage area.

3) Measures against wastes, soil pollution and groundwater pollution

i) Measures against sludge overflow and leachate

In the present thick sludge system tested in the Power Plant for transport of ash from PCF, the mixing ratio of ash and water widely fluctuates between 1:1.5 and 1:24. The composition of ash differs between PCF and CFBC. Therefore, situations of transport and solidification of sludge, and behavior of water in sludge differ between PCF and CFBC ashes. Accordingly, in addition to the thick sludge transport technology, impermeable sheet should be laid at the bottom of the sludge storage area in order to intercept the overflow completely and prevent groundwater pollution. Overflow should be collected into drain pipes on the sheet and recycle it as sludge transport water, utilizing the existing piping from sludge storage area to Borsod Power Plant.

ii) Treatment of waste acid and waste alkali

At present, the waste acid and waste alkali produced in the regenerating process of ion exchange resin used for treating the boiler feed water are disposed at the dumping area. Due to the salts produced by neutralization, groundwater pollution is observed. Borsod Power Plant is also examining the possibility of using acid and alkali wastewaters as the transport water for thick sludge in the future. However, if the pH value is acidic or alkaline due to imperfect neutralization, the harmful substances such as heavy metals contained in the sludge may elute with high possibility. Therefore, waste acid and waste alkali should be neutralized and diluted in the neutralizing basin, and discharged to Sajó River in proportion to the river flowrate so as to satisfy the applicable standards.

iii) Prevention of ash scattering from filled-up sludge storage areas

At the time when the sludge storage area and coal washing sludge areas are filled up to its maximum capacity, soil coverage or planting should be applied to prevent ash scattering.

iv) Measures for increased demand for water supply

There are two sources for water supply, Borsodszirak I and Borsodszirak I/A downstream of the groundwater flow from the sludge storage area. Among these two sources, I/A is out of use at present due to the decreased demand and the deteriorated quality of water. The source I intakes the water from Bodva River into the reservoir and furnishes almost all of the water supply through a series of treatment of ground infiltration, pumping and sand filtration. Accordingly, if the demand for water supply is increased in the future, it is desirable to enlarge the present intake and treatment capacity of the source I.

v) Other wastes

Besides the wastes mentioned above, wastes discharged from Borsod Power Plant include sludge, used ion exchange resins, oil drains, oily materials, waste oil and polluted filter media. At present, these wastes are sorted and stored in a concrete-floored building enclosed by wire netting. The waste oil is stored in vessels. Then, the wastes are taken over by licensed contractors for recycle or disposal. For hazardous wastes, licensed contractors will transport, treat, and dispose. It is considered that these contractors will be able to receive all the wastes produced in the Plant even after the operation of new CFB unit is started.

Non-hazardous wastes that will be produced during the construction period include construction rubble, piping scraps, and metal wastes such as iron and copper. Reusable metal wastes, and construction rubble and excavated soil that can be used for the landfill can be sold to the licensed contractors.

6.7 Environmental Monitoring Plan

(1) Environmental Monitoring during Construction

The following monitoring will be done conforming the present regulations and criteria in order to minimize the environmental impact of construction.

- Proper treatment of produced waste by construction works
- Preventing asbestos from scattering during the demolition of existing buildings
- Controlling noise and vibration arising from construction equipment, heavy machinery and vehicles
- Preventing excavated soil from polluting rivers especially during rain
- Preventing secondary pollution by excavated polluted soil

(2) Environmental Monitoring after Plant Commissioning

The study team propose a monitoring program for the following items after plant commissioning in order to secure earliest discovery of pollution or contamination and to take necessary countermeasures. When coal is transported partly by trucks, road transport will be monitored.

1) Flue gas monitoring (using proposed stations)

Continuous monitoring of SO_2, NOx, CO, dust, wind direction and wind velocity

2) Ambient air monitoring (using existing stations)

Continuous monitoring of SO_2, NOx, CO, dust, wind direction and wind velocity

Equipment for existing continuous monitoring stations, J-2, J-3, EC-2, EC-3 and JM-1 near Borsod Power Plant should be rehabilitated and improved.

3) Construction of continuous monitoring network for emission and ambient air quality by combining the above 1) and 2)

At present, the sources and environment are under the separate controls of two administrative bodies, EKF and ANTSZ. The study team proposes to unify these two bodies for efficient monitoring.

4) Ground water monitoring

Regularly sampled water will be analyzed and assessed for contaminants.

5) Regular monitoring of other items including effluent, noise and amount of traffic

Chapter 7

Project Implementation Plan

Chapter 7 Project Implementation Plan

7.1 Basic Considerations for Contracting Method

As there is a time limit for the project period, the construction of the new 150 MW unit and the renovation of the existing facilities are assumed ot be contracted separately as a turn-key basis. It is also assumed that the owner will have a technical and administration assistance from consulting firms. As civil and architectural works precede the other works and are to be contracted to local Hungarian companies, these works are separated from the above turn-key contracts.

The project is divided into the following four(4) parts which will be contracted separately.

a) Civil/architectural works for the new 150 MW unit

b) Equipment provision and installation works for the new 150 MW unit (turn-key basis including test-runs)

c) Civil/architectural works for the renovation of the existing facilities

d) Equipment provision and installation works for the renovation of the existing facilities (turn-key basis including test-runs)

7.2 Construction Schedule

The followings are special considerations for construction schedule.

- Power plant construction approval (the new 150 MW unit)
- Funding arrangement
- Basic/detailed design and preparation of tender documents
- Period between tender opening and contract
- Civil engineering design based on actual equipment weights
- Drawings submitted by contractors and their approval by the owner
- Construction supervision and safety management
- Individual equipment test-runs and system and/or equipment adjustments

(1) Construction Schedule for the New 150 MW Unit (Table 7.2.1)

Construction schedule for the new 150 MW unit is separated into the following three phases.

1) Preparation phase (items 1, 2, 3, 4 of the " Time Schedule")

2) Erection phase (items 5 ~ 19 of the " Time Schedule")

3) Operational tests, test run, commercial operation (items 20 ~ 22 of the " Time Schedule")

(2) Construction Schedule for Renovation of the Existing Facilities (Table 7.2.2)

Replacement works of four boilers will be done one by one to minimize the influence on the operation of the existing power plant.

Table 7.2.1 Time Schedule for Construction of the New 150 MW Plant

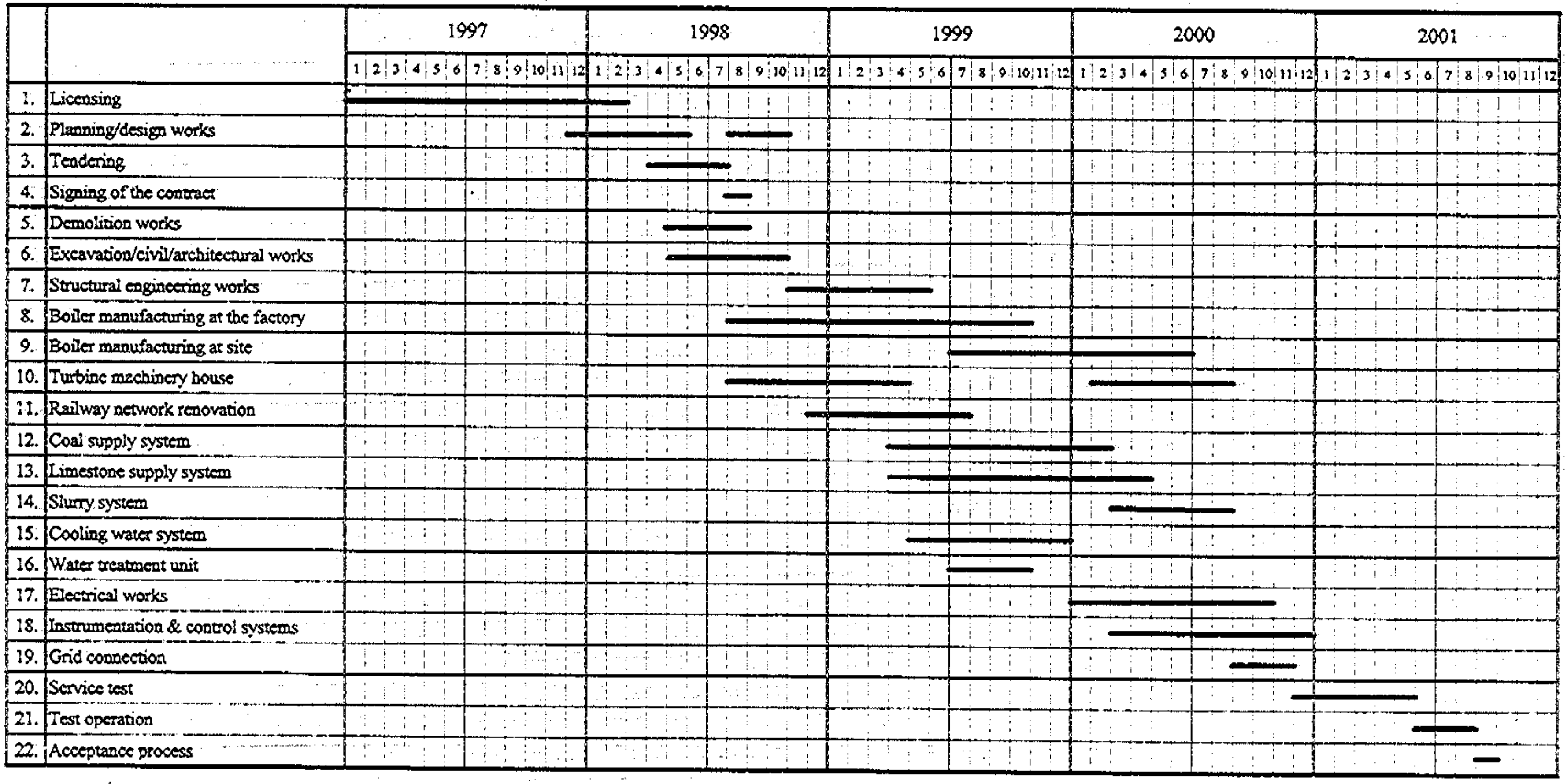
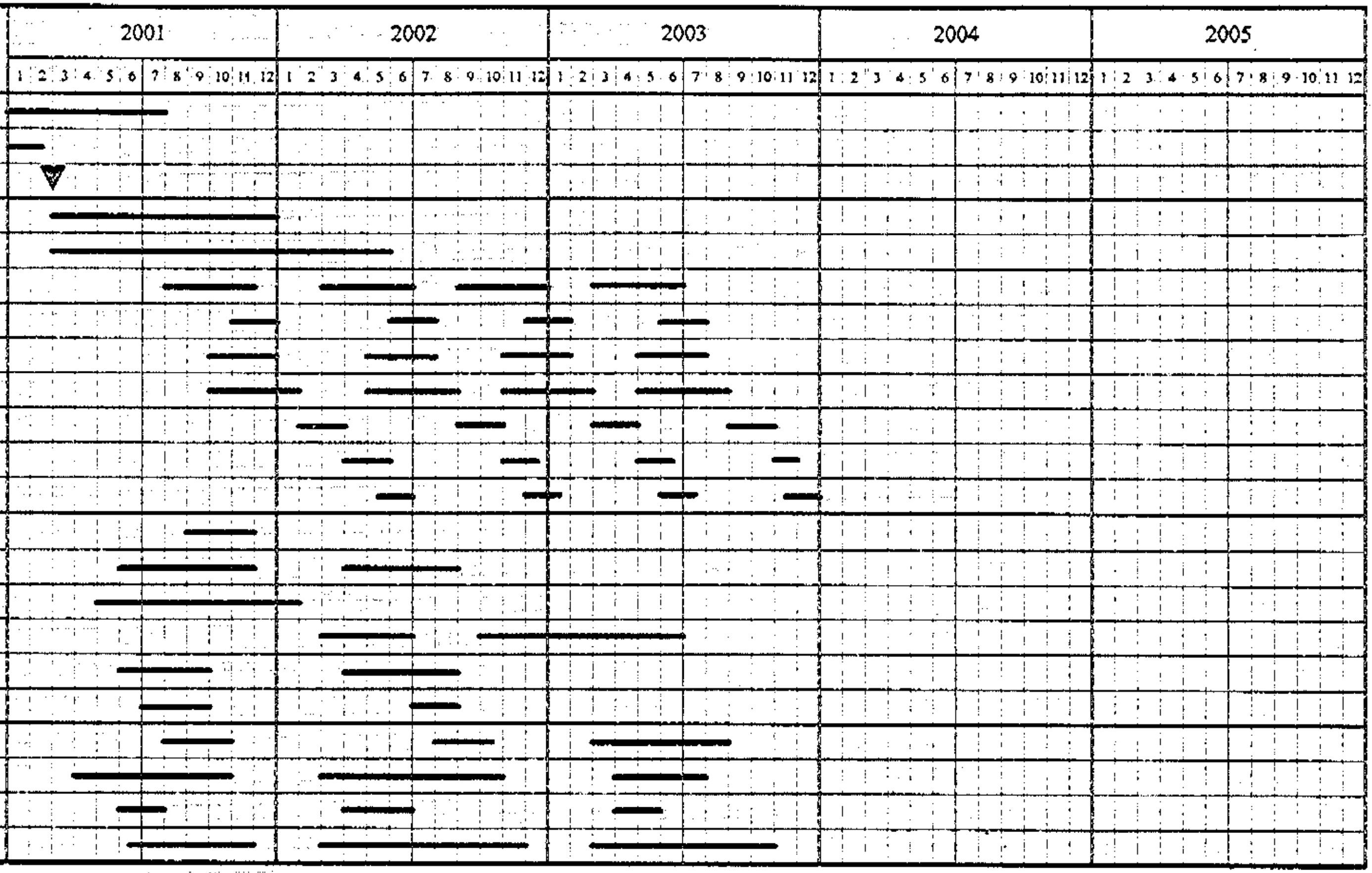


Table 7.2.2 Time Schedule for Renovation of Existing Facilities

1	Design
2	Tendering
3	Signing of the contract
4	Demolition/civil/architectural works
5	Boiler manufacturing at the factory
6	Boiler manufacturing at site
7	Isolation and refractory lining
8	Electrical works
9	Instrumentation & control systems
10	Commissioning
11	Test operation
12	Acceptance test
13	Duct works No.7 boiler
14	Gas supply system
15	Oil supply system
16	Turbine and auxiliaries
17	Water treatment and chemical dosing
18	Cooling water system
19	Grid connection
20	Mechanical works
21	Switch yard
22	Miscellaneous



Chapter 8

Project Cost

Chapter 8 Project Cost

8.1 Basic Approach for Project Cost Estimation

(1) Assumptions

As studied in section 7, full turn key contracts for both the new 150 MW plant and the renewal of the existing plant are assumed. Consulting fees for technical and administrative support are to be included in the estimate.

There are two funding options for the project, which are by own resources and by loans. As the power plant operation has been privatized, it is difficult to obtain loans from World Bank, OECF etc. which normally have lower interest rates but also several restrictions for funding. Therefore, for this study, it is assumed that the project will be funded by the loans with a little restrictions such as untied loan from Japan Export Import Bank.

(2) Cost Estimation Criteria

The following criteria were used to prepare project cost estimates.

1) Market prices in 1993 surveyed in the EGI F/S study was used as the base prices.

2) The prices of equipment to be imported were adjusted by assuming a 3%/year inflation rate on the US dollar basis up to 1997.

3) The changes in the HUF/USD exchange rate between 1993 and 1997 were taken into consideration. The exchange rate applied for 1997 is 161.06 HUF/USD.

4) For items such as the limestone plant that were not included in the EGI F/S study, market prices in 1997 were surveyed.

5) For costs of the civil works, a price increase factor of 2.078 between 1993 and 1997 was used.

6) For costs of mechanical installation works, a price increase factor of 1.8635 between 1993 and 1997 was used.

7) The cost estimate table was prepared in compliance with the authorized format used in the Hungarian power industry.

8 % of direct costs for the new 150 MW plant and 10 % of direct costs for the renovation of the existing facilities were reserved for contingencies (technical reserve).

The consulting fees will vary widely depending on the scope of works and the duration which will be decided by the owner. Therefore, these were calculated as 6.5% of the direct construction cost conforming the standard estimation methods in Hungry.

8.2 Project Cost

Construction costs for the proposed project (CFBC type) for the new 150 MW unit and the renovation of the existing facilities are shown in Tables 8.2.1 and 8.2.2, respectively.

Table 8.2.1 Construction Cost for the New 150 MW Unit (Proposed Project)

Price level 1997
Currency MHUF

	Designation	Civil work	Local	Import	Custom duty	Erection	Other	Total capital	Other develop-ment cost	Total invest-ment
01	Design						1140.00	1140.00		1140.00
02	Site preparation	91.00	31.00					122.00		122.00
03	Leveling	9.60						9.60		9.60
04	Roads	29.50						29.50		29.50
05	Railway siding	58.60	17.80	10.00	0.90	31.00		118.30		118.30
06	Fence	14.50						14.50		14.50
08	Demolition	31.20	19.50					50.70		50.70
91	Main-building	535.00						535.00		535.00
92	Chimney (reconstruction)	290.00						290.00		290.00
93	Boiler and furnace installation	93.50		5591.00	671.00	1081.00	151.80	7588.30		7588.30
94	Steam turbine	145.80	1752.00					1897.80		1897.80
95	Alternator and Block-transformer	139.20	364.30			8.40		511.90		511.90
96	Feed system		168.50	964.50	84.30	326.50	48.00	1591.80		1591.80
97	Cranes (Main-building) reconstruction		95.00					95.00		95.00
98	Electrical equipment (Main-building)		524.60	509.60		177.80		1212.00		1212.00
99	Control system		233.60	735.70	79.40	270.10	19.40	1338.20		1338.20
100	Fuel transport, storing	372.00	532.00	79.70	6.70	184.00		1174.40		1174.40
101	Limestone handling	235.00	212.00	30.80	2.20	72.80		552.80		552.80
11	Slag and ash removal	10.00	170.00			76.80		256.80		256.80
12	Cooling water system	155.40	342.60	102.30	11.20	113.00		724.50		724.50
13	Water treatment system	59.50	320.50	50.30	5.60	87.50		523.40		523.40
14	Outdoor switch gear	23.80	33.70			6.40		63.90		63.90
15	Workshop (reconstruction)	24.50	39.10					63.60		63.60
16	Offices	11.00						11.00		11.00
18	Life and property defense	5.00	19.80	4.80	0.50	7.90		38.00		38.00
19	Environmental protection	35.30	47.60					82.90		82.90
20	Area light	19.00						19.00		19.00
21	Fire fighting systems	26.00	45.70	8.00	0.70	14.00		94.40		94.40
22	Technology and installation piping	71.50	11.20					82.70		82.70
23	Canalization	81.40						81.40		81.40
25	Laboratory		13.00					13.00		13.00
26	Costs of Investor's services and trial run						500.00	500.00		500.00
27	Costs of P.P. Company during commissioning							0.00		0.00
28	Administrative costs of Investment and bank charges							0.00		0.00
29	Traffic and transport equipment		21.00					21.00		21.00
30	Telecommunication and fire alarm system	47.70	176.00	36.20	4.20	55.00		319.10		319.10
32	Means of organization on site	64.40	176.80					241.20		241.20
33	Miscellaneous cost	80.00				22.80		102.80		102.80
34	Expenses of not installed equipment		160.00	197.00	18.00			375.00		375.00
35	Expenses for acceleration of the Investment							0.00		0.00
36	Technical reserve (contingency)						1700.00	1700.00		1700.00
	01-36 Subtotal:	2759.40	5527.30	8319.90	884.70	2535.00	3559.20	23585.50		23585.50
	Connected Costs: Electrical connection									
	Connected Costs: Gas connection									
	Total cost Investment									
	Engineering fee (6,5 %)	100.00	450.00	350.00	10.00	523.00	100.00	1533.00		1533.00
	Total	2859.40	5977.30	8669.90	694.70	3058.00	3659.20	25118.50	0.00	25118.50

Table 8.2.2 Construction Cost for Renovation of the Existing Facilities (Proposed Project)

Price level: 1997
Currency : MHUF

	Designation	Civil work	Local	Import	Custom duty	Erection	Other	Total capital	Other develop-ment cost	Total invest-ment
01	Design						310.00	310.00		310.00
02	Site preparation	15.00	5.00					20.00		20.00
03	Leveling	6.00						6.00		6.00
04	Roads	6.00						6.00		6.00
05	Railway siding							0.00		0.00
06	Fence							0.00		0.00
07	Stores(reconstruction)	2.00	2.00				10.00	14.00		14.00
08	Demolition	30.00	20.00					50.00		50.00
91	Main-building	1124.00						1124.00		1124.00
92	Chimney (reconstruction)	12.00						12.00		12.00
93	Boiler and furnace installation	20.00	516.50	180.00	21.60	137.00	40.00	915.10		915.10
94	Steam turbine	92.00	910.00	100.00	12.00	196.00		1310.00		1310.00
95	Alternator and Block-transformer							0.00		0.00
96	Feed system		15.50	50.00	4.50	10.00		80.00		80.00
97	Cranes (Main-building) reconstruction							0.00		0.00
98	Electrical equipment (Main-building)		195.00	200.00	18.00	67.00		480.00		480.00
99	Control system		42.00	300.00	18.00	90.00		450.00		450.00
100	Fuel transport, storing	120.00	253.00	60.00	5.00	82.00		520.00		520.00
101	Limestone handling							0.00		0.00
11	Slag and ash removal							0.00		0.00
12	Cooling water system	30.00	60.00	10.00	1.00	9.00		110.00		110.00
13	Water treatment system	40.00	224.50	50.00	5.50	70.00		390.00		390.00
14	Outdoor switch gear	40.00	60.00	10.00	1.00	24.00		135.00		135.00
15	Workshop (reconstruction)	5.00	15.00					20.00		20.00
16	Offices	10.00						10.00		10.00
18	Life and property defense	2.00	2.00	3.00	0.30	0.70		8.00		8.00
19	Environmental protection	6.00	10.00	20.00	3.00	1.00		40.00		40.00
20	Area light	5.00						5.00		5.00
21	Fire fighting systems		3.00	8.00	1.00	3.00		15.00		15.00
22	Technology and installation piping		40.00	100.00	12.00	8.00		160.00		160.00
23	Canalization							0.00		0.00
25	Laboratory		15.00					15.00		15.00
26	Costs of Investor's services and trial run						40.00	40.00		40.00
27	Costs of P.P. Company during commissioning							0.00		0.00
28	Administrative costs of Investment and bank charges							0.00		0.00
29	Traffic and transport equipment		10.00					10.00		10.00
30	Telecommunication and fire alarm system	10.00	30.00					40.00		40.00
32	Means of organization on site	10.00	35.00			15.00		60.00		60.00
33	Miscellaneous cost							0.00		0.00
34	Expenses of not installed equipment		7.00	30.00	3.00			40.00		40.00
35	Expenses for acceleration of the Investment							0.00		0.00
36	Technical reserve (contingency)						686.00	686.00		686.00
	01-36 Subtotal:	1585.00	2470.50	1121.00	105.90	712.70	1085.00	7081.10		7081.10
	Connected Costs: Electrical connection.									
	Connected Costs: Gas connection.									
	Total cost Investment.									
	Engineering fee (6,5 %)							460.27		460.27
	Total							7541.37	0.00	7541.37

Chapter 9

Economic and Financial Analyses

Chapter 9 Economic and Financial Analyses

9.1 Economic Analysis

(1) Construction Cost

The construction costs for the project have been estimated as presented in Chapter 8. These are summarized below. The direct construction cost is calculated by excluding the technical contingency cost and engineering fee from the total project cost. No sunk cost (costom duty) is accounted in the economic evaluation.

Project category		Cost category	Million HUF	Million USD
New Unit	Proposed Project	Total construction cost	24,223.8	150.402
		Direct construction cost	21,000.8	130.391
	Alternative Project	Total construction cost	22,623.3	140.465
		Direct construction cost	19,533.6	121.334
Facility Renovation	Proposed Project	Total construction cost	7,435.5	46.160
		Direct construction cost	6,289.2	39.043
	Alternative Project	Total construction cost	9,835.6	61.068
		Direct construction cost	8,301.2	51.541

(2) Net Present Value (NPV) and Benefit/Cost (B/C) Ratio

Cost and benefit of each year is discounted at 8.0%. This 8.0% is the target profit level, of which MVM assures the power stations by granting the capacity charge, contracted mining charge, energy charge and other revenues. The results are summarized below. They indicate that the proposed projects for both the new unit and the facilities renovation are more advantageous than the alternative projects, and can be judged to be feasible enough.

	NPV(thousand US $)	B/C	EIRR(%)
150MW New Unit	10,337.4	1.03	17.3
Facility Renovation	15,096.7	1.11	NA

(3) Economic Internal Rate of Return (EIRR)

EIRR for the new unit project is 17.3%, which is well over 12.0% of the social rate of discount.

For the facilities renovation project, EIRR is not available by definition since the construction cost and the operation and maintenance cost of the proposed project are less than those of the alternative project.

(4) Sensitivity Analysis

In order to measure the influence of the change of the related factors, such as coal prices and the plant load factor (PLF), sensitivity analyses are carried out as follows:

[New Unit]

	NPV(thousand US $)	EIRR(%)	B/C
10% Construction Cost Up	-8,413.0	3.5	0.98
10% Coal Price Up	9,465.8	16.6	1.02
PLF Down I	6,556.8	14.3	1.02
PLF Down II	8,467.0	15.9	1.02
PLF Up	12,669.8	19.0	1.03

(Note)
Variation of Plant Load Factor (PLF): Base Case = 6,000 hrs/y
PLF Down I = 4,000 hrs/y
PLF Down II = 5,000 hrs/y
PLF Up = 7,200 hrs/y

In the case of 10% construction cost up, the analysis reveals the negative result in all the indices.

With better thermal efficiency of the CFBC boiler, the indices go up along with increase of the fuel cost and the plant load factor.

[Facility Renovation]

	NPV(thousand US $)	B/C
10% Construction Cost Up	9,034.1	1.07
10% Unit Price of Natural Gas Up	9,293.1	1.07
10% Demand Down	11,789.1	1.10

Technical alternatives are limited to only two types of combustion, of which the proposed project with natural gas combustion is definitely advantageous over the alternative project employing pulverized coal combustion with FGD system.

9.2 Financial Analysis

Financial analysis was made for the whole project by integrating the new unit project and the facility renovation project, since their operations are inter-related to each other.

(1) NPV, FIRR, B/C Ratio

Net present value (NPV), financial internal rate of return (FIRR), benefit/cost (B/C) ratio are calculated as follows:

	NPV(thousand US $)	FIRR(%)	B/C
Base Case	185,297.5	17.4	1.37

The FIRR at 17.4% is well over the interest rate (8.2%) applied to the borrowing from the financial institutions and the target profit level which is set currently at 8.0% by MVM. With all the indices, the project is regarded as financially feasible and attractive.

(2) Sensitivity Analysis

The sensitivity of the proposed project is analyzed under the following conditions:

- Construction cost increased by 10%
- Fuel cost increased by 10%
- Both construction cost and fuel cost increased by 10%

The results are summarized as follows:

	NPV(thousand US $)	FIRR(%)	B/C
Construction Cost 10% Up	160,631.6	15.7	1.31
Fuel Cost 10% Up	162,990.5	16.4	1.31
Construction Cost and Fuel Cost 10% Up	138,324.6	14.7	1.25

In addition to the analyses of the sensitivity to cost factors, sensitivity to revenue factors are analyzed. The results are as follows:

	NPV(thousand US $)	FIRR(%)	B/C
Electricity Tariff 10% Down	125,510.4	14.7	1.25
Heat Energy Price 10% Down	176,938.8	17.1	1.36
Electricity Tariff and Heat Energy Price 10% Down	117,151.7	14.3	1.24

FIRR in the case of electricity tariff 10% down is 14.7%, which is the same as that in the case of 10 % up of both the construction cost and fuel cost. This indicates that the project is fairly sensitive to the change of the electricity tariff.

The break-even point of the electricity tariff which balances the revenue and the cost after deduction of interest and depreciation is 10.3 HUF/kWh (0.06 US$/kWh). This is about 70% of 14.93 HUF/kWh (0.09 US$/kWh), the tariff rate applied to estimate the revenue from electricity sales in this analysis. As the revenue from heat energy sales has been and will be quite stable, the project would be financially profitable unless the electricity tariff is reduced by more than 30%. Even in the case that the electricity tariff is reduced by a little more than 20% from the adopted rate, the project could expect 8% return as net operating profit.

Chapter 10

Suggestions for Power Plant Development in Hungary

Chapter 10 Suggestions for Power Plant Development in Hungary

10.1 Coal Combustion Technology in Power Plants

(1) Power Plants Development Plan in Hungary

The electric power demand in Hungary continually decreased during the period from 1989 to 1993 due to the industrial stagnation, but thereafter, it has been on the trend of gradual increase. While the total electric power consumption in 1995 was 36.5 TWh, it is projected to increase to a range of 43.3 - 49.3 TWh in 2010, a considerable increase even with the lowest growth of demand.

On the other hand, thermal power generation facilities, which account for 74 % of the Hungary's present total power generation capacity of about 7,400 MW, are mostly superannuated with decreased efficiency, and are urged to be renewed since they are not able to meet the environmental protection requirements comparable to those of EU countries that are to be effected in 2005.

Through the national energy policy, coal mines in vicinity of power plants have been managerially integrated into the power plants. Therefore, such power plants are obliged to use their own coal thereby contributing also to the regional employment stability, while implementing sufficient environmental protection measures. Borsod Power Plant is one of such power plants.

Under these circumstances, MVM conducted a economic efficiency analysis of the power plant development scheme for the period 1998 - 2010 using the least cost planning (LCP) method. The candidates for type of power generation unit, fuel, and capacity by sites were selected as shown in Table 10.1.1.

The power generation units which were judged to be appropriate for construction as the result of above analysis included 4 cogeneration units and 5 - 6 condensing units of the FBC type with 150 - 155 MW capacity. The new unit for Borsod Power Plant belongs to the former. These units to be built in existing plant sites need to utilize low-quality domestic coal, and satisfy the environmental protection requirements.

Table 10.1.1 Candidates of Power Plant Development

Site	Type of unit		Fuel	Units x MW	Total MW
Existing Plant Sites	1	C. C. + cogeneration unit	natural gas	4 x 100	400
	2	C. C. + condensing unit	natural gas	6 x 225	1,350
	3	FBC + cogeneration unit	coal	4 x 150	600
	4	FBC + condensing unit	coal	6 x 155	960
	5	Gas turbine (peak load)	light fuel oil	6 x 155	930
	6	Oil fired large unit	heavy fuel oil	1 x 550	550
	7	PCF large unit	coal	3 x 350	1,050
	8	Nuclear unit	nuclear	2 x 630	1,260
New Plant Sites	9	Gas turbine with inert gas unit	inert gas	1 x 80	80
	10	Lignite-fired unit	lignite	3 x 450	1,350
	11	PCF unit	coal	3 x 550	1,650
	12	Nuclear unit	nuclear	2 x 630	1,260

Source : The Economic Efficiency Analysis of the Long Term Expansion Strategy of the Hungarian Power System, provided by MVM in March 1996.

The CFBC technology selected by MVM in the previous feasibility study for Borsod Power Plant is a variation of FBC technology, and it has the following advantages from the environmental view point:

1) Since desulfurization agents circulate within the combustion chamber, the agent utilization ratio is high resulting in a high removal efficiency of sulfur in fuel (above 90 %).

2) Because the combustion temperature is low at about 850 ℃, generation of NOx is reduced.

3) The high combustion efficiency results in the reduction of fuel consumption.

Because of above advantages, the CFBC technology has been widely employed in the world including Japan where 11 boilers of 50 - 250 t/h capacities are operated. However, there are only three cases of application of this technology to large-scale power generation boilers of the capacity class at around 460 t/h, which is required in aforementioned FBC power units in Hungary including Borsod Power Plant. These are one in the USA (499 t/h), one in Germany (400 t/h), and one in France (700 t/h).

In the present Study, investigations were made on above three CFBC boilers concerning operational problems and their countermeasures. As a result, the following measures were adopted in application of the CFBC technology in Borsod Power Plant where brown coal having high ash content (35 - 45 %) and sulfur content (above 2 %) is to be used:

1) To reduce the total ash content by mixing the brown coal and imported coal of low ash content

2) To install external heat exchangers (EHE) of appropriate capacity corresponding to the amount of ash produced

3) To install high-accuracy automatic control system for optimization of separation, circulation, and heat recovery of ash

4) To reduce the amount of ash generation by optimizing the amount of limestone addition

With above measures, it is considered that the CFBC technology can be commonly applied to aforementioned 150 MW class units being planned in Hungary, subject to careful study of particular conditions of each power plant including the quality of domestic coal to be used.

As a reference for such study, considerations to be given in the application of the CFBC technology are suggested below based on the investigations of the existing CFBC boilers made in the present Study.

(2) Considerations for Application of the CFB Technology

The Study Team conducted investigations of the large-scale CFB boilers in power plants operated in the world. As mentioned above, there are three power plants using a CFB boiler firing relatively low-quality coal. They are as follows:

1) Goldenberg Power Station (Germany)
2) Texas - New Mexico Thermal Power Plant, TNP-1 (USA)
3) Provence - Gardanne Power Plant (France)

The results of the investigations of CFB boilers in these power plants are described in detail in the Supporting Report.

The CFB boiler at Goldenberg Power Station (400 t/h) is of the EVT type, and those at TNP-1 (499 t/h) and Provence Power Plant (700 t/h) are of the Lurgi type. The largest difference between these two types is that external heat exchangers (EHE) are provided in the later. This chapter focuses on the problems of CFB at TNP-1 and Provence Power Plant with the EHE. The findings from these problems and studies for their solutions can be reflected on planning new CFB boilers in Hungary.

The commission of TNP-1 in U.S.A. was 1991. The operation of the CFB unit in Provence Power Plant started in 1995. During this 4 year period, however, the capacity was increased from 499 to 700 t/h. Findings at TNP-1 were reflected to the CFB unit at Provence Power Plant, reducing number of plant outage during the first year operation. As a result of many improvements made in the CFB design, the capability of the CFB unit has increased to 700 t/h. Based on these examples, the following issues were examined and proposed for planning application of the CFB technology to brown-coal-firing power plants in Hungary.

1) Appropriate loading on the separation and recycle system or EHE system of ash from the combustor

   Reduce loading on separation and recycle system or EHE system of ash from the combustor to a similar level of the CFB unit at the Provence Power Plant that has already been proven. The ash yield of a 150 MW CFB unit should be reduced from 80 t/h (brown coal used by 100 %) to 44 t/h by mixing local brown coal and import coal at a ratio of 1:1 in calorific value.

2) Quality of import coal

   Import coal to be mixed must be of high quality with a calorific value of 25 MJ/kg or more, and 0.8-1.0% of sulfur content.

3) Limestone feeder

   The findings from frequent failure of limestone feeders in TNP-1 should be reflected to the new CFB boilers.

4) Heat load balance

   Heating loads of the superheating and reheating done in the superheater, the reheater, the ash separator and recycle system or in the EHE system must be well-balanced.

5) Control of ash separator and recycle system or EHE system

To achieve close cooperation between the ash separator, the recycle system, the EHE system, the combustor, and the primary air fan, monitoring and automatic operation control of these components should be done by minutes or seconds using computers.

6) Summary

A new technology develops with the process of solving various problems encountered in attempting scale-ups. It is suggested that the problems and solutions mentioned above be properly fed-back in planning, designing, and operation of CFB boilers considered in Hungary for new coal-fired power units in the existing power stations.

10.2 Environmental Impact Study and Environmental Protection Measures for Thermal Power Plants

The past industrial development in Hungary lacked considerations for environmental protection as in the case of other advanced countries which experienced serious environmental pollution in the past. The industrialization under the socialistic system affected the environment heavily and resulted in the present environmental pollution. In consideration of such circumstances, the following are suggested, proposed, or recommended concerning the development of electric power in Hungary.

Thermal power plants in Hungary have many common problems. Therefore, the following suggestions and recommendations are largely applicable to Borsod Power Plant as well.

(1) Observation of Regulations and Standards

The Hungarian Government intends to enforce new emission standards for air pollutants from 1st January, 2005. In urbanized areas, it may be difficult to observe the ambient air quality standards even in the case power plants take adequate environmental protection measures to meet the emission standards, unless appropriate measures are taken at other sources including residences. The following measures are suggested in order to satisfy environmental standards such as of SO_2. The target year should be set for 2005, or a proper year for each development program.

1) For stationary air pollution sources, guidance and control are strengthened so as to observe the new emission standards.

2) The degree of contribution by coal-fired home heating to air pollution is high. At present, changing the fuel for home heating from coal to naturalgas is in progress. Compared to the amount of coal used during 1992-1993 when the JICA's air pollution control study for the Sajo Valley area was conducted, it may be reduced to a half by 2005. However, to satisfy the environmental standards, further promotion of gasification is required.

3) In many cases, coal fired power plants are located in the neighborhood of industrial zones. In general, there are many waste storage areas, and even illegal dumping sites. For the treatment and disposition of wastes, guidances should be given to observe the environmental protection regulations laid down in various ordinances and to reinforce the control of illegal dumping.

4) Protection of the environment during the construction period and protection of the working environment tend to be neglected. The persons concerned should observe the regulations and standards applicable to the work environment. Supervisory bodies should also give thorough guidances.

(2) Considerations for Environmental Survey

1) General consideration

In Hungary, there are many places with marvelous nature to be protected, including the national parks and the areas designated by international environmental protection treaties. However, in some of industrial zones, urban areas and tourism areas, man-made environmental pollution has become prevalent. In some places, the problem is serious.

Air pollution is significant during heating seasons. In residential areas, home heating is substantially contributing to the pollution. In urban areas, automobile emissions are added, and in the neighborhood of industrial zones, emissions from factories are added. Combined with meteorological conditions that give rise to the formation of ground-level inversion layers, the air pollution becomes serious.

In industrial zones and adjacent areas, there are factories and related residences. Thus, polluters can be also sufferers of pollution.

Another feature is that wastes have to be either landfilled or dumped into rivers except the cases of reuse.

When planning development of power plants in Hungary, it is important to know exactly the present conditions of natural and social environments of the areas which may be affected, based on the understanding of above-mentioned features of Hungary.

2) Considerations in environmental measurements

There are many excellent environmental engineers in Hungary, but the function of data cross-checking is not sufficient. The term " environmental measurement" not only aims to judge whether the environment is conforming to the applicable standards but also aims to examine the background of the measurement results and to analyze them comprehenlysive. In this way, " environmental measurement" forms the foundations for promoting environmental protection.

In the " environmental measurement," the following considerations are required.

a) To establish accurate measurement system

If measurement is inaccurate, the standards themselves become meaningless. Measurements should be done in accordance with the official methods in principle, but suitable application technologies are required depending on the nature of samples.

b) Efforts of analysts to improve accuracy

Analysts tend to maintain that good instruments produce correct results. But any analysis or measurement involves errors. Therefore, it is proposed to establish a system where data are cross-checked between analysts or analytical institutions to confirm their technical levels. If any problem occurs, the cause should be searched, and analysts should attempt to improve techniques constantly. Only with these efforts, it is possible to maximize the benefit of the capacity and characteristics of measuring instruments.

c) Public participation

For improving and protecting the environment, widespread participation and cooperation of local residents, in addition to those of power plants, are indispensable. Also for this purpose, disclosure of data, whether convenient or not for respective parties, is important.

d) Representativity of samples

For setting up sampling spots, it is necessary to consider about what areas are to be represented by the spots. In some cases, sampling errors can be far larger than analytical errors. In addition, simultaneity and continuity of sampling should be taken into consideration.

(3) Environmental Protection Measures at Power Plants

The following measures are recommended in power plants in Hungary for securing environmental protection.

1) For preventing the groundwater pollution by coal ash, various techniques can be considered in power plants, including the thick sludge technique and the impermeable sheet technique, etc. According to the information from power plants, they intend to apply the thick sludge technique only for preventing

groundwater pollution. Even though satisfactory results have been obtained using quality coal with less ash content, it is not guaranteed that similar results can be obtained for domestic coal of low quality. It is unnecessary to take excessive measures for preventing groundwater pollution, but it is necessary to prove in advance that the thick sludge technique is capable of preventing the groundwater pollution. The use of the water treatment plant effluent containing salts is not recommendable at this stage.

2) The recovery of environemtnal degradation requires a large cost and a considerable time in general. For removing the source of trouble in the future, safer and more reliable measures should be taken instead of the measures with insufficient verification.

3) The development of power plants contributes to the regional development. On the other hand, it affects the environment considerably together with other plants and factories. When considering the environment for the future, it is recommended not only to avoid or reduce negative environmental impacts, but also to create semi-natural environments and to consider the landscape. For example, creation of a new environment in place of a environmental resource lost by the development can be also regarded as a positive measure of environmental protection.

4) Hg and As contents in Hungarian coal are high. Compared to imported coal, the content per calorific value is much larger. Most of Hg scatters in a vapour form, and As remaining in ash results in groundwater pollution. This fact, should be taken into consideration for planning environmental protection measures.

5) Consideration for downwash

If emission gas from a stack is subjected to downwash by the influence of buildings, a high concentration of the gas may occur at the ground level near the stack. It is recommended to examine the possibility of and the prevention measures for the downwash when planning construction of a power plant.

(4) Environmental Impact Prediction and Assessment

When developing a power plant, it is necessary to predict and assess impacts on the environment, and provide for measures to avoid or reduce such impacts in relation to the target of the environmental protection.

Various methods are available for predicting and assessing the impacts. It is necessary to adopt methods that enable objective assessment under natural and social conditions of the areas concerned. The same are applicable to the setup of parameters used for prediction models.

There are cases in Hungary where sufficient environmental considerations were not taken for industrial development including power plant construction.

In conducting environmental impact surveys, it is recommended to invite local residents and specialists for participation, as many as possible, to take account of their opinions. This will bring about satisfactory results for both entrepreneurs and local residents in the future.

(5) Environmental Monitoring

In general, the purposes of environmental monitoring include: to judge necessity of emergency measures, to compare the actual data with the applicable environmental standards, to judge the effect of the measures taken, and to utilize the data for management of the environment. For maximizing monitoring functions at power plants in Hungary, the following are recommended.

1) At present, the control of sources and the environmental monitoring are undertaken separately by Regional Environmental Protection Inspectorates and Regional Institutes of National Public Health Services. It is proposed that above two functions be integrated through close cooperation of the two administrative bodies, so that necessary actions can be taken promptly.

2) It is proposed to prepare manuals and draw up programs for the operation and maintenance of measuring instruments.

3) It is proposed to secure the budget for environmental monitoring with high priority.

(6) Environmental Management System in Power Plants

In Hungary, privatization of state-owned enterprises including electric power companies and gas companies has been promoted. In power plants in general, responsible staff is assigned for each field of environment, boilers, power generation and water production, etc.. Recently privatized power plants, such as Borsod Power Plant, seem to have certain confusions in environmental management system. In some cases, the environmental control system is not fully functioning.

As an example for the system, it is suggested to organize an Environmental Management Committee headed by the plant manager or the manager in charge of environment. Under this, subcommittees for fields such as environment, energy saving and disaster prevention may be placed. Each subcommittee proposes implementation of measures within its field in charge. It is desirable that each subcommittee is participated by many sections concerned. The subjects to be dealt with the environmental management committee generally include the following:

1) Protection and improvement of the environment through all activities.
2) Energy sawing, and reduction and control of emissions and wastes
3) Development and application of environmental protection technologies
4) Emergency measures
5) Clarification of the persons in charge and define their responsibility
6) Cooperation with local society
7) Environmental education and enlightenment of employees
8) Regular monitoring of the environment and emission sources

10.3 Possibilities of Financial and Technical Cooperation on the Official Basis

(1) Possibility of Japanese Assistance for the Hungarian Power Sector

Former centrally planned economies including Hungary have been pushing forward the scenario of transition of their economy to market-oriented by reducing the role of public sector on one hand, and introducing private initiatives as much as possible in their economic activities on the other. At the same time, irrespective of economic system and situation, both developed and developing countries, private participation in many economic infrastructure utilizing private funds, and technology and know-how has been actively and progressively pursued recently.

While economic development through private initiatives should be in principle advanced in concerted effort of the government and private sector of each country, Japanese government has selectively extended assistance, when requested by the government and/or private sector of the project country, and when the assistance is considered really contributive and indispensable to the project.

Bilateral Japanese official assistance to Hungary, who is a member of OECD, should be selectively provided, in addition to multilateral assistance provided by international financing institution like EBRD and World Bank. Means and schemes which might be considered possible for Japanese financial assistance and cooperation by institution including Export -Import Bank of Japan are illustrated in Figure 10.3.1.

All parties concerned in Hungarian power sector should review the possible means and schemes of Japanese financial cooperation for consultation with development consultants and institutions.

(2) JICA

Major portion of Japanese bilateral grants is undertaken by the Japan International Cooperation Agency(JICA). JICA's program in environmental sector is summarized as follows:

1) assistance in project formulation by dispatching JICA's own administrative staff, expert and/or preliminary study team;

2) implementation of various development study (ex. master plan, feasibility study, after-care study, inclusive of various recommendations);

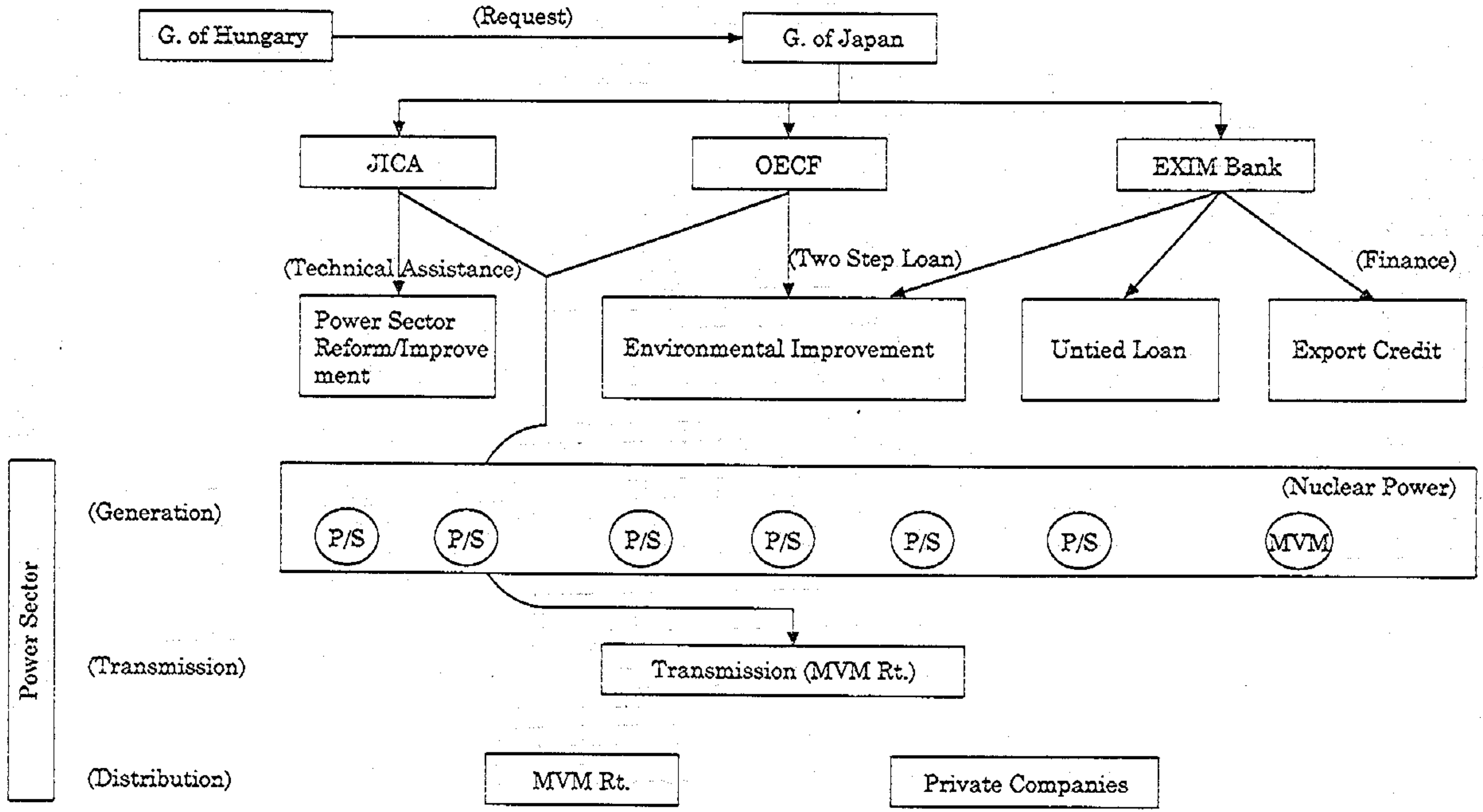


Figure 10.3.1 Possibility of Financial and Technical Assistance of Japanese Government for the Electric Power Sector in Hungary

3) intellectual assistance through transfer of specialized knowledge and technology through various means and occasions;

4) JICA's Expert Dispatch Program aimed at transfer and dissemination of technical knowledge and skills most suited to the needs of the country and the project (aggregated number of people dispatced: 28);

5) training of qualified personnel and future leaders for technical cooperation through various training programs in Japan and in third country (aggregated number of people trained: 527).

(3) OECF Loan

In targeting at environmental protection and improvement, there might be a possibility that an already privatized power station is involved as one of implementing parties or end-borrowers of a sub-project consisting of a comprehensive project which is financially assisted by OECF. Hungarian government's guarantee is a prerequisite for receiving OECF loan since the loan is in principle contracted between the governments of both sides. Terms and conditions of the loan is currently 4.0% as interest, 25 years of loan period with 7 years of grace period. They are periodically reviewed.

In power sector generation appears to have better possibility as a recipient sector of OECF loan than transmission and distribution in environmental protection project. A privatized power station might become an end-borrower of a comprehensive project for improving regional environment which is financially assisted by OECF loan under two-step-loan scheme.

(4) EXIM Japan

The purpose of the activities of the Export-Import Bank of Japan (EXIM) is to facilitate Japan's economic interchange with foreign countries through providing their financial services available. It should be noted that extending financial cooperation toward other countries to help a recipient country promote her economy is included as one of the bank's objectives. Backed by EXIM's financial cooperation a project may be facilitated with less project risks like political risk, and reduced financial cost. Except untied loan program, EXIM's service is usually more conveniently and timely available than OECF loan since the bank does not require a government guarantee for their loans and other services.

In addition to their loan facility, guarantee facility to private financial institutions in Japan are available to private infrastructure project.

Specific EXIM programs available to infrastructure and environmental projects are as follows:

1) Buyer credit to finance the purchase of Japanese goods and services.

2) Overseas investment loan to be extended to Japanese corporation, or foreign government or foreign banks for equity participation in or loans to corporation in which a Japanese corporation has an equity share.

3) Guarantee to private financial institutions in Japan for their financing to foreign entity.

4) Untied loan to be extended to foreign government and institutions for high priority projects and economic restructuring programs in foreign countries on condition of government's guarantee to EXIM.

5) Project finance extended to infrastructure project undertaken by Japanese corporations.

These programs are illustrated in Figure 10.3.2.

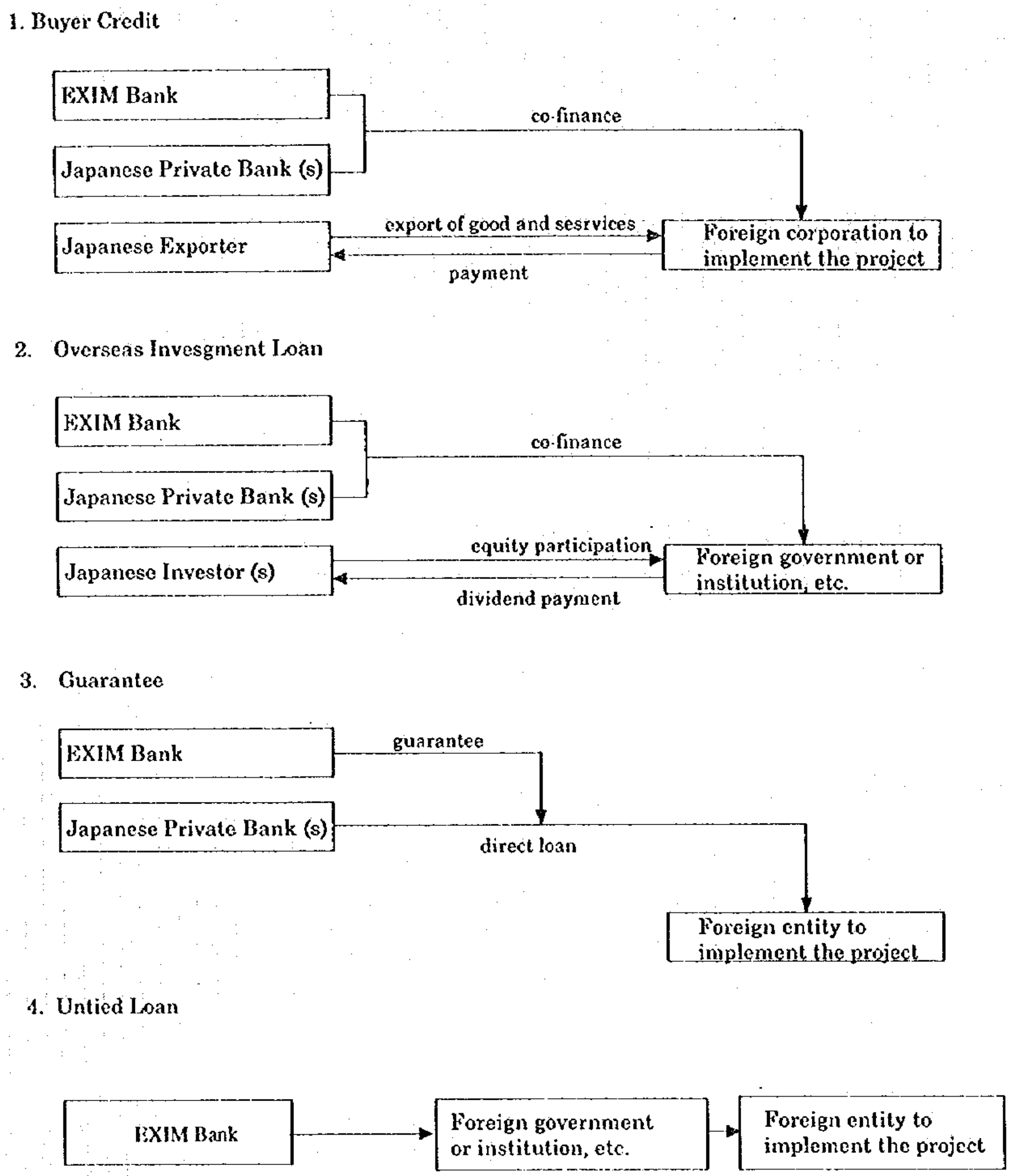


Figure 10.3.2 EXIM Bank's Facilities for Infrastructural Project Implemented by Private Sector