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WASH Field Report No. 409

WATER QUALITY PRE-INVESTMENT STUDIES IN THE SAJO-HERNAD BASIN IN HUNGARY

Prepared for the Europe Bureau,
U.S. Agency for International Development,
under WASH Task No. 420

by

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PREFACE

This basin report describes one of four pre-investment studies WASH has prepared on four river basins tributary to the Danube River: the Yantra basin in Bulgaria, the Sajo-Hernad basin in Hungary, the Arges basin in Romania, and the Hornad basin in Slovakia. The purpose of the studies is to identify wastewater pollution control projects for municipalities and industries within the aforementioned Danube River basins.

The studies were conducted from September 1992 through May 1993 by two teams of three people each. The three members of the team that prepared the Sajo-Hernad and Hornad basin reports are Jim McCullough, team leader and financial specialist; Dave Horsefield, municipal wastewater specialist; and Tarik Pekin, industrial wastewater specialist.

Local support and technical assistance to the WASH team was provided under a WASH subcontract by Innosystems of Budapest. The Hungary study was carried out in coordination with another USAID project, the Local Environmental Management Project. Funding and coordination of the four WASH pre-investment studies were provided by the Europe Bureau of USAID.

The purpose of this report is to summarize the WASH pre-investment studies on the Sajo-Hernad River basin, which include prefeasibility studies to identify water pollution control problems and possible solutions for the Sajo-Hernad aquifer. In cooperation with local and national pollution control officials, the aquifer was identified in the interim basin report as the highest priority site for WASH prefeasibility studies within the Sajo-Hernad basin.

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ACRONYMS

A.I.D.	U.S. Agency for International Development (Washington)
BOD	biochemical oxygen demand
COD	chemical oxygen demand
DO	dissolved oxygen
EBRD	European Bank for Reconstruction and Development
EC PHARE	European Community/Poland-Hungary Aid for Restructuring of Economies
ERV	North Hungarian Regional Water Works Authority
FC	fecal coliform
GPA	groundwater protection area
GOH	Government of Hungary
HH	household
LEM	Local Environmental Management (Project)
MERP	Ministry of Environment and Regional Planning
MOI	Ministry of the Interior
MTTWM	Ministry of Telecommunications, Transport, and Water Management
MWB	Miskolc Water Board
OECD	Organization for Economic Cooperation and Development
OTP	State Bank of Hungary
PPF	project preparation facility
SS	suspended solids
TDS	total dissolved solids
UFW	unaccounted for water
USAID	U.S. Agency for International Development (overseas missions)
WASH	Water and Sanitation for Health (Project)
WHO	World Health Organization

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WWTP	wastewater treatment plant
WS&S	water supply and sanitation

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UNITS

cmd	cubic meters per day
cu m, m^3	cubic meters
cu m/sec	cubic meters per second
dca	decare; 1,000 square meters or 0.1 hectares
g	grams
ha	hectares
HUF	Hungarian forints
kg	kilograms
km	kilometers
L	liters
mg	milligrams
ml	milliliter
rkm	river kilometer
s, sec	second
sq km, km^2	square kilometers
t	metric tons; 1,000 kg

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EXECUTIVE SUMMARY

This pre-investment study was carried out by the Water and Sanitation for Health (WASH) Project under contract to the United States Agency for International Development (USAID) from October 1992 through April 1993. The purpose of the study was to identify high-priority investment projects for wastewater pollution abatement in the Sajo-Hernad River basin as part of the multi-country Danube River Basin Environmental Program. In addition, the study is intended to help accelerate action in the investment program by taking one of the high-priority projects through the prefeasibility analysis stage.

The study was initiated with an intensive analysis of water pollution problems in the Sajo-Hernad basin, using existing data sources. Data were assembled from many sources within Hungary, notably the regional and local water authorities, municipal governments, local and national environmental offices, specialized water research organizations, and national ministries. Analysis of those data led to an identification of potential projects, which the WASH team ranked by priority after close consultation with central and local government officials. The WASH team then carried out a prefeasibility study on the highest-priority project: protecting the groundwater resources of the aquifer lying at the confluence of the Sajo and Hernad rivers.

Summary Analysis

The rapid decline in industrial activity in the Sajo valley and the decrease in agricultural fertilizer application in the Hernad valley has led to generally improved water quality throughout the Sajo-Hernad basin. In-stream water-quality data show dramatic improvements in most parameters. In addition, the decrease in municipal water consumption (due both to lessened economic activity and much higher water tariffs) has lowered demand on municipal water supply and wastewater treatment facilities. A number of problems remain however, especially in terms of threats to drinking water sources. These threats are caused primarily by insufficient municipal sewerage coverage in certain areas, the land application of unstabilized sludge from the Miskolc wastewater treatment plant (WWTP), industrial discharges, the overloaded Szikszo WWTP, and the existence of numerous waste dumps (including solid waste, hazardous waste, sewage lagoons, and sludge deposits) that are poorly monitored. In addition, nonpoint sources from agricultural operations in the area pose potential threats, but these are not yet well documented.

In addition to the physical threats to local groundwater resources are some pressing institutional needs. Water and sewer tariffs throughout Hungary, and especially in the study area, have been raised tremendously during the past four years. This has had the beneficial result of lowering water consumption overall but has also discouraged households from connecting to sewerage networks. Furthermore, tariff rates in the Sajo-Hernad area are now on par with average rates in Europe and the U.S. in absolute terms, meaning the local households are devoting a much larger share of their income to water and sewer services.

Little evidence exists that local water and sewer agencies have instituted management efficiencies or cost control measures to make these services more affordable.

Identification of Priority Projects

On the basis of the assessment of current wastewater pollution problems in the Sajo-Hernad basin, the WASH team identified seven potential projects (see Figure 1). These projects were classified in terms of size and severity of impact, availability of technical solutions, and financial feasibility. In consultation with government officials, further prefeasibility work was targeted to the highest-priority project—protection of the Sajo-Hernad aquifer, which includes Project No. 1, Project No. 7, and elements of Project No. 4 (mainly dealing with the lower third of the Hernad basin).

Proposed Project Rationale

The proposed project is a comprehensive, phased effort to protect the critical groundwater resources of the Sajo-Hernad confluence. The overall project area includes the greater Miskolc metropolitan region an area of approximately 350 square kilometers with a population of almost 300,000 (Miskolc City alone has a population of 200,000). The Sajo-Hernad aquifer contains not only one of the main sources of drinking water for the Miskolc metropolitan population but also a large part of the regional supply system of the North Hungarian Regional Water Works Authority (ERV), which serves an additional 300,000 people. (The basin has a total population of 740,000.) At the center of the project study area is the location of main drinking water wells defined as a groundwater protection area (GPA). Figure 2 provides a map of the study area and the target protection site.

The nature of the threat to the area's key groundwater resources is several-fold:

- A number of unsewered communities lie over and adjacent to the GPA. These communities are experiencing steady population growth even as Miskolc City is losing population.
- The Miskolc wastewater treatment plant discharges inadequately treated sewage into the Sajo as it skirts the GPA. The WWTP requires upgrading, including the completion of secondary treatment facilities now under construction, addition of more secondary treatment capacity to meet the needs of increased sewerage coverage, and upgrading of sludge processing and sludge management facilities.
- The town of Szikszo requires replacement of its poorly functioning wastewater treatment plant and an expansion of sewerage coverage of its unsewered areas.
- Miskolc requires a program to improve industrial pretreatment for industries discharging into the municipal sewer system (both to safeguard the treatment facilities and to permit sludge utilization in agriculture).

- A major brewery adjacent to the GPA will likely require upgrading of its wastewater treatment facilities. Additionally, a nearly abandoned industrial site within the GPA will require some hazardous waste cleanup.
- More than 90 potential sites of groundwater contamination (waste dumps, lagoons, livestock compounds, gravel, and sand pits) have been identified but not analyzed.

Figure 1

Potential Investment Projects

Project No. 1:	Protecting the groundwater resources at the confluence of the Sajo and Hernad rivers.
Project No. 2:	Protecting the Lazberc Reservoir.
Project No. 3:	Protecting the Bodva River as a drinking water source.
Project No. 4:	Reducing nitrate levels in the Hernad River.
Project No. 5:	Protecting water quality in the Sajo basin.
Project No. 6:	Remedying the scattered waste dump sites.
Project No. 7:	Controlling industrial wastewater discharges to the Miskolc municipal sewerage system.

Project Components

The proposed project has been divided into three phases based on priority ranking. Priority phasing has been determined by the severity of the problem being corrected, availability of technical solutions to the problem, and availability of funding to undertake the work. While the overall program could be undertaken as a single package, it is more reasonable to expect that the separate components will likely be undertaken in stages, given the decentralized nature of wastewater responsibilities and financing in Hungary.

Phase 1: Highest Priority

The following activities are most critical and can be undertaken immediately. Technical assistance activities (notably the industrial pretreatment program noted in Component 1.3 below), should be considered high-priority candidates for donor grant funds now being programmed. Miskolc may serve as a model for developing an industrial pretreatment program since the industries located within the city contribute a high proportion of the municipal wastewater.

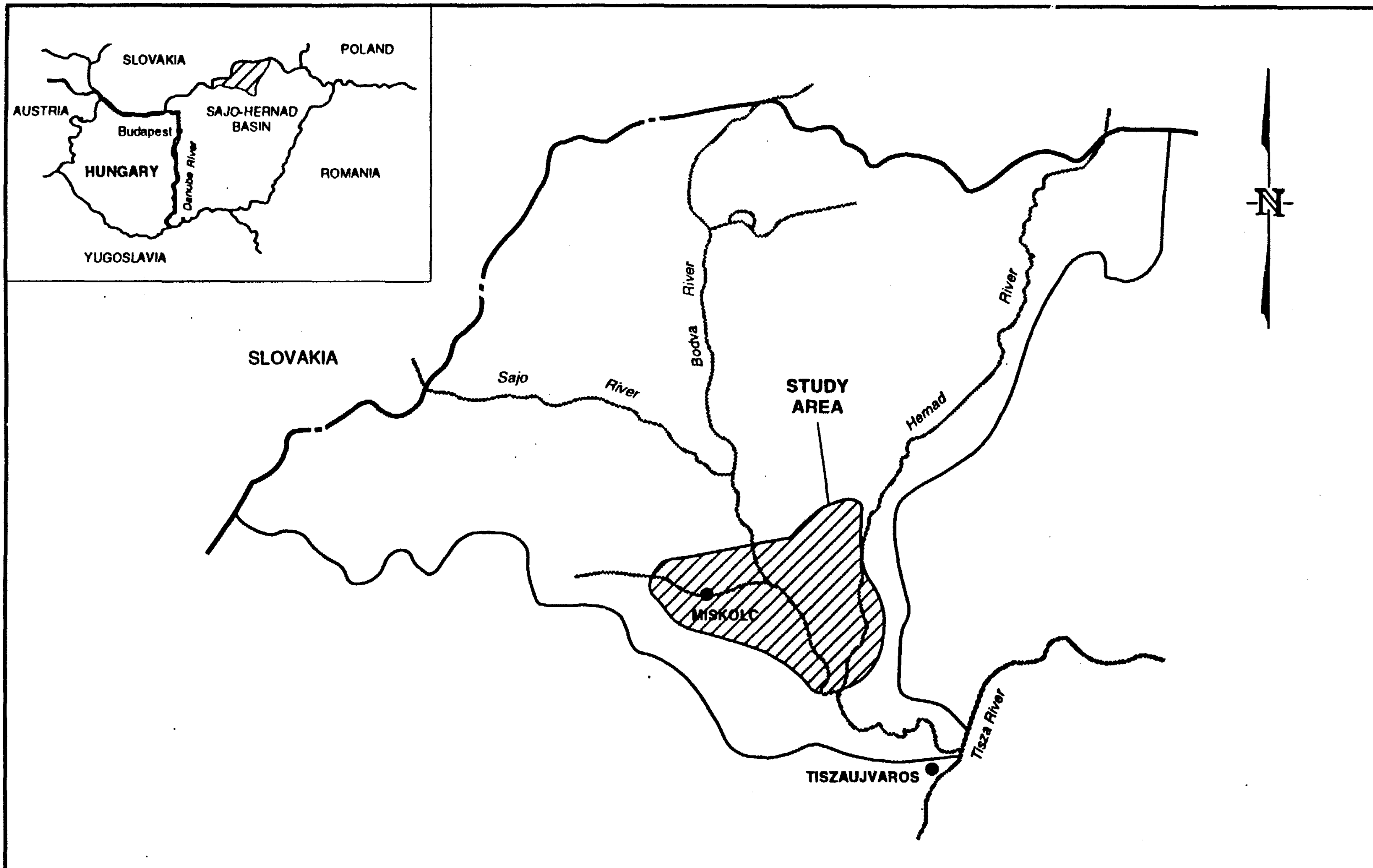

Figure 2

Map of the Sajo-Hernad Basin Study Area

These three components are affordable, assuming the continued availability of existing national grant programs and stable levels of municipal revenue; however, as noted later in this report, municipalities will also need access to long-term credit to finance the project.

Component 1.1: Extend sewerage coverage to 10 unsewered municipalities in and near the groundwater protection target area (including connection to Miskolc wastewater treatment plant).

Component 1.2: Institute a program to identify, remedy, and control groundwater contamination from waste dump sites in the groundwater protection area.

Component 1.3: Institute an industrial pretreatment program for the Miskolc sewerage system.

Phase 2: High Priority

The following activities should be undertaken as soon as financing arrangements can be secured. Technical assistance activities (notably the improvements to operating efficiencies cited in Component 2.2 below), should be considered high-priority candidates for donor grant funds now being programmed.

Expansion of the Miskolc wastewater treatment plant should be affordable if agreement can be reached to spread the cost recovery among the facility's current and future users.

Component 2.1: Upgrade and expand the Miskolc wastewater treatment plant to meet requirements to the year 2010, including expanding biological treatment capacity and upgrading the sludge processing system.

Component 2.2: Improve operating efficiencies in water supply and wastewater agencies including activities to increase connection rates, improve financial management, and improve operation and maintenance performance.

Component 2.3: Improve the Borsod Brewery (Bocs) wastewater disposal system (filter field, conveyance, and treatment).

Phase 3: Lower Priority

The following activities have been ascribed less priority, primarily for financial reasons. They have relatively high unit costs (cost per household served) and may not be affordable in the near term.

Component 3.1: Extend sewerage coverage to unsewered and partially sewered areas of Miskolc and suburban municipalities.

Component 3.2: Reconstruct the Szikszo wastewater treatment plant and extend sewerage coverage.

Implementing the Project

The project may be implemented as a single package or as individual components. While most of the project components are separate and may be implemented singly, some important linkages exist between them. For example, unless the problem of household resistance to hooking up to the sewer system is overcome, investments in new sewerage networks will be unproductive. In addition, investment in new sewerage networks will also require expansion of the Miskolc plant beyond its current capacity. Furthermore, the industrial pretreatment program in Miskolc is needed to ensure that the sludge from the wastewater treatment plant can be used in land applications in the area.

Costs and Financial Consideration

The proposed program is a mixture of technical assistance and capital investments activities that should be phased according to priority. As noted above, the financing for the different project components will likely come from different sources. Assumptions about financing sources are based on existing central government grant programs and patterns of central-local fiscal transfers and municipal revenues. Given that Hungary is going through a period of fiscal turbulence (high central government deficits, lower than expected revenues, persistently high inflation, and high market rates of interest), these assumptions may not hold.

The following sections discuss the financing options for the technical assistance and capital investments components of the project. Figure 3 summarizes the cost estimates for the project components.

Technical Assistance Components

The technical assistance components should be funded with the assistance of external donor grant programs. In many cases, the proposed activities fit into existing grant program work scopes. For example, assistance in management improvements to the local water and wastewater agencies (Component 2.2) fits partially within the proposed World Bank study for the North Hungarian region. Similarly, the assistance in waste dump remediation (Component 1.2) follows up the current work being done by the European Community/Poland-Hungary Aid for Restructuring Economies (EC PHARE) in waste site identification.

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Figure 3

Project Component Costs

	$ US
Phase 1	
Component 1.1: Extend sewerage coverage to 10 unsewered municipalities	15,870,000
Component 1.2: Institute a program to identify and control waste dump contamination	725,000
Component 1.3: Institute an industrial pretreatment program for Miskolc sewerage system	200,000
Phase 2	
Component 2.1: Upgrade and expand the Miskolc wastewater treatment plant	21,920,000
Component 2.2: Improve the operating efficiencies in water and sanitation agencies	2,465,000
Component 2.3: Improve the Borsod Brewery wastewater system	1,200,000
Phase 3	
Component 3.1: Extend the sewerage network to unsewered areas of Miskolc and suburbs	19,150,000
Component 3.2: Renovate the Szikszo WWTP and expand the sewerage network	5,220,000

Capital Investment Components

The investment components can only be financed at present by access to multiple sources, including central government grants and loans to municipalities, as well as direct cost recovery from service consumers. The central government has a set of grant programs in place that, when supplemented by municipal borrowing, should make feasible the investment projects in Phases 1 and 2.

The existing central government grant programs are complex but, in general, should be able to fund 50 to 80 percent of the costs of new sewerage system construction, based on current eligibility requirements of the "targeted grants" program for municipalities. The smaller municipalities, and those without sewerage systems at present, qualify for the higher-percentage grants. In addition, competitive grant programs are provided via the environment and water funds, which can be used to supplement the targeted grants program.

The balance of the capital investment costs will have to be financed by loans to the municipalities and possibly to the Miskolc Water Board itself. Initial discussions with a number of the mayors of the 10 municipalities lying in and near the groundwater protection area indicate they would be willing to take on loans for sewerage system construction and pledge the amount of their shared income tax revenues for repayment.

There is also a need to finance sewerage hookups to households. At present, the cost of connection is borne entirely by individual households at a rate of about 20,000 HUF per house. Such high costs discourage households from connecting with sewerage networks. A program to allow households to amortize these costs over an extended period of time (say five years) should be examined.

Recovering the capital costs of upgrading Miskolc wastewater treatment plant (Component 2.1) involves more difficult choices. It is unclear whether any central government grant programs can be used to fund part of these costs since wastewater treatment facilities do not automatically qualify for any targeted grant program. (Instead, the facilities must apply for the grants on a competitive basis.) Without such aid, the burden would fall on either the municipal budget or consumers or both. Alternatively, were the entire cost of upgrading the treatment plant to be financed by a loan to the municipality, debt service (principal plus interest over 15 years) would consume about 4 percent of total municipal spending based on 1992 amounts[1] Part of this debt obligation could be capitalized in the tariff rate base. However, tariffs are so high at present that such a move should only be contemplated if the current operating costs of water and sewer services can be reduced.

Two additional obstacles must be overcome in financing the project's capital investments. First, no channels exist for providing long-term loans to municipalities for infrastructure investment. While a communal bank is being proposed, it is not yet established and the terms and conditions for creating such a bank are unknown. Second, no funds exist for project preparation studies, which are needed to enable municipal governments to apply for targeted grants and approach lending agencies for supplemental loans.

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[1] These figures must be used cautiously since forecasts for 1993 indicate an expected drop in Miskolc municipal revenues by about 5 percent in current terms, or approximately 25 percent in constant terms.

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Key Institutional and Policy Issues

Industrial Sites

Three key industrial issues remain to be resolved, all of which require action at the national policy level: (1) determination of legal liability for cleanup of past contamination for industries, especially those undergoing privatization; (2) allocation of responsibility for cleaning up industrial waste dumps, especially those that have been abandoned by industries now shut down; and (3) availability of medium-term credit for environmental investments that are moderate in size ($US 1 million to $US 15 million) but too small to qualify as a single loan project by major international lenders. Until these issues are resolved, environmental investments in industrial sites will continue to move slowly.

Municipal Sites

Three main institutional issues require immediate attention: (1) putting in place the financing and management systems to support the restructured system of municipal ownership of water supply and sewerage services; (2) introduction of measures to control the very high operating costs of the existing water and sewer services; and (3) creation of a capital financing structure that can both provide loans to municipalities and coordinate those loans within existing grant channels. Hungary has made great progress on promoting cost recovery through tariffs; now, greater efficiency needs to be introduced into the system so that water and sewer services are available at affordable prices.

Chapter 1

EXISTING CONDITIONS

1.1 General Features of the Basin

The Sajo-Hernad basin is located in Borsod-Abauj-Zemplen County in northeastern Hungary (see Figure 4). The Sajo River system is composed of three main subbasins, comprising the main Sajo River stem, the Bodva River, and the Hernad River (see Figure 5). All three rivers originate in Slovakia. Indeed, the larger part of each of the three drainage basins lies in Slovakia (see Table 1).

Figure 4

Location of Borsod-Abauj-Zemplen County in Northeast Hungary

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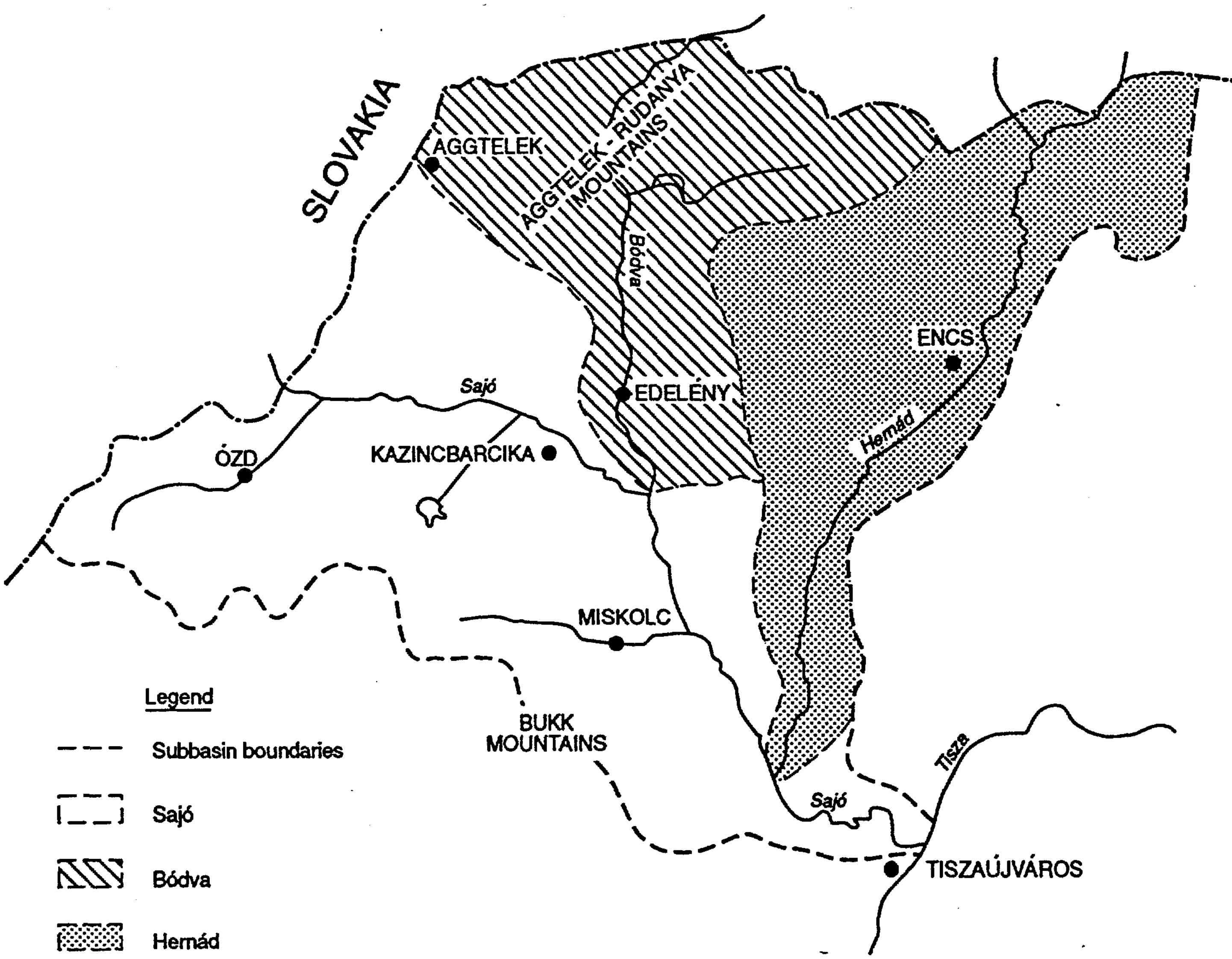

Figure 5

Major Subbasins

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Table 1

Sajo-Hernad Basin Drainage Area

Catchment	Slovak Name	Area (km^2) Hungary	Slovakia	Total
Sajo River	(Slana)	2,339	3,206	5,545
Bodva River	(Bodva)	862	920	1,782
Hernad River	(Hornad)	1,013	4,346	5,359
Total study area:		4,214	8,472	

The main geological features of the region include the Bukk Mountains, which form the southwestern boundary of the basin, the Aggtelek-Rudanya Mountains, which form the northeastern boundary, and the alluvial plains lying along the river valleys. The two mountain formations are mainly karstic limestone that is highly permeable and vulnerable to groundwater pollution. The Bukk Plateau serves as a major water source for the city of Miskolc. The Aggtelek Mountains are the location of an extensive series of caves (extending under the Slovakian border) and are a major tourist destination. Of the cave region around Aggtelek, 20,000 hectares were established as a national park in 1985.

1.1.1 Climate

The yearly average temperature in the valley areas of the Sajo is 8 to 10°C, while the mountain areas range from 5 to 8°C. The average annual rainfall varies from about 550 mm in the lower Hernad, Sajo valley, and Bukk Mountains, to upward of 700 mm in the Aggtelek highlands.

1.1.2 Land Use and Settlement Patterns

The major population settlements are located in the main Sajo valley, which contains Miskolc, the main urban center; as well as Kazincbarcika, Ozd, Tiszaujvaros, Sajoszentpeter, and Putnok (see Figure 6 and Table 2). More or less continuous settlement occurs from Miskolc to Ozd, with the major industrial concentrations at Miskolc (steel, ore refinery, paper, and mechanical equipment manufacturers); Kazincbarcika (chemical and fertilizer complex, electric power station); and Ozd (steel manufacturer). At the upper end of the Sajo are coal mines, which mainly are used for the electric generating plant at Kazincbarcika.

The Hernad valley contains two small towns (Szikszo and Encs) and numerous farming villages; the major industry is agriculture. In the lower Hernad valley lies the only major industry, a beer brewery at Bocs.

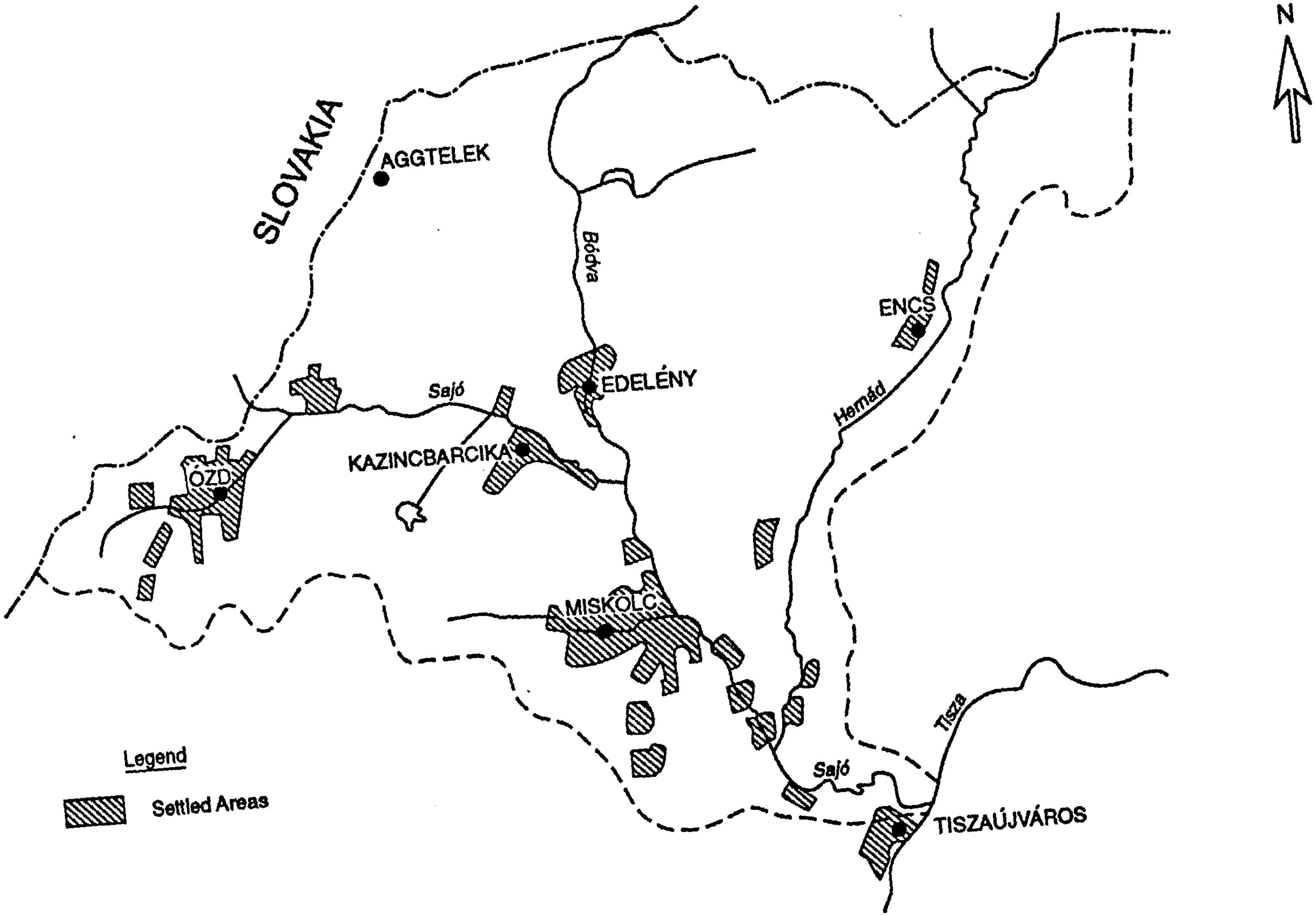

Figure 6

Main Settled Areas in Basin

Table 2

Population of Municipalities
above 5,000 in Study Area, 1990

Miskolc	196,442
Ozd	43,592
Kazincbarcika	36,855
Tiszaujvaros	18,685
Sajoszentpeter	13,370
Edeleny	12,140
Putnok	7,318
Felsoszolca	6,939
Encs	6,536
Szikszo	6,106
Alsoszolca	5,723

The Bodva valley is characterized by agriculture and mining. The upper part of the valley contains the Rudabanyi iron ore mine and a gypsum mine. The middle part of the valley contains a surface gypsum mine and several coal mines. Limestone is mined at numerous locations. The only town of size is Edeleny in the southern part of the valley, with its numerous farming villages extending up the Bodva valley and its tributaries.

The upland areas of the study area are heavily forested, while the lowlands are primarily open fields and meadows. The area is linked by a single two-lane highway to the rest of Hungary, running southwest from Miskolc to intersect with the four-lane expressway at Gyongyos (about 90 km away). Miskolc is also linked to southern Slovakia by a two-lane highway running north along the Hernad to Kosice (about 80 km). A major two-lane highway also runs from Miskolc to Ozd, linking the towns and industries along the main stem of the Sajo. All of the main towns in the area are also linked by the state railway system. Indeed, much of the industrial trade in the region moved by rail in the past, mainly iron ore inputs from Ukraine and exports via Ukraine to the former Soviet Union. Miskolc is linked by train to Budapest (three hours) and to Kosice (two hours). Miskolc has no commercial airport; the closest regional airport is at Kosice.

All three valleys in the study area (Sajo, Bodva, and Hernad) are experiencing high levels of unemployment, for slightly differing reasons. In the main Sajo valley, the general reduction in industrial activity has led to many plant layoffs; the most critical has been in the Ozd area with the shutdown of the steel industry, although Kazincbarcika and Miskolc also have been hit hard. Coal mining activity has also declined in the Ozd-Putnok area, due to reduced demand in the industrial sector.

In the lower Bodva, high unemployment has also been caused by plant reductions in the Kazincbarcika area. In the middle and upper Bodva, reduction in mining activity has also contributed to unemployment, while in the Hernad, reductions in the agricultural work force have been caused by the restructuring of the farm economy.

Five municipalities in the Sajo area have been classified by the central government as economically "depressed" including (in the Ozd region) Ozd, Putnok, and Borsodnadasd. Also so classified are the two major towns in the Hernad: Encs and Szikszo. Local estimates put unemployment rates in these areas at about 25 to 30 percent.

In general, it is unlikely that industrial activity will recover to its former level because most of the area's heavy industry was oriented to supplying the former Soviet Union—a market that has virtually disappeared. Much of this heavy industry appears to need new technology and management to compete in open world markets. Further complicating matters, as noted above, the transport links with the western part of Hungary (and to western export markets) are not well developed.

The economic downturn has affected population growth rates as well. In the past few years, there appears to have been a net outmigration. In Miskolc, for example, the municipality has lost about 3 percent of its population, while surrounding suburban municipalities have grown. The total population decrease for the greater Miskolc region since 1980 is about 1 percent.

1.2 Water Resources

The main water resources of the Sajo-Hernad basin may be grouped into three categories:

- surface waters—rivers and reservoirs,
- springs-mainly in the karstic uplands of the Bukk and Aggtelek areas, and
- subsurface aquifers.

1.2.1 Surface Waters

The Sajo-Hernad basin's river systems predominate among the surface waters; in fact the area has only two reservoirs of any size: a drinking water supply reservoir on a tributary to the Sajo above Kazincbarcika (draining part of the Bukk watershed); and a flow control reservoir on a tributary of the upper Bodva (see Figure 7). Outside of the study area, but directly affected by Sajo water quality, is a large irrigation reservoir on the Tisza River about 60 km below the confluence of the Sajo and Tisza.

The Sajo has a mean flow of about 20 m^3/sec as it enters Hungary from the northeast and a flow of approximately 35 m^3/sec just before it joins the Hernad. The Hernad has a mean flow of about 32 m^3/sec as it enters Hungary from the north and about 32 m^3/sec as it joins the Sajo. The Bodva has a flow of about 4 m^3/sec as it enters Hungary from the north and approximately 7.5 m^3/sec as it joins the Sajo just below Kazincbarcika. The Bodva flow,

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however, varies considerably because it is used for water supply impoundment in Slovakia, which greatly reduces its initial flow at times.

1.2.2 Springs

Numerous springs are located in the Bukk and Aggtelek uplands. Miskolc draws about half its drinking water supply from a single source in the Bukk Mountains that varies in volume considerably depending on the rainfall in the mountains. Due to the high percolation in karstic formations, these spring sources are highly vulnerable to surface pollution. The upper Bodva, also contains many springs. Because this area is not densely settled and has no industry, it has been designated a protected watershed area for drinking water. The area does, however, have a number of settlements without sewer systems, so some form of household wastewater collection is required to protect the area effectively.

1.2.3 Subsurface Aquifers

The alluvial plains along the three river basins feed very productive aquifers. The most productive is located in a triangle at the confluence of the Sajo and Hernad rivers. This area is the location of the high-volume wells of the North Hungarian Regional Water Works Authority (ERV) that feed many of the water supply systems along the Sajo, Hernad, and lower Bodva valleys.

These subsurface aquifers receive infiltration from the Sajo and Hernad rivers. Consequently, water quality in those rivers is related to the quality of the aquifers.

1.3 Existing Water Quality

1.3.1 Surface-Water-Quality Measurements

Surface water quality in the Sajo basin has been regularly sampled and analyzed for 25 parameters since at least 1968. These data have been obtained at 15 sampling points in the basin plus 2 points along the Tisza River upstream, and downstream from its confluence with the Sajo River. Since 1989, heavy metal concentrations for nine parameters also have been determined. Based on analyses of these data, several observations may be made:

- Dissolved oxygen (DO) levels have risen consistently over the past 10 years, evidence of improving water quality. Only the Sajo River below the discharge from Miskolc wastewater treatment plant, Hangony Creek below Ozd, and the upstream portions of the Hernad River now appear to be below acceptable DO levels (5 mg/L) more than 5 percent of the time.

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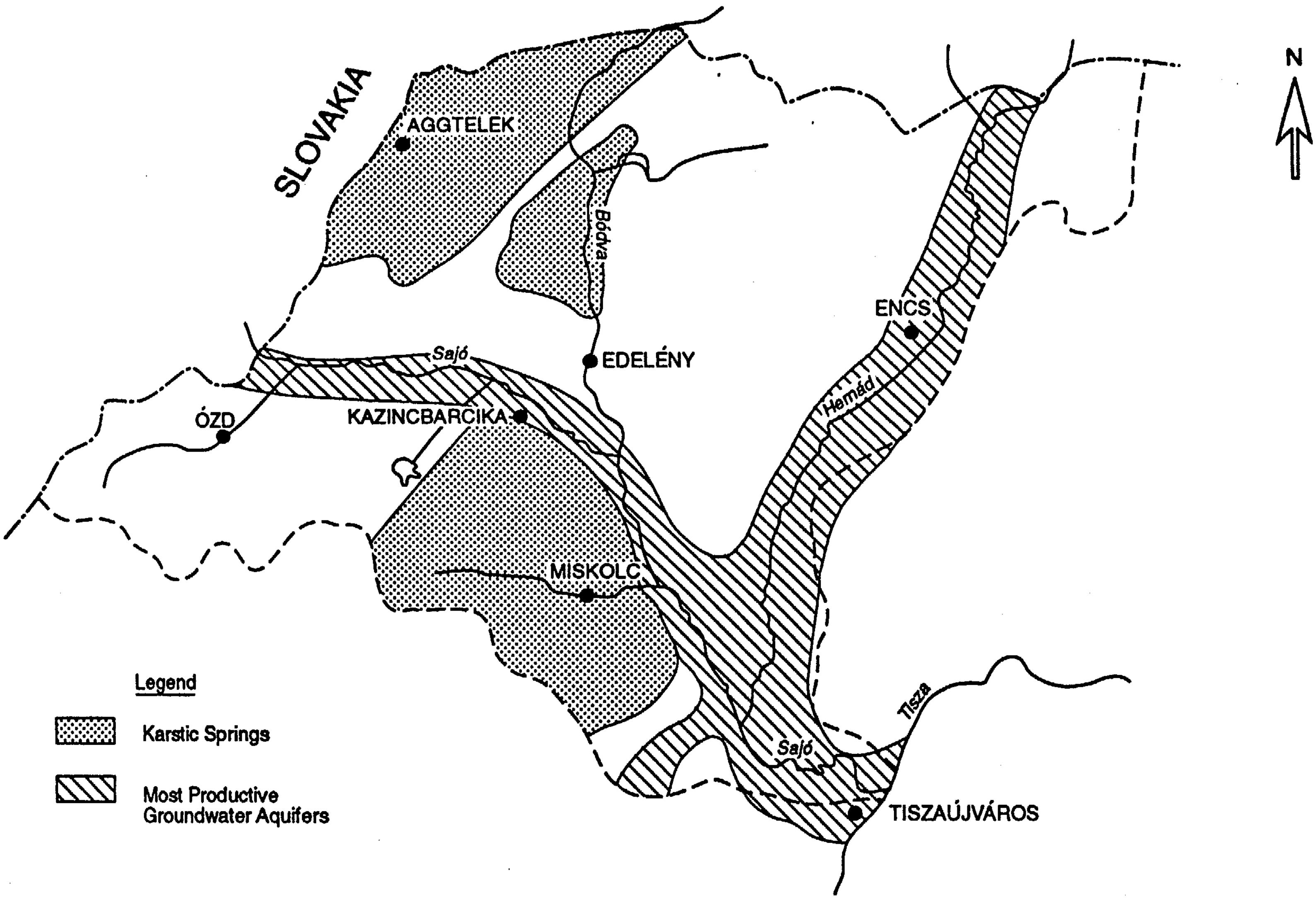

Figure 7

Main Water Sources

- Nitrate (NO_3) concentrations are consistently higher than acceptable for drinking water and irrigation and are therefore a cause of concern.

- Fecal coliform (FC) levels are frequently above the acceptable level (1,000 FC/100 ml) for crop irrigation water, especially in upstream reaches of several streams. This condition appears to reflect the discharge of raw sewage and animal waste into relatively small streams.

- Chemical oxygen demand (COD) indicates the total demand on a stream's oxygen resources from both organic and inorganic materials. Concentrations have tended to decrease with time, with the most dramatic decreases occurring along the whole length of the Sajo and below the Dimag Metallurgical Works in 1991 on Szinva Creek. A major reduction in manufacturing operations at Dimag in 1990 is believed to have been responsible for much of this improvement.

- Concentrations of heavy metals (e.g., cadmium, copper, lead, mercury, zinc) in streams below Ozd, Kazincbarcika, and Diosgyor show great reduction since 1989, in most cases to levels below those recommended in the World Health Organization's (WHO's) guidelines. This improvement clearly reflects the wholesale drop in large manufacturing operations in the watershed. Unacceptable heavy metals concentrations (relative to WHO guideline levels) are discussed below.

- Total dissolved solids (TDS) in irrigation water must be held at or below certain concentrations to maintain soil productivity. TDS concentrations at most sampling stations in the basin have held at levels above those deemed by WHO to be suitable for crop irrigation (450 mg/L). However, concentrations are generally less than the WHO guideline level for drinking water (1,000 mg/L).

- Sodium (Na) concentrations must be maintained at low levels to protect plant life. All stations reported good to excellent levels of sodium.

The above observations indicate generally the water quality in the Sajo-Hernad basin. They are based on a review of the recorded results of grab samples taken at intervals of from one week to two months. A continuous sampling program would be required to confirm these results. Additional sampling and analysis of water quality has been performed by the Borsod County Water Board for surface and groundwater sources providing drinking water to settlements (municipalities). These data show a number of settlements with elevated levels of nitrate in their drinking water source (see Figure 8).

1.3.2 Analysis of Sediments

The study team has been unable to identify reliable data specifically on present sediment contamination in the Sajo-Hernad basin. Rather, the team has analyzed data from studies of heavy metal contamination in the Sajo-Hernad from the late 1980s when most industries were still in full production. Because heavy metals persist in river sediments for a long time, these

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in-stream data indicate where likely problems of heavy metal contamination should exist in river sediments today.

The most pertinent data come from a study published in 1988 by the KGI Institute for Environmental Protection showing heavy metal contamination in the surface waters of Hungary. Analysis of the KGI data shows the following:

- Lead concentrations of 100 to 500 mg/kg in the Sajo River are common. The concentration at Ozd is greater than 500 mg/kg—the highest in Hungary. These levels far exceed drinking water limits but are within the limits for crop irrigation.
- Cadmium concentrations above the drinking water limit of 5 mg/kg were found below Ozd, in Szinva Creek (Miskolc), and below Miskolc in the area just above the confluence of the Sajo and Hernad. These concentrations are also within the limits (100 mg/kg) for crop irrigation.
- Mercury concentrations were found to be below 2 mg/kg at all sampling stations, indicating little or no problem.
- Copper concentrations were below the limits for drinking water and irrigation at all locations except Szinva Creek, which exceeded both limits.
- Zinc concentrations were below the limits for drinking water and irrigation except at Ozd, where levels were recorded near the irrigation limit (2,000 mg/kg).
- The data on chromium were inconclusive.

1.3.3 Water-Quality Problem Summary

Based upon analysis of available water-quality data, several problem areas have been identified. Water pollution levels in these areas exceed recommended parameters (WHO guideline limits), thereby endangering human health (see Table 3).

Nitrate contamination appears most serious for drinking water and irrigation use in Hangony Creek below Ozd, the entire Bodva River, and the entire Hernad River.

Fecal coliform levels appear highest relative to irrigation use in the upper reaches of the Bodva, Hernad, and Sajo rivers.

Heavy metal concentrations appear most serious in Hangony Creek below Ozd (lead and cadmium, for drinking water), Szinva Creek below Diosgyor (cadmium, for drinking water), lower reaches of the Hernad River (lead, for drinking water), and Szartos Creek near the Slovak border (chromium, for irrigation).

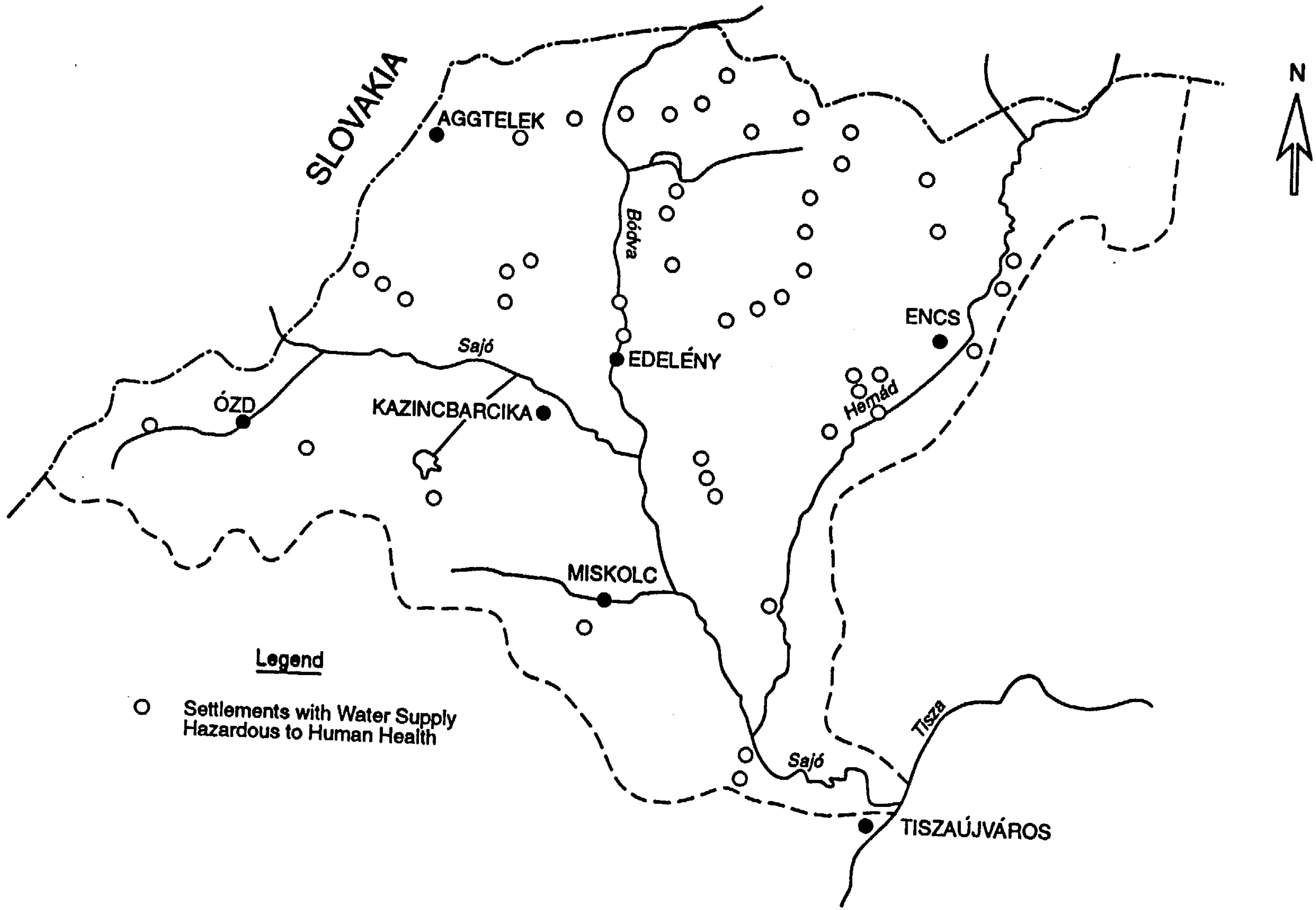

Figure 8

Location Where Groundwater Cannot Be Used for Drinking

Table 3

Maximum Contaminant Levels of Selected Parameters

Fisheries Parameters	Level[a] Drinking Water	Irrigation Water	Fisheries
Total coliform	0-10/100 ml	-	-
Fecal colifor	-	1,000/100 ml	-
Chemical oxygen demand (COD	-	-	-
Dissolved oxygen (DO)	(b)	-	-
Nitrate (NO_3)	10 mg/L	5 mg/L	100 mg/L
Ammonia (NH_4)	-	-	-
Total dissolved solids (TDS)	1,000 mg/L	450 mg/L	10,000 mg/L
Sodium (Na)	200 mg/L	-	_
Cadmium (Cd)	0.005 mg/L	0.1 mg/L-	_
Chromium (Cr)	0.05 mg/L	0.01 mg/L	-
Copper (Cu)	1.0 mg/L	0.2 mg/L	-
Iron (Fe)	0.3 mg/L	5.0 mg/L	-
Lead (Pb)	0.05 mg/L	5.0 mg/L	-
Manganese (Mn)	0.1 mg/L	0.2 mg/L	-
Mercury (Hg)	0.001 mg/L	-	-
Nickel (Ni)	-	0.2 mg/L	-
Zinc (Zn)	5.0 mg/L	2.0 mg/L	-

(a) WHO water-quality guidelines, 1988.

(b) Must be present (not included in WHO guidelines).

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Chapter 2

EXISTING EMISSIONS AND WASTEWATER TREATMENT

2.1 Municipal Wastewater Systems

In the Sajo River basin, there are 15 municipal wastewater treatment plants (WWTPs) serving approximately 290,000 people (as listed in Table 4). The authorities that operate the plants are the Miskolc Water Board (which runs the plant in Miskolc); the Borsod-Abauj-Zemplen County Water Works Company, or BAZ Co. (which runs 10 of the plants); and the North Hungarian Regional Water Works Authority or ERV (which operates the remaining 4 plants). (These three authorities are discussed in more detail in Section 2.2.) Of these 15 plants, emissions data have been obtained for 9, as listed in Table 5 and shown on the map in Figure 9. The percentage of municipal population served by sewerage systems varies considerably, from a high of 95 percent in Kazincbarcika to a low of 9.4 percent in Szikszo. Overall, 76 percent of the population is concentrated into about a dozen areas. In general, the larger municipalities serve higher proportions of their populations with sewerage systems than do the smaller towns. Population served, and sewer system lengths, types, and ages for the 15 WWTPs are shown in Table 6.

It is believed that the systems constructed before 1980 are functioning as if they were partially combined (sanitary and storm water) whether or not they were originally designed as separate sanitary sewers. The three systems constructed in 1989 or after were designed as separate sanitary sewers and are connected to the Miskolc wastewater treatment plant. Physical chemical data are available, but no heavy metals concentrations are indicated for these plants. Emissions data for the nine plants in Table 5 are discussed below.

2.1.1 Miskolc

The Miskolc treatment plant discharges mechanically treated (primary) wastewater directly to the Sajo River downstream of the city and upstream of a major source of drinking water near the Sajo's confluence with the Hernad River. Emissions data show biological oxygen demand (BOD) and suspended solids (SSs) consistent with the levels achievable with primary treatment. A new secondary treatment facility is under construction; when it comes on line, the effluent quality should show dramatic improvement. For example, BOD should drop from about 150 mg/L to 12 mg/L and NH_4-N (ammonia nitrogen) from about 25 to 6 mg/L in the effluent. However, nitrates may show an increase.

The safety and continuity of the current sludge disposal procedure are cause for concern. Thickened and dewatered primary sludge (8 percent solids) is now land-applied on cooperative farms growing corn, wheat, and sunflowers within a radius of 20 to 30 km. Application is by subsurface injection to a depth of about 60 cm. The heavy metals content is checked and if zinc, mercury, and cadmium concentrations are high, the sludge is stored. Several problems exist with the present procedure:

- Raw primary sludge contains pathogenic organisms that present health risks to persons who may come into contact with it.
- As the cooperative farms become privatized, it is likely that they will refuse to accept wastewater sludge unless they are fully convinced about its safety and value.
- Application of raw primary sludges on lands serving also as recharge areas for drinking water aquifers is a dangerous practice.
- Injection of sludge 60 cm deep may not enable effective biological activity and thus may increase the likelihood of groundwater contamination.
- Deep injection may prevent crops from using valuable nutrients. (Depths to 30 cm are used in the U.S.)
- Storage of sludge containing high heavy metal concentrations does not solve the problem of its ultimate disposal.

Land application of sewage sludge, however, is highly desirable provided that the following conditions are met:

- pathogens are reduced or eliminated;
- soil characteristics, plant needs, and sludge nutrients are matched;
- heavy metals content is reduced to acceptable levels; and
- land application is not practiced in groundwater recharge areas used for drinking water supply.

Techniques are available that will enable the beneficial and safe use of municipal wastewater treatment plant sludge.

2.1.2 Ozd

The Ozd treatment plant along Hangony Creek provides secondary treatment by means of the activated sludge process. This plant reportedly removes 96 percent of the BOD and 93 percent of SS. These figures represent excellent performance. The ammonia concentration is reduced by 91 percent through the plant and is converted to nitrate (NO_3). The nitrate concentration is thus increased from 1 to 35 mg/L, which is well above safe levels. Phosphate (PO_4) levels are high (15 mg/L).

Sludge is heat digested and disposed of at a landfill. The study team was concerned about the proper disposal of this sludge. The practice of sludge disposal in refuse landfills without adequate leachate monitoring, control, and treatment is unacceptable in the U.S., for example.

Table 4

Inventory of Municipal Wastewater Treatment Plants in the Sajo River Basin

Plant Location	Other Settlements Served	Est. Population Served 1992	Year Built[1]	Design Capacity m^3/day x 1000	1991 Flow m^3/day x 1000 Avg. Day	1991 Flow m^3/day x 1000 Max. Hr.	Treatment Process	Sludge Management	Operating Agency
1 Miskolc	7	197,073 (88%)	1978	140.0	70	139.2	Primary[2]	Dewatering Land Application by Injection	Miskolc Water Works
2 Ózd	-	30,216 (64%)	1965[3]	11.8	6.3	13.9	Activated Sludge	Heated Digestion Landfill	BAZ Co.
3 Putnok	-	3,524 (44%)	-	1.3	0.7	1.6	Oxidation Ditch	Landfill	BAZ Co.
4 Kazincbarcika	4	48,912 (95%)	1958[3]	15.0	7.7	15.8	Activated Sludge	Heated Digestion Landfill	BAZ Co.
5 Aggtelek	-	76 (12%)	1969	0.25	0.04	-	Oxidation Ditch	Landfill	BAZ Co.
6 Edelény		3,260 (25%)	1969	1.0	0.6	0.96	Oxidation Ditch	Landfill	BAZ Co.
7 Sajószentpéter	-	7,144 (50%)	1958	3.5	1.4	-	Trickling Filters	Dump	BAZ Co.
8 Feketevölgy	-	-	1958	0.23	0.16	-	Oxidation Ditch	Landfill	BAZ Co.

Table 4

Inventory of Municipal Wastewater Treatment Plants (continued)

Plant Location	Other Settlements Served	Est. Population Served 1992	Year Built[1]	Design Capacity m^3/day x 1000	1991 Flow m^3/day x 1000 Avg. Day	Max. Hr.	Treatment Process	Sludge Management	Operating Agency
9 Encs	-	3,520 (51%)	1975	0.5	0.3	0.9	Activated Sludge	Landfill	BAZ Co.
10 Szikszó	-	588 (9.4%)	1975	0.33	0.31	0.72	Activated Sludge	Landfill	BAZ Co.
11 Gönc	-	184 -	1961	0.08	0.06	-	Septic Tank	Landfill	BAZ Co.
12 Kirald	-	224 (21%)	1965	0.6	0.25	-	Trickling Filter	Landfill	ERV
13 Rudolf telep	-	-	1968	0.15	0.11	-	Trickling Filter	Landfill	ERV
14 Sajobabony	-	2,300 (69%)	1969	0.5	-	-	Connected to Industrial Plant	-	ERV
15 Berente[4]	?	-?	1968	4.0	2.40	-	Trickling Filter	Landfill	ERV

Notes

(1) Or latest upgrade if known.
(2) Activated sludge facilities under construction with design capacity of 70,000 m^3/day.
(3) Treatment plant has been upgraded in steps.
(4) Part of Kazincbarcika.

Table 5

Municipal Water Treatment Plant Emissions

Plant Location	Receiving Water	Plant Discharge River km	1991 Avg. Flow m^3/day x 1000	% Industrial Flow	Major Industry Type	Plant Effluent Concentrations mg/L COD c	BOD$_5$	SS	NH$_4$	NO$_3$	PO$_4$	μΩ/cm cond.	mg/kg Zn	Pb	Cu	Cd
1 Miskolc	Sajó R.		70	20	Steel	350	150	150	25	1.3	12	1,000	-	-	-	-
2 Ózd	Hangony C.		6.3		Steel	35	10	15	5	35	15	1,100	-	-	-	-
3 Putnok	Sajó R.		0.7			94	10	40	29	3.4	30	1,400	-	-	-	-
4 Kazincbarcika	Sajó R.		7.7		Chemical	95	25	20	30	0	15	1,300	-	-	-	-
6 Edelény	Bodva R.		0.6			60	12	25	15	40	15	1,700	-	-	-	-
7 Sajószentpéter	Sajó R.		1.4		Glass	40	16	20	13	30	10	1,200	-	-	-	-
9 Encs	Belus Ck.		0.3		Furniture	145	40	100	50	0	20	1,350	-	-	-	-
10 Szikszo	Vadasz Ck.		0.3	50	Animal protein	55	5	80	4	120	15	1,700	-	-	-	-
15 Berente	Sajó R.		2.4			25	7	70	3	25	3	1,400	-	-	-	-

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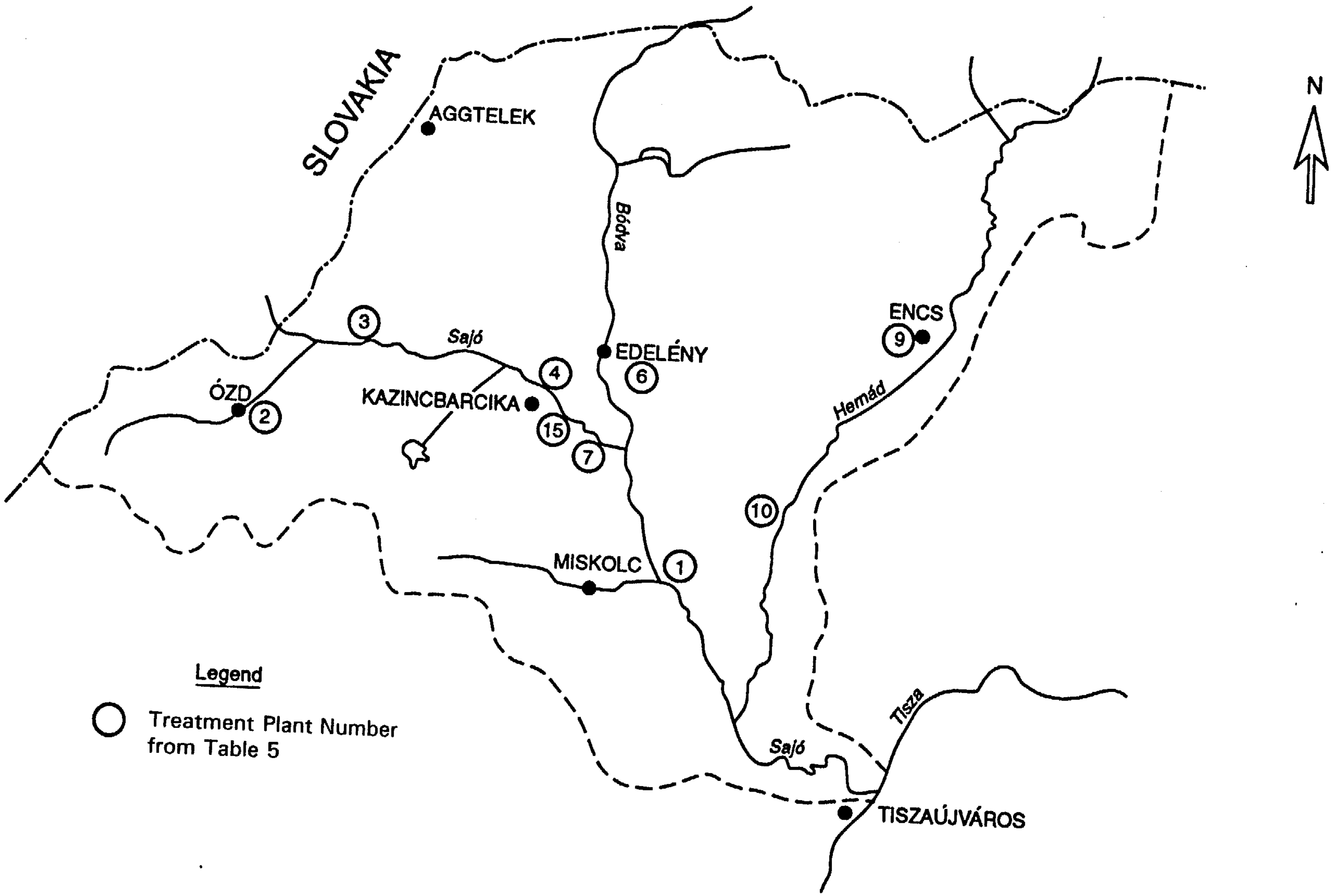

Figure 9

Municipal Wastewater Treatment Plant Map

Table 6

Wastewater Collection Systems

Age Municipality		Population Served (Percent)	Sewer Length (km)	Type of System	of Sewers[a]
1.	Miskolc	88.0	315.0	Partially combined	1901
	Alsoszolca[b]	-	45.6	Separate	1989
	Felsoszolca[b]	-	40.3	Separate	1990
	Malyi[b]	-	16.8	Separate	1990
2.	Ozd	64.0	49.6	Unknown	1965
3.	Putnok	44.0	15.2	Unknown	-
4.	Kazincbarcika	95.0	83.4	Unknown	1958
5.	Aggtelek	12.0	11.2	Unknown	1969
6.	Edeleny	25.0	15.5	Unknown	1969
7.	Sajoszentpeter	50.0	12.5	Unknown	1958
8.	Feketevolgy	-	2.0	Unknown	1958
9.	Encs	51.0	18.7	Unknown	1975
10.	Szikszo	9.4	5.6	Unknown	1975
11.	Gonc	-	1.4	Unknown	1961
12.	Kirald	21.0	1.0	Unknown	1965
13.	Rudolftelep	-	2.0	Unknown	1968
14.	Sajobabony	69.0	3.5	Unknown	1969
15.	Berente	-	2.0	Unknown	1968

Notes

(a) Earliest known sewers still in service, or date of plant construction.

(b) Suburban settlements connected to Miskolc.

2.1.3 Putnok

The Putnok treatment plant along the upstream portion of the Sajo River has an oxidation ditch that aerates wastewater to a secondary level of treatment. This plant appears to be functioning well because BOD and SS are reduced by 94 percent and 73 percent, respectively. Ammonia and phosphate (PO_4) concentrations in the effluent are high (29 mg/L and 30 mg/L, respectively); advanced treatment would be needed to reduce these levels significantly. Comments on sludge disposal are the same as for Ozd.

2.1.4 Kazincbarcika

The Kazincbarcika wastewater treatment plant along the Sajo River has activated sludge as its main treatment process. It reduces BOD by 90 percent and SS by 92 percent, which indicates good performance. Ammonia content is high (30 mg/L), and the reported nitrate concentration of zero is suspect. Phosphate is also high (15 mg/L). Advanced treatment would be needed to reduce nitrogen and phosphorus to acceptable levels. Comments on sludge disposal are the same as for Ozd.

2.1.5 Edeleny

The Edeleny municipal wastewater treatment plant along the Bodva River has an oxidation ditch similar to the one at Putnok. The plant appears to be functioning well; BOD and SS reductions are about 90 percent. However, the effluent contains high amounts of nitrates (40 mg/L), ammonia (15 mg/L), and phosphate (15 mg/L). Advanced treatment would be required to reduce these levels. Comments on sludge disposal are the same as for Ozd.

2.1.6 Sajoszentpeter

The Sajoszentpeter treatment plant along the Sajo River uses trickling filters for biological removal. The plant appears to be functioning well with 87 percent reduction of BOD and 89 percent of SS. These removal rates are higher than one would expect from a trickling filter plant, however, and therefore these indicated removals are suspect. Ammonia, nitrate, and phosphate levels are elevated (13, 30, and 10 mg/L, respectively). Advanced waste treatment and sound sludge disposal practices would be needed.

2.1.7 Encs

The Encs plant along the Hernad River uses the activated sludge process. It receives high-strength waste and achieves 86 percent BOD reduction and 80 percent SS removal, both of which appear reasonable. Ammonia and phosphate levels (50 and 20 mg/L, respectively) are quite high in the effluent, and the reported zero level of nitrate is suspect. As above, advanced waste treatment and sound sludge disposal practices are needed. Industrial waste pretreatment may also be required.

2.1.8 Szikszo

The Szikszo plant along the lower Hernad River uses the activated sludge process. It also receives high-strength waste from an animal protein processing plant (ATEV) and reportedly achieves a 98.6 percent BOD reduction rate (this rate appears unreasonably high) and 73 percent SS reduction. Ammonia and phosphate levels measured in the effluent were elevated (more than 50 and 15 mg/L, respectively), and nitrate levels were extraordinarily high (120 mg/L) when the ATEV plant was operating full time. Industrial waste pretreatment may be required, along with advanced wastewater treatment and sound sludge disposal practices.

2.1.9 Berente

The Berente wastewater treatment plant serves a part of Kazincbarcika. It uses trickling filters for biological treatment. The plant appears to have unusually weak sewage (about one-third of normal domestic strength) which may result from one or more causes, such as excessive infiltration and inflow, industrial cooling water, or excessive drinking water wastage to the sewer system. BOD reduction of 89 percent appears to be too high for a trickling filter plant, and the SS removal of zero is suspect. Advanced treatment would be required to reduce nitrates (25 mg/L) to acceptable levels. Sound sludge disposal practices are also needed.

2.2 Municipal Water Supply

Piped water is provided to the municipalities (towns and incorporated villages) through three authorities:

- Miskolc Water Board (serving Miskolc City and several surrounding municipalities);
- Borsod-Abauj-Zemplen County Water Works Company (BAZ Co.), which serves municipalities in the county; and
- North Hungarian Regional Water Works Authority (ERV), which provides bulk water to Miskolc, BAZ Co., and major industries, as well as supplying a number of additional municipalities.

The Miskolc Water Board and BAZ Co. are mandated to be the principal suppliers to individual water consumers; however, ERV has also become a direct water service provider in a number of municipalities (mainly those municipalities that lie along its distribution network and can be supplied readily by ERV).

BAZ Co. currently provides water service to 192 municipalities in the Sajo-Hernad basin. It uses a combination of groundwater wells located in the vicinity of each municipality, augmented by purchased water from ERV. BAZ Co. is mandated to provide potable water to all municipalities. Where the local groundwater is polluted or construction costs are too high, BAZ Co. delivers bottled drinking water to households.

Figure 8 above shows the areas where groundwater is too contaminated for use as drinking water. In addition, some areas contain high nitrate levels in well water (above 20 mg/L), which pose serious contamination problems. These are mainly located along the main stem of the Sajo or on tributaries of the Sajo, clustering in the following regions:

- the upper reaches of Szuha and Csorgos creeks just south of Aggtelek;
- the upper reaches of Csernely Creek above the main ERV drinking water reservoir at Lazberc;
- the Bodva valley, in and near Edeleny, as well as in Bodva Village near the confluence of the Bodva and Sajo;
- Putnok and its neighboring village, Benreve; and
- Kazincbarcika.

The ERV drinking water sources comprise a number of deep wells, one karstic spring, and the reservoir at Lazberc. The most productive deep wells are located in the area of Sajolad just below Miskolc, tapping the deep-water aquifer at the confluence of the Sajo and Hornad.

The total capacity of the ERV sources is about 81,000 m^3/day, of which 15,000 to 20,000 m^3/day is supplied to Miskolc. The latter amount fluctuates depending on the amount produced by the Miskolc karstic spring supply in the Bukk Mountains. These sources are interconnected through the ERV supply network, which runs from Ozd along the Sajo valley to Sajolad with a main branch reaching up the Bodva valley to Szendro.

2.2.1 Miskolc Water Supply

The Miskolc Water Board provides water and wastewater services to the city of Miskolc and nearby municipalities. The total population served is about 216,000. The water system also serves a number of industries located within Miskolc, many of which also have their own wells.

Miskolc is currently supplying about 80,000 to 90,000 m^3/day with a maximum daily production of 92,000 m^3. In 1989, before substantial water rate increases took effect and while industrial production was still strong, water consumption in Miskolc was about 105,000 m^3/day. Thus water consumption has dropped about 15 percent during the past three years; Miskolc water officials estimate that demand will continue to drop about 5 percent per year (mainly as a result of continuing tariff increases).

In 1989, unaccounted for water (UFW) was about 15 percent in Miskolc. Currently, it stands at almost 30 percent but there is some disagreement as to the accuracy of the earlier measurements.

Overall, the dramatic rise in water prices has been accompanied by a falling demand for water (see Chapter 3). Unless there is unexpected growth in water-intensive industrial activity, existing drinking water sources should be adequate for the foreseeable future. However, several important sources are located in vulnerable areas:

- The reservoir at Lazberc is threatened by contamination from a number of unsewered villages located in its drainage areas.
- The high-volume wells of ERV are located in the aquifer at the confluence of the Sajo and Hernad rivers just below Miskolc and are therefore threatened by pollution from Miskolc.
- The upper reaches of the Bodva contain many unsewered villages and agricultural operations that already render much of the local groundwater unsuitable for drinking.

2.2.2 Municipal Water Sources

The three water supply agencies in the study area rely extensively on groundwater sources, including deep wells, bank-filtered wells along streambeds, and springs (primarily in the karstic areas).

ERV maintains the only active surface water reservoir, at Lazberc above Kazincbarcika. The other main sources for ERV are deep wells, three of which lie within the hydrogeological protection area near the confluence of the Sajo and Hernad rivers.

The Miskolc Water Board operates a very productive karstic spring supply at the headwaters of Szinva Creek in the Bukk Mountains (average production about 40,000 to 50,000 m^3/day) as well as some deep wells at Sajolad near the confluence of the Hernad and Sajo rivers. Its own sources provide a total of about 55,000 to 60,000 m^3/day, or on average, 75 percent of Miskolc City's water needs. The balance is purchased from ERV.

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2.3 Industrial Pollution Sources

2.3.1 Overview

The Sajo valley, starting at its upstream tributary of Hangony Creek and running to the Miskolc area, is one of the most heavily industrialized areas in Hungary. Industries there include iron and steel works, metal finishing, cement and concrete panel production, power, glassmaking, and chemical manufacturing.

Recent political changes and the subsequent economic slowdown in Central and Eastern Europe had a significant impact on the area's industries. Production levels, particularly in the steel industry, fell drastically due to market changes. Some production plants were closed down completely. These changes significantly affect surface water quality. Review of available in-stream water- quality data from 1989 to 1991 indicate a dramatic improvement in the quality of the Sajo that can only be attributed to the fall in industrial production. Evidence shows that similar changes in Slovak industries have also had a positive impact on the water quality in the Sajo, which has almost 60 percent of its tributary area in Slovakia.

The industries in the study area will continue to experience many changes in the coming years to adjust to the market realities. However, it appears that production levels now have stabilized at their reduced level. Wastewater volumes have also been reduced and stabilized. The issue of the viability of many industries has become clearer relative to a few years ago. Industrial managers plan to maintain this downsizing while seeking to improve competitiveness through efficiency and higher-quality products. Industries operating in the Sajo valley are already equipped with wastewater treatment plants of generally good design. In some cases, the treatment plants are working significantly below capacity. Because of these factors, control of industrial wastewater point sources does not appear to be of high priority in the Sajo valley compared with other sources.

Although industrial wastewater point sources are manageable, the large number of solid-waste and hazardous-waste sites in the basin points to a potentially significant industrial waste problem. Data are being collected under new programs for Hungary but are limited, particularly in terms of defining the extent of the problem and whether the hazardous wastes are contained or mobile.

Available data on priority pollutants—particularly toxic organics—are very limited in all media, including stream flows, industrial and municipal point-source emissions, groundwater, soils, and sediments. Priority pollutants may be present at unacceptable levels in any of these media. Experience in the U.S. has shown that source controls and minor process changes are generally highly cost-effective for removal of these pollutants from point sources but that treatment of groundwater and soils is extremely costly and time-consuming. A very high priority for the Sajo basin, then, is documentation of the extent of this type of pollution.

Nitrate levels in drinking water remain a constant problem and concern in the Sajo valley, although the in-stream water-quality data from 1989 to 1991 show significant reduction in nitrate levels every year. The closing of the fertilizer industry in the Sajo valley, as well as the drop in fertilizer use due to the lifting of fertilizer subsidies, account for these reductions.

2.3.2 Description of Industries and Their Impacts

Major industries of the Sajo-Hernad basin in Hungary are discussed below by location, starting with Hangony Creek at the upper reaches of the Sajo valley and following the flow of the Sajo to the Miskolc area. The Bodva and the Hernad subbasins of the Sajo basin do not have large industries in their Hungarian section.

The major industries discharge to the Sajo directly or through creeks. However, Miskolc has a large number of industries that discharge to the municipal treatment plant, which provides primary treatment only. Tables 7 and 8 list the major direct dischargers in the Sajo valley and the indirect discharges into the Miskolc municipal system. River sampling stations located downstream of the Sajo valley dischargers are noted. Selected in-stream water-quality data or profiles for different years are also presented graphically (see Figures 11 through 15) to show the effects of industry and the dramatic changes in the transition period until 1991.

Appendix A presents more detailed information on the industrial wastewater discharges to the Miskolc municipal system.

Hangony Creek

Hangony Creek drains the western edge of Borsod County. The Borsodnadasd Steelplate Works and the Ozd Metallurgical Works are located in this basin in the towns for which they are named.

The Borsodnadasd Steelplate Works is under liquidation, and thus its 1992 production was negligible.

Table 7

Major Industrial Direct Dischargers and River Sampling Stations

Location/Name	**Wastewater Flow (m^3/day)**
Hangony Creek:	
Borsodnadasd Steelplate Works (on Arlo Creek)	300
Sampling Station 7 - rkm 13.8[a]	
Ozd Metallurgical Works	1,000
Sampling Station 8 - rkm 2.0	
Sajo River:	
Sampling Station 1 - rkm 123.5	
Sampling Station 2 - rkm 95.1	
Borsodchem Rt. Chemical Works	21,000
Borsodi Coal Mines (on Os-Szuha Creek)	3,000
Borsod Power Station	3,800
Ytong Hungary Ltd.	3
Sajoszentpeter - Pannonglas	10
Sampling Station 3 - rkm 76.5	
Sajobabony - Saszolg Chemical Works	11,000
Sampling Station 4 - rkm 53.8	
Sajokeresztur Metallurgical	195
Miskolc - Diosgyor Paper Mill (on Szinva Creek)	1,100
Miskolc - Diosgyori Gepgyar (on Szinva Creek)	2,500
Miskolc - DIMAG Steel Mill (on Szinva Creek)	3,000
Sampling Station 5 - rkm 43.6	
Sampling Station 6 - rkm 10.4	

(a) rkm = river kilometer.

Table 8

Miskolc Sewerage System: Major Industrial Dischargers

Industry	Water Use (m^3/year)
DIMAG Steel Mill	1,850,000
BAZ County Meat	590,000
Borsod County Dairy	345,000
Miskolc Cooling	198,000
D4D Wire Factory	195,000
Miskolc Liquor	155,000
MAV Service (Rail)	135,000
Mezogep Machinery	119,000
HCM Cement Factory	81,600
Intercsokolade (Chocolate)	62,000
MAV Korzeti (Rail)	57,000
Chinoin Hypodermic	47,000

The Ozd Metallurgical Works is being audited and worked only intermittently for two months in 1992. It is expected that only the rolled stock mill will survive and that raw iron and steel production will not resume.

The following graphs (Figures 11 and 12) show the significant drop in iron and phenol levels in the Hangony Creek over several years parallel to the drop in production (sampling stations 7 and 8 are located upstream and downstream of the industries, respectively). Iron and phenols are typical indicators of pollution from steel mills. Sampling data for various other pollutants such as mercury and chromium, as well as for COD, show the same significant drops.

Upper Sajo

In this section of the Sajo and in the town of Kazincbarcika is the Borsodchem Chemical Works (downstream of river sampling station 2). This complex covers an area about 7 km long and 3 km wide. Its products include plastic raw materials (polyvinyl chloride [PVC] and dioctyl phthalate [DOP]), caustic soda; hypochloride; fine chemicals including organics; and nitrogen fertilizer. The fertilizer was exported to the former Soviet Union. Fertilizer production, which was a major part of the plant's operations, has now been completely abandoned. The company's work force has been reduced from a high of 6,000 to its current 3,500. Plans have been drawn for privatization of the complex, to be overseen by the State Auditing Department and foreign banks. Borsodchem has a wastewater treatment plant with separate physical/chemical and biological treatment stages, plus a polishing lagoon. Its capacity is 50,000 m^3/day but the present flow is between 15,000 and 17,000 m^3/day. The difference is due to elimination of nitrogen fertilizer production, which contributed about 30,000 m^3/day. The current effluent meets the limits for all parameters except for TDS, whose limit of 2,000 mg/L the plant occasionally exceeds. The complex has on-site solid-waste storage, and some liquid wastes are incinerated as part of the plant's processes.

Presently, the major environmental problem at Borsodchem is the 400 tons of mercury waste it buries on site. In-situ stabilization of this waste has been considered, but no real solution has been found yet.

In this general location, Borsodi Coal Mines and Borsod Power Station are also located. The available data on their effluents are limited and do not indicate any significant pollutant loadings. Ytong Hungary Ltd. and Pannonglas (Sajoszentpeter) are minor dischargers.

Downstream of the confluence of the Sajo and its tributary Bodva River, in the town of Sajobabony, is the Saszolg Chemical Works. Its production levels, and therefore its wastewater volume, have been reduced significantly in recent years. This plant is also undergoing restructuring. Recent effluent data are limited, but Saszolg's cadmium and phenols have been major pollutants in the past.

Profiles of nitrate and mercury in the Sajo are also presented in Figures 13 and 14 (sampling stations 1 through 6, which are shown in the map in Figure 10). The industries discussed above are all located between sampling stations 2 and 3, except for the Saszolg Chemical Works, which is located between stations 3 and 4. The nitrate profile gives evidence of the impact of Borsodchem Chemical Works as well as Saszolg Chemical Works on the Sajo during 1982-1986 and 1987-1991, with the impact almost disappearing in 1991. Sampling data also indicate significant drops in the levels of heavy metals (e.g., cadmium) in this segment of the Sajo by 1991, except that mercury levels remain elevated and no decrease is indicated for 1991. A graph for cadmium is presented in Figure 15.

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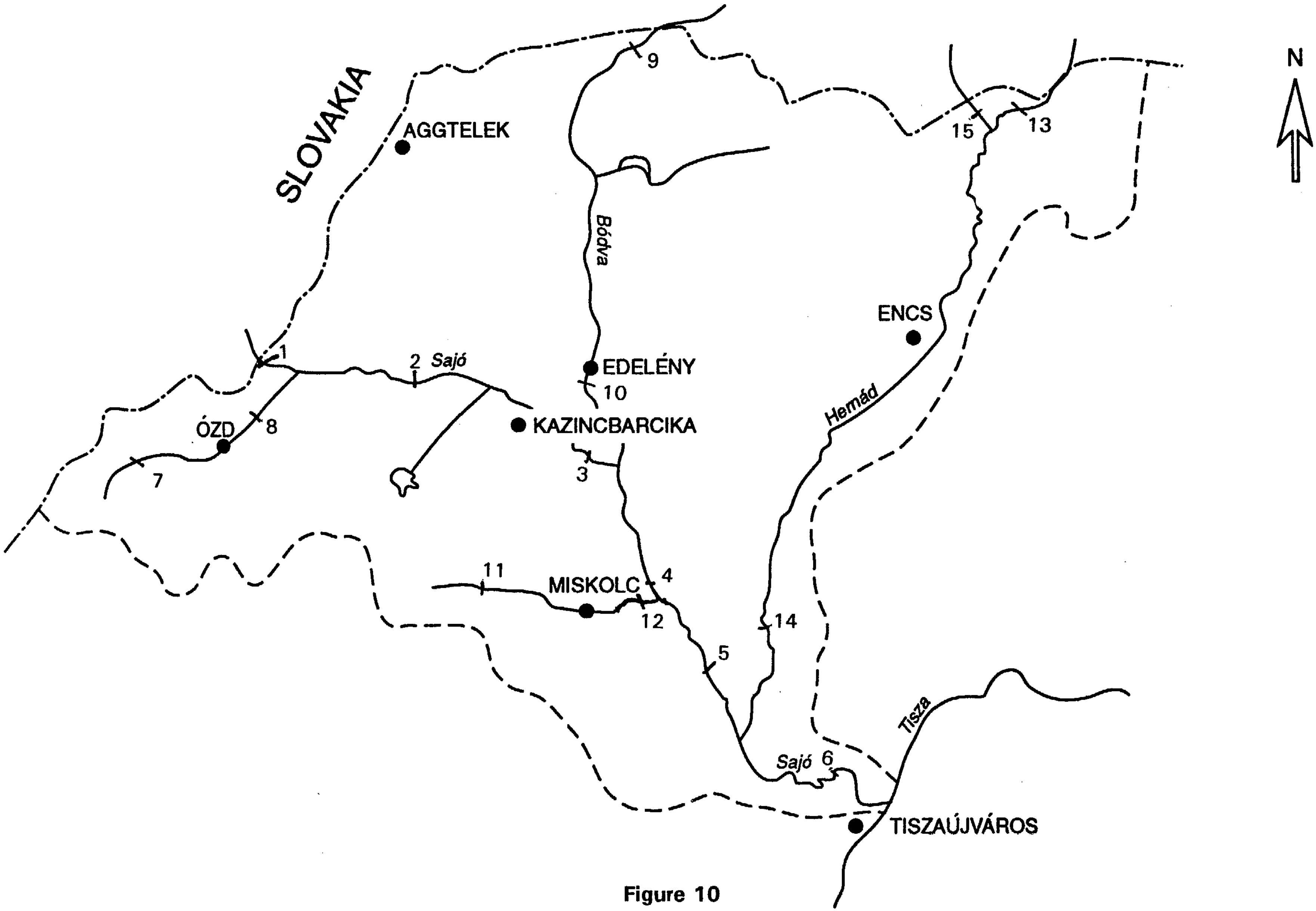

Figure 10

Sampling Station Locations

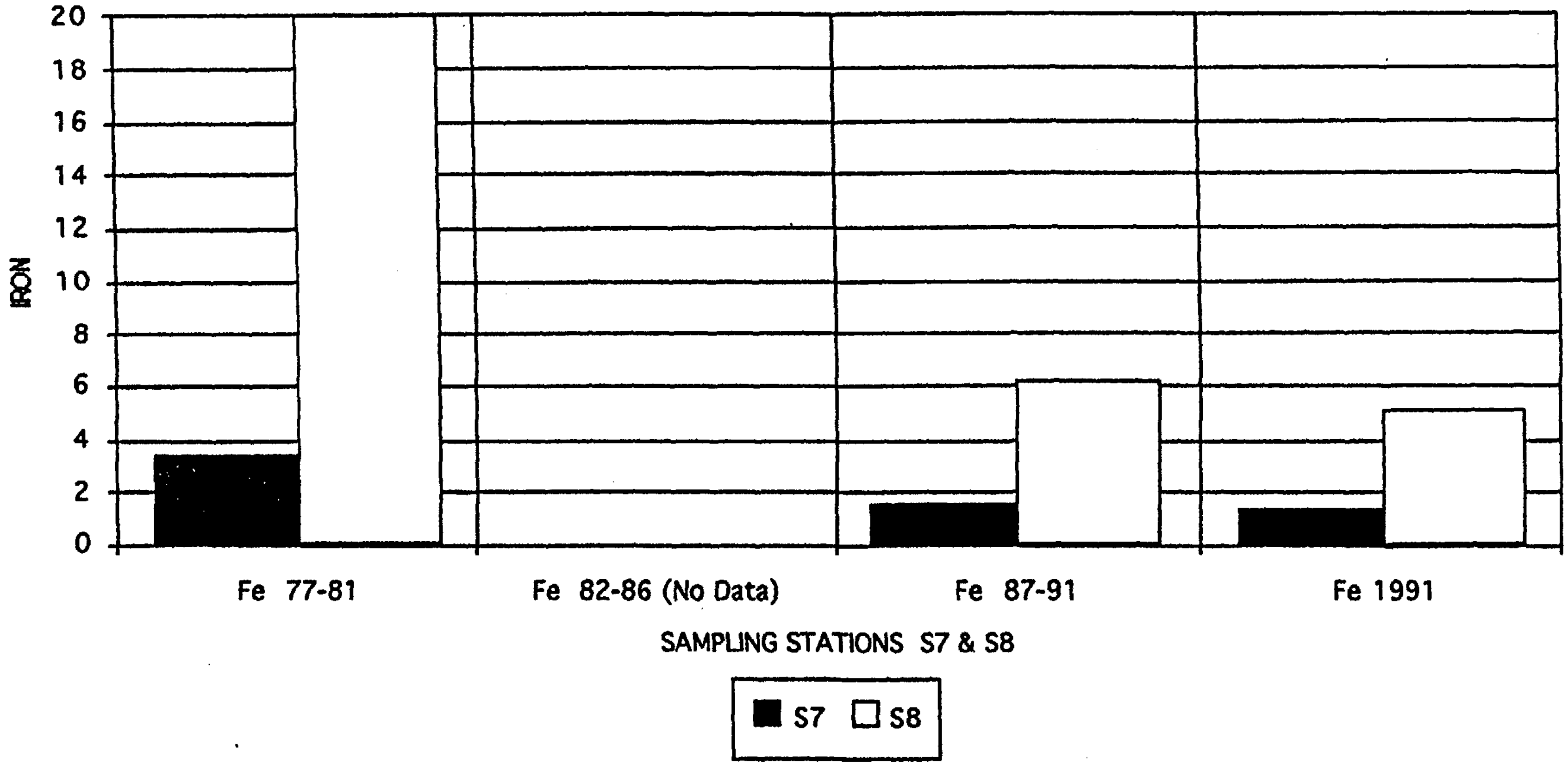

Figure 11

Iron Levels in Hangony Creek

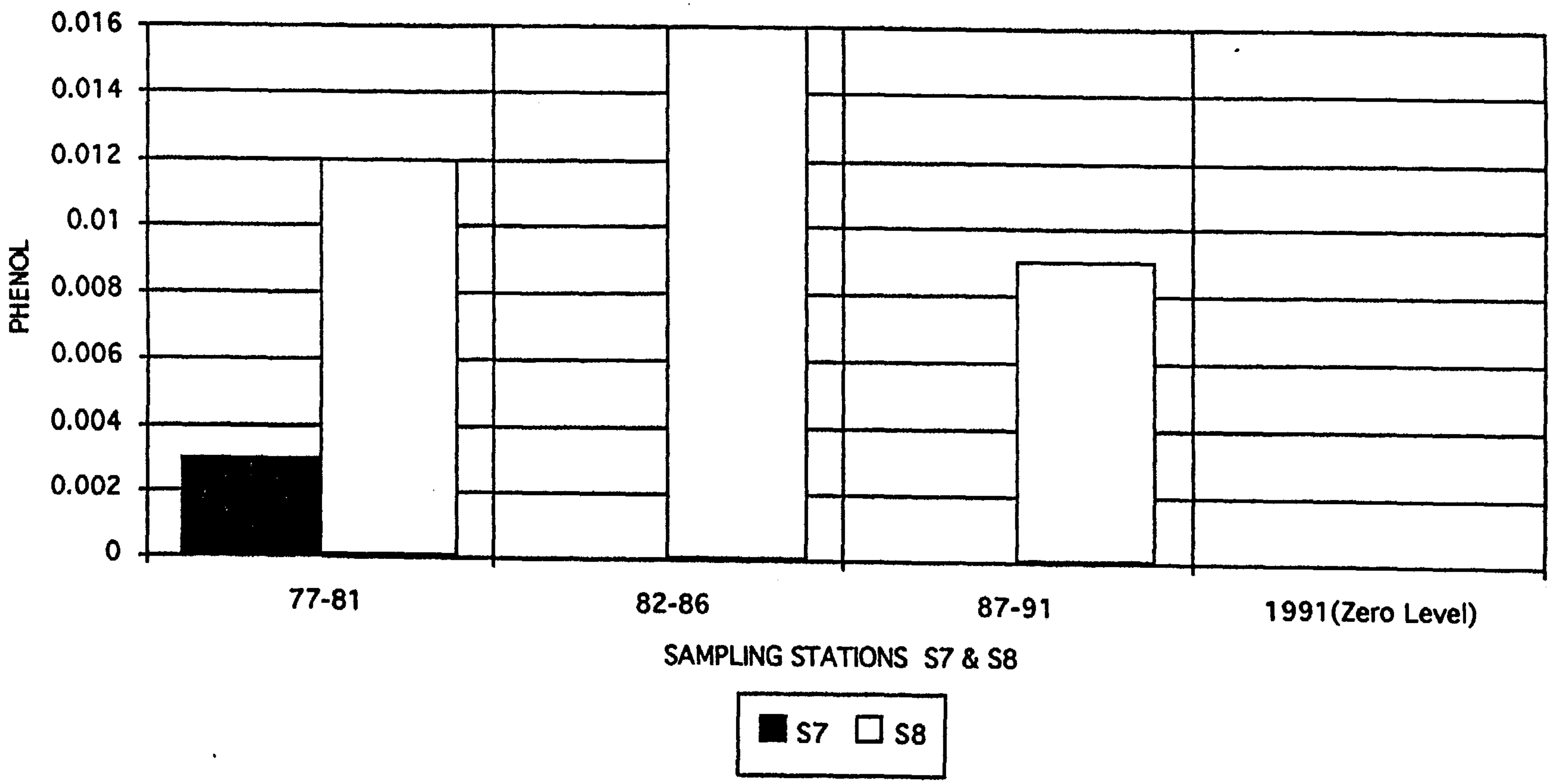

Figure 12

Phenol Levels in Hangony Creek

Miskolc Area

Miskolc is the industrial center of the prefeasibility study area. The DIMAG Steel Mill, Diosgyori Gepgyar, and Sajokeresztur Metallurgical are the main metals-related direct dischargers in this area, with DIMAG being the most significant.

DIMAG currently is undergoing restructuring. It once employed 15,000 workers; that number has been reduced to 6,000 today and there are plans to lay off an additional 1,000. The mill has its own water treatment plant to treat river water. A physical/chemical treatment plant treats industrial wastewater, and domestic wastewater is discharged to the Miskolc municipal plant. The treated effluent is discharged to the Sajo through the Szinva Creek. Review of yearly sampling data for the Szinva Creek show that stream quality had improved significantly by 1991. Mill representatives informed the study team that currently they were meeting all the wastewater discharge limits. The mill produces significant solid-waste deposits.

The majority of the industries discharging to the Miskolc municipal system have pretreatment plants. Records for permit violations indicate conventional organics as the parameter most frequently exceeded. As the Miskolc facility provides only primary treatment, such indirect industrial organic loading in the Sajo is not well controlled.

The Bodva and Hernad Subbasins

The Bodva subbasin has no significant industries.

The Hernad subbasin contains the Borsod Brewery at its downstream section, which discharges into filter fields, and the Onga Metal Joints Plant, which discharges to the Barsonyos Canal. Both of these industries are significant potential sources of pollution.

Available data indicate that the water quality in both the Bodva and the Hernad tributaries is significantly better than in the Sajo's main reach. Nitrates are still of concern, however, and occasionally, lead levels marginally above drinking water limits have been observed in the Hernad (although the source cannot be clearly identified because the section of the Hernad in Slovakia receives many industrial discharges and is quite polluted).

2.3.3 Priorities

The highest priority related to industrial and hazardous wastes is defining the extent of the problem so that risks can be assessed and compared accurately. The amount of analytical data available on priority pollutants is very small, and is generally limited to heavy metals, which are relatively inexpensive to analyze.

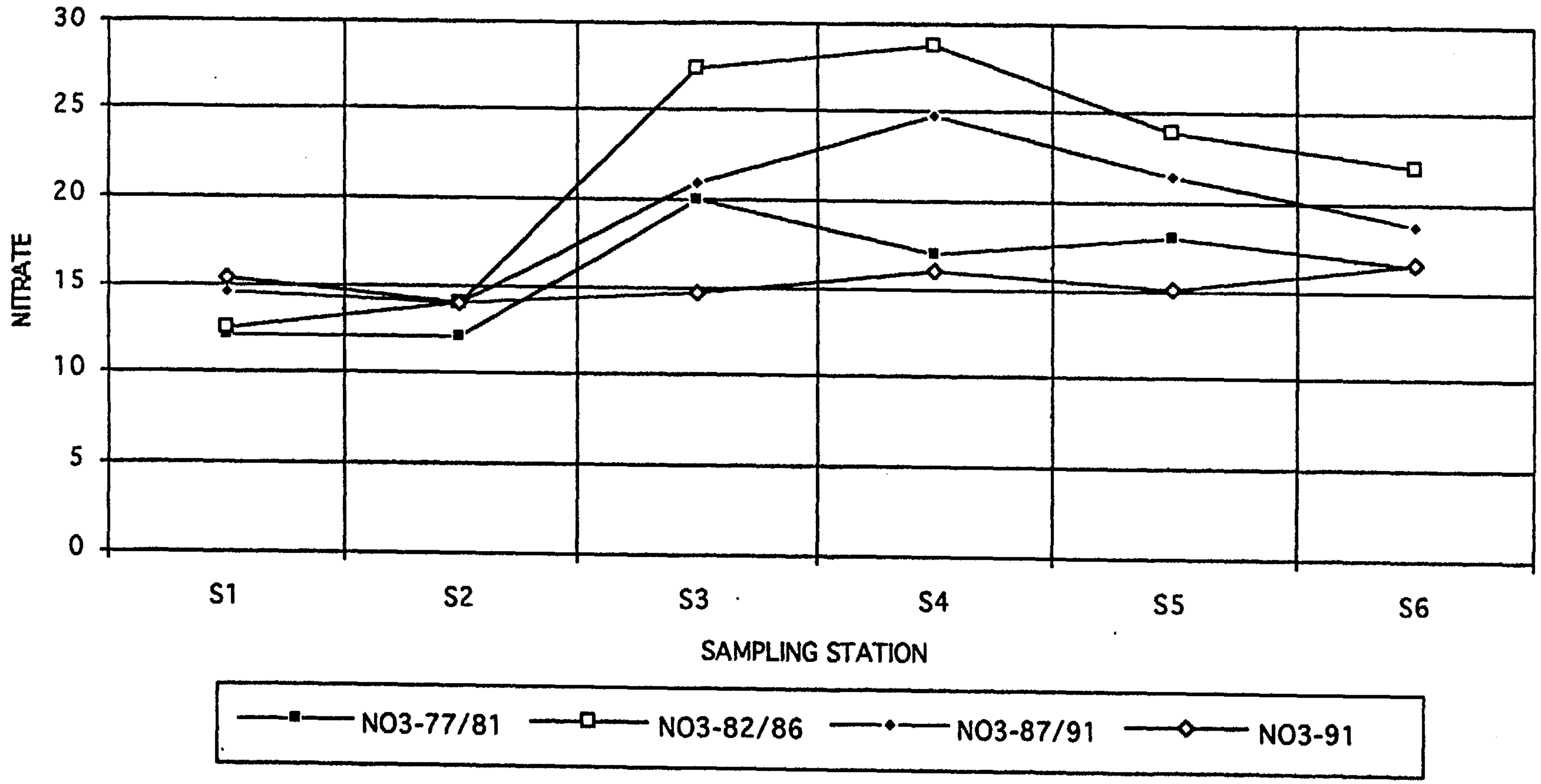

Figure 13

Nitrate Levels in the Sajo

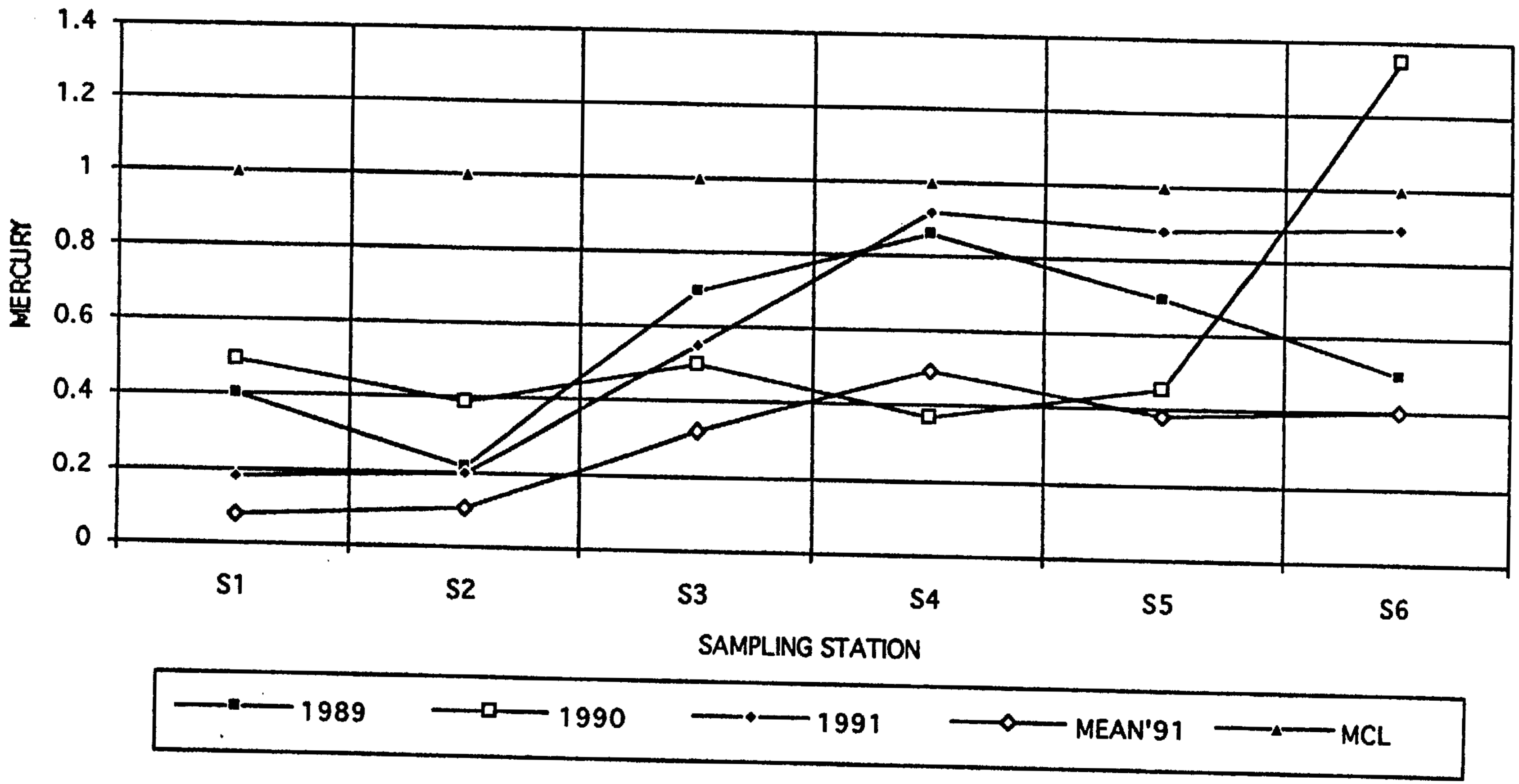

Figure 14

Maximum Mercury Levels in the Sajo

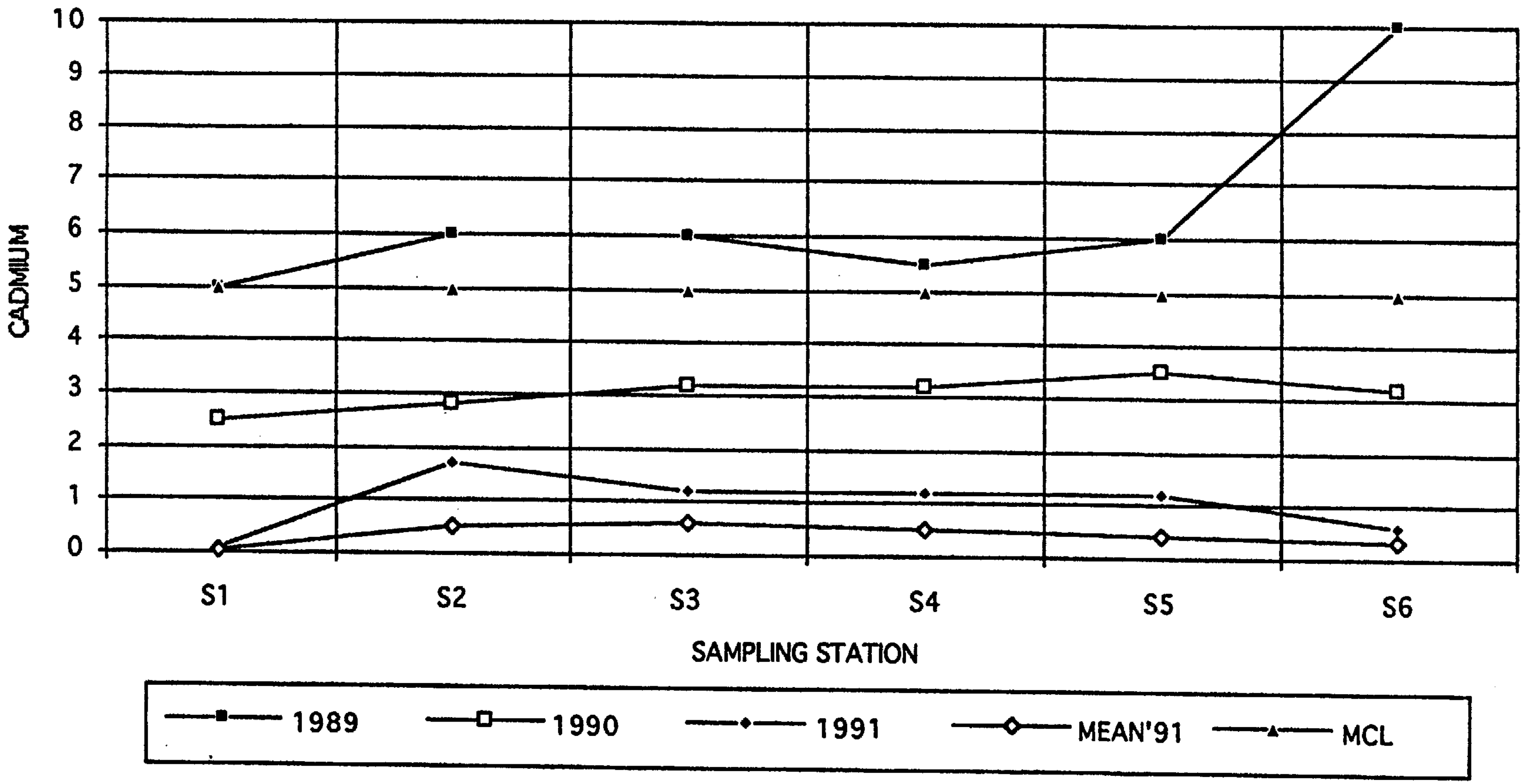

Figure 15

Maximum Cadmium Levels in the Sajo

The industrial sites that are known to have significant hazardous waste problems are the following:

- Borsodchem Chemical Works (mercury waste deposit and potentially toxic organics),
- DIMAG Steel Mill (solid-waste deposits), and
- Ozd Steel Mill area (solid-waste deposits).

2.4 Groundwater Pollution

Groundwater pollution may come from several different sources in the Sajo region:

- infiltration of household sewage not discharged to communal sewerage systems;
- infiltration from municipal and industrial sewerage lagoons;
- municipal and industrial solid-waste dumps (legal and illegal);
- soil contamination on industrial premises;
- mine runoff;
- runoff and infiltration from fish ponds, stock rearing areas, and chicken farms;
- infiltration of contaminated surface waters and rivers in the region;
- runoff from agricultural operations, including land application of fertilizers and pesticides; and
- disposal of animal waste.

Given the large number of industries and settlements in the Sajo valley, the risk of groundwater contamination is high. There are 41 settlements in which groundwater is unusable, largely because of bacterial contamination from septic tank infiltration and because of high nitrate levels (either from septic tanks or from agricultural fertilizers). Figure 8 shows the settlement locations where groundwater is unsuitable for use as drinking water. Although the country's health and water works departments have been very aware of drinking water contamination in the past, there has been no systematic assessment of sources of groundwater pollution until now.

At present, at least two groundwater studies are being carried out in the Sajo basin. The first is being conducted under the European Community/Poland-Hungary Aid for Restructuring of Economies (EC PHARE) program to identify and characterize all sources of potential groundwater pollution in key high-risk areas of Hungary, including four subareas of the WASH study area (Bukk Mountains, Aggtelek Mountains, main stem of the upper Sajo, and the triangle around the confluence of the Sajo and Hernad). The second is being conducted by a nongovernmental environmental action group in Miskolc and is aimed at characterizing the waste sites in the Sajo valley and their health implications.

Both studies are still in progress. Furthermore, these studies are just the first step in identifying potential problems; there has been very little monitoring of groundwater contamination in the vicinity of these sites or analysis of what pollutants exist there. The EC PHARE study has so far identified more than 200 sites in its four subareas of the basin (which omits most of the middle and upper Hernad valley, all of the Bodva, and the area around Ozd). The breakdown of pollution sources identified in the four subareas, not counting household septic systems, is as follows:

- waste dumps—132 sites
- agricultural activities—52 sites
- waste lagoons—40 sites

These sites are spread throughout the study area. The most critical areas, however, in terms of protecting drinking water supplies, are the Bukk Mountains (especially in the area of the Miskolc water source); the Sajo-Hernad confluence aquifer; and the Aggtelek Mountains and upper reaches of the Bodva.

Chapter 3

INSTITUTIONAL AND FINANCIAL CONDITIONS

3.1 Sector Organization

Hungary's water supply and wastewater sector is undergoing significant changes, primarily as a result of the decentralization of service delivery functions and of the service pricing policies adopted by the central government. (Table 9 provides a summary of the roles and responsibilities of the main actors in the sector up to the present.) The main changes are occurring in the structure of service delivery at the local level and in the manner of cost recovery. The previous system was characterized by state-owned authorities that planned and built facilities, and then delivered services to the local population with low levels of direct cost recovery (and, consequently, high levels of central government subsidy). While tariff rates for water and sewer services were quite low, the capital financing of system extensions (both water supply and sewer) in fact involved a substantial amount of user contribution.

3.1.1 Water and Sewer Service Management

The main organizational change in the sector is the transfer of water and sewer assets from the state-owned authorities to the individual municipal governments. In the past, the water supply and sewerage system networks were built by municipal governments but then turned over to the water works authorities to operate. These municipal assets then became assets of the state authorities. Now, new legislation on municipal property transfer mandates a return of water supply and sewerage system facilities to the municipal governments. This legislation has had the effect of breaking up the regional and county water works authorities because many municipalities want to establish their own water enterprises, or at least negotiate a new relationship between the municipality and the water works authority. For the majority of municipalities, however, the water and sewer systems will continue to be managed by the local water works authorities under contract. Larger municipalities are beginning to establish their own authorities; very small municipalities can associate with others in area-wide systems.

Tariffs will be set by the municipalities. Although operating subsidies are being phased out of the system, capital grants will continue to be made.

The shifting organizational structure of local water authorities has been keenly felt in the Sajo area, where the institutional structure is somewhat more complex than usual. There, (as noted earlier), water and wastewater services are delivered by three different entities: the Miskolc Water Board (for the greater Miskolc area), the Borsod-Abauj-Zemplen County Water Works Company (BAZ Co.), and the North Hungarian Regional Water Works Authority (ERV). ERV was mandated to develop bulk water supply (selling to Miskolc and to BAZ Co.) to

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supplement the other two entities own water sources and also to serve major industries in the Sajo. BAZ Co. was established to serve the smaller towns and villages in the area.

It is not yet clear just what institutional structure will finally emerge from the current restructuring. The central government's concept is that whatever remains of the ERV and BAZ Co. authorities should be self-financing enterprises and may be "privatized." It seems likely that BAZ Co. will become a contractor to manage local municipal systems (which may be individual systems or, for smaller municipalities and villages, area-wide systems). It is less clear that there is a long-term role for the ERV as simply a bulk supplier, given that some of its major customers—Miskolc and the various large industries—are continuing to reduce their bulk water purchases.

The "municipalization" of water and sewer assets is virtually complete in the Sajo area, with 98 percent of the assets transferred to municipalities from BAZ Co. There is still considerable argument over the remaining 2 percent, which consists of assets that belong to the whole system (e.g., central offices) and cannot be readily divided up among the municipal governments.

Plans are already in place for part of the BAZ Co. to be split off. Operating units at Satoraljaujhely, Ozd, and Tiszaujvaros will be run as three separate companies providing service to a total of 60 municipalities. At least 100 municipalities will likely remain with the "new" BAZ Co. The structure of the new BAZ Co. is also being hotly debated. Three plans have been put forward: (a) joint stock company, (b) joint municipal enterprise, or (c) joint stock company combined with ERV. A number of the affected municipalities have formed an organizing committee to attempt to work out a solution in the near future.

3.2 Standards for Drinking Water and Wastewater Discharges

Hungary has high drinking water standards (issued in 1978 and revised in 1990) that compare favorably with WHO guidelines and standards in other European countries. There is some question, however, as to whether local laboratories can measure the full range of organic and inorganic micropollutants included in the standards.

Hungary's wastewater discharge standards are generally not as high as EC standards, but it is expected that they will be progressively tightened to meet EC standards in the future. Three problems complicate the enforcement of wastewater standards at present. The first is jurisdictional. The regional environmental inspectorates have jurisdiction over discharges to surface waters but not to municipal sewer systems (which are the responsibility of the local sewer authority). The local authorities do not appear to be capable of monitoring and enforcing industrial discharge limits for local sewer systems. Second, similar to the problem with laboratory facilities for drinking-water-quality measurements, capability is inadequate for measuring the full range of critical wastewater pollutants. Third, enforcement of industrial and municipal discharge limits is spotty, with numerous exemptions and failure to collect fines.

Table 9

Summary of Roles and Responsibilities

Organization	Responsibilities
1. The Ministry of Environmental Protection and Regional Development	Establishes national policy and regulations for water quality control and management. Sets standards for water quality and effluent. Controls and supervises, through its National Environmental Protection Authority, the regional inspectorates and the national water quality monitoring network.
Department for Air, Water, and Soil Protection	Provides policy analysis and planning for water quality control and management. Coordinates the development of standards, legislation on water quality, and in-stream water quality. Develops annual report on the status of water quality.
National Environmental Protection Authority	Manages and supervises 12 regional environmental inspectorates; compiles national data base on sources of pollution and water effluent and in-stream water quality; enforces and collects fines for sanctions on pollution.
Institute for Environmental Management	Provides environmental research, information, and data analysis. Maintains national data base on water quality monitoring network.
2. The Ministry of Telecommunications, Transport, and Water Management	Large umbrella agency for public utilities, including airports, roads, public transportation, and water.
National Water Authority	Implements water services, planning, and construction of water and wastewater systems. Enforces national policy relating to drainage, accidental water spills and pollution, and inland navigation. Responsible for river basin management through 12 district water authorities and manages some drinking water and wastewater through 5 regional companies. Maintains international bilateral water management agreements (dams and floods).
District Water Authorities (12)	Responsible for river basin management, flood control, accidental spills in rivers, river channel maintenance, and construction of waterways. Grant licenses (with concurrence from the environmental inspectorates) for water extraction, water supply and treatment, and wastewater treatment. Provide technical assistance to local councils for water and wastewater. Issue water use permits. Under the National Water Authority.

Table 9

Summary of Roles and Responsibilities (continued)

Water Management Services Department	Operates water and wastewater companies in five regional areas of the country; has state enterprises where local authorities do not operate. State enterprises are in transition to limited shareholding companies. Under the National Water Authority.
3. Scientific Research Center for Water Resources Development	Established in 1952. Formerly under the National Water Authority to provide water-related research and to serve agricultural and other water use research: hydrology, hydrobiology, engineering, and water pollution control. Now, a portion of the organization has been made a shareholding state enterprise, and recently 40 percent of shares were purchased by private foreign interests.
4. Ministry of Health and Welfare	Sets and monitors drinking water standards with the assistance of the National Public Health Institute. Maintains national laboratory network for sampling drinking water. Issues water use permits for public consumption.
5. Ministry of the Interior	Coordinates activity of local government and manages matching fund grants to public utilities for financing water and wastewater system construction.
County Governments (19)	Oversee county water quality management and permits for wastewater and industrial discharge into county and municipal systems. Enforces sanctions and fines for discharges into municipal systems.
6. Large Municipal Companies	Large cities all operate their own water and wastewater management units through special departments under the mayor. Local councils divide large urban cities into neighborhood units. The latter must be involved in water and wastewater provision decisions, tariffs, and investments.
7. Municipal Government	Smaller towns also operate municipal water and wastewater companies. Former county water companies now are owned by municipalities that either operate them directly or have formed limited shareholding companies to do so. The municipal government operates water and wastewater treatment plants and grants land use permits.
8. The Ministry of Agriculture and Food	Monitors surface water and sediment for pesticide residue for agricultural use, irrigation, and fish ponds.

Source: Dan Edwards, *Point Source Pollution in the Danube Basin: Institutional Studies of Bulgaria, the CSFR, Hungary, and Romania* (Volume II). Prepared for the Europe Bureau, U.S. Agency for International Development. WASH Field Report No. 374, July 1992 (pp. Hungary-1 - Hungary-2).

3.3 Capital Investment Financing for Water Supply and Wastewater

The capital financing system employed in Hungary is complicated and unique. Although some variations to the model persist, in general capital financing is arranged by local municipal governments. The municipalities assemble funding from three main sources:

- a collection of central government grant programs (mainly "specific" and "addressed" grants from the Ministry of the Interior; "Water Fund" grants from the Ministry of Telecommunications, Transport, and Water Management [MTTWM]; "Environmental Protection Fund" grants from the Ministry of Environment and Regional Planning [MERP]; and newly created "Regional Development Fund" grants from MERP);
- municipal budget funds (the largest share of which derives from central government transfers and shared taxes); and
- contributions from the project beneficiaries via participation in a "civil works association" formed specifically to raise funds.

The "civil works associations" have been entitled to receive loans through the state bank OTP at highly subsidized rates, so their beneficiary "contributions" have in fact been highly underwritten by the central government as well. On the other hand, such associations historically have accounted for a significant portion of capital funds raised for system expansion. In 1991, the World Bank estimated that such associations provided 49 percent of the total capital financing of new water supply and sewerage area networks.

Two of the funds cited above, the Water Fund and the Environmental Protection Fund, are used specifically for water and wastewater services (although the latter is used for a wide range of other environmental projects as well). In addition, municipalities already devote a small share of their total revenues to investment in water supply and wastewater. In 1991, this share amounted to a total of 8.33 billion HUF across all local governments, or about 2 percent of total local government expenditures. Table 10 shows the total amounts of the various grant funds allocated to local governments in Hungary in 1991 and 1992. The table does not necessarily capture all of the subsidies flowing to the local governments or to water and sewer investments (for example, the interest rate subsidies to civil works associations, described above). However, the data do make the point that the Water Fund and the Environmental Protection Fund are relatively small parts of overall central government support to municipal services. Even the municipalities share of their own budgetary resources (8.33 billion HUF) invested in water and sewer about doubles the total amount of the Water Fund and Environmental Protection Fund combined.

Table 10

Transfer Funds for Local Governments and Environmental Services

Local Government Transfers for Hungary

Grant Type	Amount (billion HUF) 1991 Actual	1992 Planned
Block (normative)	148.5	170.7
Specific (addressed)	11.8	10.0
Specific (targeted)	5.6	16.6
Supplementary	17.9	11.5
Income tax equalization	6.9	7.4
Other (misc.)	0	2.0
Shared Taxes		
Income tax	47.0	63.0
Vehicle tax	0	4.0
Price Subsidy to Water Companies	3.1	1.5

Off-Budget Funds

Fund	1992 Planned	1993 Planned
Water	1.9	2.0
Environmental Protection	2.4	2.6
Regional Development	4.9	

Note: The above transfers exclude Social Security funds.

Sources: (1) Ian Blore and Nick Devas, *Policy Determinants of Municipal Credit in Hungary* European Bank for Reconstruction and Development 1992. (2) Budget Proposal of Republic of Hungary, 1993.

3.4 Water Pricing and Cost Recovery

The central government has allowed water and sewerage prices to rise over the past three years to a level of "full" cost recovery. This figure is somewhat elusive; whether capital costs have been recovered is almost unknowable given the complicated system of capital financing which incorporated multiple direct and indirect subsidies. In any event, water rates in the region have risen enormously during the past three years and now equal the prices found in other parts of Europe and in the U.S. In terms of percentage of total household income devoted to water and wastewater services (roughly 1.5 to 2 percent), Hungarians are paying much more than any country within the Organization for Economic Cooperation and Development (OECD).

To illustrate the rise in water and sewer rates, the Miskolc Water Board has raised the rate per cubic meter from 1.20 HUF in 1990 to 31.40 HUF in 1992 (a 25-fold increase!). Table 11 shows the water and sewer rates for all jurisdictions in the country in 1992. The rates are set every year by the MTTWM based on cost data provided by each water authorities. In theory, the rates approved each year allow the water authority to recover full costs and achieve a 1 to 5 percent "profit."

In the Sajo region, profitability for water authorities is increasingly hard to achieve. In 1992, BAZ Co. was in the red for the first time, mainly due to arrears from industrial companies that could not pay or had gone bankrupt. In that year, arrears to BAZ Co. totaled approximately 120 million HUF. This, in turn, has prompted BAZ Co. to reduce its payments to ERV—to which BAZ Co. is now about 70 million HUF in arrears.

Miskolc has cash-flow problems of a somewhat different sort. With the rapid increase in tariffs, Miskolc has seen its rate of unaccounted-for water rise from 15 percent to almost 30 percent in three years. Miskolc pays ERV 24.00 HUF per m^3 of water purchased and sells water to consumers at its regulated rate of 31.40 HUF. With a 30 percent unaccounted for rate, Miskolc has to buy 3 m^3 in order to sell 2 m^3. This means Miskolc loses about 3 HUF on each cubic meter bought from ERV. The only way that Miskolc can avoid losing money is to use more of its own water supply from the Bukk Mountains and reduce its purchases from ERV. Fortunately, in the past several years, water consumption in Miskolc has been dropping in response to higher tariffs. Consumption is down about 15 percent from 1990 and is expected to continue dropping approximately 5 percent per year. Unfortunately, the Bukk Mountains supply is highly variable and in periods of low rainfall, such as happened last summer, the supply drops dramatically. In this environment, the Miskolc Water Board has great difficulty forecasting its actual costs over the course of a given year and, therefore, cannot manage its finances with any precision.

The future of water and sewer tariffs across Hungary is unclear. The breakup of the regional water works authorities means that individual municipalities will end up with highly differentiated rates if they are to be individually self-financing. Even now, the set rates for water supply range from 16.80 HUF to 65.80 HUF in different parts of the country. Even within the Sajo area, the Miskolc Water Board charges a combined water/sewer rate of 40.40 HUF per m^3, while BAZ Co. charges 76.00 HUF. (In fact, BAZ Co. can only recover 60.00

Table 11

National Water and Sewerage Tariffs of the Non-Bulk Companies, 1992
(In HUF per cubic meter)

Company	Water	Sewerage
Baranya megyei Vízmu Vállalat/Komló/	55,10	35,-
Békés megyei Víz- és Csatornamu Vállalat /Békéscsaba/	34,70	32,30
Borsod-Abaúj-Zemplén megyei Vízmuvek Vállalat /Miskolc/	46,-	30,-
Csongrád megyei Víz- és Csatornamu Vállalat /Szentes/	33,20	32,40
Debreceni Vízmu és Gyógyfurdo Vállalat /Debrecen/	27,80	10,60
Dél-Bács-Kiskun megyei Vízmu Vállalat (Kiskunhalas)	24,50	24,70
Délzalai Víz, Csatornamu- és Furdo Vállalat /Nagykanizsa/	32,90	17,30
Dunaújvárosi Víz- és Csatornamuvek /Dunaújváros/	31,80	12.10
Észak-Bács-Kiskun megyei Vízmu Vállalat /Kecskemét	29,-	19,70
Északzalai Víz-, Csatornamu és Furdo Vállalat /Zalaegerszeg/	29,30	24,50
Fejér megyei Vízmuvek /Székesfehérvár/	47,80	22,30
Fovárosi Csatornázási Muvek /Budapest/	-	9,50
Gyor- és Kornyéke Vízmu- és Furdo Vállalat /Gyor/	25,80	12,-
Gyulai Vízmuvek /Gyula/	16,80	25,40
Hajdú-Bihar megyei Víz- és Csatornamu Vállalat /Debrecen/	36,-	20,70
Heves megyei Vízmu Vállalat /Eger/	31,-	19,-
Miskolci Vízmuvek, Furdok és Csatornázási Vállalat /Miskolc/	31,40	9,-
Nógrád megyei Víz- és Csatornamu Vállalat /Salgótarján/	65,80	22,20
Pest megyei Víz- és Csatornamu Vállalat /Budaors/	42,60	31,20
Sopron és Kornyéke Víz- és Csatornamu Vállalat /Sopron/	44,60	22,10
Szabolcs-Szatmár-Bereg megyei Víz- és Csatornamu Vállalat /Nyíregyháza/	38,-	24,-
Szegedi Vízmuvek és Furdok /Szeged/	17,-	8,50
Jász-Nagykun-Szolnok megyei Víz- és Csatornamuvek /Szolnok/	34,30	20,10
Tolna megyei Víz- és Csatornamu Vállalat /Szekszárd/	36,80	37,30
Vas megyei Víz- és Csatornamu Vállalat /Szombathely/	32,70	17,30
Veszprém megyei Víz- és Csatornamy Vállalat /Veszprém	36,60	14,40

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HUF per m^3 from customers due to a ministry-imposed ceiling. The central government reimburses approximately another 10.6 per m^3 to the water authority. This ceiling rate and reimbursement scheme are due to be eliminated in 1993.)

There is widespread sentiment among municipal officials that water/sewer rates are much too high and that "municipalization" will help reduce costs by doing away with control by inefficient state authorities. Clearly, some cost-efficiencies may be realized by combining ERV and BAZ Co. as well as operating in a more businesslike manner. Beyond that, unless some form of competition for management contracts is introduced, the "new" BAZ Co. will be the monopoly contractor. It is also likely that municipal officials will be under pressure to cap, or even to roll back, rates. This means that, over time, local tax revenues will likely be used to subsidize water/sewer costs. In addition, maintenance and rehabilitation costs may be deferred in order to keep down tariffs.

A major determinant of whether tariffs will continue to rise is the question of continuing central government subsidies of capital facility financing. As noted above, the central government, through both direct and indirect means, covers a very large percentage of all capital costs. Compelling reasons exist for providing some public subsidies in wastewater systems, given the nature of the benefits and the high capital costs. Indeed, virtually every country in the world subsidizes these types of facilities. However, in Hungary today, the system of subsidies is incredibly complicated, and it is virtually impossible to determine how much public subsidy is directed to which beneficiaries. Furthermore, the overlapping system of separate capital grant funds means that some communities inevitably receive disproportionate shares of the public subsidy.

In order to redress the issue of subsidies in capital financing, the central government must provide access to credit. If no credit is available, rationing of grant funds is the only practical avenue—a practice that is already in effect.

3.5 The Role of Credit in Sector Financing

Hungary's new legislation regarding municipal access to credit (Act on Local Self-Government) is extremely liberal. The law goes beyond almost all other countries' regulations in removing any constraints on local government indebtedness. However, municipal governments in Hungary are unlikely to rush into debt, for several key reasons.

- *Lack of demonstrated creditworthiness.* Lending institutions are unlikely to extend large amounts of credit to untested borrowers, and Hungary's municipal governments rarely borrow. In fact, only about 1 to 2 percent of their total revenues come from loans at present.
- *Established dependence on grants.* Local officials simply are used to central government grants and are most comfortable using those channels of funding.
- *Fear of high interest rates.* Current interest rates are high in Hungary (although they have dropped somewhat from their peak earlier this year). Current market rates of

about 27 percent are still so much higher than subsidized rates used in the past that local officials are reluctant to accept them.

- *Natural conservatism (and inexperience) of local officials.*

The result of the above four factors is that credit usage in the sector (and for municipal infrastructure in general) likely will not increase unless specific steps are taken to stimulate it. The Ministry of the Interior (MOI) is currently planning to establish a municipal development bank that will specialize in lending for local government infrastructure projects. This institution will be modeled on the municipal development bank model common in Western Europe. The model is that of a specialized credit institution that raises funds on the international and domestic capital markets and on-lends to local governments at market rates. As a specialized institution, such a bank can lower its credit risk by developing a keen understanding of its market; it can also provide a certain amount of technical assistance to borrowers to make them better risks (some of the costs of technical assistance can also be borne by the central government, especially at the outset).

Even with a municipal credit institution in operation, central grant funds will continue to be needed. If the credit institution is forced to become the sole provider of capital for municipal infrastructure (including water supply and wastewater), it will almost certainly fail. Experience in other countries shows that some local governments simply cannot afford to borrow. If the credit system is forced to accommodate them, their inability to repay will likely undermine the entire system.

One of the main issues emerging as credit becomes a major source of capital financing for municipal infrastructure is the set of criteria used for continuing grant allocations. At present, grant allocations for environmental infrastructure are handled on an ad-hoc basis. Municipalities "shop" their projects around to the different grant funds (controlled by three different ministries) trying to line up a maximal amount of grant funding.

Another major issue at present is how to keep investment capital flowing into the system at a time when central subsidies in general are diminishing and local institutional restructuring is creating confusion. Hungary is taking steps to keep the funds available through capitalizing the proposed municipal development bank with a loan from the European Bank for Reconstruction and Development (EBRD), infusing capital into the Environmental Protection Fund through a grant from the EC PHARE program, and creating a regional development fund to channel support to economically depressed areas. In addition, the level of general grant funds allocated to municipalities (through the normative, addressed, and specific grant channels) has been increasing more or less in line with inflation.

Chapter 4

POTENTIAL PROJECTS

4.1 Summary Analysis

The rapid decline in industrial activity throughout the Sajo basin has greatly diminished the problems of current wastewater discharges. In-stream water-quality data show dramatic improvements for almost all parameters. In addition, the decrease in municipal water consumption (due both to lessened economic activity and much higher water tariffs) has lowered demand on municipal wastewater treatment facilities. A number of problems remain, however, especially in terms of threats to drinking water sources. These threats are caused primarily by lack of municipal sewerage coverage in certain areas, the land application of unstabilized sludge from the Miskolc wastewater treatment plant (WWTP), industrial discharges, the overloaded Szikszo WWTP, and the existence of numerous waste dumps (including solid waste, hazardous waste, sewage lagoons, and sludge deposits) that are poorly monitored. In addition, non-point sources from agricultural operations in the area pose potential threats, but these are not yet well documented.

The following sections describe the major problems in wastewater emissions that the WASH team identified in the Sajo-Hernad basin area. A summary table of the problems and their potential solutions is presented in Table 12.

4.2 Municipal Wastewater Abatement Projects

Area water supply from municipal wastewater faces two primary threats that are amenable to immediate intervention:

- endangerment of the highly productive aquifer at the confluence of the Sajo and Hernad, which is affected by industrial and domestic (mainly household) discharges from Miskolc and the unsewered towns in the vicinity; and
- endangerment of the Lazberc Reservoir from unsewered villages upstream.

In addition, ERV faces a potential threat to its well fields at Borsodszirak because of abandoned waste dumps in the immediate vicinity. (This threat is being investigated under another A.I.D. sponsored project, the Local Environmental Management [LEM] project, which is providing technical assistance to selected municipalities in the Sajo basin.)

4.2.1 Protecting the Sajo-Hernad Aquifer

Protecting this area requires extending the sewer system of the greater Miskolc area to the unsewered areas; completing the construction of, and further upgrading, the secondary treatment facility (and upgrading sludge processing and disposal) at the Miskolc wastewater treatment plant; and providing suitable treatment for the expanded service area, whether by expanding the Miskolc plant or by building additional plant(s) downstream. It also necessitates continuously monitoring and controlling industrial waste discharges, upgrading the Szikszo WWTP, and improving the waste dump sites. A major focus of this effort must be sludge handling and disposal from Miskolc and surrounding municipalities. The effort will be made more difficult by existing problems with solid-waste disposal in the region and the sensitivity of groundwater resources. This situation calls for a regional plan and solutions that take into account current residential, industrial, and commercial activities in the Sajo-Hernad triangle. Given that economic activity and demand characteristics have changed much during the past two years, all past studies and recommendations should be reconsidered.

4.2.2 Protecting the Lazberc Reservoir

Protecting this area requires sewering of approximately 10 settlements lying upstream from the reservoir. Although limited work has begun, the municipalization of water/sewer system assets has caused some confusion about how such systems will be financed and managed. Clearly, an area-wide system should be considered, probably tied to the existing wastewater treatment plant at Kazincbarcika.

4.3 Industrial Wastewater Abatement Projects

There are two candidates for potential projects in this category, both of which are programmatic interventions rather than single-site investments:

- cleaning up industrial waste dumps, and
- controlling industrial wastewater discharged to the Miskolc sewerage system.

4.3.1 Industrial Waste Dumps

Currently, two studies are in process to identify and characterize the waste dumps in the Sajo region. One major known contamination site is at the Borsodchem Chemical Works in Kazincbarcika, which contains about 400 tons of mercury-laced soil in two locations. Beyond that, other sites are not well studied. However, among the more than 200 waste dump sites identified so far by the EC PHARE program, some are almost certainly contaminated with heavy metals or other hazardous waste. For the purposes of this report, the highest-priority sites are those that lie near major drinking water sources: the karstic springs

Table 12

Danube River Basin Environmental Program, Sajo River Basin, Hungary: Potential Investment Program

Target Problem	Type of Exposure	Population Affected	Potential Solutions	Financial Feasibility	Other Remarks
MUNICIPAL SITES					
1. Protecting Sajo-Hernad Aquifer	Surface water contamination may affect water supply aquifer for Sajo basin	Population in service area: ca. 650,000	1. Extend sewers to unsewered areas 2. Complete Miskolc WWTP upgrading 3. Provide WWTP for expanded service area.	Total costs for entire system not known. Miskolc upgrading est. cost: $20 mil. Candidate for IBRD funded program.	
2. Protecting Lazberc Reservoir	Surface water contamination from 10 unsewered towns may pollute inlet streams	Population in service area: ca. 650,000	1. Install sewers 2. Connect to WWTP in Kazinbarcika	Costs not known; affected municipalities have no funds for investment.	
3. Protecting Bodva R. for drinking water source.	Surface water contamination from unsewered towns	Population in Bodva valley: ca. 100,000	1. Install sewers 2. Develop series of WWTP facilities 3. Water TP for Edeleny	Est. total costs: $150 mil. per 1992 basin study. Affected municipalities have no funds for investment; GOH provides some grants thru RDF.	
4. Reducing nitrate levels in Hernad	Surface water contamination from unsewered towns and agricultural runoff	Population downstream: ca. 750,000	1. Study to determine cause and solutions	Costs not known.	

Table 12 (continued)

Danube River Basin Environmental Program, Sajo River Basin, Hungary: Potential Investment Program

Target Problem	Type of Exposure	Population Affected	Potential Solutions	Financial Feasibility	Other Remarks
5. Protecting water quality in Sajo basin	High levels of surface water contamination (nitrates and coliform bacteria)	Population in basin: ca. 650,000	1. Study to determine cause and solutions	Costs not known.	
INDUSTRIAL SITES					
6. Scattered waste dump cleanup	Potential groundwater contamination in key drinking water supplies	Population in area: ca. 800,000	1. Study to target high-priority sites.		
7. Controlling industrial wastewater discharges in Miskolc	Surface water contamination affecting Sajo-Hernad aquifer	Population in service area: ca. 650,000	1. Study to determine magnitude of problem	Could be part of Miskolc WWTP upgrading feasibility studies	

in the Bukk Mountains (Miskolc water supply); the highly productive aquifers underlying the Sajo, Bodva, and Hernad rivers (most particularly the confluence of the Hernad and Sajo); and the karstic springs of the Aggtelek-Rudanya Mountains.

4.3.2 Controlling Industrial Wastewater Discharges in Miskolc

Miskolc operates the only municipal sewerage and waste treatment system in the region that receives significant industrial discharges. It is the sole responsibility of the Miskolc Water Board to monitor these discharges—both for fee/fine collection and to ensure that toxic substances do not reach the Miskolc waste-treatment plant. Although the recent decline in industrial activity has lessened this problem, there are indications that episodic hazardous discharges are entering the system. The data available to the WASH team were insufficient to judge the severity of the problem but the system should be noted as a potential problem area requiring further study.

Both of these potential projects are candidates for long-term program development; they are not immediate investment opportunities. The waste dump problem requires developing specific interventions based on the findings of the two studies now under way. It is likely that additional preinvestment work will be required to select high-priority sites and to design the interventions.

The issue of industrial discharges into the Miskolc sewerage system also requires additional study to ascertain the magnitude of the problem and whether it requires facility investments or management interventions. Such an effort may also be handled as part of a larger project to upgrade the Miskolc wastewater treatment plant (see below).

4.4 Nonpoint-Source Abatement Projects

Three longer-term problems in the Sajo-Hernad basin in Hungary deserve further attention but do not appear to pose immediate threats to public health:

- reducing elevated nitrate levels in the Hernad;
- reducing elevated nitrate and coliform contamination in the Bodva; and
- reducing elevated nitrate and coliform levels in the Sajo.

4.4.1 Protecting Water Quality in the Hernad

The Hernad water-quality sampling that the WASH team examined shows moderately high levels of nitrates fluctuating around 20 to 25 mg/L both at the Slovakian border and at the point of confluence with the Sajo. The levels probably were the result of agricultural runoff and the numerous unsewered farming villages in the area, as well as the high baseload coming from the Kosice area in Slovakia. This problem does not appear to be seriously affecting drinking water quality in the basin thus far. Furthermore, proposed improvements to the Kosice wastewater treatment plant, when completed, as well as other improvements in Slovakia, should reduce the base levels such that the resulting water quality reaches acceptable levels where the Hernad enters Hungary. Thus, no immediate threat to public health is apparent.

4.4.2 Protecting Water Quality in the Bodva

The Bodva has been designated as a Class I river to be protected as a future drinking water source. However, there are many unsewered settlements along the Bodva's main stem and its tributaries. Many of these settlements also have contaminated groundwater, primarily from septic tank and possibly agricultural runoff. BAZ Co. has prepared a long-term plan for providing sewerage system coverage along the Bodva basin (at an estimated total cost of about US$ 150 million), but funds are unavailable to cover the costs. In addition, two of the municipal wells serving Edeleny show very high nitrate levels, requiring either special treatment or replacement of their water sources (i.e., with water purchased from ERV). Given that the Bodva is not needed immediately as a drinking water source, and that the affected communities would require substantial subsidy to provide sewerage coverage, this project must be considered a longer-term and lower-priority one for the present.

4.4.3 Protecting Water Quality in the Sajo River

Water-quality analyses in the Sajo main stem and its main tributaries, Hangony Creek and Szinva Creek, show consistently high levels of nitrate and coliform bacteria. Such levels pose immediate threats to public and private water users along these streams. In addition, high nitrate levels are found in municipalities lying above the Lazberc Reservoir and at the upper end of the Sajo basin near Putnok. A study of the extent and causes of high nitrate levels is required.

Heavy metal contamination is primarily a spot problem in several locations rather than a wide spread, in-stream water-quality issue. The team found contaminated sediments in Ozd (lead, cadmium, and zinc) and in Miskolc (cadmium and copper). Moderately high levels of cadmium sediments were also found in the Sajo just below Miskolc near the confluence of the Sajo and Hernad, a particularly sensitive area. Monitoring of aquifiers near these heavy-metal deposits is required to ensure that those metals are not contaminating important drinking water supplies (routine well field testing does not indicate a problem at present).

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4.5 Institutional Development

Beyond the set of potential pollution abatement projects identified above, Hungary needs assistance in revamping its institutional structure for providing water supply and wastewater services to localities. As described earlier, the current restructuring involves turning over water supply and sewerage system assets to the municipalities. However, there are a number of institutional issues to be addressed primarily deal with regional concerns: provision of (and tariff setting for) bulk water supplies; area-wide planning for new facilities; provision of water to communities with contaminated groundwater; watershed protection; and development of wells, surface intakes, and water treatment plants. In addition, the individual municipalities will likely need assistance in contract management for water/sewer services, tariff setting, capital investment programming, and related issues of service management. There appears to be no mechanism in place to provide this type of technical support.

The futures of the North Hungarian Regional Water Works Authority (ERV) and the BAZ County Water Works Company (BAZ Co.) are also in some doubt. Clearly there is a need for some regional institution to provide bulk water (i.e., managing the infrastructure that is already in place) and a need for an agency to provide management services to municipal water/sewer systems. Just how ERV and BAZ Co. may be restructured is still uncertain, but the outcome of the restructuring is critical for the sound management of the region's water resources.

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Chapter 5

THE PREFEASIBILITY STUDY

5.1 Project Selection and Rationale

Based on review of the assessment data in Chapters 1 through 4 above, the Government of Hungary (GOH) selected for further prefeasibility work the development of a project to protect the groundwater aquifer lying at the confluence of the Sajo and Hernad rivers. This corresponds to Project No. 1 on the list of seven potential projects listed in Table 12 in Chapter 4. The GOH also requested that the project incorporate elements of both Project No. 7 (industrial wastewater discharges in the Miskolc municipal system) and Project No. 4, which concerns the quality of the Hernad River on the lower third of its length.

On the basis of this mandate, the WASH team has defined a comprehensive, phased effort to protect the critical groundwater resources of the Sajo-Hernad confluence. The overall project area includes the greater Miskolc metropolitan region, an area of approximately 350 square kilometers with a population of almost 300,000 (Miskolc City alone has a population of 200,000). Within this region, the two key drinking water sources are the karstic springs lying to the west of Miskolc (which produce about half of the city's water supply) and the alluvial aquifer lying between the Sajo and Hernad (which contains half the city's water supply and serves as a source for the regional supply systems as well). This latter source also provides the major source of bulk water for an additional population of more than 300,000 through ERV (the basin has a total population of 740,000). The aquifer comprises the main target for the proposed project with the immediate vicinity of the main drinking water wells defined as a "groundwater protection area." Figure 16 provides a map of the study area and the target protection site.

The nature of the threat to the area's key groundwater resources is several-fold:

- A number of unsewered communities lie over and adjacent to the groundwater protection area (GPA). These communities are experiencing steady population growth even as Miskolc City is losing population.

- The Miskolc wastewater treatment plant discharges inadequately treated sewage into the Sajo as it skirts the GPA. The WWTP requires upgrading, including the completion of secondary treatment facilities now under construction, addition of more secondary treatment capacity to meet the needs of increased sewerage coverage, and upgrading of sludge processing and sludge management facilities.

- The town of Szikszo requires replacement of its poorly functioning wastewater treatment plant and an expansion of sewerage coverage of its unsewered areas.

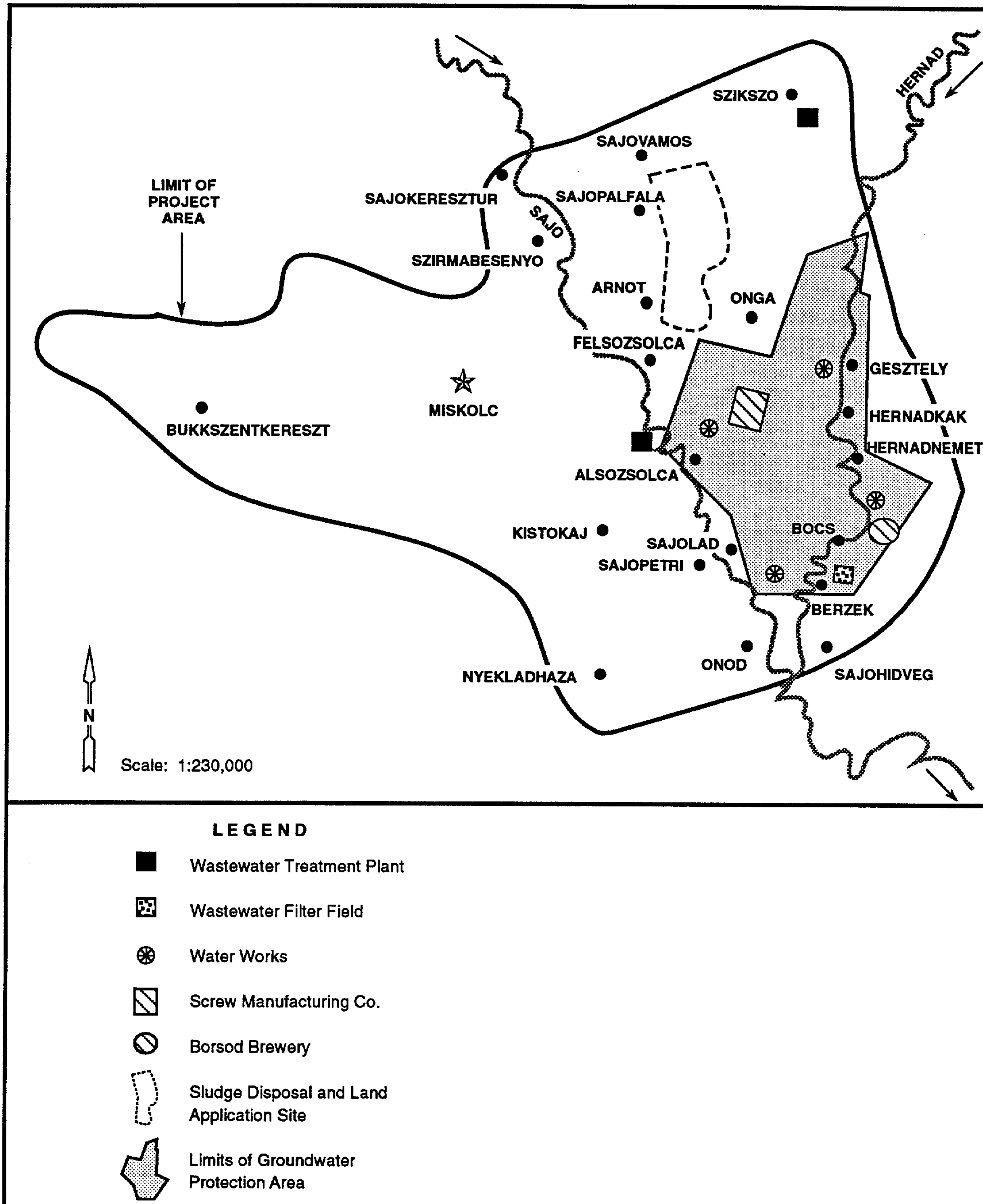

Figure 16
Map of Sajo-Hernad Prefeasibility Study Site

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- Miskolc requires a program to improve industrial pretreatment for industries discharging into the municipal sewer system (both to safeguard the treatment facilities and to permit sludge utilization in agriculture).
- A major brewery adjacent to the GPA will likely require upgrading of its wastewater treatment facilities. Additionally, a nearly abandoned industrial site within the GPA will require some hazardous waste cleanup.
- More than 90 potential sites of groundwater contamination (waste dumps, lagoons, livestock compounds, gravel, and sand pits) have been identified but not analyzed.

The GPA near the confluence of the Sajo and Hernad rivers was determined in 1991. It encompasses four major water supply extraction well systems: Eastern Peak Demand Water Works, Sajolad Water Works, Alsoszolca Water Works, and the Borsod Brewery Water Works. The aim of establishing this protection area was to restrict or counteract activities and land-use patterns within the area that potentially or actually endanger or pollute the aquifer's water quality. To date, the demarcation of this protection area has done little to remove the threat posed by human activities, although there is increased recognition of the need to do so. The GPA's creation has led to at least one unfortunate repercussion. In the case of Belegrad (near the Eastern Peak Demand Water Works), for example, strict land-use controls are reportedly driving residents to leave and are hurting economic activity.

The proposed project area, as shown in Figure 16, encompasses the critical areas that directly effect the GPA. The limits encompass the groundwater protection area, the entire Miskolc City wastewater collection system, communities that are expected to be connected to the Miskolc system in the future, all communities (mostly unsewered) lying north of the confluence of and along the Sajo and Hernad rivers up to Szikszo, and the Miskolc sludge disposal/land application site near Arnot.

Medical evidence linking improper treatment and disposal of wastewater in the GPA with disease incidence is inconclusive. No waterborne epidemic has been reported in the past 20 years, and no epidemiological studies have been performed. However, the medical community is concerned about the connection between malfunctioning septic tank systems and contamination of vegetables as well as degradation of the underlying aquifer. In the vicinity of the confluence of the Sajo and Hernad rivers, cancer incidence reportedly has risen by a factor of 4 or 5 in the past 10 years.

5.2 Project Components

The proposed project has been divided into three phases based on priority ranking. Priority phasing has been determined by the severity of the problem being corrected, availability of technical solutions to the problem, and availability of funding to undertake the work. While the overall program could be undertaken as a single package, it is more reasonable to expect that the separate components will likely be undertaken in stages, given the decentralized nature of wastewater responsibilities and financing in Hungary.

For some of the project's facility design/construction activities, the WASH team has assumed that a project preparation facility (PPF) could be established.

5.2.1 Phase 1: Highest Priority

The following activities are most critical and can be undertaken immediately. Technical

assistance activities (notably the industrial pretreatment program) cited in Component 1.3 below should be considered high-priority candidates for donor grant funds now being programmed. Miskolc may serve as a model for developing an industrial pretreatment program since a wide range of industries are located within the city that contribute a high proportion of the municipal wastewater.

Component 1.1: Extend sewerage coverage to 10 unsewered municipalities in and near the groundwater protection target area (including connection to Miskolc wastewater treatment plant).

Under this component, all wastewater from 10 communities located in and near the GPA would be collected and pumped to the Miskolc WWTP for treatment. The 10 communities to be served by this new system are the following:

- Berzek
- Bocs
- Gesztely
- Hernadnemeti
- Hernadkak (and Belegrad)
- Onga
- Sajolad
- Sajopetri
- Sajohidveg
- Onod

The communities had a total 1992 population of 32,501, and are projected to have about 35,750 by the year 2000. The new system will call for the abandonment of all septic tank and other on-lot disposal systems in the area and the construction of a sewerage network consisting of approximately 25 km of main sewers, 125 km of street laterals, and 11 pumping stations.

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The WASH team examined two main alternatives for treating the wastewater from the 10 municipalities:

- Via a new network, route the entire flow of the 10 municipalities to the existing Miskolc WWTP (with required enlargement of the pumping station at Alsoszolca); and
- Route the flow of those municipalities that lie along the lower Hernad to a WWTP below Sajohidveg (which would have to be built) with the balance of the municipalities utilizing the Miskolc WWTP.

Alternative 1, routing the entire flow to Miskolc, is the cheaper solution because of the scale economies of using the existing Miskolc WWTP (and being able to take advantage of the excess capacity of the primary treatment facilities already installed there). Therefore, the team has selected alternative 1 as the basis for Component 1.1 of the proposed project.

Connections from individual houses to the sewerage network are the responsibility of homeowners. An estimated 7,900 house connections are required.

Estimated construction costs at mid-1993 price levels are estimated as follows: sewerage network, $US 13.97 million; and house connections, $US 1.90 million, for a total component cost of $US 15.87 million.[2]

Component 1.2: Institute a program to identify, remedy, and control groundwater contamination from waste dump sites in the groundwater protection area.

Subcomponent 1.2.1: Further analyze priority sites for waste cleanup in the groundwater protection area (including waste dumps, lagoons, livestock compounds, open mine pits, and contaminated soil at sites of closed industries).

Under this subcomponent additional analysis[3] should be performed to determine priority sites for the cleanup of nonpoint sources of pollution. About 90 such sources have been identified, including lagoons, waste dumps, manure piles, livestock compounds, agricultural cooperatives (which produce fertilizers, pesticides, and oil), open sand and gravel mines, and contaminated soil.

The total estimated cost of the study is $US 600,000.

Subcomponent 1.2.2: Establish regulations and an enforcement program to control new groundwater- and surface-water-contamination activities in the GPA.

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[2] These cost estimates do not contain allowances for contingencies and should be used only as preliminary estimates; they have been derived using U.S. facility cost functions adjusted for Hungarian labor cost factors.

[3] This analysis should make use of the results of studies being carried out under EC PHARE support that are in the process, as of early 1993, of identifying such sites in the study area.

Under this subcomponent, regulations and an enforcement program should be developed to control and prevent new and potential groundwater- and surface-water-contamination activities in the project area, especially in the GPA. The program will be prepared early because of its urgency in stopping further degradation of the water environment.

The total estimated cost of this subcomponent is $US 125,000.

Component 1.3: Institute an industrial pretreatment program for Miskolc sewerage system.

Miskolc contains most of the industries in the Sajo basin, with the industrial load contributing 23 to 25 percent of the demand on the Miskolc WWTP at present. Appendix A contains a more detailed analysis of the industrial wastewater loads in Miskolc, as well as analysis of the existing emissions control program. In summary, the existing program is not functioning well, putting at risk the groundwater resources in the study area from two different sources: the direct discharge from the Miskolc WWTP into the Sajo discharge may be contaminated with industrial waste and threatens the sensitive biological treatment process under construction); and the WWTP sludge, which may contain heavy metals and toxic organics, making application on agricultural land hazardous.

For the above reasons, development of an industrial wastewater pretreatment program for Miskolc is recommended. This would be a short-term activity with long-term benefits. Because Miskolc has a large number of various types of industries, it could serve as a pilot area for studying and implementing related national environmental policies. The elements of the work would include the following:

- industry survey;
- effluent analysis;
- development of regulatory scenarios;
- estimate of industrial pretreatment costs;
- evaluation of environmental and economic impacts of scenarios;
- evaluation of methods for recovering industrial wastewater treatment costs; and
- issuing permits and reporting on compliance with monitoring scenarios.

The total estimated cost of this subcomponent is $US 200,000.

5.2.2 Phase 2: High Priority

The following activities should be undertaken as soon as financing arrangements can be secured. Technical assistance activities (notably the improvements to operating efficiencies cited in Component 2.2 below) should be considered high-priority candidates for donor grant funds now being programmed.

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Component 2.1: Upgrade and expand Miskolc wastewater treatment plant to meet requirements to the year 2010.

Subcomponent 2.1.1: Complete current construction and installation of secondary (biological) treatment capacity of 70,000 m^3 per day.

The construction of a 70,000 m^3 per day biological (activated sludge) treatment facility at the Miskolc WWTP is expected to be completed in 1993. However, its completion is overdue and is essential to the effectiveness of Components 2.2 and 2.3. No cost has been assigned to complete this subcomponent, and an in-depth review is needed to confirm whether cost should be assigned under this project.

Subcomponent 2.1.2: Upgrade sludge processing system (capacity of 105,000 m^3 per day) to permit safe land application.

Under this subcomponent, the sludge processing facilities at the Miskolc WWTP will be completely upgraded. This upgrading will result in a processing capacity of 105,000 m^3 per day and will treat mixed primary and excess activated sludge. The addition of biological treatment facilities significantly changes sludge's consistency and increases its volume from that experienced with primary treatment only. Appendix B provides a discussion of the technical issues in and alternatives to upgrading the Miskolc WWTP.

Major sludge processing elements include thickening, digestion or alternative stabilization technology such as N-VIRO advanced alkaline stabilization, and dewatering. (For a description of the N-VIRO process, see Appendix D.)

It is anticipated that between 60 and 75 m^3 per day of dewatered sludge will be produced at 25 to 32 percent solids content, suitable for agricultural land application.

Estimated construction cost is $US 8.56 million. Total subcomponent cost is $US 9.42 million.

Subcomponent 2.1.3: Expand secondary (biological) treatment capacity by 35,000 m^3 per day (bringing total capacity up to 105,000 m^3 per day).

Under this subcomponent, the biological treatment facilities at the Miskolc WWTP would be expanded from a capacity of 70,000 m^3 per day to 105,000 m^3 per day. This new capacity will match that of the upgraded sludge processing facilities.

Major processing elements include aeration, intermediate pumping, final sedimentation,equipment/operating buildings, site development, and piping/utilities.

Design of the facilities will be performed as part of the project. Estimated construction cost is $US 11.37 million. Total estimated subcomponent cost is $US 12.50 million.

Component 2.2: Improve operating efficiencies in water supply and wastewater agencies.

Subcomponent 2.2.1: Undertake activities to increase the connection rates of households to existing sewerage networks.

Under this subcomponent, activities would be performed to encourage and increase the rates of household connections to existing sewerage networks. This effort would also benefit the rate of connection to new networks constructed under the project.

The total estimated cost of this subcomponent is $US 125,000.

Subcomponent 2.2.2: Assist local water and wastewater agencies in improving financial management and cost recovery by focusing on minimizing cost, reducing unaccounted for water, and improving bill collection.

Under this subcomponent, assistance would be provided to local water and wastewater agencies to improve their services at lower costs.

The estimated cost of the work is $US 250,000.

Subcomponent 2.2.3: Conduct a performance evaluation and training program at Miskolc wastewater treatment plant.

Under this subcomponent, two activities would be performed:

- Miskolc WWTP performance evaluation, to determine where operational improvements to the plant may be made.
- A training program for Miskolc's sewerage systems and WWTP. The program should also encompass training equipment needs.

The estimated total cost of this subcomponent is $US 40,000.

Subcomponent 2.2.4: Purchase inspection, cleaning and maintenance equipment for the Miskolc wastewater collection system.

Under this subcomponent, wastewater collection system inspection, cleaning, maintenance, and monitoring equipment needed by the Miskolc Water Board would be purchased.

The estimated total cost of this subcomponent is $US 1.95 million.

Subcomponent 2.2.5: Develop a public information program for sludge utilization on agricultural sites.

Under this subcomponent, a public information program would be developed to assist authorities in obtaining the acceptance of the public and of agricultural operations in particular as to the proper utilization of sludge. It is important to develop this acceptance prior to completing the new sludge processing facilities at the Miskolc WWTP.

The estimated total cost of this subcomponent is $US 100,000.

Component 2.3: Improve the Borsod Brewery (Bocs) wastewater disposal system (filter field, conveyance, and treatment).

For the Borsod Brewery in Bocs, a new 58-hectare (ha) surface irrigation system would replace the existing 27 ha poplar tree filter area. Further studies will be required as part of the design to verify the new area required.

The estimated total cost of this component is $US 1.20 million, including system design.

5.2.3 Phase 3: Lower Priority

The following activities have been ascribed less priority, primarily for financial reasons. They have relatively high unit costs (cost per household served) and may not be affordable in the near term.

Component 3.1: Extend sewerage coverage to unsewered and partially sewered areas of Miskolc and suburban municipalities.

Under this component, the sewerage network would be extended to unsewered areas that are now being planned or that must be connected with the existing Miskolc sewerage network for treatment at the Miskolc WWTP. The 11 communities to be connected under this component are as follows:

Now planned by the Miskolc Water Board:

- Omassa
- Bukkszentlazlo
- Szirma
- Martintelep

Estimated total population to be sewered—30,085.

Other unsewered communities:

- Kostokaj
- Bukkszentkereszi
- Nyekladhaza
- Sajokeresztur

- Szirmabesenyo
- Sajovamos
- Sajopalfala

Estimated total population to be sewered—16,547.

The total 1990 population of 46,632 to be served under this component (30,085 + 16,547) is projected to increase to 48,287 by 2015. The new system would call for abandonment of all septic tank and other on-lot disposal systems and construction of street laterals, main sewers, and several pumping stations.

Estimated construction costs for the proposed sewerage network extensions are as follows: systems now planned, $US 7.28 million; other communities, $US 6.75 million.

The total estimated cost for construction of the proposed sewerage network extension is $US 14.03 million.

Under this component, house connections would be made to the sewerage network constructed. All houses would be connected; the estimated number of house connections required is broken down as follows: to four systems now planned—15,275; in seven other communities—5,201.

Estimated construction costs for the house connections are $US 3.82 million for the four systems now planned, and $US 1.30 million for the other seven, for a total of $US 5.12 million.

Component 3.2: Reconstruct the Szikszo wastewater treatment plant and extend sewerage coverage.

Under this component, the Szikszo WWTP would be replaced and the Szikszo sewerage system will be extended to serve the entire community. The area's 1990 population was 6,119, and a population of 6,730 is projected for 2015.

The new WWTP would replace the existing 300 m^3 per day, outmoded, overloaded plant. The new plant will be sized for about 1,000 m^3 per day, but this may require adjustment depending on the disposition of the ATEV animal feed production plant, which is now in liquidation.

The expanded sewerage network would permit the abandonment of all septic tank systems in Szikszo. The expansion would consist of approximately 30 km of main sewers and street laterals. An estimated 2,100 house connections will be required. Estimated construction costs are as follows:

- WWTP: $US 2.10 million;
- Sewerage network: $US 2.62 million; and
- House connections: $US 500,000

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The estimated total component cost is $US 5.22 million.

A summary of all project component costs is provided in Figure 17.

Figure 17

Project Component Costs

Phase 1		$ US
	Component 1.1: Extend sewerage coverage to 10 unsewered municipalities	15,870,000
	Component 1.2: Institute a program to identify and control waste dump contamination	725,000
	Component 1.3: Institute an industrial pretreatment program for Miskolc sewerage system	200,000
Phase 2		
	Component 2.1: Upgrade and expand the Miskolc WWTP	21,920,000
	Component 2.2: Improve the operating efficiencies in water and sanitation agencies	2,465,000
	Component 2.3: Improve the Borsod Brewery wastewater system	1,200,000
Phase 3		
	Component 3.1: Extend the sewerage network to unsewered areas of Miskolc and suburbs	19,150,000
	Component 3.2: Renovate the Szikszo WWTP and expand the sewerage network	5,220,000

5.3 Implementing the Project

The project may be implemented as a single package or as individual components. The advantage of implementing the project as a single package is that the components can be better integrated and that, if total financing can be arranged, benefits will start to accrue sooner. On the other hand, this approach bears some disadvantages. First, the financing package will take considerable time to assemble since it will almost certainly come from different sources. Second, a project coordination unit should be established for dealing with the many different agencies at the local level. This not only adds to the overall cost of the project, but may run counter to the decentralization objectives of the Government of Hungary. It should be noted that all of the project components comprise functions that are already assigned to one agency or another at the local level.

A major institutional question is the role of the Miskolc WWTP (and sewerage network) as a regional, rather than municipal, asset. The economics of the proposed project clearly indicate that the Miskolc WWTP should become the main treatment facility for up to 17 other municipalities. Indeed, the WWTP already serves parts of several other municipalities in the suburban Miskolc area. However, if a large number of municipalities become clients of the Miskolc system, some new form of municipal control over the Miskolc Water Board (MWB) may be indicated. This issue is discussed in more detail in Section 5.4 below.

While most of the project components are separate and may be implemented singly, some important linkages exist between them. For example, unless the problem of household resistance to hooking up to the sewer system is overcome, the investments in new sewerage networks will be unproductive. In addition, investment in new sewerage networks will also require expansion of the Miskolc plant beyond its current capacity. Furthermore, the industrial pretreatment program in Miskolc is needed to ensure that the sludge from the wastewater treatment plant can be used in land applications in the area.

5.4 Financial Analysis

5.4.1 Affordability

Table 13 summarizes some of the basic data on which the financial analysis is based.

Table 14 shows the cost of the four project components that involve large-scale capital investment. The table includes costs of the infrastructure construction as well connection charges to hook up individual households to the sewerage networks. Average cost per household served is also provided and is instructive. The cost of upgrading the Miskolc wastewater treatment plant, although the largest project cost item, has a low cost per household (HH) served given the large number of users that would benefit. Conversely, the Szikszo project is the most expensive in terms of cost per user. It should also be noted that the cost of upgrading the Miskolc WWTP will also be added to the costs per HH of Components 1.1 and 3.1 since those households will also benefit from that upgrading and expansion.

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Table 13

Summary of Financial Data, Hungary in $US

National GNP/capita (1992 est.): $3,450

Inflation: 1991 = 32% 1992 = 25% 1993 (est.) = 20%

Average household income: $7,200

Number of persons/household: 3.5

Municipality income/capita (nationwide): $527 (1991 actual)

Composition: Central grants = 65%

Shared taxes	=	12%
Local taxes	=	20%
Miscellaneous	=	3%

Grants for local WS&S investments = $56.4 million or $5.32/capita (1991).

Table 14

Project Capital Cost Breakdown in $US

Project Component	Project Cost	HHs Served	Cost per HH Served
1.1 Sewerage in 10 municipalities in GPA	$15,870,000	11,143	$1,424
2.1 Miskolc WWTP expansion	$21,920,000	73,800	$297
3.1 Miskolc sewer expansion	$19,150,000	9,353	$2,047
3.2 Szikszo WWTP and sewer	$5,220,000	2,100	$2,486

5.4.2 Cost Recovery

There are three potential sources for recovering the capital costs of the four investment components cited in Table 14:

- direct charges to users (either through the tariff or direct assessment);
- contribution from municipal revenues; and
- nonrepayable grants from the central government.

It is difficult to ascertain the exact percentage of cost recovery among the three sources in the past since these investments have historically been financed with a good deal of hidden subsidization. For example, the World Bank estimates that 35 percent of water supply and sanitation (WS&S) sector investments in 1991 came from the central government, with the balance raised via "water civil works associations" plus local government contributions. The civil works associations contributed 49 percent with about two-thirds of that amount provided through subsidized loans by the OTP.

Direct Charges to Users

The WASH team expects that direct cost recovery for capital investment will increase under the fiscal decentralization policies of Hungary's central government. However, given that tariff rates have risen so greatly during the past three years, there appears to be little room left in the tariff for further increases. In Miskolc, the average household bill for water and sewer services has risen from 525 HUF ($US 7.40) per month in 1992 to 775 HUF ($US 9.23) per month in 1993, reflecting a 50 percent increase in the combined rate. Indeed, tariff rates in Hungary now are on par with rates in other European countries and the U.S., despite much lower income levels.

The sharp increase in the Miskolc tariff rates is troublesome because it reflects largely increases in operating costs. Depreciation only accounts for about 15 percent, which is consistent with the experience of water authorities throughout Hungary; they average 12 to 13 percent of total water and sewer costs devoted to depreciation. If a greater percentage of capital cost is to be recovered through the tariff, operating costs must be contained (and, in fact, the very large recent increases must be rolled back).

From discussions with local officials in the study area, it has been suggested that direct assessments from beneficiaries could only be used to cover the connection charges for new sewer networks, a sum of about $US 240, or 20,000 HUF per household. Were this cost financed over a five-year period at 20 percent interest, it would require payments of about $US 6.36 per month, equal to about 70 percent of the 1993 average household water/sewer bill.

Contributions from Municipal Revenues

Municipalities have historically contributed relatively little to WS&S sector investments in Hungary. However, that is mandated to change as municipal governments have now been given ownership of WS&S assets at the local level. In addition, municipal governments have taxing authority and receive substantial transfers from the central government, so they will become increasingly the focal point for resource mobilization to finance WS&S investments locally.

As noted in Table 13, municipal governments are extremely dependent on central government transfers for revenues. Furthermore, most of that revenue comes in the form of grants that are not tied to any secure revenue base. Local governments do receive about 12 percent of their revenues in "shared taxes," mainly a percentage of the personal income tax collected in each jurisdiction. That revenue is also not secure since the percentage allocation can be changed readily by the central government.

Discussions with local government officials of the 10 municipalities in the GPA indicate a willingness to assume a debt to cover at least 20 percent of the proposed capital cost of the sewer construction and to guarantee that debt with the shared tax receipts. Since shared tax revenues may decline somewhat with lowered employment in the area, the WASH team used a figure of 10 percent of 1991 total local revenues as an estimate of such guarantees. This produces a figure of $US 107.50/HH for the 10 municipalities and $US 161/HH for Miskolc City.[4] Table 15 shows how much of the project costs could be covered by such guarantees, assuming the full amount of the shared tax revenues was devoted to debt service.

The figures above indicate that project Component 1.1 would require approximately 47 percent additional financing beyond local sources under the assumptions outlined above. Components 3.1 and 3.2 would require, respectively, 63 percent and 73 percent more.

[4] Miskolc is expecting a drop in shared tax income from the personal income tax in 1993 to about one-third of that realized in 1991 and 1992. With this expected reduction, the shared tax will still account for about 11 percent of total municipal revenues. The smaller municipalities in the GPA are expecting a smaller decline of about 15 to 30 percent.

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Table 15

Estimates of Local Debt Capacity

Project Component	Paid by HH Monthly Payment per HH ($US)	Paid by Municipal Government/ Month per HH ($US)	Total Residual Amount to be Covered per HH ($US)	Percent of Original Investment
1.1 Sewerage in GPA	6.36	8.95	674.41	47
3.1 Miskolc sewer expansion	6.36	13.42	1,282.89	63
3.2 Szikszo WWTP and sewer expansion	6.36	8.95	1,811.59	73

Notes: Household payment covers connection fee of $US 240 amortized over 5 years at 20 percent interest. Municipal payment equals 10 percent of total local revenues (1992 amount). Residual calculated assuming net present value calculation of municipal payment amortized over 15 years at 20 percent interest.

Central Government Grants

Component 1.1 should qualify for targeted grants of 60 percent of the cost of the project, given that the participating municipalities are presently unsewered; several of the 10 may qualify for additional amounts given their very small size. In addition, the 10 municipalities are proposing to undertake the project as a consortium and have expressed the intent also to apply for additional funding from the central Environment and Water Funds. Given the high priority attached to protecting the underlying aquifer in the GPA, the case for additional grant consideration is strong.

Even without the additional funds beyond the targeted grants, Component 1.1 appears to be affordable. The main contention is how much of the project cost beyond the targeted grant amount can be secured from the other funds and how much will each municipality have to pay from its own revenues. As noted above, local officials from the 10 municipal governments have stated willingness to pay for 20 percent of investment costs from local revenues (which would average about 6.5 percent of local revenues in 1992). The extent to which they may have to go higher will depend on the success of applications to the Water and Environment Funds.

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Project Components 3.1 and 3.2 are more problematic with regard to affordability. First, it is unclear just how much of targeted grant support either project could anticipate. Szikszo has a sewerage network, though small, and a wastewater treatment plant, though poorly functioning at present, so it does not qualify as an unsewered municipality. The areas that fall into Component 3.1 are similar in that they do not appear to qualify automatically for targeted grant support. Furthermore, both components will require substantially more aid (per household) than Component 1.1. At this time, neither project component appears affordable.

Cost recovery for upgrading the Miskolc wastewater treatment plant poses some special problems. On the positive side, its cost can be spread over a large number of users. On the other hand, there appears to be no automatic grant program for which it qualifies. Furthermore, local municipal support may be hard to mobilize given that (a) municipalities outside of Miskolc are already contributing to sewer system expansion, (b) the Miskolc municipality contributed 150 million HUF (about $US 2 million) in 1992 to the upgrading program at the wastewater treatment plant, and (c) the sheer number of separate municipal jurisdictions that would have to agree (18 in number) will confound the process.

Allocating the cost of the Miskolc WWTP upgrading involves both allocations across municipalities and between industry and residential users. Table 16 shows the current usage allocation for the Miskolc WWTP. Currently, industry uses 25 percent of plant capacity on a simple volume basis. If we assume growth in the region (and thus wastewater demand) will come mainly from household formation in the suburban Miskolc area, then by 2025 industrial utilization will decline slightly to 20 percent. If we allocate capital cost on this basis, industry would be assessed 20 percent of the cost, dropping the cost per individual household of the project to about $US 238/HH.

Table 16

Usage of Miskolc Wastewater Treatment Plant

Usage	1,000 m^3/Day	% Total	% Billable
Billable:			
Domestic/Institutional	35,000	50	75
Industrial/ Commercial	11,700	17	25
Nonbillable:			
Infiltration	16,500	23	
Other	7,100	10	
Grand total	70,300		

The most straightforward way to recover costs of the Miskolc WWTP upgrading would be to create a uniform assessment that covers both households currently connected as well as future connections. Under this scheme, the Miskolc Water Board (MWB) would assess each household connection a lump sum amount that could either be financed over five years or paid in full. The amount would be calculated on the total number of households expected to be hooked up during the next 25 years (current estimate is 73,800 households). For future hookups, the assessment amount would be increased in line with the cost of financing the unused capacity (i.e., it would increase roughly in line with the interest rate paid by the MWB).

Table 17 shows the assessment amounts for existing households (assuming payment made in 1994) and, to illustrate the escalation for future connections, the table also indicates assessments for households that might join in 1999. The assessment amount, if financed, could be added to the water/sewer bill each month as a surcharge. In the event an individual municipality wanted to cover the assessment amount for its residents either partially or in full, that municipality could make payment to the MWB and the monthly surcharge for those residents would be removed.

Table 17

Estimated Assessment Amounts for Household Cost Recovery
for Miskolc Wastewater Treatment Plant

Existing Households	Future Household Connections
1994 lump sum payment $US 190.00	1999 lump sum payment $US 394.40
Monthly payment (5 year, 20% interest) = $US 5.03	Monthly payment (5 year, 20% interest) = $US 10.44

Designating MWB as the recipient of a loan for the proposed project poses two problems: (1) the MWB would require 100 percent financing because it has no capital reserves of its own; and (2) the Water Board could only secure the loan with future revenues and has no alternative source of repayment in case those revenues prove insufficient.

The MWB has had rather erratic financial performance in the past few years and is currently plagued with very high operating cost increases. The MWB would be required to provide a substantial amount of financial appraisal and some technical support in order for a lending agency (even the central government) to be confident of repayment. One alternative would be to have the participating municipal governments guarantee the loan to the MWB with local revenues, probably in proportion to the number of households in each locality. In exchange for such a guarantee, the municipal governments would undoubtedly demand some authority over MWB operations and financial management. Given that the Miskolc WWTP is evolving

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into a regional asset, perhaps it is time to reconstitute the Water Board as a regional body with participation by the affected municipalities.[5]

Since few lenders would be interested in providing 100 percent financing for any project, the MWB is also confronted with the problem of raising funds for a local matching amount. While this amount is generally negotiable, it would probably not be less than 25 percent. These matching funds could be raised most likely from two sources: internal cash generation from the recent high tariff increases, and contributions from participating municipal governments. Both of these would require a considerable amount of time to arrange, and are not at all certain.

5.4.3 Sources of Financing

The proposed project's capital investment components will require a combination of grant and loan financing. As noted above, the existing grant programs appear to be sufficient to enable Component 1.1 to move ahead. It is unclear, however, that any grant programs will cover the other three components (although, as described above, the Miskolc WWTP upgrading should be financeable with a creative cost recovery program that allocates cost across industry and households, both now and in the future).

Two possible sources of loan financing are available for Components 1.1 and 2.1 (the other two project components do not appear financially feasible at this time and will not be discussed further). The first potential financing source is the proposed communal bank that is under development at present. It is to be capitalized with a loan from the EBRD and will make loans to municipal governments for all types of infrastructure projects, including WS&S investments. The communal bank will operate on the model of the typical European local government credit facility, raising funds in the domestic and international capital markets for on-lending to local governments at nonsubsidized rates. Since the terms and conditions of the Hungarian Communal Bank have not been announced, it is not known whether projects the size of Components 1.1 and 2.1 will qualify.

The other source of financing is a proposed World Bank sector loan that will provide a total of about $US 75 to $US 100 million to the government for financing high-priority WS&S projects. While this loan has not been prepared yet, it will likely involve on-lending to local governments as envisioned in Components 1.1 and 2.1. Preliminary discussions with the World Bank staff have indicated an interest possibly for both components to be considered as candidates for the World Bank program. Given the limited total amount of the World Bank loan, however, it remains questionable whether the loan would cover all of the borrowing requirements of both Components 1.1 and 2.1.

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[5] This issue could be a central concern of the World Bank's proposed study of institutional reform in the WS&S sector in North Hungary.

5.5 Next Steps

Components 1.1 and 2.1 are affordable and financeable, although the latter will require considerable work (and probably time) to put together its cost recovery program and loan package.

Table 18 presents the next steps required to move Component 1.1 forward expeditiously. Clearly, the most critical action is to undertake a detailed feasibility study and design work, since the key institutional and financial decisions require that as input. At the same time, the development of a lending channel must also proceed since none currently exists. The table also shows that the 10 municipalities need to develop a series of agreements, both among the group and within the individual town councils. One of the key decisions to make is whether to allocate cost among municipalities on an actual-cost versus an average-cost basis. This question arises because the actual construction cost of the sewer network varies substantially from one municipality to another, meaning that cost per household can vary by as much as a factor of 2.

Also needed will be an organizing unit to coordinate activities and to perform overall project management and financial coordination. This role should begin immediately because much organizing work must be done to put together the initial applications for the "Water Rights Authorization," as well as the grant proposals.

The "next steps" to take for Component 2.1 are presented in Table 19. These steps are less clear-cut than those for Component 1.1 because the prospects for financing this component are much fuzzier. Some key institutional issues must also be sorted out. The study being prepared by the World Bank could be quite helpful in this regard, if it were to focus on these specific issues of the MWB operations.

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Table 18

Next Steps for Project Component 1.1: Sewerage Extension in the GPA

Technical/Design Steps

1. Detailed feasibility study and system design

Institutional Steps

1. Formal agreement among the 10 municipalities to develop joint system and financing arrangement (including designation of project management and financial control unit)
2. Formal agreement between the 10 municipalities and the Miskolc Water Board for the right to connect to Miskolc WWTP
3. Submission to and approval of "Water Rights Authorization" by the central government to develop a wastewater system[a]

Financing Steps

1. Application to central government for targeted grant for system construction[a]
2. Applications to Environment Fund and Water Fund for grants to supplement targeted grant[a]
3. Agreement on allocating costs among participating municipalities (actual-cost vs. average-cost basis)[b]
4. Agreement on allocation of cost recovery between individual households and municipal governments[b]
5. Formal resolutions by individual town councils as to their willingness to assume debt, commit municipal revenues, and pledge shared tax receipts[b]
6. Preparation and submission of loan request[c]

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[a] Requires feasibility study and preliminary design

[b] Requires firm estimate of central government grant allocation

[c] Requires lending channel be established

Table 19

Next Steps for Project Component 2.1: Upgrading the Miskolc WWTP

Technical/Design Steps

1. Feasibility study and detailed design for WWTP upgrading (including selection of sludge handling process)

Institutional Steps

1. Agreement on role of participating municipalities in MWB management
2. Management improvements to control operating costs of water supply and sanitation services
3. Agreements on cost sharing and cost recovery procedures among participating municipalities

Financing Steps

1. Procedures to create capital investment reserve fund to serve as local loan match source
2. Discussions with potential lenders to determine terms and conditions
3. Discussions with central government agencies to determine possibilities for grant financing
4. Arrangement of legal agreements with municipalities to guarantee loans to MWB, if necessary
5. Establishment of cost recovery procedures and mechanisms

Appendix A

INDUSTRIAL WASTEWATER SOURCES IN THE SAJO-HERNAD BASIN IN HUNGARY

Existing Conditions

General

Miskolc is the second largest city in Hungary and the industrial center of Northern Hungary. The industries presently contribute about 23 percent of the wastewater and the organic load to the municipal wastewater treatment plant. The food industry and the metals related industries are concentrated in this area. The industries have pretreatment facilities to remove pollutants that are not compatible with municipal (biological) treatment systems in accordance with the national pretreatment regulations. The industries employ physical/chemical treatment processes to neutralize wastes and remove pollutants such as heavy metals and oil and grease. The operational efficiency and condition of these systems are regarded as substandard. Currently, these facilities are generally meeting the discharge standards because they are operating well below their nominal capacity due to the drastic drop in industrial production in recent years. In case of an industrial recovery, these treatment systems are not expected to meet effluent standards. The existing Miskolc treatment plant provide only primary treatment with an efficiency of about 30 to 40 percent organic waste removal and about 30 to 50 percent metals removal. As a result, the industrial waste load on the Sajo through the sewerage system is significant.

Some of the industries in the area discharge their treated industrial wastewaters directly to the receiving streams. These include the paper mill, the steel mill and several metal finishing industries on Szinva Creek running through Miskolc. There are few industries in the study area outside of the Miskolc system and these include the brewery in Bocs and a metal products plant in Onga. All of these industries has also experienced a drop in production or the installed capacity has not been reached in the case of the brewery.

Regulatory Background

The industrial treatment and pretreatment standards are set by the by the National Water Authority under the Ministry of Telecommunications, Transport, and Water Management. The standards vary according to the classification of the receiving streams. The Sajo has recently been upgraded to Class III from Class V. These uniform standards are in line with standards in effect in the EC and the US. However, effluent monitoring program and the enforcement of the standards are not effective. Pretreatment compliance is monitored by the Miskolc Water Works and effluents discharged directly to streams are monitored by the Environmental Inspectorates. The monitoring programs are designed essentially around the penalty clause given in the standards. Samples are taken by the enforcement authority about twice a year and penalties are assessed if noncompliance is documented. Sampling frequency is increased for violators. In any, case, the penalties are not high enough to favor compliance. The data base on industrial discharges is also limited to violations and do not attempt to document actual levels of emissions.

Industries in Miskolc

The industries discharging to the Miskolc sewerage system in 1991 are listed in Table A-1. The table also gives information on the type of industry, water use, pretreatment system utilized, pollutant parameters exceeded and the fines collected by the City. The highest volume of water consumption was by the DIMAG Steel Mill for domestic use only. DIMAG has its own industrial wastewater treatment plant discharging directly to the Szinva Creek. The major pollutant load on the Miskolc treatment plant from the industry consist of conventional pollutants. The 1991 record of parameters exceeded by the industries is also given in Table A-1 and show that those exceeded were primarily conventional pollutants rather than toxic substances such as heavy metals.

A breakdown of the wastewater volumes and pollutant loads by domestic plus institutional and industrial sources is given in Table A-2 based on 1992 data. The levels shown in the grand total are actually the average levels measured at the Miskolc Treatment Plant during 1992. The breakdown of loads between various sources is only approximate. The industrial flow and COD loads are estimates from the industrial wastewater monitoring data which is limited. The infiltration/inflow component for domestic and institutional sources and also the industrial sources are rough estimates. The industrial sources contribute about 25 percent of the hydraulic and organic load. This contribution was close to 40 percent before the recent political and economic changes.

Other Industries in the Project Area

The major industry in the project area outside of the Miskolc sewerage system is the Borsod Brewery located in the Town of Bocs. The domestic wastewater volume generated at this plant was an average of 175 m^3 per day in 1990 and 1991. The domestic wastewater is treated and discharged to the Hernad. The plant produces 250,000 tons of beer, 50,000 tons of soft drinks and 48,000 tons of malt per year. The volume of industrial wastewater ranges from 400 to 500 m^3 per day. This wastewater is treated by land application on agricultural land (locally referred to as wastewater filter field) but operational problems were claimed by various sources. As this discharge is located in the groundwater protection area, a detailed monitoring program and necessary improvements should be given priority.

The Onga Metal Works at Onga was another major industrial plant in the project area but it currently has minimal production. In 1990 and 1991, the domestic wastewater volume was 91 and 71 m^3 per day, and the industrial wastewater volume was 77 and 140 m^3 per day, respectively. A visit to the site by the WASH team in March 1993 indicated that there is hardly any activity. The major concern now is the storage of drums on the site and potential

Table A-1

Miskolc Sewer System Industrial Wastewater Dischargers in 1991

Industrial Plant	Type	Water Use m³/year	Pretreatment System	Parameters Exceeded	Fines (HUF)
DIMAG	Steel Mill	1,800,000	None (Domestic Waste only)	COD, Oils, Solids	Not assessed
BAZ County Allatforg.	Meat Packing	592,040	Grease Trap, Flotation	COD, Sulfide, Solids	239,868
Borsod County Dairy	Dairy	344,886	Grease Trap	COD, Oils, Sulfide, Solids	1,689,563
Miskolci Cooling Co.	Miscellaneous	198,347	Screening	COD, Oils, Sulfide, Solids	70,542
D4D	Wire Factory	195,000	Grease Trap		
Miskolci Liquor Factory	Liquor & Soft Drinks	154,773	Neutralization	COD, Oils, pH	57,118
MAV Service	Rail Transport	134,954	Oil Trap, Neutralization, Sed.	pH, Total Salts	37,853
Miskolci Mezogep	Garage	119,000	Neutralization		
HCM Co.	Cement Factory	81,590	Grease Trap, Sedimentation	Sulfide	2,436
Intercsokolade Diosgyor	Chocolate	62,000	Grease Trap, Sedimentation		
MAV Korzeti	Rail Transport	57,304	Oil Trap, Sedimentation	Oils, Sulfide, Solids	62,208
Chinoin Hypodermic	Ampules	47,000	Neutralization		
Borsod Volan	Trucking	41,602	--	Solids	352,215
Miskolci Plastic	Garden Furniture	39,160	--	Solids	4,629
Miskolci Laundry	Laundry	32,966	Solvent Trap, Sedimentation	Oils, pH, Solids, Detergents	60,660
Pannonglas Ipari	Glass Plate	31,000			
Epfu Szolg	Trucking	26,500	--		
Miskolci Bread Bakery	Bakery	25,000			
Chinoin Diosgyor	Pharmaceutical	22,351	Oil Trap	COD, Oils, Solids	
Koalfem Trans	Metal Products	12,250	Sedimentation	Oils, Sulfide, Solids	
Forest Products Factory	Forest Products	12,732	Neutralization	Salt, pH, Solids	108,936

Table A-1 (Continued)

Industrial Plant	Type	Water Use m^3/year	Pretreatment System	Parameters Exceeded	Fines (HUF)
Golden Star Restaurant	Restaurant	12,189	Grease Trap	COD, Sulfide	16,752
Posta Gepjarmu Szall.	Transport	11,749	Neutralization, Sedimentation	Oils	5079
Interglobe	Trucking	9,700	Oil Trap, Sedimentation		
Borsod County Nyomdaipari	Printing	8,251	Sedimentation		
Borsod County Zoldert	Restaurant	8,246	Grease Trap	COD, Oils, Sulfide, Solids	238,050
Cementipari	Garage	7,780	Oil Trap, Sedimentation, Filter		
Miskolci Bakery	Bakery	7,900		Salt	2,565
Miskolci Heating	Power Plant	7,000	--		
Express Restaurant	Restaurant	6,559	Grease Trap	COD, Sulfide	46,305
Gasztrofol Foods	Restaurant	6,316	Grease Trap	COD, Sulfide	39,966
Miskolci Autojavito	Garage	4,060	Oil Trap, Sedimentation	Oils, Sulfide, Slids	22,868
BVM Miskolci	Concrete Blocks	2,800	Grease Trap, Sedimentation		
Dental Center	Dental Services	1,892	Sedimentation	Solids	20,148
Ofotert Color Laboratory	Photo Lab	646	Sedimentation	Silver, Sulfide	4,193

Table A-2

MISKOLC WASTEWATER TREATMENT PLAN—JANUARY 1993

WASTE SOURCES AND ESTIMATED LOADS

SOURCE	POPULATION EQUIVALENT	FLOW m3/d	FLOW l/c/d	COD kg/d	COD kg/c/d	COD mg/l	BOD kg/d	BOD kg/c/d	BOD mg/l	TKN kg/d	TKN kg/c/d	TKN mg/l
Domestic & Institutional												
Domestic	166,063	29,550	178									
Institutional	30,628	5,450										
Infiltration/Inflow		18,000										
Total	196,691	53,000	269	26,800	0.136	506						
Industrial												
Food Processing	48,806	3,400		6,650	0.136	1,956						
Metallurgy	6,092	5,000		830	0.136	166						
Mechanical	514	630		70	0.136	111						
Construction	367	350		50	0.136	143						
Chemical	734	360		100	0.136	278						
Light Industry	294	190		40	0.136	211						
Transportation	2,202	1,000		300	0.136	300						
Telecommunications	220	100		30	0.136	300						
Other	954	670		130	0.136	194						
Infiltration/Inflow		6,000										
Total	60,181	17,700		8,200	0.136	463						
Grand Total	**256,872**	**70,700**	**275**	**35,000**	**0.136**	**495**	**14,540**	**0.057**	**206**	**3,570**	**0.014**	**50**

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contamination of the groundwater from past activities. It should be noted that the concern for groundwater contamination is not limited to this site alone as the extent of contamination in other sites is not documented.

Major Issues

The major issues related to industrial waste management are summarized below.

- The Miskolc sewerage system has the majority of the industries in the project area. The industries now contribute about 23 percent of the waste load to the system (down from 40 per cent before the economic slowdown). The present pretreatment performance is generally acceptable mainly because of the drop in industrial production. There is a good opportunity now to develop and implement an industrial wastewater pretreatment program as Miskolc moves toward upgrading the municipal treatment plant to biological treatment. The goals of such a program would include
  - Effective protection of the biological treatment system and wastewater sludges from metals and other toxic contamination.
  - Participation of the industry in cost recovery in an equitable way.
- Documenting extent of the hazardous waste contamination in the project area is of high priority. The present programs are in the inventory stage. Better documentation is needed to define the extend of environmental liabilities which is a significant issue in privatization of industries.
- Institutional and regulatory improvements are a prerequisite to implementation of any of above programs, and therefore, have the highest priority.

Recommendations

- Development of an Industrial Wastewater Pretreatment Program for Miskolc is recommended. This would be a short term activity with long term benefits. Since Miskolc has a large number of various type of industries, it can be a pilot area for studying and implementing related national environmental policies. The elements of work would include:
  - Industry survey
  - Effluent analysis
  - Development of regulatory scenarios
  - Estimate industrial pretreatment costs
  - Evaluate environmental and economic impacts of scenarios
  - Evaluate methods for recovery of industrial wastewater treatment costs

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- ☐ Permitting, reporting and compliance monitoring scenarios

- ■ Control of hazardous wastes is a long-term activity in all countries. One of the first steps that needs to be completed is determination of the magnitude and extent of the problem. As noted earlier, the present programs in Hungary are related to the inventorying of solid waste sites which, of course, is essential. Further activities toward quantification of the problem are recommended. Presence of various solid waste sites in the groundwater protection area addressed in this study and the absence of any related quantitative data exemplifies the need for such activities.

Appendix B

MUNICIPAL TECHNICAL ISSUES CONCERNING THE SAJO-HERNAD BASIN IN HUNGARY

Size of Miskolc WWTP Expansion

The design capacity of the existing primary (mechanical) treatment facilities is 140,000 m^3/d, and the capacity of the secondary (biological treatment facilities now under construction is 70,000 m^3/day. Sludge processing facilities are now capable of handling only primary sludge and not excess activated sludge.

From 1986 to 1991 flows to the WWTP averaged about 95,000 m^3/day on an annual basis, and in 1992 flows averaged slightly over 70,000 m^3/day. It is not known whether this drop in flow to the plant will continue, but it appears prudent to assume that little further reduction will occur inasmuch as the heavy impacts of both the economic slowdown and water rate increases have already been felt. Many suburban communities in the proposed project area now exhibit significant growth. Thus, influent flows may be expected to increase again in the future.

The hydraulic design of a WWTP expansion should not be based solely on present average annual flow rates, but rather on a maximum sustainable flow rate basis, for example, the maximum week or month flow rate. For the Miskolc WWTP in 1992 the following rates were recorded:

Annual Average	70,300 m^3/d
Average for Max. Month	78,980 m^3/d
Average for Max. Week	94,050 m^3/d
Average on Max. Day	115,580 m^3/d

With the connection of unsewered and partially sewered areas to the Miskolc WWTP the average flow in the maximum month may be expected to increase to 93,000 m^3/d and in the maximum week to 111,000 m^3/d. Based upon these data, it appears that the proposed 105,000 m^3/d capacity of the upgraded secondary treatment and sludge processing should be accepted.

Need for Denitrification

Concern has been expressed regarding high nitrate concentrations in the rivers relative to infant mortality. Studies of the Sajo and Hernad rivers do not show excessive levels of nitrates in the vicinity of the groundwater protection area (GPA). These non-excessive levels are consistent and are observed despite the fact that the Miskolc WWTP now provides only primary treatment before discharge to the Sajo. In addition, there appear to be effective subsurface barriers which prevent the ready passage of contaminants from the river to the aquifer. Thus, denitrification is not considered necessary at the Miskolc WWTP at this time.

At a new Szikszo WWTP, on the other hand, denitrification appears to be warranted based on available data. Extremely high nitrate levels occur in the effluent from the existing overloaded WWTP which discharges into Vadasz Creek which in turn flows into the protection area. Further evaluation is needed of the operation of the animal feed production facility in Szikszo to determine its potential future impacts on nitrate levels.

Performance Evaluation of the Miskolc WWTP

The existing Miskolc WWTP appears to be a well-operated and maintained facility. However, the installation of new secondary treatment and sludge processing facilities will bring new O&M complications in areas such as staffing, training, standard operating procedures, preventive, corrective and emergency maintenance, scheduling, quality control, safety and others. To assure the optimum performance of both new and old facilities a thorough plant evaluation should be made by an expatriate specialist with extensive experience in such evaluations.

Wastewater Collection System Operation and Maintenance

The proper operation of a municipal WWTP such as the Miskolc WWTP depends heavily on the proper functioning of its tributary collection system. Indeed, the WWTP and collection system are integral parts of one system to collect, convey, treat and discharge flows of acceptable quality into nearby water courses. The provision of sufficient sewer maintenance equipment, vehicles and supplies is needed along with effective management to not only assure prompt effective response to problems as they arise, but also to provide preventive maintenance. A collection system O&M specialist should review existing facilities, procedures and training arrangements and recommend improvements for both Miskolc and Szikszo.

Disinfection of Treated Wastewater

There is concern regarding the danger to human health from potentially carcinogenic compounds caused by the chlorination of wastewaters containing organic compounds. The benefits of chlorination in reducing bacterial and viral contamination of wastewaters are well documented in technical literature. Nevertheless, it is reported there is minimal, if any, risk to the population of the project area from the present practice of non-disinfection of WWTP effluent. In addition, there seems to be little likelihood of wastewater contaminants entering the protected aquifer from the Sajo River. Therefore, the practice of continuous year-round effluent chlorination at Miskolc and Szikszo is not considered essential. However, the installation of chlorination facilities to provide emergency/backup disinfection in the event of process failure or evidence of breakthrough into the protected aquifer is recommended for the proposed project.

Connection between River Water Quality and Groundwater Quality

Several studies have been performed which clearly define the hydrogeologic regime in the triangle formed by the confluence of the Sajo and Hernad rivers.

The relationship between river water quality and well water quality is indicated below and shown on the cross-sections and map attached. (Figures B-1, B-2, and B-3).

Moving off the Sajo River in the 'S-S' cross-section there is a decreasing tendency in the content of the following parameters; temperature, pH, dissolved oxygen, iron, sodium, orthophosphate, ammonium, nitrite, nitrate, COD and total suspected solids. On the other hand, there is an increasing tendency in the following parameters in departing from the Sajo: free carbon dioxide, conductivity, alkalinity, hardness and parameters influencing it, manganese, hydrocarbonate, total dry material and total dissolved material.

Moving off the Hernad River in the 'H-H' cross-section there is a decreasing tendency in the content of the following parameters: pH, dissolved oxygen, alkalinity, hardness, conductivity and parameters influencing it, iron, sodium, carbonate, sulphate, orthophosphate, hydrocarbonate, nitrate, COD, total dry material and total dissolved material. On the other hand, there is an increasing tendency in the following parameters in departing from the Hernad: free carbon dioxide, manganese and ammonium.

There appear to be layers of rather impervious material lying above the aquifers tapped by the deep wells operated by the ERV and Borsod Brewery. For this reason evidence that contamination in the rivers is reaching these important ground water sources is limited to:

- areas in the vicinity of gravel mine lakes,
- seepage from the Barsonyos Canal which flows through the center of the protected area, and
- areas where the impervious (clay) layer is discontinuous.

Protection of the Aquifer

Good water supply practice ideally calls for the isolation of water sources from potential pollution resulting from man's activities. Such practice also calls for redundancy; i.e. the provision of standby power sources to operate treatment facilities in the event of primary power source failure, and preliminary disinfection in the event of contamination of the raw water source. In the case of the proposed project area, the land above the protected area continues to be used for many of man's activities. The mining of sand and gravel, for example, has opened up the underlying aquifer to the threat of direct contamination. In addition, there is a hazardous waste disposal site containing over 1,200 drums of pesticides, fertilizer, oil and other materials located between two major well fields. There are also large agricultural farms which produce, store and spread manure, located in the protected area. There is urgent need to assure that such activities are conducted in ways which cannot contaminate the aquifer, and

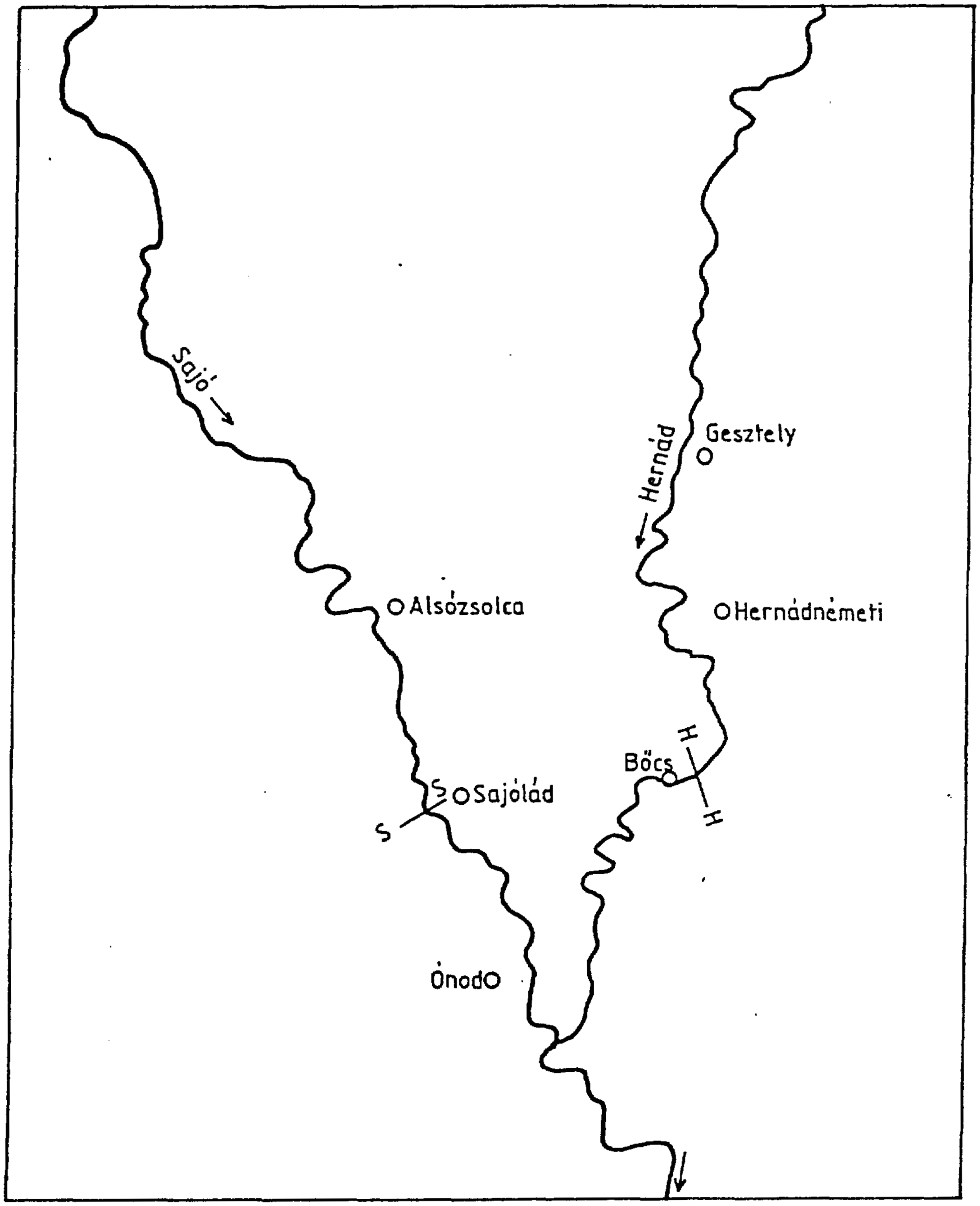

Figure B-1

Sampling Points and Cross-sections

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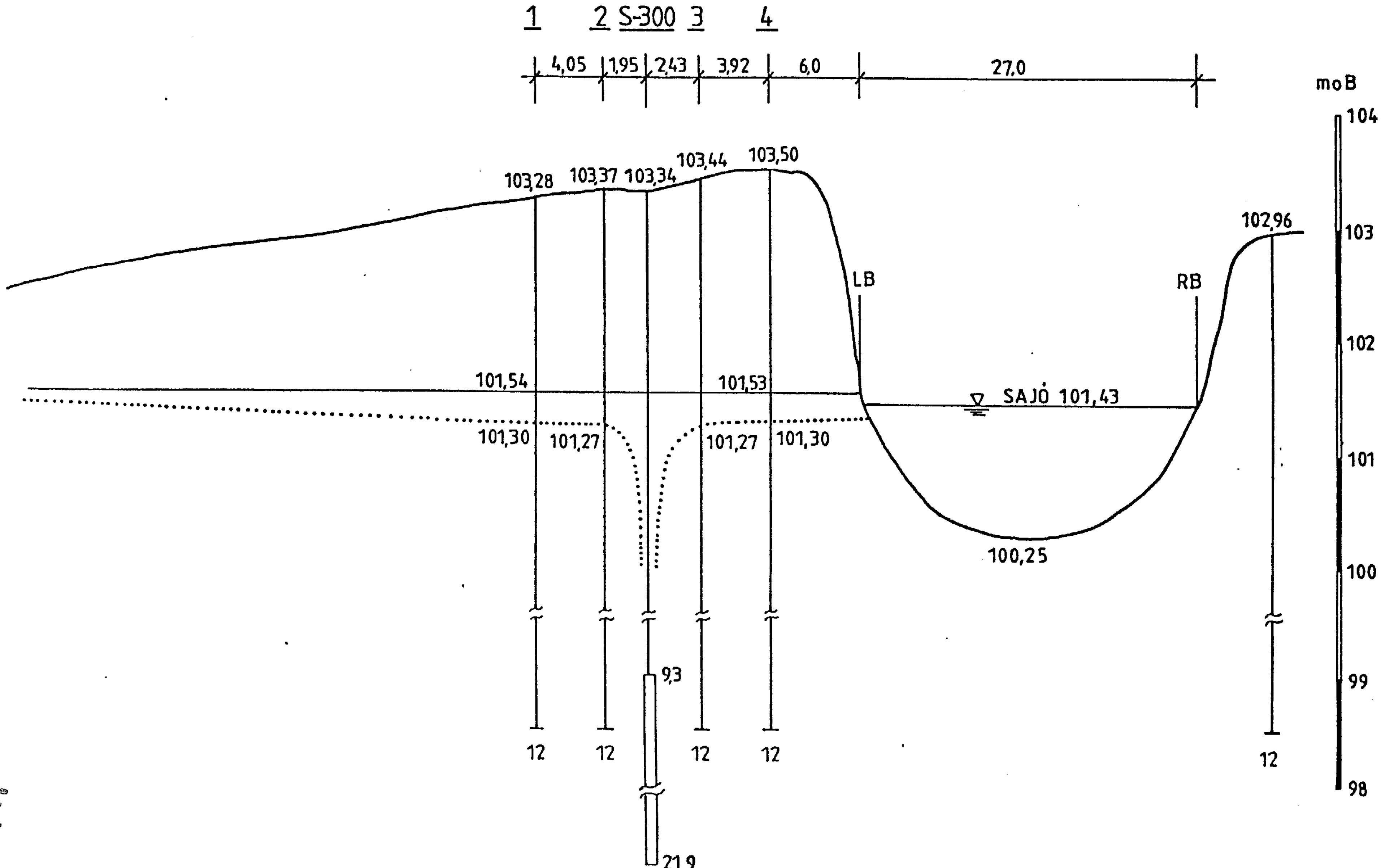

Figure B-2

Cross-section "S-S" at River Sajo

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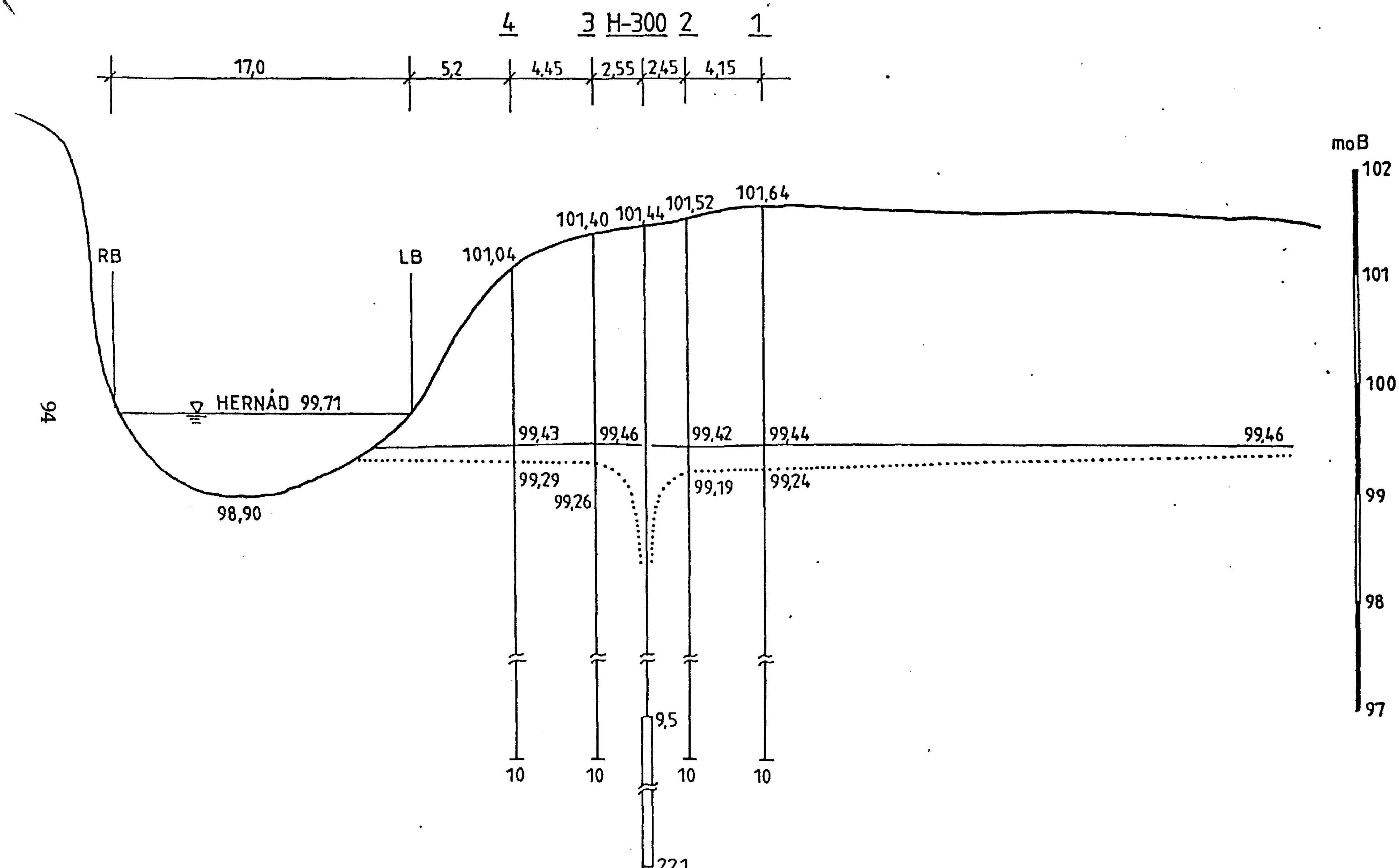

Figure B-3

Cross-section "H-H" at River Hernad

in the case of hazardous wastes, they must be physically removed from the area and the site(s) remediated.

Septic Tanks and Aquifer Contamination

In addition to industrial and agricultural activities in the GPA, there are ten communities which are presently unsewered and use septic tank systems. Many of these same communities now have public water systems. Improperly maintained septic systems are notorious for their record of failure, and quantities of untreated sewage discharged in the vicinity of homes are increased as a result of the installation of public water systems. In addition, strongly enforced regulations to assure long-term proper operation of septic systems are not in place. This, coupled with lack of maintenance and inevitable clogging of leach beds, provides high probability for aquifer pollution in the proposed project area.

Utilization of Wastewater Sludge

The utilization of wastewater sludge through application on agricultural lands is now practiced at both the Miskolc and Szikszo WWTP's and should be continued in the future. There is concern, however, that land application of sludge from Miskolc may be curtailed when the cooperative farms are privatized, possibly in the next couple of years. By improving the quality of sludge, assuring its consistent high quality, improving land application techniques and sites and educating potential users to its value and safety, sludge from the Miskolc WWTP can and should continue to be land applied. Analyses of Miskolc WWTP sludge indicate significant levels of nitrogen, phosphorus and other valuable elements. Its nutrient content and its value as a soil conditioner can help maintain soil productivity and also reclaim marginally productive farm land.

Identification of Alternatives

1. A number of alternative physical system scenarios are identified herein for which comparisons are made based on economic and non-economic factors. These alternatives are identified to provide the basis for the selection of cost-effective and practical solutions within the proposed project area to threats now posed to the groundwater protection area near Miskolc.

2. Within the proposed project several alternatives are identified to resolve the following specific problems:

   - sludge processing at the Miskolc WWTP
   - conveyance and treatment of communal sewage from unsewered communities
   - conveyance and treatment of Borsod Brewery wastewater
   - conveyance and treatment of Szikszo wastewater

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3. A summary of a conceptual plan for sludge processing at the Miskolc WWTP was prepared by Melyepterv Civil Engineering Consultants Ltd. in September 1992. That plan recommended the staged construction of a total technological sludge processing line consisting of sludge thickening, digestion, dewatering and sludge drying. The proposed design capacity was 2,225 m^3/day of mixed raw primary and excess activated sludge based upon a wastewater flow of 105,000 m^3/day. 1992 average daily flow was 70,000 m^3/day. The facilities recommended in that report are based on the assumption of sludge disposal only and appear to be appropriate only if the following conditions should apply:

   - sludge quality after WWTP upgrading remains unacceptable for safe agricultural land application
   - an effective industrial waste pre-treatment program is not implemented
   - the economic value of sludge as a fertilizer or soil conditioner is not demonstrated to farmers
   - sound land application techniques are not employed
   - strict control and maintenance of sludge quality is not achieved

   As an alternative, the proposed project will include resolution of each of the above conditions. On this basis, a lower cost alternative is to land apply "clean" sludge on farms growing suitable animal feed and non-edible crops. Sludge processes applicable to this alternative include thickening, dewatering, composting, lime stabilization, and sludge pumping such that either dewatering or liquid sludge may be land applied.

4. Conveyance and treatment of sewage from presently unsewered communities in the Bocs/Sajolad area near the confluence of the Sajo and Hernad Rivers has been the subject of several technical studies over the past ten years. All studies agree that the installation of public sewage collection and treatment system(s) is essential to protect public health and the water quality of the target groundwater aquifer. For the proposed project the following alternatives are considered:

   A. All wastewater generated in the area will be conveyed for treatment at the Miskolc WWTP.

   B. Wastewater generated in the area will be conveyed for treatment at two locations:

      - ☐ Sajo River communities for treatment at the Miskolc WWTP
      - ☐ East Bank Hernad River communities for treatment at a new WWTP near Sajohidveg

   Under either alternative the wastewaters generated by facilities such as the Screw Manufacturing Plant, agricultural enterprises and recreational areas (e.g., gravel and sand mine lakes) will be considered for possible pre-treatment, conveyance and treatment along with domestic sewage. All septic tank systems will be abandoned, removed, or destroyed.

5. The production of wastewater at the Bocs Brewery amounts to about 1.5 million m^3/day. All of this wastewater is now applied on a 27 hectare (ha) poplar tree plantation by means of on-surface irrigation and on a 43.5 ha meadow and hay field by rain irrigation. High application rates reportedly have caused serious overloading of the poplar tree filter field irrigation site. One of two alternatives will be considered for implementation in the proposed project. These two alternatives are:

   A. Abandon part (about 5.2 ha) of the poplar tree filter field and construct a new surface irrigation site located about 2km southeast of Bocs municipality.

   B. Abandon all of the poplar tree filter field and construct a new larger irrigation site southeast of Bocs.

   C. Abandon all poplar tree filter field and irrigation sites in and around Bocs, and convey all brewery wastewater to the Miskolc WWTP.

   The design loading rates for filter fields and irrigation sites should be determined based upon soil moisture requirements, rainfall, crop requirements, and other factors. Conveyance of brewery wastewater to the Miskolc would be considered along with the conveyance of communal wastewater. Brewery wastewaters would have a significant beneficial impact on sludge quality produced by the Miskolc WWTP by virtue of its high organic content.

6. The existing Szikszo WWTP requires complete reconstruction and enlargement to fully treat both communal and industrial wastewaters. The alternative to construction of a new WWTP is the conveyance of all generated wastewaters to the Miskolc WWTP. If a new WWTP is selected for implementation, the treatment process should include nitrification and denitrification stages as may be required based on anticipated production levels at the ATEV animal feed production facility.

Evaluation of Alternatives

1. The technical alternatives have been compared on the basis of mid-1993 construction and O&M costs expressed in US dollars. The costs shown include only items significant in making the comparison; for example, those items which are required under each alternative compared (e.g., communal sewerage systems, and contingencies) are not included. Common items are included in recommended project costs.

2. A comparison of sludge management alternatives shows the clear economic advantage of adopting a utilization strategy for sludge generated at the Miskolc WWTP rather than a disposal strategy which considers sludge to be a liability rather than an asset.

	Alternative Cost, US$ million			
	A (Disposal)		B (Utilization)	
	Capital	O&M	Capital	O&M
Sludge Processing	17.0	1.2/yr	5.0 to 9.0	0.5
Sludge Transportation	-	0.4	-	0.6
Total	17.0	1.6	5.0 to 9.0	1.1

The apparent cost advantage of Alternative B will be partially offset by costs associated with an enhanced industrial waste pre-treatment program and stricter quality control of the sludge leaving the WWTP. Among Alternative B's additional advantages are:

- more environmentally sound
- lower energy consumption
- less air pollution
- reduced purchase of commercial fertilizers

It is concluded that Alternative B should be included in the proposed project.

3. A comparison of the cost of two alternatives for sewering unsewered communities in the Bocs/Sajolad area indicates that capital costs are almost the same for each alternative. However, under Alternative A which calls for all wastewater to be conveyed to the Miskolc WWTP for treatment, a new separate WWTP would not be required, and advantage can be taken of economy of scale at the Miskolc WWTP. Under Alternative B a new WWTP would be required near Sajohidveg on the east bank of the Hernad. This new plant would require management, operation and maintenance staffing and also implementation of another sludge management program. Pumping and conveyance costs will be slightly higher for Alternative A but will be more than offset by much higher O&M costs for a new WWTP. It is concluded that all communal wastewater flows from the Bocs/Sajolad area should be conveyed for treatment at the Miskolc WWTP.

4. Comparison was made of the cost of conveying and treating wastewater from the Bersod Brewery at the Miskolc WWTP with the cost of upgrading the filter field and irrigation system now used. There is a clear cost advantage in upgrading the irrigation system because of its close proximity to the brewery, low reliance on expensive, sophisticated equipment and low O&M costs. Upgrading the expansion of the irrigation area will require the preparation of sufficient land area to assure proper storage and/or utilization of nutrients in the wastewater at all times, and safeguards must be provided to assure the protection of surface and ground waters. Preliminary studies indicate that at least 60 ha

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of land will be required and that the old seepage and filter fields adjacent to Bocs be abandoned.

5. For the municipality of Szikszo the cost comparison of alternatives indicate that it is economic to construct and operate a new WWTP at Szikszo rather than pump all wastewater from Szikszo to the Miskolc WWTP. The deciding factor is the high cost of a 15 km force main to convey the wastewater to Alsoszolca where it would enter the Miskolc system.

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Appendix C

ANALYSIS OF MUNICIPAL EMISSIONS IN THE SAJO-HERNAD BASIN IN HUNGARY

Population Projections

1. Population projections provide the basis for any analysis of municipal emissions. Such projections when combined with per capita emission rates and development trends provide the most reliable basis for estimating future quantities and rates of emissions for residential and institutional sources of pollution.

2. The proposed project area contains groups of communities which now are or potentially may be connected to the Miskolc WWTP. Approximate residential (and institutional) populations for each group in the 1990-1992 period are as follows:

- Miskolc City—191,623.
- Communities partially connected to the Miskolc system—16,161.
- Ten unsewered communities in the groundwater protection are (GPA)—32,501
- Seven other unsewered communities near Miskolc—16,547

The total population of all the above communities is about 256,832.

3. Present population trends indicate that Miskolc city is losing population due to economic conditions, high unemployment and movement to the suburban communities. Population is expected to remain rather steady in the future. On the other hand, suburban communities such as those in the ten unsewered communities in the GPA are expected to grow by 20 percent over the next 20 years. A field visit in the area identified many new homes under construction. Other suburban communities are projected to grow by 10 percent over the same period.

4. In planning future capacity requirements for WWTP's and sewerage networks, it is important to estimate the rate at which connections to the networks from homes and other buildings will take place. This factor, plus the factors discussed above are considered in the projection of connected population shown in Table C-1.

5. The projected connected population of all the communities included in Table C-1 is expected to increase from about 166,000 at present to over 258,000 by the year 2015, or a 55 percent increase. By that time the total residential population of the proposed project area is projected to be about 268,000.

6. There are four locations in the GPA where major withdrawals of groundwater from the protected aquifer are now occurring:

- Alsoszolca (ERV) 3 bank filtered wells: 11,000 m^3/day
- Csucsu (ERV) 4 bank filtered wells: 25,000 m^3/day
- Sajolad (ERV) 6 bank filtered wells: 18,000 m^3/day
- Borsod Brewery wells: 9,000 m^3/day

7. Potential withdrawal rates from these four sources based on existing plant capacities are:

- Alsoszolca 15,000 m^3/day
- Csucsu (Eastern Peak Water Works) 40,000 m^3/day
- Sajolad 50,000 m^3/day
  (if electrical system is upgraded)
- Borsod Brewery 10,000 m^3/day

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Table C-1

Projection of Connected Population
in Proposed Project Area

Community Group	Connected Population (Percent Connected)		
	1990-92	**2005**	**2015**
Miskolc City (1)	161,538 (84.3)	182,042 (95)	182,042 (95)
Communities partially connected to Miskolc			
Felsoszolca	2,042 (29)	4,648 (60)	8,452 (100)
Alsoszolca	807 (14)	6,341 (100)	6,918 (100)
Malyi	1,676 (50 est.)	2,112 (60)	3,688 (100)
Subtotal	4,525	13,101	19,058
Ten unsewered communities in the GPA (2)	0 (0)	35,750 (100)	39,000 (100)
Seven other unsewered communities near Miskolc (3)	0 (0)	8,687 (50)	18,202 (100)
Total	166,063	239,580	258,302

Notes:
(1) Including Omassa, Bukkszentlazlo, Szirma, and Martintelep.
(2) Including Gesztely, Hernadkak (and Belegrad), Hernadnemeti, Bocs, Berzek, Sajohidveg, Onod, Sajolad, Sajopetri, and Onga.
(3) Including Kistokaj, Bukkszentkereszi, Nyekladhaza, Sajokeresztur, Szirmabesenyo, Sajovamos, and Sajopalfala.

8. The three water sources operated by the ERV are interconnected with the regional water supply system serving much of northeastern Hungary. This area has a total population of around 600,000.

9. Typical average per capita rates of water consumption for domestic and institutional use in the proposed project area are:

Onga	86 liters/capita/day
Szikszo	132 liters/capita/day
Felsoszolca	102 liters/capita/day
Alsoszolca	111 liters/capita/day
Miskolc	215 liters/capita/day

Per capita water consumption in the suburban communities may be expected to increase in the future:

- as standards of living increase
- as discharge to septic tanks is replaced by connection to a sewerage network

For Miskolc per capita water consumption may be expected to decline somewhat in the future:

- as true water losses are identified and corrected
- as water metering is extended to closer to 100 percent of connections

10. Ranges of raw water quality at each of the four water treatment plants in 1992-93 are shown in Table C-2.

Table C-2

Raw Water Quality—1992-93

Parameter (mg/l)			Plant		Limit (mg/l)
	Alsoszolca	Eastern Peak	Sajolad	Brewery	
Iron (Fe)	-	0-16.6	0.6-2.6	0-0.05	0.3
Manganese (Mn)	-	0.28-3.8	1.0-1.6	2.5-3.1	0.1
Nitrate (NO_3)	-	0-55.2	0.5-0.7	-	10.0
Ammonia (NH_4)	-	0.05-0.7	0.16-0.37	-	0.1

Note: Ranges of values indicate variances among different wells.

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11. Treatment of the raw water produces drinking water of generally acceptable quality. At the Eastern Peak Demand Water works deacidification, iron and manganese removal and disinfection are provided.

12. At the Sajolad Water Works the following water treatment processes are in operation:

- prechlorination
- aeration
- iron and manganese removal
- filtration
- post chlorination

Finished water leaving the plant has the following characteristics:

- ammonia less than 0.10 mg/l
- chlorine residual 0.5 mg/l

Municipal Wastewater Analysis

13. The average annual flow to the Miskolc WWTP for the 1992-93 period is about 70,300 m^3/day. Components of this wastewater flow are as follows:

■ domestic and institutional	35,000 m^3/day
■ industrial and commercial	11,700
■ infiltration and inflow	16,500
■ other	7,100
TOTAL	70,300 m^3/day

14. During the 1992-93 period of record at the WWTP the following flows occurred:

Minimum daily average	32,180^3/day
Average daily weather	70,300
Maximum daily average	115,580
Maximum weekly average	94,050
Maximum monthly average	78,980

The maximum flows occurred during August 1992.

15. Average flows to the Miskolc WWTP in 1990 were about 95,000 m^3/day. The sharp reduction in flow since then is attributed to the sudden downturn in industrial activity and greatly increased water tariffs.

16. Per capita sewage flow in Miskolc is estimated to average about 211 liters/capita/day which is almost equal to the estimated per capita water consumption.

17. Influent loads to the Miskolc WWTP as of January 1993 are estimated to be as follows:

    - Chemical Oxygen Demand—493 mg/l-35,000 kg/day (COD)
    - Biochemical Oxygen Demand—205 mg/l-14,540 kg/day (BOD_5)
    - Total Nitrogen—51 mg/l-3,570 kg/day (TKN)

18. A projection of future wastewater flows to the Miskolc WWTP is shown in Figure C-1. It shows that average daily flows with all neighboring communities connected to the Miskolc sewerage network will reach 98 percent of planned plant capacity by year 2015. In this projection it is considered that industrial wastewater, infiltration, stormwater inflow and other flows will remain constant through the period.

Miskolc Wastewater Treatment Plant

19. The Miskolc municipal WWTP is located on the flood plain of the Sajo River about 5 km east-southeast of downtown Miskolc. The existing total treatment capacity of the plant is 140,000 m^3/day. The original plant was built in 1978.

20. The existing treatment process includes preliminary and primary (mechanical) treatment, disinfection, sludge thickening, mechanical sludge dewatering and equipment for land application. Major process units are listed in Table C-3.

21. Biological treatment (activated sludge) facilities are now under construction with a planned completion date of mid-1993. A new contractor must be selected before this work can proceed to completion from its estimated 80 percent complete status.

22. The treatment capacity of the biological facilities is 70,000 m^3/day for which flow the aeration basins will have a retention time of 4.73 hours. Studies have been conducted on a 35,000 m^3/day expansion of these facilities.

23. Over the past 3 to 5 years average influent flows to the WWTP have dropped by about 26 percent. In 1990 flows to the WWTP averaged about 95,000 m^3/day, whereas in 1992 the average flow was about 70,000 m^3/day. This drop is attributed to reduced industrial flows resulting from a weakening economy and reduced domestic consumption resulting from greatly increased water rates.

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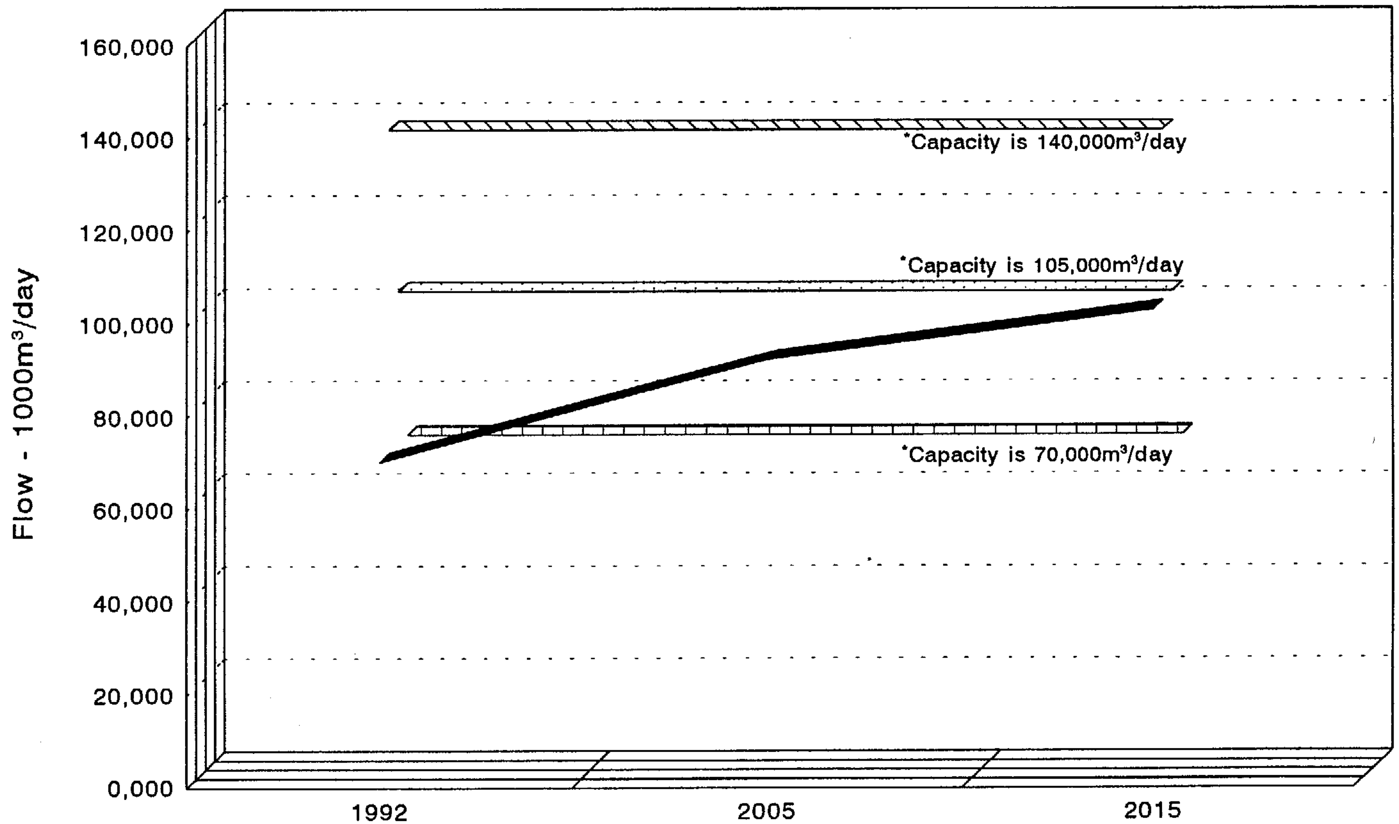

	1992	2005	2015
Projected Sewage Flow	70,300	92,440	103,230
Existing Primary Treatment	140,000	140,000	140,000
Planned Biological Treatment	103,230	103,230	103,230
Biological Treatment Under Construction	70,300	70,300	70,300

Figure C-1

Wastewater Flow Projections and Miskolc WWTP Capacity

Table C-3

Miskolc Wastewater Treatment Plant

MAJOR PROCESS UNITS

<u>Existing Facilities</u>	
Bar Screens	2 manually cleaned grids with grid width of 25 cm. 2 mechanically cleaned grids with grid width of 25 mm.
Lift Pumps	8 pumps with total capacity of 2, 130 m^3/sec.
Primary Settling Tanks	4 tanks at 1800 m^3 each (32m diameter x 2.8m depth) with 630 m^2 effective surface area, with sludge and scum collectors.
Chlorine Contact Basin	1 tank at 1,474 m^3 volume, with chlorine gas injection. Chlorinators are Advance type.
Sludge Thickeners	2 prethickening tanks at 630 m^3 volume and 200 m^2 surface area each, with pickets.
Centrifuges	3 KHD horizontal mounted centrifuges (1 standby)
Earth Basins at Agriculture	3 basins with storage capacities of 120,197; 21,724 and
Cooperative	18,290 per m^3 respectively.
<u>Facilities Under Construction</u>	
Activated Sludge Plant	3 aeration basins at 4,600 m^3 volume each, with diffused air. 2 air supply blowers, type HV-TURBO KA-22. 4 secondary settling tanks at 2,800 m^3 each, (40m diameter x 2.8m depth) with 1000 m_2 effective surface area, with sludge scrapers.

24. Primary treatment produces about 650 to 750 m^3/day of raw sludge with an estimated dry solids content of 2 percent. This sludge is thickened in gravity thickening tanks to about 8 percent dry solids. This thickened sludge is injected into agricultural land of the Alsoszolca cooperative near Arnot for almost 9 months per year. During the winter the thickened sludge is dewatered to about 25 percent dry solids in recently installed

centrifuges after which it is transported to earth basins at the agricultural cooperative. Dewatered sludge is stored in these basins until the next growing season when it is land applied.

Sludge volumes are:

- injected sludge 48,000 m^3/year
- dewatered sludge 3,300 m^3/year

Total raw sludge volume is expected to increase by 1.4 times the present volume when the new biological treatment facilities are operating.

25. While sludge injection for crop growing can be a most commendable practice, the current practice has several deficiencies:

- sludge is not stabilized or pathogen-free before land application
- application periods may exceed the growing season
- the application area is immediately up-gradient from the GPA
- depth of injection may exceed the optimum for plant utilization
- a fully effective industrial waste pretreatment program is not in place

Miskolc Sewerage Network

26. The Miskolc sewerage network consists of about 315 km of street mains and lateral sewers, which were constructed on the separate plan, i.e. they were intended to carry sanitary sewage only. However, roof connections and illegal connections allow some stormwater to enter the system. It is reported that little if any mixed sewage and stormwater overflows to the Sajo without treatment.

27. The sewerage network dates back to 1901 and many of the older pipes remain in service. As such systems grow older, the needs for inspection, maintenance and repair increase. The Miskolc Water Board has identified shortages in the equipment necessary to perform this work. A list of the needed equipment is included in the proposed project.

28. Three other municipalities now are served by the Miskolc WWTP. Each of them has a new sewerage network built on the separate plan. The lengths of main sewers and street laterals are as follows:

- Alsoszolca—45.6 km
- Felsozzolca—40.3 km
- Mayli—16.8 km

29. It is estimated that there are currently about 61,131 household connections to the Miskolc sewerage network. This represents 84.3 percent of all dwellings in the city in 1992. It is

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estimated that another 15,275 house connections will be required to fully serve Miskolc and the three communities identified above.

30. Within the city it is currently planned by the Miskolc Water Board to extend street sewerage in Omassa, Bukkszentlazlo, Szirma and Martintelep. The Water Board's cost estimate for this work is about 550 million HUF.

31. In the ten communities located on the GPA it is estimated that about 7,900 household connections will be required to fully connect households to a sewerage network by the year 2000. It is estimated that 25 km of main sewers, 125 km of street laterals and 11 pumping stations will be required to connect this area to the Miskolc WWTP. (See Identification of Alternatives).

32. Seven additional communities near Miskolc also are now unsewered as discussed above. Their sewerage will require about 5,200 household connections and completely new sewerage networks to discharge to the Miskolc WWTP.

Szikszo Municipal Sewerage System

33. The 1992 population of Szikszo was 6,223 and a design population of 7,000 is used for planning.

34. According to the ERV and BAZ Co. domestic water consumption averaged 650 m^3/day.

35. The population connected to the municipal sewerage network is around 10 percent. Street sewer length is 5.6 km, and another 1.5 km is now under construction.

36. The Szikszo activated sludge WWTP is operating at its design flow of about 330 m^3/day, but about half of this flow has been high strength waste from the ATEV animal fodder production plant.

    The average flow to the WWTP dropped from 307 m^3/day in 1991 to 270 m^3/day in 1992. At present wastewater flow from ATEV is negligible due to greatly reduced activity at the plant. It is considered likely that the ATEV plant will be closed, but possible utilization of the site and facilities is not known. Characteristics of the high strength wastewater reaching the WWTP are:

    - COD—1000 mg/l
    - Ammonia (NH_4)—over 100 mg/l
    - Phosphorus (P)—40 mg/l

37. The Szikszo WWTP consists of the following facilities:

    - equalization tank with preaeration
    - two activated sludge tanks with surface aerators
    - sludge dewatering

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- reserve sludge drying beds

Sludge is transported to the municipal refuse landfill.

38. WWTP effluent concentrations were high when ATEV worked full time.

    - COD—less than 100 mg/l
    - Ammonia—over 50 mg/l
    - Nitrate—over 50 mg/l

    Effluent discharges into Vadasz Creek, a tributary of the Hernad River.

39. If population projections hold and a unit sewage discharge rate of 150 liters/capita/day a used, a new WWTP with a capacity of about 1,000 m^3/day would be required. Such a conclusion is dependent on the future of ATEV.

Non-Point Source Pollution

40. In addition to the community point sources of pollution identified above, over 90 miscellaneous sources of pollution have been identified within the proposed project area. These miscellaneous sources are termed herein as non-point sources (NPS) of pollution. Inventory information has been developed by Aquarius Ltd. and more recently by Innosystem under the PHARE program. The areas covered by these inventories do not include all of the proposed project area, but they are considered adequate to identify the range of problems to be encountered in the program to protect the groundwater aquifer.

41. Sources of pollutants include:

    - gravel and sand mines
    - communal solid waste disposal sites
    - illegal dump sites
    - car wash
    - concrete factory
    - metals industry
    - agricultural cooperatives
    - pesticide storage facilities

42. Types of pollutants include:

    - mixed solid wastes
    - glass refuse

- wine-making refuse
- oils
- chemical salts
- acids
- pesticides
- organic manures
- artificial fertilizers

43. At the Onga Screw Works over 1,200 plastic, glass and iron containers have been observed on the site of this largely abandoned industrial complex. These containers are believed to contain pesticides, chemicals and fuel.

44. At the Borsod Brewery near Bocs there is extensive storage on site of many types of chemicals, oil and other refuse.

Appendix D

N-VIRO PROCESS DESCRIPTION

The N-VIRO process was developed to achieve pasteurization of sewage sludge using alkaline admixtures. By using the exothermic heat generated by these anhydrous admixtures, pasteurization and permanent odor stabilization can be achieved.

The fine alkaline admixture materials are mixed into dewatered sewage sludge cake. Uniform and thorough additions are achieved by using mechanical mixing to produce a pasteurized, stabilized, treated sludge.

Goals

The goals of the N-VIRO process are summarized as follows:

- Pasteurize sludge—kill disease-causing organisms, but leave normal flora.
- Produce consistent product—meet the pH of 12 throughout the alkaline admixture/sludge mixture.
- Provide odor control—in the mixing and heating operation and produce a stable, low-odor-threshold product by using the proper dosage of alkaline admixture and windrowing.
- Produce a granular, soil-like end product—use high quality alkaline admixture, provide good mixing, and control windrowing operation.
- Produce metal hydroxides—proper dosage of alkaline admixture will tie-up metals as a metal hydroxide and will help bind metals in the soil.
- Meet EPA regulations—N-VIRO process has passed the most stringent requirements for any sludge processing operation, the PFRP criteria.

Using the proper dosage and mixture of alkaline admixtures is the key to the process.

The treated sludge heats up as a result of exothermic reactions from the alkaline admixture materials and achieves a temperature of at least 52°C throughout the sludge. The mixture is stored at 52°C for a minimum of 12 hours. The heat-treated sludge is then air dried (while pH remains above 12 for at least three days) through intermittent turning of windrows until the solids level reaches and maintains a minimum of 50 percent solids. This process is simple and can be broken down into distinct steps:

1. Alkaline Admixture (Storage and Blending)

The N-VIRO process requires dose rates ranging from 25 percent-45 percent of the sludge cake wet weight. Approved admixtures are stored in silos.

2. Mixing

Alkaline admixture and dewatered sludge cake are mixed in a mixer designed to provide complete and intimate contact between the sludge cake and alkaline admixture. Design and selection of the mixer is based on the requirement to blend the two materials intimately without breaking the structure of the sludge cake and producing a "plasticized" paste-like material, i.e., mixing without shearing. The discharge from the blender should resemble small, granular pellets or sand-like grainy particles.

3. Heat Pulse

The blended material of alkaline admixture and sludge cake must be "cured" for a 12-hour period while the temperature is monitored and maintained above 52°C. It is the exothermic reaction of the CaO in the alkaline admixture with water that generates the heat. The material is stored in containers for proper heat control.

4. Windrow and Drying

Following the 12-hour curing period, the blended material is discharged from the containers onto the windrow deck in long piles to form the initial windrow. The windrow deck, asphalt or concrete, covered or uncovered, must provide an area for turning the blended material with an auger/aerator attachment mounted on a skid tractor or loader. The material should be windrowed daily for three to five days. Windrowing is complete when the solids content of the mixture attains 50 percent while pH remains above 12. Further windrowing may be desirable to reduce volumes of materials to be handled, raising the solids content to 65 percent. The solids content can reach 65 percent within three to five days if the initial dosage of alkaline admixture is correctly controlled.

A covered windrow area is feasible, particularly in areas with high annual rain/snow falls, but proper ventilation is important for moisture removal.

5. Final Storage

The storage pad is used to hold materials for distribution as required. Some distribution markets have ready access all year, such as landfill cover, while others have seasonal application requirements. The material is easy to handle and can be piled with a stacking conveyor. Because the material meets PFRP regulations, it can be stored on the site for as long as necessary. The storage pad is sized according to site-specific needs in the distribution plan.

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6. Ammonia and Odor Treatment

Ammonia is released during the process of mixing the alkaline admixture and the sludge because of the high pH. The amount of ammonia released is significantly lower for raw sludge than for digested sludge. The alkaline admixture helps control odor and ammonia release because of absorption with its components. It also helps to control other odorous compounds in the sludge.

Most of the ammonia is released in the first two steps and is treatable. Any remaining ammonia is released as a pulse during the windrowing operation in the open atmosphere. Ammonia release is therefore controlled and the end product is a stable, very-low-odor threshold material that has been described as earth-like.

The combination of factors that result in a pasteurized, dry, sludge product include the following: 72 hours of high pH, creating an anti-microbial environment; the correct volume of admixture to accelerate moisture absorption; a "curing" period at a temperature of 52°C to rid the product of pathogens such as parasites and ascaris; and the release of ammonia in the pile, which disinfects the sludge, leading to an end product that contains soil-type organisms and that will resist microbial recontamination.

2 Process Parameters	Proposal
	MISKOLC W.W.T.P
SOLIDS LOADING	4.00% liquid feed
	10,585 tons dry solids/year
OPERATION	365 days/annum
	16 hours/day
LIQUID LOADING	204,025 m^3/year
	725 m^3/day
SLUDGE CAKE	25.0% d.s. after pressing
ANNUAL SLUDGE CAKE PRODUCTION	42,100 tons
DAILY SLUDGE CAKE PRODUCTION	116 tons
DAILY REQUIREMENT ALKALINE ADMIXTURE	
CaCO3	34.8 tons
Quickline QL	11.6 tons
DAILY PRODUCT MIX PRODUCTION	
Assume density of product is 1050 kg/m^3	162.4 tons
DAILY VOLUME OF PRODUCT	154.7
HOURLY PRODUCT MIX	6.7 tons

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