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POINT SOURCE POLLUTION IN THE DANUBE BASIN

REPORT ON DATA MANAGEMENT, INSTITUTIONAL STUDIES, AND PRIORITY PROJECTS

VOLUME I

WASH
WATER AND SANITATION
FOR HEALTH PROJECT

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POINT SOURCE POLLUTION IN THE DANUBE BASIN

REPORT ON DATA MANAGEMENT, INSTITUTIONAL STUDIES, AND PRIORITY PROJECTS

VOLUME I

Prepared for the Europe Bureau,
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PREFACE

The project reported on herein was conducted in cooperation with the governments of Bulgaria, the Czech and Slovak Federal Republic (primarily Slovakia), Hungary, and Romania and with technical assistance from the Bureau for Europe (EUR) of the U.S. Agency for International Development (A.I.D.). This assistance was provided through the Water and Sanitation for Health (WASH) Project, which is operated by Camp Dresser & McKee International Inc. and associated firms, for the Bureau for Research and Development (R&D) of A.I.D.

The members of the WASH team that conducted the study and prepared this report were Timothy Bondelid (data base specialist), Max S. Clark (computer specialist and sanitary engineer), Daniel Edwards (institutional specialist), Dr. William Lord (economist), Tarik Pekin (industrial wastes engineer), and Robert H. Thomas (team leader). The task manager for this activity was Craig Hafner, who was assisted by Teresa Sarai. The studies' two workshops were designed and facilitated by Kathy Alison. Teresa Sarai provided the logistical coordination for the second workshop.

The Scope of Work for the project (see Appendix A) was originally intended to be primarily oriented to development of an emissions inventory for the Danube River basin. However, the work statement was subsequently reoriented on the basis of (a) a study conducted for the EUR Bureau by Blair Bower, Jack Day, and Frank Rijsberman based on a brief visit to the four project countries by Day and Rijsberman in the summer of 1991 and (b) the results of discussions at the Danube Basin Conference, which was sponsored by the Bulgarian Academy of Sciences and the Global Environmental Facility and held in Sofia in September 1991. The Scope of Work and progress of the project were also taken into account in the development of the Three Year Action Plan by the Danube Task Force in Brussels in February 1992.

The major tasks in the Scope of Work, to be accomplished by the WASH team by mid-1992, were as follows:

1. Prepare an initial computer-based system to manage data on point-source wastewater emissions and emitters to support reduction of pollution in the Danube basin;
2. Demonstrate the utility of the system in one or more river basins within the Danube basin;
3. Identify high-priority, immediate investment needs, for which preinvestment studies might be funded and executed by international donors and funding agencies; and
4. Evaluate institutional conditions and needs to support the computer-based system and for implementation of wastewater emissions control programs.

This report comprises the WASH team's presentation of the results of the project, including its conclusions and recommendations. Although the work of the project was conducted in

close cooperation with the four assisted governments and other entities (see Acknowledgments), the findings and recommendations reported herein are those of the WASH team. They do not necessarily represent official positions of the governments of the four assisted countries nor of the United States.

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Dr. Vladimir Rojanschi, Scientific Director, Research and Engineering Institute for Environment, Ministry of Environment

ACRONYMS

A.I.D.	Agency for International Development
BOD	biochemical oxygen demand
COD	chemical oxygen demand
CSFR	Czech and Slovak Federal Republic
DEMDESP	Danube Emissions Management Decision Support Project
DEMDESS	Danube Emissions Management Decision Support System
EBRD	European Bank for Reconstruction and Development
EC	European Community
ECU	European currency unit
EPA	Environmental Protection Agency (U.S.)
EPDRB	Environmental Program for the Danube River Basin
EUR	Bureau for Europe, A.I.D.
HCH	Lindane
ISC	Institute for Sustainable Communities
JTU	Jackson turbidity unit
MPN	most probable number
NPK	nitrogen, potassium, phosphorus
PVC	Polyvinylchloride
R&D	Bureau for Research and Development, A.I.D.
REIE	Research and Engineering Institute for Environment (Romania)
RGA	Regia General de Apa, Romania
TDP	Trade and Development Program, U.S. Department of Commerce
TSS	total suspended solids

UNITS

cmd	cubic meters per day
cmh	cubic meters per hour
cu m	cubic meter
g	gram
ha	hectare
Kcs	korunas, CSFR monetary unit
kg	kilogram
km	kilometer
L	liter
Lcd	liters per capita per day
mg	milligram
MLd	million liters per day
s	second
sq km	square kilometer
t	ton
T	metric ton
µg	microgram

SUMMARY

Project Outline

In the summer of 1991, the U.S. Agency for International Development (A.I.D.) Bureau for Europe funded a wastewater emissions study in the part of the Danube basin in Bulgaria, the Czech and Slovak Federal Republic (CSFR), Hungary, and Romania. The R&D Bureau Office of Health's Water and Sanitation for Health (WASH) Project undertook this study and began the collection of available data in the summer of 1991 and assembled a team of six persons in September 1991 to conduct the studies called for. The team began its field work in late September 1991 and completed it in May 1992.

The Scope of Work of the WASH team had three principal elements:

- Prepare an initial computer-based system to manage data on point-source wastewater emissions and emitters to support reduction of pollution in the Danube basin, and demonstrate the utility of the system in one or more pilot river basins within the Danube basin;
- Identify high-priority, immediate investment needs for which preinvestment studies might be funded and executed by international donors and funding agencies; and
- Evaluate institutional conditions and needs to support the data management system and implementation of wastewater emissions control programs.

During the course of the team's preparatory work, it became clear that the type of data management system that was of the greatest interest to the responsible pollution management personnel was a decision support system that could be used to estimate the impacts of technical, financial, and other potential control policies, not only on emissions and water quality, but also on costs and other concerns.

Two events of key importance in the course of the project were (a) an international Project Planning Workshop, held in Visegrad, Hungary, in December 1991, at which concepts and needs for the decision support system were agreed upon and the name Danube Emissions Management Decision Support Project (DEMDESP) was decided on; and (b) an international Institutionalization Workshop, held in Dubravka, Slovakia, in May 1992, at which the future uses and support needs of the decision support system were identified and some potential pilot projects prioritized in each country.

The study resulted in the following products:

- *Point Source Pollution in the Danube Basin*
  - *Volume I— Report on Data Management, Institutional Studies, and Priority Projects* (this report)
  - *Volume II— Institutional Studies: Bulgaria, the CSFR, Hungary, and Romania*

- *Volume III— Country Technical Reports: Bulgaria, the CSFR, Hungary, and Romania*
- A user manual for DEMDESS (the Danube Emissions Management Decision Support System), completed in July 1992

The basic purposes of this report are to present for general audiences in the four assisted countries, for interested agencies and donors, and for A.I.D. as the client, the methodology, findings, and recommendations of the WASH team; to record the key technical and institutional data that were collected; and to set down for potential DEMDESS users and clients guidelines for the system's application and ongoing use.

The Scope of Work of the project was carefully coordinated with the overall Environmental Program for the Danube River Basin (EPDRB). An important component of the study was the technical contribution made by the U.S. Environmental Protection Agency (EPA) in regard to potential pilot projects.

Findings

- **Background.** During much of the last 45 years, development of industry, agriculture, and public housing was a primary focus in the four participating Danube countries; control of associated water pollution problems was given limited or delayed attention. In the recent period of economic restructuring and democratization, funding for water pollution control has virtually ceased in many cases. Each country has a host of pressing political and socioeconomic problems that have largely been given higher immediate priority by their governments in the belief that environmental problems can be deferred, rather than addressed immediately as an integrated part of overall restructuring. Although environmentalists played a key role in moving the four countries toward democracy, policies the respective governments have adopted in response to economic realities have often prevented rapid resolution of water pollution problems. The lack of understanding by senior policymakers of the economic benefits of immediate water pollution control and the high cost of further delay is constraining economically sound water quality improvements.

- **External assistance.** In the interim, external assistance can be beneficial in preparing national and local water pollution control programs and can hasten their implementation, which can begin as soon as appropriate institutional and financial conditions are achieved.

- **Major pollution problems.** Wastewater emissions from cities and industry have serious environmental and health impacts on receiving waters, most notably in the tributaries of the Danube. Nonpoint-source runoff from rural areas contributes to the pollution, in the form of nutrients (primarily nitrates) from overapplication of inorganic fertilizers, pesticides, and organic waste in the partially treated effluent from large animal feed lots. The Danube River itself provides high dilution of wastewaters entering

it and has a high self-purification capacity with respect to biodegradable organic wastes. Nonetheless, low levels of dissolved oxygen and fish kills occur occasionally in its tributaries. Algal blooms in storage reservoirs during the summer are somewhat more common; these are caused by high nutrient levels and affect the treatment of potable supplies from surface water sources.

Many cities and towns rely on bank-filtered water supplies, which usually consist of tunnels, wells, or infiltration galleries placed in coarse alluvium parallel to the banks of a river. In several areas of the CSFR and Hungary, babies are given bottled water to avoid high nitrate levels found in some bank-filtered supplies. Heavy metals from industrial emissions have the potential to affect the food chain and aquatic biota, and pose risks to the environment and human health in the Danube Delta and Black Sea regions. In Hungary, fuel leaks and spills at former military bases are endangering potable water aquifers. Elsewhere, in several instances, salty and oily industrial residue affect soils and crops in irrigated areas downstream. Bacterial and organic contamination of surface water potable supplies cause odor, taste, and potential health problems, and disinfection of such waters by chlorine may lead to formation of carcinogens.

- **Major point sources of pollution.** All of the older and larger cities in the four countries have combined (this is, wastewater plus stormwater) sewer systems serving a majority of the population. Interceptors and pump stations have been built to receive flows from sewer systems and carry wastewater to treatment sites, but rarely do the interceptors serve all of a city. Biological secondary wastewater treatment plants have generally been designed for the larger cities, and have been built to various stages of completion.

  Effective operation and maintenance of completed wastewater treatment plants has been achieved in only a handful of cities in the four countries. Critical pieces of equipment in treatment plants are often defective or inefficient, and many municipal plants are overloaded. Sludge treatment and disposal is a major problem at essentially all treatment plants. None of the municipal treatment plants encountered in this study was providing disinfection of the treated effluent, and none was designed or equipped for removal of nutrients (nitrogen or phosphorus). Industries in the four countries have been developed on a large scale to produce chemicals, steel, petroleum, processed food, automobiles, and many other products. Technologies for industrial processing, manufacturing, and treatment of industrial wastewater are generally outdated and evolved during an era when environmental protection was not a major concern. Industrial wastewater treatment or pretreatment plants are often primitive and are operated ineffectively. In many cases, large industrial complexes have been developed at locations where available water resources cannot dilute or assimilate industrial emissions.

- **Economic and financial causes of pollution.** Although industrial activity has declined with the imposition of free market conditions, the reduction of former

subsidies, and the movement toward privatization, industrial wastewater emissions remain a major source of water pollution. High unemployment rates in many cases prevent the closing of factories that do not meet water quality standards for emissions, while economic uncertainties and lack of profitability prevent investment in less-polluting technologies or improved wastewater treatment technologies. Many municipal plants have been designed but not completed, due to the lack of national subsidies and user tariffs that are insufficient to fund the remaining construction.

- **Institutional development.** Under the previous centralized system of government, each country had developed a priority list of cities and industrial installations to receive funds for improved wastewater treatment. A system of fines for emissions exceeding allowable standards was also in place, although not always applied and certainly not effective when all institutions were state controlled and state funded. Each country is now in the midst of developing a new institutional structure and system of taxes and fines under which municipalities, privatized industry, and other local institutions will have a much larger role to play in water pollution control.

  All of the countries have at their service dedicated, well-educated, and experienced water pollution control professionals. Thus, our study received significant assistance and cooperation from the ministerial, regional, and municipal levels of government, and (with some exceptions) from representatives of industrial installations.

Conclusions and Recommendations

The conclusions and recommendations developed in this study relate to three topics:

- Priority investment opportunities, regarding which candidate cities and industrial facilities with water pollution control problems have been identified from field visits to a limited number of sites and from discussions with experts in each country.
- Requirements for institutional development, including possible changes in approach and methodology for promoting international cooperation among the Danube countries, for establishing national, regional, and local institutions, and for supporting such functions as setting national policy, water quality standards, stream quality classifications, fees, and sanctions; monitoring and enforcement; basin planning; investment program development; implementation; establishing and collecting user fees; and improved operation and maintenance of facilities.
- Further integration and use of the DEMDESS data base and software in the respective Danube countries, to provide a common computational framework and decision support tool during the current phase of establishing viable water pollution control programs in the four countries.

Investment Opportunities

In many cases, urban areas that include major industrial concentrations already collect both industrial and domestic wastewater. Given the uncertain viability of most industries, however, early capital investment in pollution reduction is likely to be limited. It appears more likely that, pending the introduction of industrial waste reduction through process changes or pretreatment, early reduction of such components as heavy metals could be achieved by municipal treatment. Fees levied against industrial dischargers could be used to fund such treatment.

Regarding Hungary specifically, dumped fuel remains a major pollution problem. Given the country's great use of groundwater and the deleterious effect that the passing of time has on clean-up efforts, this problem demands consideration as a pollution investment priority.

Based on the above, the WASH team concluded that initial external assistance to Bulgaria, the CSFR, Hungary, and Romania would be likely to include projects where (a) urban areas contain heavy concentrations of industry, (b) industrial areas appear economically viable, and (c) groundwater aquifers are contaminated by fuels dumped or leaked at former military installations. Potential projects were identified from discussions and information provided by local experts in each country, and project sites were visited to the extent permitted by time constraints. The locations of potential projects are shown in Figure A.

The potential projects were prioritized in accordance with several criteria: known or potential impact on health; actual or imminent damage to a critical resource, such as potable groundwater aquifers; readiness to proceed; significant human health or economic benefit even if other projects in the same basin do not proceed; large benefit in relation to cost (such as completion of substantially built treatment plants); and inclusion of projects with a range of sizes, types, and costs. Some potential projects were discarded. The remaining projects were assigned to three priority levels, as indicated in Table A.

It should be noted that these early priority projects do not represent an exhaustive list of all high-priority projects in the four countries. In particular the following omissions are apparent: The Hornad basin in eastern Slovakia and the Sajo basin in Hungary, which have significant pollution problems, were under study by others, but were not visited or evaluated due to time constraints; the large portion of northwestern Romania that drains to the Tisza River in Hungary, and the Timis basin in southwestern Romania, which drains into Yugoslavia, were not visited due to time constraints and were not evaluated due to a lack of data. Yugoslavia and its successor states were not included in the scope of work due to the security situation there.

Information on the 15 first-priority projects is summarized in Table B. Eleven of the projects are concerned with treatment of municipal wastewater in cities producing significant industrial wastewater flows and having partially built wastewater treatment plants; 3 are concerned with upgrading industrial wastewater treatment; and a countrywide project in Hungary is to clean up or contain the effects of fuels that were dumped or leaked at 300 former military installations.

FIGURE A
POTENTIAL PRIORITY EARLY PROJECT LOCATIONS IN THE DANUBE BASIN
Approx. Scale: Km
KEY
BASIN BORDERS
DANUBE BASIN BORDER
POTENTIAL PROJECT LOCATION
CSFR
CZECH REPUBLIC
SLOVAK REPUBLIC
POLAND
UKRAINE
AUSTRIA
HUNGARY
ROMANIA
YUGOSLAVIA
BULGARIA
OSTRAVA
OLOMOUC
BRNO
PRESOV
KOSICE
TRENCIN
NOVAKY
RUNSKA BYSTRICA
SENICA
BOSANY
NITRA
BRATISLAVA
VIENNA
MISKOLC
DEBRECEN
IASI
GYOR
BUDAPEST
SZOLNOK
ORADEA
CLUJ-NAPOCA
TIRGU MURES
SZEGED
ARAD
PECS
TIMISOARA
BRASOV
GALATI
BRAILA
RIMNICU-VILCEA
PITESTI
PLOESTI
BUCHAREST
TURNU-SEVERIN
BELGRADE
CRAIOVA
TIRGU MUGURELE
SOFIA
Danube River
Black Sea

Table A
Potential Priority Early Projects

Country	FIRST PRIORITY		SECOND PRIORITY		THIRD PRIORITY	
	Basin	Project	Basin	Project	Basin	Project
Bulgaria	Iskar	Sofia and Samokov	Osem	Troian and Lovetch	Ogosta	Michailovgrad
	Vit	Pleven	Rusenski Lom	Razgrad		
	Jantra	Gabrovo and Veliko Tornovo	Jantra	Gorno Oriahovitsa and Liaskovetz		
CSFR*	Danube	Istrochem (Bratislava)	Váh	Hlohovec and Leopoldov	Danube	Bratislava, central left bank
	Váh	Trenčín	Nitra	Koželužne tannery (Bošany)	Dudvah	Senica
	Nitra	Novaky industry	Danube	Bratislava, right bank	Morava	Brno
	Morava	Olomouc				
Hungary*	Danube	Györ and Moson Island	Danube	Budapest, north system	Danube	Komárom
	All	Fuel-contaminated groundwater	Tisza	Szolnok		
			Altalar	Tata		
Romania	Jiu	Craiova	Olt	Rimnicu-Vilcea	Danube	Municipal treatment needs in Braila and Galati
	Olt	Govora (Rimnicu-Vilcea)	Danube	Industries in Braila and Galati		
	Arges	Pitesti and Bucharest				

* The analysis of high-priority basins was one of a number of pieces of information provided to donors in early May 1992, to assist them in deciding on future basin studies involving potential investments. Although the Hornad basin in Slovakia and the Hernad and Sajo basins in Hungary were not addressed in the WASH study, the host government and other environmental experts have determined that they are highly polluted and warrant further analysis and investment. Hence, these basins will be the subject of further assessment during Phase II WASH activities.

Table B
Summary of Top-Priority Projects

Country	Basin	Project	Population	Flow, MLd*	Type of Industries/Project Elements
Bulgaria	Iskar	Sofia	1,200,000	520	Metals, machines, chemicals, textiles, wood, foods/two interceptors, treatment rehab, sludge management
	Iskar	Samokov	47,000	30	Limited industry/further treatment to protect Sofia's water supply reservoir, possible nutrient removal, disinfection
	Vit	Pleven	130,000	108	Animal feed, sugar, oil refinery, slaughterhouse, poultry, dairy, winery, metal finishing/pretreatment, municipal treatment to remove oily waste
	Jantra	Gabrovo	90,000	79	Machines, food, electronics/interceptor for industrial flows, treatment upgrading, sludge management to protect Jantra headwater
	Jantra	Veliko Tomovo	90,000	46	Chemicals (manganese waste)/treatment upgrading, sludge processing equipment
CSFR	Danube	Istrochem	Industrial	21	Rayon, fertilizer, explosives, propylene, polymers/biological treatment added to existing physical/chemical treatment
	Váh	Trenčín	54,000	70	Yeast, alcohol, textiles, building materials, furniture, equipment repair/full treatment of yeast and alcohol waste, new right-bank treatment plant, sludge treatment repair at left-bank plant
	Nitra	Novaky	Industrial	36	Power, PVC plastics/control of arsenic leaching from ash disposal site, restructuring of PVC processing and industrial treatment
	Morava	Olomouc	102,000	53	Food, chemicals, pharmaceuticals/upgrade of existing treatment plant, additional new treatment plant
Hungary	Danube	Györ, Moson Island	120,000	60	Machines, textiles, processed food, alcohol, galvanizing/pretreatment for distillery, completion of Györ and five regional treatment plants to protect groundwater in coarse alluvium
	All	Fuel spills	NA	NA	Dumped or leaked fuels at 300 former military sites/emergency control over migration in aquifers, removal and possible reuse of fuels
Romania	Jiu	Craiova	317,000	500	Chemicals, cars, electrical machinery, food, alcohol, bricks, cement, power/ completion of interceptor and municipal treatment plant, rehabilitation of chemical-plant treatment facilities
	Olt	Govora	Industrial	275	Caustic soda, 70 petrochemicals, machines, power/reduction of brine discharges to the Olt, waste minimization, rerouting of flows or new pretreatment plant for one of three flow streams
	Arges	Pitesti	175,000	150	Oil refinery for fuels and plastics, dyes, beer, rubber, electric motors, chemicals, furniture, meat, wine, cars/upgrading of refinery's treatment, nutrient removal at city's treatment plant
	Arges	Bucharest	2,300,000	1500	Paints, beer, furniture, leather, drugs, textiles, machines, food, trams, electronics, power/completion of 2,000 Mld treatment plant

* Dry-weather wastewater flow or treatment capacity; 3.78 Mld (megaliters per day) = 1 mgd (million U.S. gallons per day)

Institutional and Policy Issues for Investment in Pollution Reduction

Each country must improve its management of the water pollution control sector before entering into expensive capital investments, particularly if large commitments are to be made with international hard-currency loans. Preinvestment studies should focus on both institutional and structural needs. Institutional issues that must be addressed include cost recovery from users, the level of subsidy from national governments, reduction of industrial wastes in concert with end-of-pipe treatment, improvements in staffing and equipment for operation and maintenance, and the development of management systems and procedures (e.g., for setting standards, stream classifications, discharge permits, public participation in basin water quality planning, design criteria and equipment specifications, supervision of construction, monitoring requirements, and personnel training for operation and maintenance)

The key areas for continued sectoral improvement in the four countries are as follows.

- **Appropriate national laws, sanctions, and enforcement policies.** The four countries are in various stages of revising sectoral laws and policies. These positive efforts have been supported with technical assistance from the EPA and other entities. A positive use of the experience gained to date would be to provide mechanisms for sharing ideas and experiences among the four countries; the Visegrad and Dubravka workshops on the conceptual design and institutionalization of DEMDESS were seen by the participants as rare, and very welcome, opportunities for open discussion of the common problems the four countries face.

- **Economic incentives and financial reform.** Tariffs for water and wastewater service are generally insignificant in the four countries, and are rarely sufficient to cover even the operating expenses. As the former state subsidies on food, housing, public utilities, and other consumer goods and services are reduced, salaries of workers will increase and inflation may continue for several years at its recent rapid pace. During this complex economic evolutionary process, it may prove necessary to increase the prices for water and sewer service frequently, and in concert with rehabilitation programs to reduce water losses, to conserve water wasted by industry and consumers, and to improve metering of customer water use. While water must remain affordable to users, prices must begin to reflect its true financial cost.

  Tariff studies must be undertaken in each country as part of the feasibility studies prior to investment, to establish feasible tariffs for each type of user (domestic, industrial, commercial, institutional) and possible cross-subsidization of domestic users by higher industrial fees. Studies on organization and management must also be undertaken, since privatization of semi-autonomous municipal or metropolitan water and wastewater agencies may prove necessary to ensure financial self-sufficiency, and to prevent bureaucratic stifling of local initiatives. Such decisions at the municipal level require decisions at the national level on subsidies and fairness between communities.

- **Water conservation.** In the past, many industries in the four countries have been irresponsible in their use of water; therefore, water conservation measures must be

included in the modernization of industry, equipment, and management programs to improve industrial economic efficiency. Consumer plumbing fixtures are of low quality and are poorly maintained due to the low price of water; the resulting waste of water from drips and leaks can substantially increase the wastewater flows requiring treatment. Higher tariffs will reduce waste, and other more direct programs could bring about the desired reduction in water use more quickly.

- **Industrial pretreatment.** Industrial pretreatment can be defined as treatment that allows wastewater to be put into municipal sewers without damaging sewer materials and without interfering with the operation of municipal wastewater treatment plants. In combination with water conservation and waste reduction in industry, more attention must be given to industrial pretreatment, to ensure the effective operation of municipal biological treatment processes and to reduce contaminants in sludge that prevent its agricultural reuse. In addition to improved monitoring and enforcing of pretreatment requirements, it may be desirable in some cases to subsidize industrial redevelopment when building pretreatment facilities that serve large industrial complexes. The economic viability of individual factories may be in doubt, such that early investment in pretreatment facilities for them would be risky. For an industrial complex as a whole, however, the composition and magnitude of flows to be treated should be more predictable, and hence the financial risk more manageable.

- **Human resources development in water quality management.** Training programs specifically designed to meet the management and planning needs of the sector in Central and Eastern Europe should be designed and implemented. Such programs should focus on management practices and decision support systems; the collection of reliable and appropriate information; procedures that include public participation by citizens, industry, and agencies in the planning processes; and training programs that provide skills in cost management.

- **Role clarity and sectoral coordination.** Each of the four countries should carefully reexamine decisions relating to agency roles and responsibilities that have been made under the transitional pressures of the past two years. Institutional analyses are needed to define optimal ways to set up coordination mechanisms, eliminate overlapping of roles, and provide clear mechanisms to issue and monitor discharge permits and coordinate activities in water quality control. Alternatives should be put forth and decided on in each country for the involvement of all interested parties (industry, municipal agencies, private citizens, ministries) in the management of river basins. The objective should be to find a model that does not duplicate efforts and that allows for coordinated actions that work.

- **Laboratories and monitoring programs.** Efforts are under way within the donor community to provide enhanced laboratory and monitoring equipment to each of the four countries. Building laboratory capacity and improving the overall quality and reliability of available data is a necessity. The EPDRB working group on data management should specify basic frequencies of sampling, the types of laboratory

tests, and the water quality parameters that are needed, from which the dimensions of need can be estimated, and measures taken to ensure appropriate basic capacity.

- **Data requirements for DEMDESS.** The usefulness of the DEMDESS software and data base depends partly on the quantity and quality of data from laboratories and monitoring programs, and also on institutional cooperation to obtain the broad variety of information needed in water pollution control planning and policy analysis. In several of the countries, transfer of information between ministries or institutes is inhibited, particularly for institutes that must sell data in order to survive. More freedom of access to data collected using public funds is needed in such countries.

The Decision Support System

The Danube Emissions Management Decision Support System (DEMDESS) consists of a data base and software that have been developed and applied to a pilot river basin in Bulgaria, the CSFR, Hungary, and Romania. The DEMDESS software and data bases, which were developed using Paradox® and Quattro Pro® computer programs, have the following uses:

- Providing the information needed by decision makers in the four countries to enable them to develop effective and coordinated strategies and policies for reduction of polluting emissions by
  - Quantifying and forecasting the environmental and economic effects of emissions control options;
  - Making forecasts of emissions of specific pollutants under various scenarios of population and economic growth and industrial technology and development;
  - Estimating the effects of river basin management strategies at various levels of aggregation (e.g., by tributary, type of industry, or political subdivision);
  - Evaluating the effects of industrial restructuring and policy options affecting industry, such as economic incentives, emissions-based discharge fees (taxes) and fines, and pretreatment criteria;
  - Identifying the cost-effectiveness of applying controls to specific "hot-spots" or population concentrations; and
  - Providing information on the institutional and financial implications of policy options, such as user tariffs; manpower needs for planning, design, and operations; training requirements; and funding needs.
- Providing the basis for the development and funding of programs for the collection of emissions data and the monitoring needed to support effective pollution reduction.

The DEMDESS effort was described as a very good first step by most of the country representatives in the Institutionalization Workshop. This assessment was based on the following factors:

- A system design is in place that includes data compatibilities programmed to interface, both nationally and internationally, with most existing data bases in the four countries.
- DEMDESS stores information in an interchangeable, standardized format and operates on personal computers, the most common computer platform in Eastern Europe. It can perform the tasks of data storage and manipulation for multiple uses and multiple users in each country.
- DEMDESS can be used to conduct cost, institutional, and other analyses that facilitate responding to questions about the impacts of various possible interventions.

Other DEMDESS advantages include the following:

- Use of DEMDESS as a tracking tool for enforcement imposes no major institutional constraints. As mentioned above, DEMDESS takes full advantage of existing emissions-related data bases. Most of the system's data are taken from current administrative routines. Additional data that DEMDESS needs can be reasonably gathered from paper reports; such data includes standards, taxes, and fines.
- DEMDESS includes the primary components necessary for emissions management and decision support: information on existing emissions, water quality, waste treatment effects, costs of treatment, regulations, and institutional relationships.
- DEMDESS integrates the above data in a format that is specifically designed for diagnostic evaluation, alternative emission scenario analysis, and policy support. It is important to note that in most cases, such critical data integration had not previously existed operationally.
- No other systems currently available for Eastern Europe perform the operational integration and analysis that DEMDESS does.
- DEMDESS is designed with the future in mind: the system is open to the use of new information, new analysis techniques, and new technologies as they become available. For instance, GIS can link with DEMDESS.
- DEMDESS is primarily based on water quality and emissions management techniques and principles that have evolved over the past 20 years in the United States. DEMDESS adapts some of these techniques to meet Eastern Europe's particular emissions management requirements in a straightforward and logical manner.

The above features provide a basis for data management, even if DEMDESS is not used as a planning tool. Testing DEMDESS with real data from demonstration basins showed that DEMDESS can answer the questions it was designed to answer. Because the system is data driven, improving the first attempt at data entry and expanding data collection beyond the

demonstration basins are very important for establishing DEMDESS as an operational tool that can adequately reflect real-world issues. Testing and proving the accuracy of the system will require substitution of additional, updated, and verified data to complete the initial activity in each country.

Institutional Measures for DEMDESS Implementation

The basic institutional structure and capacity now exist for DEMDESS implementation in each of the four countries. Improvements are needed, however, in various institutions regarding decision analysis, coordination, communication among entities, and the capability to collect and evaluate data. If the DEMDESS program is to work as a management tool, an information system, and a decision-analysis tool, it must become understood and integrated into the normal administrative routines of institutions. At the policy level, there must be an understanding of the system's capabilities and potential applications. Orientation will therefore be required for decision makers in how to use decision support tools such as DEMDESS.

The current status of implementation in the four countries is summarized below.

- **Bulgaria** is fully committed to DEMDESS as a key data management, reporting, and policy tool. This support extends to the regional inspectorate level for the entire country. The Ministry of Environment has made significant resource commitments, including staff time, office space, equipment support, and briefings to the minister. The Danube "focal point" and staff have devoted substantial efforts in support of the system. In fact, total cooperation has been provided at all levels. The high level of support and existing technical capability virtually assures the institutionalization of DEMDESS, especially with continued A.I.D. support.

- **Slovakia** has all of the conditions necessary to institutionalize DEMDESS. Top-level management views DEMDESS as a potentially key policy tool for the COE (Slovak Commission on the Environment). The COE has been able to coordinate, access, and cooperate effectively with the Water Research Institute, the Hydrometeorological Institute, and the regional water authorities. Additionally, Slovakia has excellent existing administrative routines for supporting the DEMDESS data requirements. Preliminary technical "buy-in" in the institutes has occurred through well-attended technical presentations. Institutionalization of DEMDESS will occur if it is used as a key tool in the prefeasibility studies and development of policy-level analyses for the COE. On a technical level, DEMDESS is bringing together several independent, well-developed national data bases.

- **Hungary** has bought into DEMDESS to the extent that the Ministry of the Environment and Regional Planning (MERP) has spent money to develop the Altalar Pilot Basin demonstration; MERP paid Vituki for the technical support. Vituki has tentatively bought into DEMDESS as a valuable technical analysis tool.

Institutionalization of DEMDESS is certainly possible; it depends upon management and financial support from MERP or others.

- **Romania** has provided an institutional home at REIE (the Research and Engineering Institute for Environment). There are many changes taking place in the Ministry of Environment, but REIE will probably remain a stable, powerful supporter. Romania in general is very short of resources, but valuable commitment of staff time has been generously provided by the institute in support of DEMDESS. Institutionalization of DEMDESS is possible with steady support and tangible demonstration of use in the prefeasibility studies.

At the moment of turnover to the countries involved, DEMDESS will have an immediate use as a data base for monitoring pollution control and the application of sanctions. Additionally, the decision-analysis elements of the system can become significant if users learn to make use of them for this purpose.

Eventual broader use of DEMDESS will require a coordinated effort and a management structure for its maintenance. This process will require an interaction between management and operators in which uses of the system are specified and scenarios are programmed for analysis. Some options-analysis scenarios have been programmed, but the need for others will emerge during the first year of use.

Within the next year of DEMDESS operation, each country ideally should have accomplished the following:

- Expanded DEMDESS to cover all, or most, river basins as a part of a national data base system and harmonized it with existing information networks;
- Incorporated DEMDESS as a part of its national monitoring, sanctions, administrative, and management routines at the level of various operational users, such as river basin authorities and environmental inspectorates;
- Used the system at higher levels for options analysis and decision support for short- and long-range planning; and
- Developed a national network of user and client groups, coordinated by a primary user at the national level.

In addition, it is hoped that international donors and EPDRB will find DEMDESS useful as a way of forging international linkages for data management. Widespread adoption, however, will depend on the speed with which EPDRB's task force on data management accepts DEMDESS or recommends alterations or alternatives to it.

Future needs for DEMDESS fall into six categories of activity:

- Bridging to initial use,
- Operating DEMDESS in selected priority river basins,
- Incorporating DEMDESS, in a staged manner, into operational routines for data base management at inspectorate and operational offices,

- Expanding DEMDESS to all basins in each country and to full operational and decision/policy use,
- Establishing country- and basinwide system maintenance and improvement, and
- Developing international uses and linkages.

The following steps are recommended for the international donor community in support of the above activities:

- A one-year bridging activity should be undertaken by an international donor to support DEMDESS installation, debugging, validation, and initial use.
- A.I.D. should encourage the use of DEMDESS in prefeasibility work it sponsors as part of the next round of EPDRB activities.
- Multilateral lenders considering the funding of pilot projects under the EPDRB should also encourage the use of DEMDESS as a standard data base to support preinvestment studies. If this is done, it will not only assist in the preparation of projects, but will also help define requirements for improved monitoring and data management.
- A donor could consider supporting a small amount of DEMDESS maintenance activity, including periodic updating of DEMDESS manuals and occasional responses to problems encountered with the system during the next two years.
- EPDRB, through its Project Coordination Unit, should continue long-term support of the international coordination of, and communications to improve, the use of DEMDESS.

Alternatives to DEMDESS

Alternatives to DEMDESS should certainly be considered; it is possible that better ways exist to meet Eastern Europe's emissions management and decision support needs. Alternatives to DEMDESS must perform essentially the same functions as DEMDESS, however, or they will fail to meet these needs.

DEMDESS has been built using a set of requirements developed by the WASH team in conjunction with the host country requirements. If the requirements for emissions management change significantly, DEMDESS should be reevaluated along with other alternatives.

Some alternatives to DEMDESS are not emissions management systems. For instance, GIS is not an emissions management tool; rather, it is a system for displaying and analyzing geographical information. GIS can provide data to a decision support system and can help display such information, but it is not an emissions management/decision support system in itself.

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Chapter 1

CONTEXT OF THE REPORT

1.1 Background

1.1.1 Key Project Events

The WASH Project's work on the Danube River basin study began in the summer of 1991 with the collection of available information, primarily in the form of reports and published documents. This was followed in September 1991 by a team planning meeting at the WASH Operations Center in Arlington, Virginia. The principal outcomes of that planning meeting were a draft Scope of Work agreed with A.I.D.'s EUR Bureau, a preliminary plan for performing the work, and initial travel schedules for the field team.

The overall approach taken during the project was to maximize the involvement of country personnel by scheduling WASH team time primarily in the four assisted countries and limiting time spent in the United States. Initial work on the decision support system aspects of the project, from late September through early December 1991, was done primarily in Bulgaria. Hungary was the principal base of operations for the team in the period from early December 1991 through mid-April 1992. The concluding field work, in May 1992, was concentrated in Slovakia. However, for the purposes of establishing system and data needs, evaluating conditions, studying institutional issues, working with local subcontractors, and making site visits, all team members spent substantial time in each participating country.

Two events of key importance in the course of the project were (a) an international Project Planning Workshop, held in Visegrad, Hungary, in December 1991, at which the concepts and needs for the decision support system were agreed and the name Danube Emissions Management Decision Support Project (DEMDESP) was decided on, and (b) an international Institutionalization Workshop, held in Dubravka, Slovakia, in May 1992.

The Scope of Work, methods used, team time distribution by country, persons interviewed, and results of the two international project workshops are summarized in Appendix A.

1.1.2 Project Deliverables

Project deliverables included the following:

- A concept paper, dated January 1992, which was a working document presenting the concepts for the decision support system and model on the basis of the understandings reached at the December 1991 Project Planning Workshop;
- A functional emissions data management and decision support system (the Danube Emissions Management Decision Support System, or DEMDESS), in a form that is common to all four participating countries but incorporates data specific to each

country in its copy of the computer-based system; those data apply primarily to the basins selected by the countries as demonstration sites;

- A user manual for the decision support system; this manual was issued in July 1992; and
- This report, also issued in draft in July 1992 (after key elements of it had already been reviewed and commented on by representatives of the four countries) and, after receipt of comments on the draft from A.I.D., in final form on August 7, 1992.

1.2 Purpose of the Report

The basic purposes of this report are to present for general audiences in the four assisted countries, and for A.I.D. as client, the methodology, findings, and recommendations of the WASH team and to record the key technical and institutional data that were collected. More important specific purposes, however, are (a) to set down for potential users and clients of the decision support system guidelines for the application and ongoing use of the system; (b) to present the team's findings and recommendations on high-priority pilot projects; and (c) to present an initial assessment of institutional issues.

In addition to the background and context of the study, the report presents the following:

- The conceptual framework and decision-making system in which the model is to operate, including decisions reached on this subject in the May 1992 Institutionalization Workshop;
- Future directions for the decision support system, also as agreed in the May workshop;
- Recommendations on high-priority early investment needs and on issues to be addressed in related preinvestment studies (see Appendix B);
- Findings and recommendations on institutional matters (see Volume II); and
- The results of country technical studies by local subcontractors to the WASH team (see Volume III).

The *User Manual*, on the other hand, is a separate document directed to a narrower audience of model users, who will invite and respond to questions and requests for assistance by decision makers and pollution control strategists. It sets out the data base design and input needs, internal linkages, computational procedures, assumptions, and potential outputs of the decision support model. It also provides instructions on basic uses and illustrations of typical potential uses related to issues having greater complexity and subtlety. Finally, it provides general guidelines for enhancing and expanding the decision support model.

1.3 Relationship to the Danube Environmental Program

To enable proper integration with the overall Environmental Program for the Danube River Basin (EPDRB), the Scope of Work was not finalized until after the Danube Basin Conference, sponsored by the Bulgarian Academy of Sciences and the Global Environmental Facility and held in Sofia, September 24-27, 1991. On the basis of discussions held and planning conducted at that conference, including the technical sessions (which were attended by A.I.D./EUR staff and WASH team members) and the intergovemmental planning sessions (which were attended by A.I.D./EUR staff but not by WASH team members), the Scope of Work for the study was adjusted to ensure its coordination with the Three Year Action Plan that was agreed by the conference attendees.

Both A.I.D./EUR and the WASH team were represented at the Danube Task Force meeting, held in Brussels, February 13-14, 1992. A brief presentation was made on the content and status of DEMDESP. From the discussions at the task force meeting, and the resulting Program Work Plan, the work of the project falls under the following two components of the agreed Three Year Action Plan:

- Short-Term Actions—(a) High Priority Actions (the high-priority investment needs and related institutional elements of the project); and
- Institutional and Technical Building Blocks—(b) Analytical Tools—(iii) Data Management (the decision support system and related institutional elements of the project).

Within the overall assistance provided by the U.S. government to EPDRB, an important component of this study has been the contribution made by the U.S. Environmental Protection Agency (EPA). This involved coordination through joint participation in project planning and progress meetings and also making it possible for the WASH team to draw on skilled persons in EPA having knowledge of conditions and needs in the four countries bearing on the selection and prioritizing of the early investment proposals.

Chapter 2

OVERVIEW OF EXISTING CONDITIONS

This chapter provides an overview of water-related conditions in the Danube River and its tributaries. The chapter begins with brief discussions of basinwide hydrologic conditions (water flows and hydrotechnical works), water use and environmental sensitivity, and water pollution and water quality. The chapter then presents an overview of the pollution loads from the main industries and sewered populations and the related pollution effects in each of the four countries participating in the study—Bulgaria, the CFSR, Hungary, and Romania. This chapter, together with the detailed technical reports on each of the four countries in Volume III, lays the foundation for the discussion in Chapter 3 of potential short-term pollution control actions in each of the four countries.

2.1 General

The Danube River passes through or along the borders of eight countries (Austria, Bulgaria, the Czech and Slovak Federal Republic (CSFR), Germany, Hungary, Romania, Ukraine, and Yugoslavia) and has tributaries or subtributaries arising in or flowing through an additional six countries (Albania, Croatia, Italy, Poland, Slovenia, and Switzerland). Table 2.1 shows the approximate distribution of catchment area and population and the length of the Danube River and riverbank among the above countries.

From Table 2.1, it can be seen that the four participating countries include over half of the catchment area, well over half of the population, and over half of the riverbank length of the Danube basin. They are also heavily industrialized. In some of them, significant proportions of the wastewater discharges are not effectively treated. These four countries account for a major part of the total pollution load on the waterways of the Danube basin.

The Danube and its key tributaries are indicated schematically on Figure 2.1. Also shown are key cities in the participating countries producing significant pollution loads, because of either population or industrial activity, and the capitals of other countries.

2.2 Hydrologic Conditions in Danube Basin

2.2.1 Flows at Selected Points

As an indication of the relative flows of the Danube and some of its key tributaries, Table 2.2 presents multiannual flows at selected points.

The highest flows occur in the summer months, generally from April through July in the upper reach of the Danube and that part of the middle reach above the entry point of the Tisza

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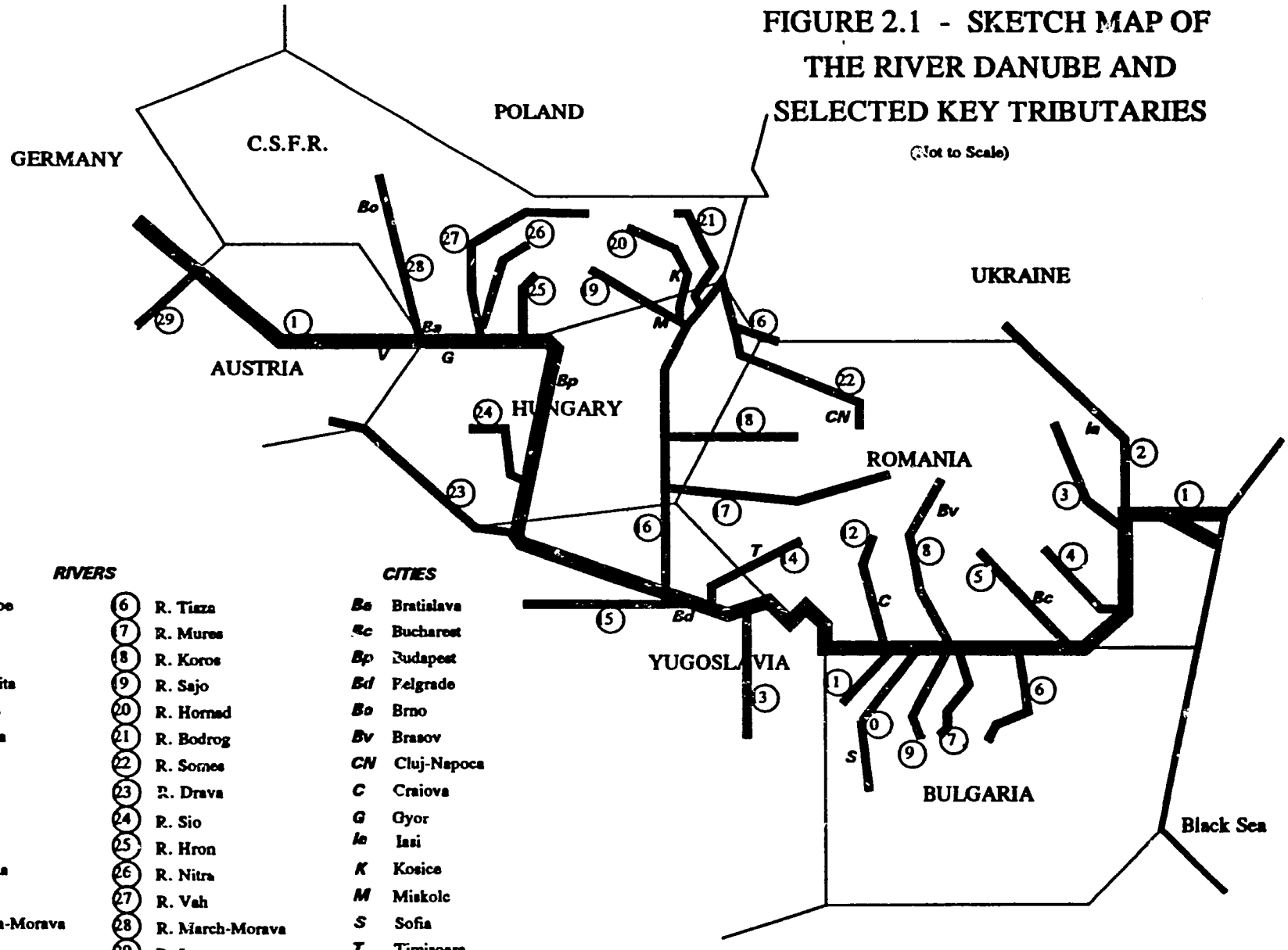
FIGURE 2.1 - SKETCH MAP OF THE RIVER DANUBE AND SELECTED KEY TRIBUTARIES

(Not to Scale)



RIVERS

1. R. Danube
2. R. Prut
3. R. Siret
4. R. Ialomita
5. R. Arges
6. R. Yantra
7. R. Osem
8. R. Olt
9. R. Vit
10. R. Iskar
11. R. Ogosta
12. R. Jiu
13. R. Velika-Morava
14. R. Timis
15. R. Sava
16. R. Tisza
17. R. Mures
18. R. Koros
19. R. Sajo
20. R. Hornad
21. R. Bodrog
22. R. Somes
23. R. Drava
24. R. Sio
25. R. Hron
26. R. Nitra
27. R. Vah
28. R. March-Morava
29. R. Inn

CITIES

Bs	Bratislava
Bc	Bucharest
Bp	Budapest
Bd	Belgrade
Bo	Brno
Bv	Brasov
CN	Cluj-Napoca
C	Craiova
G	Gyor
Ie	Iasi
K	Kosice
M	Miskolc
S	Sofia
T	Timisoara
V	Vienna

Table 2.1

CATCHMENT AREA, POPULATION, AND RIVER AND RIVERBANK LENGTH, DANUBE RIVER BASIN

Country	Area in Catchment (000 sq km)[a]	Population in Catchment (millions)[b]	River Length (km)[c,d]	Riverbank Length (km)[c]
Bulgana	48	4	470	470
CSFR	71	7	170	190
Hungary	93	11	420	690
Romania	206	21	1,080	1,370
Subtotal	**418**	**43**	**580**	**2,720**
Germany	60	10	350	1,160
Austria	81	8	590	640
Yugoslavia	183	14	80	950
Ukraine	44	1	—	160
Others	3	—	—	—
Subtotal	371	33	—	2,910
TOTAL	**789**	**76**	**2,815**	**5,630**

[a] Source: Stančík and Jovanovič (1988), adjusted for the CSFR and Romania in accordance with the relevant country reports in Volume III.
[b] Source: Rojanschi (1991).
[c] Source: Hock and Kovács (1987).
[d] Cannot be totaled by country because some parts of the river are bordered by the same country on each bank and others by different countries.
[e] Includes Croatia and Slovenia.

River, and from March through June in the remaining part of the middle and lower Danube and in the Tisza and its tributaries. Serious flooding has occurred at various times of year due to summer storms, snowmelt, and ice jams. Low flows occur in fall and winter. Poor water quality often occurs in October or November, when stream flows are at a minimum, water temperature is high, and nutrient loads are high.

Table 2.2

MULTIANNUAL FLOWS OF DANUBE RIVER, SELECTED POINTS

Point	Multiannual Mean (cu m/s)	Multiannual Specific Mean (L/s/sq km)	Multiannual Peak to Mean to Lowest Ratios
Danube above the March-Morava	1,943	19.1	2.83/1.00/0.41
March-Morava above the Danube	110	4.6	5.72/1.00/0.26
Vah above the Danube	152	14.3	6.89/1.00/0.25
Danube above the Drava	2,479	11.8	1.99/1.00/0.39
Drava above the Danube	554	14.9	2.42/1.00/0.42
Danube below the Drava (170 km above the Tisza)	3,060	12.2	1.89/1.00/0.40
Tisza above the Danube	766	5.4	2.83/1.00/0.24
Danube below the Timis	5,490	10.4	1.83/1.00/0.41
Iskar above the Danube	60	7.1	7.11/1.00/0.18
Olt above the Danube	162	7.1	6.10/1.00/0.26
Danube below the Arges	6,300	9.1	1.74/1.00/0.42
Danube below the Prut	6,550	8.1	1.62/1.00/0.45

Source: Hock and Kovács (1987).

The contributions of the territories of the four participating countries to the total water discharges leaving their downstream borders are estimated (Hock and Kovács, 1987) to be as follows:

- Bulgaria 7.4 percent
- CSFR 32.5
- Hungary 5.0
- Romania 17.4

2.2.2 Hydrotechnical Works

There are numerous river training and water retention structures on the Danube and its tributaries in the area under consideration. For the Danube itself, Stančík and Jovanovič (1988) include the following examples:

- **Flood-control embankments and training works to minimize flood flows and maintain navigability:** channel straightening and embankment construction, especially along the left bank, has been done in the CSFR section; 1,350 km of embankments exist along the Danube in Hungary, where extensive channel straightening has been done to minimize ice buildup; complete left bank protection has been provided in Yugoslavia, together with protection on certain parts of the right bank; about 300 km of levees exist along the Bulgarian part of the right bank; almost complete protection has been provided on the Romanian part of the left bank; and the Sulina branch of the delta is kept navigable by continuous dredging.
- **Hydropower facilities:** There are six existing or proposed hydropower facilities on the Danube in or adjacent to the four participating countries (Hock and Kovács, 1987). Existing facilities include the following:
  - Two dams in the Iron Gate section, between Yugoslavia and Romania, with navigation locks and power generation facilities. These dams inundate the former cataract section.
  - An internationally controversial hydropower generation and navigation system on the Danube between the CSFR and Hungary. Major river retention works are partly constructed at and between Dunakiliti and Gabčíkovo, on the north bank, respectively about 20 and 50 km downstream from Bratislava. These works include a river diversion dam at Dunakiliti and a 19-km-long, above-ground diversion canal parallel to the west bank and terminating in a dam, power plant, and navigation locks at Gabčíkovo. Additional facilities at Nagymóros, a short distance downstream from the entry point of the Ipoly River, have been abandoned. The CSFR intends to complete construction of the Gabčíkovo facilities based entirely on its own territory, including a new weir at Dunakiliti.

Tributary rivers also have hydrotechnical works. In the Tisza River, for example, flood protection levees totaling about 440 km in length have been constructed. Impounding reservoirs for irrigation, flood control, and/or urban water supply have been constructed on many tributaries of the Danube.

2.3 Water Use and Environmental Sensitivity

The greatest volumetric use of water withdrawn from the Danube River system is for irrigation. This is particularly so in Bulgaria and Romania. The other principal categories of use of withdrawn water are for community and industrial use and for fisheries. Table 2.3 shows the estimated net consumptive use of water in the four countries in 1980.

Table 2.3

NET CONSUMPTIVE USES OF WATER IN DANUBE RIVER SYSTEM, 1980
(MILLION CU M/YEAR)

Country	Withdrawal	Community and Industrial Consumption*	Irrigation	Fisheries	Total Consumption
CSFR	1,300	220	1,970	10	2,200
Hungary	2,000	410	4,710	270	5,390
Bulgaria	700	150	5,680	—	5,830
Romania	3,800	600	12,760	620	13,980
TOTAL	**7,800**	**1,380**	**25,120**	**900**	**27,400**

*Estimated by WASH team at 600 Lcd.
Source: Hock and Kovács (1987).

The quantities of water withdrawn have in general decreased since 1980. In Romania, for example, about 1,700 million ha are now irrigated using 4,400 million cu m of Danube water per year, equal to about 2 percent of the average flow in the river. Of the quantity taken, about 5 percent is estimated to be returned to the river. Irrigation water is also taken from tributaries and groundwater in Romania to the extent of about 700 million cu m/year (Rojanschi, 1991).

Urban and industrial water supplies are taken directly from rivers (for example, for Bucharest's water supply), from groundwater (as is about 78 percent of urban water supply in Hungary and about 50 percent of that in the CSFR), or from combined groundwater and river underflow through bank-filtered well supplies. Bank-filtered supplies along the Danube comprise the principal water sources for such major cities as Bratislava and Budapest and for other urban areas in western Slovakia and northwest Hungary. Budapest draws about 300 million cu m/year in this way.

Both direct and bank-filtered water supplies can be affected by wastewater discharges to rivers in the basin. Other water uses that can be affected are tourism and commercial river fishing.

Certain areas in the Danube are reported to be very important ecologically. These include the Danube Delta wetlands, the delta of the Tisza River, and isolated oxbows in various locations in the Danube and certain tributaries.

2.4 Pollution in the Black Sea

The Black Sea, with an area of 508,000 sq km, is the largest permanently anoxic basin in the world. It receives fresh water from the Danube and other rivers (including the Don, Dneiper, and Dniester), and salt water from the Mediterranean Sea and Sea of Marmara by way of bottom flow through the Bosphorus. Mixed fresh and saline water flows out in the upper layers of the Bosphorus.

The upper, oxygenated layer of the Black Sea, which has low salinity, is about 50 to 70 m deep and overlies a deep anoxic zone having high levels of hydrogen sulfide. The oxygenated layer appears to be becoming shallower, probably as a result of reductions in river flows from former Soviet countries, where abstractions of river water for irrigation have been rapidly increasing (Murray and Izdar, 1989).

The Black Sea is an important source of transportation, recreation, and fishing. It receives pollution not only from the tributary rivers but also from shipping and from wastewater discharges from communities and industries located along its shores.

2.5 Water Pollution and Water Quality in Four Study Countries

2.5.1 Overview

Wastewaters

Polluting wastewaters include treated and untreated urban wastewaters, including industrial wastes; industrial wastewater from separate industries and industrial platforms; and agricultural wastewater, including flows from animal feedlots and nonpoint pollution due to the use of fertilizers and pesticides. All four countries have a high level and wide range of industrial activity, including chemical, metallurgical, and food industries.

The levels of manufacturing activity, although high in certain sectors in relation to the internal markets of the four countries prior to 1989, have dropped substantially under open market forces and with the loss of the former international barter arrangements that depended on the Soviet system. Production levels in most individual factories have fallen and some factories have been closed. More adjustments, possibly including closures, are likely to occur during the process of privatization that is being planned or undertaken in each country. Thus, industrial wastewater emissions have changed, are changing, and will continue to change.

Wastewaters from urban areas and industries are in most cases at least partially treated. The coverage and actual effectiveness of treatment vary widely, and some major urban and industrial wastewater flows receive little or no treatment.

The principal cities, and their populations, in the four-country portion of the Danube basin are Bucharest (2.2 million), Budapest (2.1 million), Sofia (1.2 million), Bratislava (440,000), and Brno (400,000). Seven other cities in the Romanian, and one in the Czecho-Slovak, part of the basin have populations of over 300,000, and 26 other cities have populations of over 100,000.

Many cities, including large ones, provide effective treatment for none, or only a small fraction, of the collected wastewaters. Where treatment is performed, equipment is in many cases deteriorated or inefficient. Because of the lack of water conservation practices, flows are high and some treatment plants are overloaded unnecessarily. Several cities have treatment plants partially constructed, construction having been halted for lack of funds. Most treatment plants have severe difficulties with sludge management. In many cases designers assumed that sludge would be digested and used by farmers. Farmers generally refuse to take the sludge, however, because it contains toxic metals. The need for action on sludge treatment and disposal improvements is urgent in some cases.

Among the industries contributing significantly to pollution of the river system are lignite coal mining, petroleum refining, chemical industries, food industries (including sugar beet processing), pharmaceuticals, tanning, metal fabrication and plating, and steel manufacture. There are industrial concentrations in many locations, including on the following tributaries of the Danube: the Siret, Arges-Dimbovita, Jantra, Vit, Jiu, Olt, Iskar, Tisza, Drava, Nitra, Váh, and March-Morava rivers. Concentrations also exist on the following tributaries of the Tisza River: the Mures, Körös, Sajo, Hornad, Bodrog, and Somes rivers.

In Bulgaria and Romania, animal feedlots, especially on pig and cattle farms, create major pollution loads. This is currently the second-largest source (after communities) of biochemical oxygen demand (BOD_5) and suspended solids loads on the river system in Bulgaria. There are particularly large loadings in the basins of the Iskar, Ogosta, Rusenski Lom, and Jantra rivers. In some cases sedimentation is provided, but the remaining BOD_5 and suspended solids loads remain very high.

Conventional indicators of pollution, such as BOD_5, suspended solids, and nitrates, are generally monitored regularly, especially for the principal urban areas. However, the quality

of many industrial wastewaters is not well monitored, especially with respect to heavy metals and micropollutants.

Pollution of Receiving Waters and Impacts on Uses

The Danube provides high dilution of wastewaters entering it and has high self-purification capacity in relation to biodegradable organic wastes. Oxygen depletion is therefore in general not a problem in the main stem of the river, although it is in some tributaries in the CSFR, Bulgaria, and Romania.

Bacterial contamination is pronounced below the major urban wastewater discharges where disinfection is not practiced. Industrial and municipal wastewater discharges include oil, oil products, and organic micropollutants, all of which are detectable in the Danube.

In general, chlorination or ozonation of treated effluent is not used for disinfection, and reliance is placed on disinfection of the public water supply and on preventing contact with polluted waters by irrigation workers.

Forms of nitrogen are a major problem in many locations. For example, in the part of the Danube near Budapest, nitrate enters the river underflow through agricultural contamination of the groundwater, especially in the spring, when surface runoff from agricultural areas is high. In the winter, especially under ice-cover conditions, ammonia from discharged wastewater is found in the underflow. The river underflow is a major source of public water supplies in parts of Slovakia and Hungary near the Danube. Nitrates also lead to serious eutrophication in certain river sections (for example, the lower Tizsa River, isolated oxbows alongside certain tributaries, and the Danube Delta) and in near-shore sections of the western Black Sea. Nitrates (from overuse of inorganic fertilizers) exceed the limits allowed for infants (to avoid "blue-baby syndrome," or methemoglobinemia) in many areas of groundwater in the Czech, Slovak, Hungarian, and Romanian portions of the basin. Bottled water is provided for infants in areas of the CSFR and Hungary.

The eventual fate of nondegradable pollutants varies by substance and by circumstance. The iron and copper content and the hardness of the Danube increase considerably between Bratislava and the Black Sea. Heavy and toxic metals in industrial wastes, both those included in municipal discharges and those separately discharged, are found in the river system, in bottom sediments of the rivers, and in the Black Sea. While the levels of the more dangerous metals in the river waters are generally within water supply standards, there is a potential for the concentration of some of them in the food chain. Levels in the river water vary widely with time and location. Reported values near Budapest have been as high, in $\mu g/L$, as mercury, 18.7; cadmium, 29.0; and lead, 55.0 (see "Hungary Technical Report" in Volume III).

Suspended substances in effluents tend to be deposited, along with naturally occurring suspended matter, in certain areas, particularly in impoundments and in river sections where the bottom slope and, hence, the velocity are low. While their composition varies from location to location, the sediments generally have a substantial content of inorganic material

of natural origin, organic matter of sewage origin, and in many cases heavy metals of wastewater origin. Bottom sediment values in the middle reaches of the Danube have been reported to be as high, in mg/kg as mercury, 2.0; cadmium, 6.0; lead, 140; chromium, 186; and zinc, 4,200. Toxic substances in river sediments can potentially be drawn into bank-filtered water supplies.

Dissolved salts from industrial processes have seriously polluted the Olt River in southern Romania, which is understood to have caused soil and crop damage in irrigated areas downstream.

Dissolved degradable substances tend to decompose both in the surface waters and when abstracted for use, including when applied to land. Dissolved organic matter, under the generally oxygen-abundant conditions in the Danube system, are oxidized naturally. However, chlorination of abstracted water with significant organic content, for the purpose of disinfecting the water supply, has the potential to create trihalomethanes, which are suspected carcinogens. Decomposition of organics has also created anaerobic conditions that generate sulfides, iron, and manganese in bank-filtered water supplies.

An urgent and potentially serious water pollution problem in the Hungarian portion of the Danube basin is the contamination of groundwater by petroleum products and solvents leaking and/or dumped into the soil at former Soviet military bases. This is part of a broader hazardous waste problem, but it is mentioned here because in some locations it is known that dumped fuel overlies the groundwater to a depth of half a meter in some locations, is spreading laterally, and has the potential to have a major impact on water supplies taken from groundwater, including eventually, bank-filtered supplies and the Danube itself. This has been stated to be the number one environmental priority of the Hungarian government. Oil and oil products are also detectable in the river waters, especially in Danube tributaries in industrialized areas.

Because of the heavy nutrient loads entering the western Black Sea (not only from the Danube) and degradation of the resulting phytoplankton in the upper, oxygenated segment of the sea, deoxygenation in parts of that upper layer is now occurring each summer (Murray and Izdar, 1989). Commercial fish catches are now drastically reduced because of eutrophication and overfishing. It is said that fish stocks have decreased to .04 percent of their former level and that 10 species have disappeared. The Black Sea is the recipient of oil, lead, chromium, cadmium, and other toxic contaminants. Algal blooms in the western part of the Black Sea are now visible and have been occurring since 1980. Bottom species, including bivalves and mollusks, have decreased substantially.

The principal actual or potential avenues for health impact due to wastewater discharges appear to be water supply contamination, particularly by toxic and carcinogenic substances but also by bacteria, and bioaccumulation of toxic or carcinogenic substances in the food chain, in either an aquatic or a soil environment.

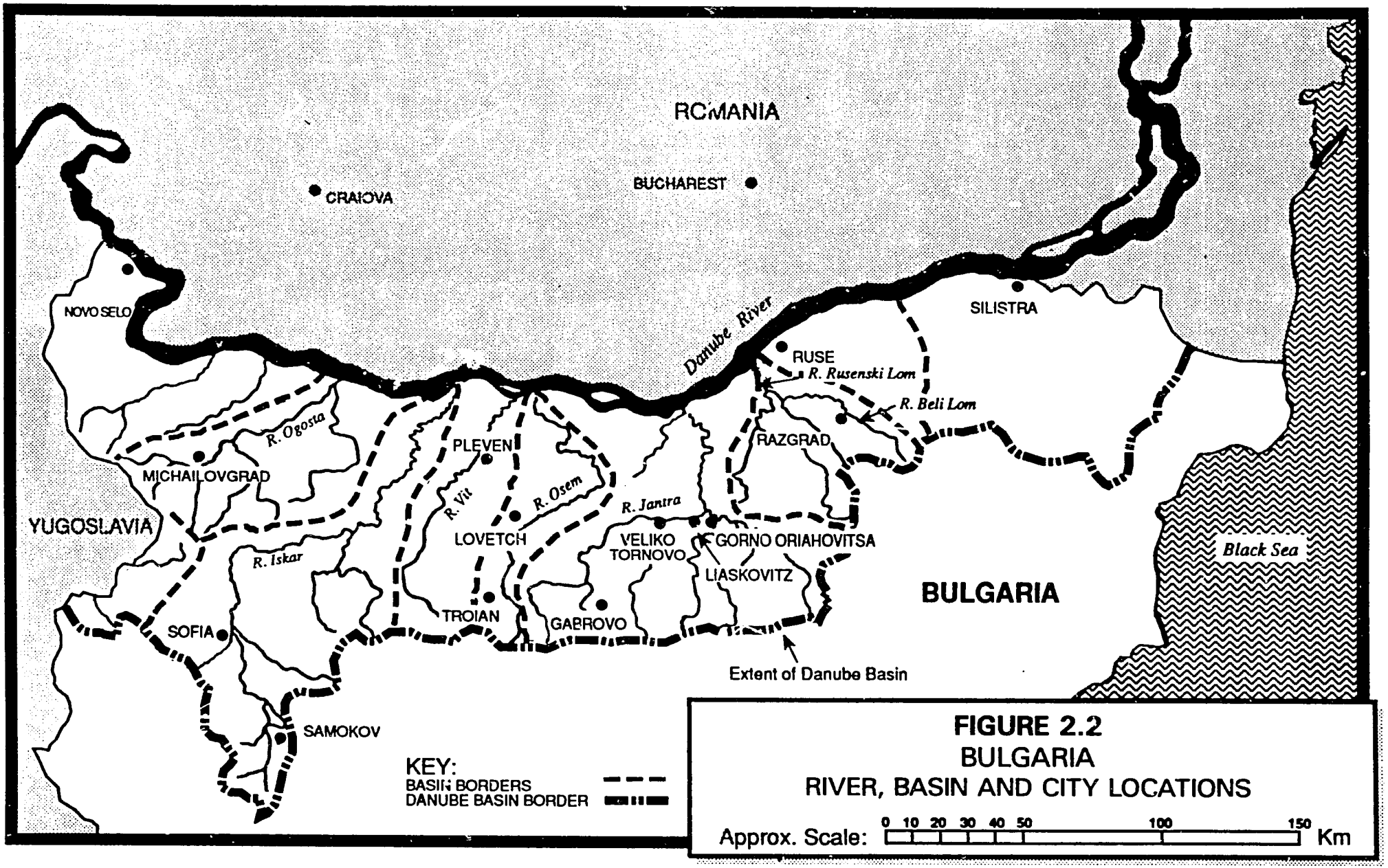


FIGURE 2.2
BULGARIA
RIVER, BASIN AND CITY LOCATIONS

2.5.2 Bulgaria

Overview

The Bulgarian part of the Danube basin covers about half of the territory of the country (see Figure 2.2). It has a population of about 3.83 million, including residents of three cities of over 100,000 population:

- Sofia (in the basin of the Iskar River), 1.2 million
- Ruse (on the bank of the Danube River), 184,000 population
- Pleven (in the basin of the Vit River), 130,000 population

Basin and town populations are included in Table 2.2.1 of the "Bulgarian Technical Report" in Volume III.

Bulgaria's total energy consumption in 1989 was the equivalent of about 78 barrels of oil per thousand persons per day (CIA, 1990). According to the World Bank, in 1989 the per capita gross domestic product was U.S. $2,320, and that number is expected to be revised downward when more data become available. With a need to import oil at world prices and shortages in nuclear power production and imported natural gas supplies, energy consumption has fallen and costs of manufacturing have increased since 1989. Markets have been curtailed for certain industries.

Pollution Loads

Current estimated pollution loads from the main industries and sewered populations (in the basin's tributary to the Danube) are presented in Table 2.1.1 of the "Bulgaria Technical Report." On a BOD_5 basis, the principal contributors to pollution loads, in decreasing order, are as follows:

PRINCIPAL BOD_5 CONTRIBUTORS (T/DAY)

Source	Loads (T/day)
sewered communities	94
farm feedlots	71
sugar beet processing	28
misc. food and beverage processing	14
chemical industries	7
dairy factories	5
petroleum and gas extraction	4
meat products and rendering	3

On a total dissolved solids basis, the following are the main polluters:

PRINCIPAL TOTAL DISSOLVED SOLIDS LOADS (T/DAY)

Source	Loads (T/day)
sugar beet processing	255
sewered communities	215
chemical industries	170
ore mining and dressing	90
misc. food and beverage processing	80

On the basis of discharged hexavalent chromium, as an example of toxic metals, the main polluters are believed to be:

PRINCIPAL HEXAVALENT CHROMIUM LOADS (T/DAY)

Source	Loads (T/day)
machinery manufacture	.031
sewered communities	.022
electrical and electronics industries	.013

Basin and factory-representative data on the principal polluting industrial enterprises are given in Table 2.3.1 of the "Bulgaria Technical Report." Basin-by-basin and farm-by-farm data on feedlot wastewaters are given in Table 2.4.1 of the same report.

Pollution Effects

Sampling at nine traverses along the main stem of the Danube, from Novo Selo in the west to Silistra in the east, in June 1991 showed the following pollution effects (Buijs et al., 1992):

- Dissolved oxygen levels at the center and toward the Bulgarian bank were always above 6 mg/L and increased from between 6 and 6.5 mg/L in the west to over 7.5 mg/L immediately below the entry point of the Rusenski Lom River, followed by some reduction below that point, possibly reflecting effects of both east and west bank flows.
- Suspended solids levels were always below 50 mg/L toward the right bank, (although levels were high at the left bank below the entry point of the Arges River below Bucharest.)
- Kjeldahl nitrogen levels at the right bank were generally less than about 0.5 mg/L but increased substantially (to values of 0.8 mg/L and above) below the entry point of the Ogosta River and above the entry of the Jantra River (with a substantial increase at the left bank below the entry point of the Olt River).
- Cadmium levels were generally below 0.1 µg/L but increased at the right bank to over 0.25 µg/L after the Danube received the flows of the Iskar, Vit, and Osem rivers (with substantial increases at the left bank below the Jiu and Arges rivers).
- Chromium values at and near the right bank were always less than 4.0 µg/L (but with a major increase at the left bank below the Jiu River).
- Lead levels were generally less than about 5 µg/L but with a right bank increase to over double that level below the entry point of the Osem River, including flows from the Iskar, Vit, and Osem rivers (with a major contribution from the Jiu River at the left bank).

The above levels show clear evidence of pollution but are not worse than corresponding numbers for West European rivers, such as the Elbe and the Rhine (Buijs, 1990). None of these values fails to comply with drinking water standards (WHO, 1984), although this alone is not an adequate criterion for substances that can be bioaccumulated in the food chain.

Conditions in the tributaries are frequently more critical than those in the Danube itself, as is the case in each of the four participating countries. For example, over parts of their lengths, the waters of the Ogosta, Iskar, and the Jantra are deoxygenated. Potential or actual sources of groundwater for urban use are understood to be subject to contamination through river pollution by urban and/or industrial wastewaters in the basins of the Vit, Jantra, and Rusenski Lom rivers.

Based on the team's discussions with the Epidemiological Research Center in Sofia, concerns related to pollution of water supply sources include the following:

- **Bacterial contamination:** General treatment and chlorination of water supplies have limited disease outbreaks to a small number of isolated events. There was a typhoid

outbreak due to local contamination of karstic groundwater (not within the Danube basin) in the early 1980s. The main water supply problems are due to lack of quantity and low pressures in the distribution systems.

- **Metals:** Iron, zinc, and copper are found in almost all waters receiving wastewaters from metal industries. The water sources for Vratse and Michailovgrad have shown increasing lead content over the past 10 years. However, these and other toxics seldom exceed the levels set by drinking water quality standards. Iron and manganese accumulated in bottom sediments in water supply dams cause interference with chlorine residual testing, and this is a concern. There must be a special test to avoid interference.

- **Nitrates in groundwater:** This is a general problem. Nitrates are present in all groundwaters, although not in excess of the water supply standards. No specific linkages to wastewater discharges or agricultural activities have been established. In two areas where fertilizer-factory wastewater is discharged into rivers (one of them the Ogosta River), high levels of nitrate, but less than the Bulgarian water supply standard of 50 mg/L, occur in downstream water supplies. Examples of blue-baby syndrome have been looked for but none has been found.

- **Trihalomethanes** have been studied in chlorinated dam, river, and groundwater supplies. They are frequently present but well below the Bulgarian standard limit of 30 µg/L.

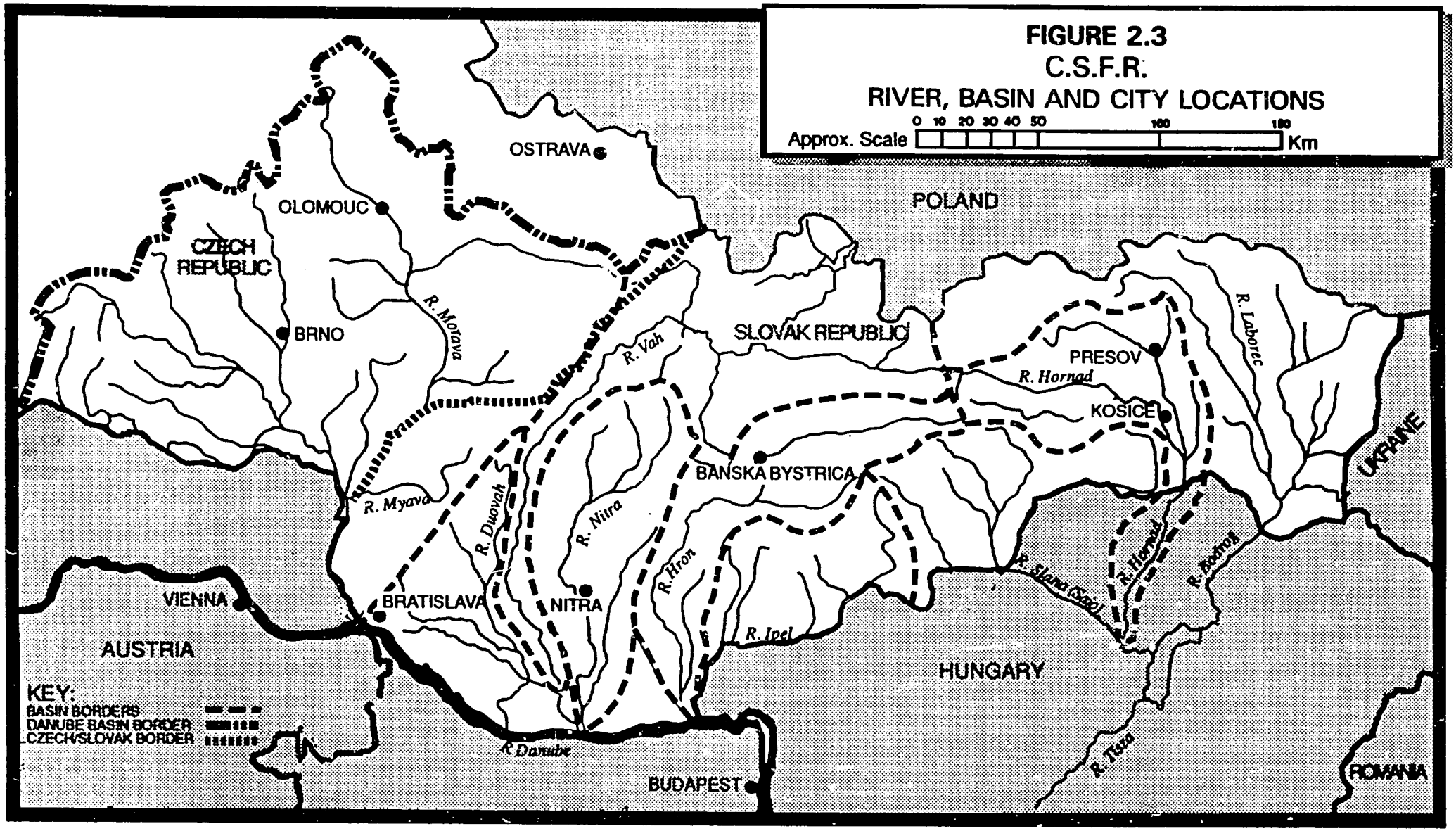


FIGURE 2.3
C.S.F.R.
RIVER, BASIN AND CITY LOCATIONS
Approx. Scale
0 10 20 30 40 50 100 150
Km
POLAND
OSTRAVA
OLOMOUC
CZECH REPUBLIC
BRNO
R. Morava
R. Vah
SLOVAK REPUBLIC
PRESOV
R. Hornad
KOSICE
R. Laborec
UKRAINE
BANSKA BYSTRICA
R. Myava
R. Duovah
R. Nitra
R. Hron
R. Slana (Sajo)
R. Hornad
R. Bodrog
VIENNA
BRATISLAVA
NITRA
R. Ipel
AUSTRIA
HUNGARY
KEY:
BASIN BORDERS
DANUBE BASIN BORDER
CZECH/SLOVAK BORDER
R. Danube
R. Tisza
BUDAPEST
ROMANIA

2.5.3 The CSFR

Overview

The part of the Danube basin that is in the CSFR (see Figure 2.3) covers almost the whole of Slovakia (approximately 47,000 sq km) plus that part of the basin of the March-Morava River that is in the Czech Republic (24,000 sq km). It has a population of about 8.04 million (5.33 million, or 66 percent, in the Slovak portion), including residents of the following three cities of over 200,000 population:

- Bratislava (on the bank of the Danube River), 440,000 population
- Brno (on the Morava River), 400,000 population
- Kosice (on the Hornad River), 240,000 population

Two other cities in the basin have populations of over 100,000.

In 1989, the per capita gross national product of the CSFR was about U.S. $7,900, and total energy consumption was the equivalent of about 100 barrels of oil per thousand persons per day (CIA, 1990). According to the World Bank, the per capita gross national product was U.S. $3,460 in 1989. Energy prices have risen, consumption has fallen, and costs of manufacturing have increased since 1989. Markets have been curtailed for some industries. Among the hardest hit have been the military-related, chemical, and textile industries.

Pollution Loads

As indicated in the "CSFR Technical Report" in Volume III, about 2.7 million people in Slovakia and 2.0 million in the Czech Republic are served by sewerage systems within the Danube basin. Of those, about 3.3 million (2.0 million in Slovakia and 1.3 million in the Czech part of the Morava basin) are served by wastewater treatment plants. A majority of the public wastewater treatment plants provide only partial treatment.

Current estimated pollution loads from the main industries and sewered populations are presented in Annex 5 of Part I and Table 6 of Part II of the "CSFR Technical Report." On a BOD_5 basis, the principal contributors of domestic and industrial point-source loads to surface waters within the Danube basin are public sewerage systems (including industries served by the public sewer systems), as summarized below:

PRINCIPAL BOD_5 CONTRIBUTORS

Source	Czech Republic	Slovak Republic	Total
Sewered communities, T/day	36	208	244
Separate industries, T/day	12	20	32
Total	**48**	**228**	**276**
Sewered communities, percent	74	91	88
Separate industries, percent	26	8	12
Total	**100**	**100**	**100**

At a typical BOD_5 production rate of 60 g/capita/day, the domestic wastewater production in sewered communities is probably (on the basis of the sewered populations given above) approximately 78 T/day in the Czech part of the basin and 120 T/day in the Slovak part. The above tabulation therefore suggests strongly that substantially higher concentrations of industries having oxygen-demanding wastewaters are located within sewered urban areas in the Slovakian part, rather than in the Czech part, of the basin. The differences may also reflect differences in overall treatment levels.

Important industries that contribute significantly to the pollution of waterways in the basin include tanneries, food industries, and textile, chemical, and metallurgical industries. There are also numerous large pig and cattle feedlots. Substances discharged by industries include metals, lignin, salts such as sulfates, organic compounds such as phenols and formaldehyde, and many others.

Pollution Effects

In the Danube itself, water quality is affected by the Morava River and wastewater discharges in the area of Bratislava. These lead to observable bacterial contamination and oil content and slight oxygen depletion. There are further impacts due to the entry of the polluted Váh River and wastewater from Komárom. At the Danube's entry point into Hungary, water quality has recovered to a high oxygen content, but it still exhibits bacterial contamination and the presence of organic compounds and petroleum products.

Many of the tributaries and minor streams in the CSFR are contaminated by pollutants, some of them seriously. Among the waterways most seriously polluted are the Nitra, Váh, and Slana (Sajo) rivers and certain river sections in the catchments of the Morava, Hrón, Hornad, and Bodrog rivers. The water quality at selected points in the tributaries, in terms of the CSFR's standards, are presented in the "CSFR Technical Report."

Several of the Danube tributaries in the CSFR are linked to important groundwater sources needed for urban water supplies. The underflow of the Nitra River, for example, was indicated to be no longer usable for public potable water supply because of arsenic contamination elutriated from fly-ash disposal activities at the thermal power plant at Novaky. Other alluvial groundwater sources in the lower catchments of such rivers as the Morava and the Váh have the potential to create health hazards due to chemicals, including organics.

The Little Danube, flowing on the northern side of Corn Island, carries a small portion of the total Danube flow and is polluted by nutrients from Bratislava's wastewater treatment plant and by chemical industry wastes.

The sources of pollution include not only conventional point-source discharges but also spills and runoff from agricultural land. More information is given in the "CSFR Technical Report."

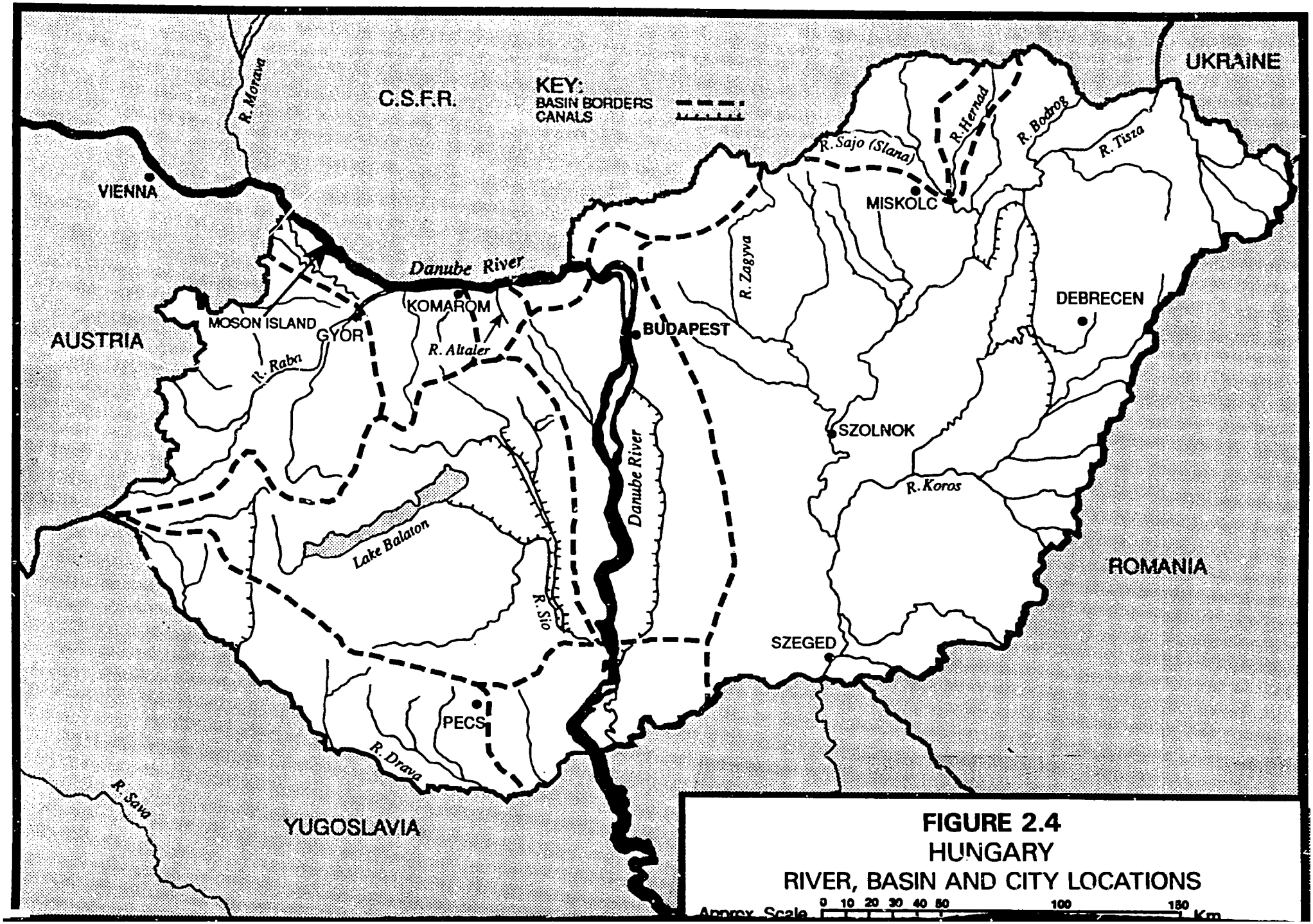


FIGURE 2.4
HUNGARY
RIVER, BASIN AND CITY LOCATIONS

2.5.4 Hungary

Overview

The Hungarian part of the Danube basin covers the whole of the country (see Figure 2.4). It has a population of about 10.6 million, including residents of the following three cities of over 200,000 population:

- Budapest (on both sides of the Danube River), 2.1 million population
- Miskolc (on the bank of the Sajo River), 240,000 population
- Debrecen (in the basin of the Tisza River), 210,000 population

Five other Hungarian cities have populations of over 100,000.

Budapest has not only 20 percent of the population of Hungary but also an estimated 40 percent of the industrial activity. Other cities with populations of over 125,000 are Szeged, Pēcs, and Györ. Town-by-town populations in the Danube and Tisza basins are given in the "Hungary Technical Report" in Volume III. In 1989, the total energy consumption of Hungary was the equivalent of about 60 barrels of oil per thousand persons per day (CIA, 1990). As a net importer of oil at world prices, Hungary has experienced increasing costs of manufacturing since 1989, and demand has fallen significantly (Szente, 1991).

Pollution Loads

Approximately 46 percent of the national population, or about 4.9 million persons, are served by public sewer systems. About half of the resulting flows are treated. Industries are largely located within urban areas and served by public sewers. However, a significant number of the largest polluting industries discharge their wastewaters directly into rivers.

Table 3 of the "Hungary Technical Report" indicates estimated current loads of combined domestic and industrial wastewaters in Hungary on the three river systems. This information is summarized below:

ESTIMATED DOMESTIC AND INDUSTRIAL WASTEWATER LOADS (T/DAY)

River	**COD**	**Salt**	**Oil/Grease**	**Ammonia**
Danube				
Budapest	480	470	26	17
Other	300	730	12	18
Subtotal	780	1,200	38	35
Drava	50	100	1	2
Tisza	170	650	10	20
Total	**1,000**	**1,950**	**49**	**57**

The current estimated distribution of discharges from the main industries and sewered populations is as follows:

ESTIMATED DISTRIBUTION OF DISCHARGES

Source	Percent Distribution
major industries*	32.9
food processing	28.5
sewered communities	26.1
agricultural point sources	12.5

(* Mining, energy, machinery, chemical, and light industries)

Among the most polluting industrial categories (mining, energy, metallurgy, machinery, and light industry), the distribution of pollution loads between surface waters and public sewer systems in 1985 (refer to Table 6, "Hungary Technical Report") was approximately as follows.

ESTIMATED DISTRIBUTION OF INDUSTRIAL WASTE EMISSIONS

Item	To Surface Water (T/Day)	To Sewers (T/Day)	Percent
COD	131.0	180.0	58
Oil and fat	14.4	4.2	23
Total salt	768.0	195.0	20
Ammonia (as NH_3)	27.0	2.7	9
Zinc	.3	.093	24
Cadmium	.008	.023	74
Chromium (total)	.060	.120	67
Nickel	.021	.016	43
Lead	.005	.030	86
Copper	.033	.041	55
Iron	.015	.016	52

The above suggests that a high proportion of the industries that emit heavy metals in their wastewaters are connected to urban sewerage systems. Of these, the majority are believed to be located in Budapest.

In comparison with the above chemical oxygen demand (COD) figures, the BOD_5 of the domestic wastewater produced by the sewered population of Hungary would, at 60 g/capita/day, be about 270 T/day. The corresponding COD could be expected to be on the order of 450 to 650 T/day. Thus, after treatment, currently not uniformly applied nor effective, it appears that the overall oxygen demands from domestic and industrial wastewaters in 1985 were of similar magnitude. Today, it is likely that the industrial component is somewhat reduced, however.

A similar comparison can be made for the wastewaters discharged above Budapest in the Danube catchment. In that part of the Danube catchment, there are seven major industrial polluters: four food industry plants, a paper mill, a chemical factory, and a pharmaceutical plant. In 1985, their combined pollution contributions, and those of other minor industries in the same area, were approximately as follows (see Table 7 in the "Hungary Technical Report"):

ESTIMATED EMISSIONS OF 7 KEY INDUSTRIES IN NORTHWEST HUNGARY

Item	Major Polluters	Others	Total
Flow (cu m/day)	52,000	26,000	78,000
COD (T/day)	26	16	42
Oil and fat (T/day)	.45	.31	.76
Total salt (T/day)	62.5	36	98.5
Ammonia (T/day as NH_3)	1.2	.3	1.5

All of the seven major polluters listed above discharge to waterways rather than to sewers.

As indicated in Table 5 of the "Hungary Technical Report," in 1985, the municipalities involved, serving 810,000 people, exerted a total COD load of about 93 T/day, a total ammonia load of 6.3 T/day, and a total salt load of 195 T/day. This suggests that, in that particular area also, municipal discharges include a high proportion of the total industrial wastewaters.

Pollution Effects

The greater part of the total pollution contribution to the river system arrives with the river flows from the upstream countries. The estimated relative contributions within Hungary are summarized below from Tables 9 and 10 in the "Hungary Technical Report," as follows:

PORTION OF POLLUTION LOADS ORIGINATING IN HUNGARY

River	COD	Salts	Ammonia
Quantity (T/day)			
Arriving	7,344	97,600	260
Added	480	1,950	57
(Percent added)	(14)	(2)	(22)
Percentage added in Hungary, by river			
Danube	20	2	25
Drava	6	1	10
Tisza	7	2	20
Total	**14**	**2**	**22**

The local impacts of wastewater discharges in Hungary are greater than is suggested by the above, however, because of the natural reduction of arriving pollution levels as the rivers flow through Hungary. To a lesser extent, that is also likely to be true of residual contaminant quantities leaving Hungary in the three rivers.

Information on receiving water conditions in Hungary is presented in Sections 1.2 and 1.3 of the "Hungary Technical Report." The principal problems indicated are summarized below.

- Organic, bacterial, iron, manganese, industrial organic, and heavy metal pollution is threatening to affect water supplies drawn from the Danube underflow; the prime examples are Budapest and, especially if the greater part of the flow of the Danube is bypassed through the Gabčikova-Nagymóros power generation and navigation system, the Moson Island communities, Györ, and Komárom;

- The contamination of alluvial groundwater aquifers, which have the potential to affect or to displace water demands to the Danube, by fuel dumped at former Soviet military bases;

- Increasing nitrogen content of bank-filtered water supplies, especially in the area of Budapest, due to agricultural activities and wastewater disposal in Budapest and nearby villages, and near Miskolc, due to the contaminated flows in the Hornad and Sajo rivers; and

- Effects of nutrients in several locations causing, for example, algal production and the need to remove plankton in the treatment of water supplies taken directly from the rivers, and eutrophication affecting ecosystems in the Tisza and the smaller arm of the Danube at Czepel Island.

Nitrate levels in the water of the Danube in Hungary have been reported by Varga et al. (1990) to range from 3.2 to 10.2 mg/L. Nitrate levels above the drinking water standard have been found in the Danube underflow beneath Czepel Island in Budapest. A Ministry for

Environment and Regional Planning document (MERP, 1989) sets out the status of water quality in relation to the Hungarian standards in all rivers in the country.

Csanády (1991) has indicated that nitrate in groundwater supplies in areas lacking public water supply and wastewater systems has caused illness and deaths in babies from methemoglobinemia (blue-baby syndrome), that enteric symptoms have been caused by contamination of drinking water by pharmaceutical waste, and that algal blooms in Lake Balaton have caused allergic symptoms and dermatitis.

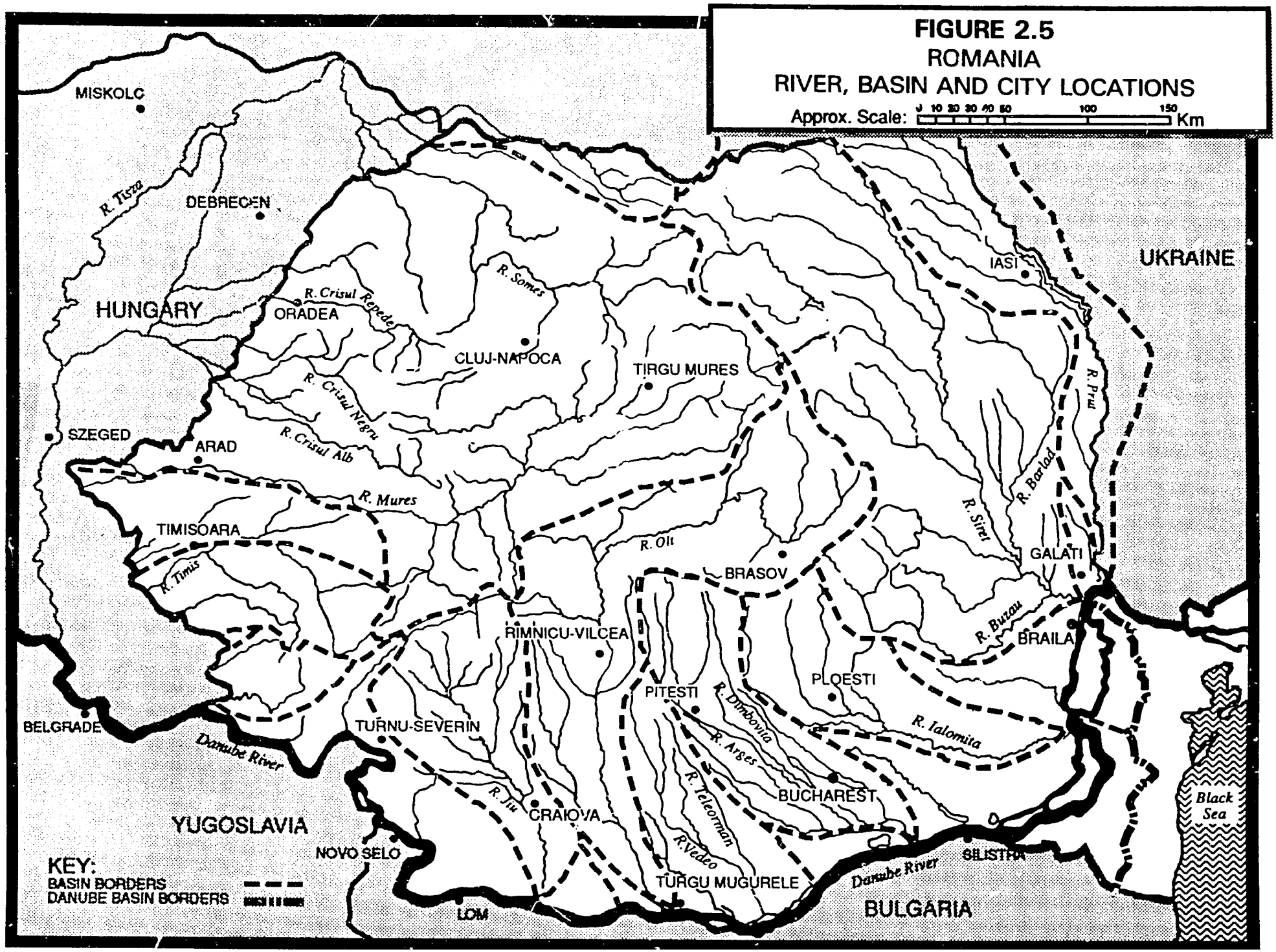


FIGURE 2.5
ROMANIA
RIVER, BASIN AND CITY LOCATIONS
Approx. Scale: 0 10 20 30 40 50 100 150 Km
MISKOLC
DEBRECEN
R. Tisza
HUNGARY
ORADEA
R. Crisul Repede
R. Somes
CLUJ-NAPOCA
TIRGU MURES
R. Crisul Negru
R. Crisul Alb
SZEGED
ARAD
R. Mures
TIMISOARA
R. Timis
R. Olt
BRASOV
RIMNICU-VILCEA
PITESTI
R. Dimbovita
R. Arges
R. Teleorman
R. Vedeo
BUCHAREST
PLOESTI
R. Ialomita
R. Buzau
BRAILA
GALATI
R. Siret
R. Barlad
R. Prut
IASI
UKRAINE
BELGRADE
Danube River
TURNU-SEVERIN
R. Jiu
CRAIOVA
YUGOSLAVIA
NOVO SELO
LOM
TURGU MUGURELE
Danube River
SILISTRA
BULGARIA
Black Sea
KEY:
BASIN BORDERS
DANUBE BASIN BORDERS

2.5.5 Romania

Overview

The Romanian part of the Danube basin covers almost the whole of the country (see Figure 2.5). It has a population of about 21 million, including residents of seven cities of over 300,000 population:

- Bucharest (in the basin of the Arges River), 2.2 million population
- Cluj-Napoca (in the basin of the Somes River), 392,000 population
- Brasov (in the basin of the Olt River), 364,000 population
- Timisoara (in the basin of the Timis River), 351,000 population
- Iasi (in the basin of the Prut River), 347,000 population
- Galati (in the basin of the Siret River), 326,000 population
- Craiova (in the basin of the Jiu River), 317,000 population

The Romanian part of the basin also includes 15 other cities with populations of over 100,000. Basin-by-basin and town-by-town populations are included in Table 9 of the "Romania Technical Report" in Volume III.

In 1989, Romania's total energy consumption was the equivalent of about 60 barrels of oil per thousand persons per day (CIA, 1990). With the need to import oil at world prices to supplement declining oil production within Romania, energy consumption has fallen and costs of manufacturing have increased since 1989. Markets have been curtailed for major industries.

Wastewater Discharges

The distribution of point-source emissions is approximately as follows:

ESTIMATED DISTRIBUTION OF POINT-SOURCE EMISSIONS (PERCENT)

Item	Urban	Industrial	Agricultural
Flow	39	58	3
BOD5	65	25	10
COD	58	37	5
Suspended solids	4	93	3

Municipalities and their street and sewer lengths, wastewater flows, BOD_5 and suspended solids emissions, and levels of wastewater treatment are presented, by basin, in Table 9 of the "Romania Technical Report." The total wastewater production, including by industries within the sewered areas, is approximately as follows: flow, 4.74 million cu m/day; BOD_5, 515 T/day; and suspended solids, 1.100 T/day. The estimated total emissions of the principal polluting industries, from Table 10 of the "Romania Technical Report," including industrial wastewaters generated within sewered areas (and therefore duplicating part of the above municipal discharges) are as follows: BOD_5, 593 T/day; COD, 1,940 T/day; and suspended solids, 7,740 T/day.

Pollution Effects

Sampling at nine traverses along the main stem of the Danube, from Novo Selo in the west to Silistra in the east, in June 1991 (Buijs et al., 1992) showed the following:

- Dissolved oxygen levels at the center and toward the Bulgarian bank were always above 6 mg/L and increased from between 6 and 6.5 mg/L in the west to over 7.5 mg/L below the entry point of the Olt River, followed by some reduction below that point, including a reduction by about 1 mg/L, apparently reflecting the effect of the entry of the Arges River.
- Suspended solids levels were initially below 50 mg/L and increased to over 250 mg/L at the left bank, including a sharp increase by about 200 mg/L, apparently due to the entry of the Arges River.
- Sharp increases occurred at the left bank in phosphate, at the point of entry of the Jiu River, and in nitrogen, at the entry points of the Olt and Arges rivers.
- Cadmium levels were generally below 0.1 µg/L but increased at the left bank to about 0.30 µg/L after the Danube received the flow of the Jiu River, and a further increase occurred at the entry point of the Arges River (with substantial increases at the right bank below the Iskar, Vit, and Osem rivers).
- Chromium values at and near the left bank were initially less than 4.0 µg/L, but showed an increase of about 45 µg/L at the left bank at the entry point of the Jiu River, with subsequent gradual diminution and then another significant increase of about 4 µg/L at the entry of the Arges River.
- Copper and lead levels were generally less than 5 to 10 µg/L, but increased at the left bank by about 25 and 15 µg/L, respectively, at the entry point of the Jiu River.
- Dissolved salts in the Olt River water are high, and a chemical plant in Turgu Mugurele (on the Danube below the mouth of the Olt) is forced to take its plant water supply from a long intake extending to the middle of the Danube.

The levels found at the nine traverses show clear evidence of pollution, which, for chromium, copper, and lead, is substantially higher in certain locations than corresponding figures for

West European rivers such as the Elbe and the Rhine (Buijs, 1990). None of these values fails to comply with recommended drinking water standards (WHO, 1984), although this alone is not an adequate criterion for substances that can be bioaccumulated into the food chain. As indicated in the "Romania Technical Report," values of dissolved oxygen, ammonia, nitrites, oil, phenols, pesticides, and heavy metals exceed Romanian pollution limits for the river.

Conditions in the tributaries are generally more critical than those in the Danube itself, as is the case in each of the four participating countries. Table 6 of the "Romania Technical Report," addressing only the tributaries that flow directly to the Danube, indicates the following:

- High levels of BOD_5 (23 to 53 mg/L), phosphorus (0.4 to 4.0 mg/L), and oil (0.2 to 1.0 mg/L) in the Arges and Ialomita rivers;
- Significant levels of ammonia nitrogen (17 to 47 mg/L) in the Ialomita River and of nitrate nitrogen (3 to 13 mg/L) in the Jiu River; and
- Significant levels of phenols, lindane, DDT, and heavy metals in the Jiu, Olt, Arges, Ialomita, and Siret rivers.

Ursu et al. (1990) have reported mercury levels as high as 8.0 µg/L in the Jiu River and maximum levels in the range of 0.7 to 2.9 µg/L in the Olt, Arges, and Ialomita rivers.

2.6 Ongoing Efforts to Control Pollution

All four countries have programs intended to improve the monitoring of wastewater emissions and the effects on receiving waters and to reduce emissions through the application of taxes and fines and through other means. New legislation to provide an adequate basis for such measures is under consideration. The organizational arrangements in each country are new. In some cases, major roles are played by technical institutes, some of which are being or may be privatized.

The pollution control programs of all four countries suffer from low budgets and lack of equipment. In some of the countries, the legal rights required for the pollution control authority to enter industrial premises and demand data do not yet exist. Decentralization is an important element of the pollution control programs of all four countries. In each case, primary data collection and strategic management of pollution at the basin level are performed by regional environmental or river authorities. The frequency of sampling and the parameters evaluated are also limited by funding considerations. In some cases, this is compensated in part by ad hoc studies of specific local problems.

The four countries are signatories of the Bucharest Declaration of 1985, under which Danube water quality data are collected at specified points and frequencies and exchanged. They are also participants in the consideration of the draft Danube Basin Ecological Convention, which among other provisions, covers such issues as coordinated monitoring and the international exchange of information.

The four countries have also participated actively in the development of the international EPDRB, under which a Three Year Action Plan has been established (at a task force meeting in Brussels in February 1992), and commitments for financial support have been made by a large number of multilateral and bilateral donor organizations. Among the components of the Three Year Action Plan are (a) a Short Term Actions component, which includes the preparation of high-priority pilot demonstration projects and support for an accident emergency warning system; (b) development of a Strategic Action Plan, including provision for national reviews, preinvestment activities for priority areas, regional studies, and preparation of the Strategic Action Plan; and (c) Institutional and Technical Building Blocks for Planning and Management, which includes preparation of inventories, analytic tools for planning and management, strengthening of institutions, and applied research. The analytic-tools item includes data management, under which one identified need is decision support systems. Chapter 5 provides a description of such a system, which it is hoped will be used by the EPDRB.

The following chapter reviews potential short-term pollution control projects the four countries studied may be able to pursue.

Chapter 3

NEEDS FOR SHORT-TERM POLLUTION CONTROL ACTIONS

The Scope of Work of the WASH team included preparation of recommendations on priority investment needs based on preliminary information on dischargers, water quality, and water uses, and subject to verification in subsequent preinvestment studies. This work was done as a contribution to the Short Term Actions component of the EPDRB's Three Year Action Plan.

Projects to be implemented as Short Term Actions are called Pilot Demonstration Projects under the EPDRB, as established during the Task Force Meeting in Brussels in February 1992. Such projects must include not only physical works but also the industrial and policy reforms essential for effective project financing, implementation, and operation. Projects that are selected to proceed by the countries and their international funding agencies will require prefeasibility studies and feasibility studies. Some elements of these preinvestment studies are presented in Appendix B.

This chapter presents the teams's conclusions on priorities for specific pilot projects for early implementation within each of the four countries. Presented in Appendix B are the details of the bases for the conclusions, general information on the need for and typical content of preinvestment studies, and some specific study issues for the identified projects.

3.1 Basis and Approach

The field work on which the following material is based was limited in its extent by the available time and resources. It does not represent an exhaustive evaluation of conditions and needs in any of the four countries. In each country, preliminary criteria for identification of urgent needs were agreed, and to the extent possible, visits were made to selected locations suggested by country officials on the basis of those criteria. Many of the field visits were primarily oriented to interviews with local officials, although existing facilities were also observed where feasible.

In all cases, limited data were available on dischargers, emissions, and the quality of the receiving waters. In some cases all that the team could obtain was anecdotal information. In a few cases, especially for pollution hot-spots that happened to be within demonstration basins selected for the initial DEMDESS, the data were adequate to support firm conclusions. As a generalization, however, the justification for all of the indicated projects will require further analysis based not only on deeper research into available data but also on selected flow measurements, sampling, and analysis.

3.1.1 Basis for Project Selection and Prioritization Criteria

In terms of nonconservative pollutants, such as BOD_5 and bacteria, the Danube River has a high assimilative capacity regarding pollution loads. This is illustrated by the rapid recovery of water quality below Budapest and below the entry points of the highly polluted tributaries. The substantial flow of the main stream enables it to dilute conservative pollutants rapidly. However, many of the tributaries and subtributaries have low flows and severely limited capacity to assimilate or dilute the existing imposed loads. In addition, large quantities of heavy metals and other pollutants are entrained in benthic deposits or carried into the Black Sea Delta.

In addition to pollution of tributaries, the principal actual or potentially serious impacts of industrial and municipal pollution include the following:

- Effects on bank-filtered water supplies;
- Significant loads of toxic substances that could find their way into the food chain either in the river system itself (through, for example, fishing or crop irrigation) or after the flows reach the Black Sea;
- Significant loads of salts, which either prevent use of the water for irrigation or cause significant damage to the capacity of soils to support agriculture; and
- Toxic contamination of potable aquifers that may affect, or from which water demands may be transferred to, the surface water system.

Among the high-urgency problems made known to the team was the contamination of groundwater by fuel dumped or leaking at numerous former Soviet military bases in Hungary. The aquifers affected include important groundwater resources for urban potable water supplies. Other impacts that appear to require early reduction include those due to discharges of toxic and oily wastewaters from industry.

The team concluded that efforts to identify high-priority, feasible, early investment opportunities should be directed primarily toward (a) reducing surface water pollution from urban areas that include heavy industrial concentrations and (b) identifying and remediating major fuel leaks and spills that threaten groundwater supplies. (See Figure 3.1 for a map of potential project locations.) The reasons for focusing on urban areas with heavy industrial concentrations include:

- The importance of reducing toxic and oily industrial discharges,
- The extreme difficulty, under current economic and industrial-technological conditions in the four countries, of identifying financially feasible short-term pollution reduction measures in individual factories,
- The opportunity to use economy of scale to obtain the maximum reductions in pollution for early expenditures on improvements,
- The opportunity to achieve substantial reductions in bacterial and organic loadings from domestic wastewaters, along with reductions of toxics in industrial wastes, and

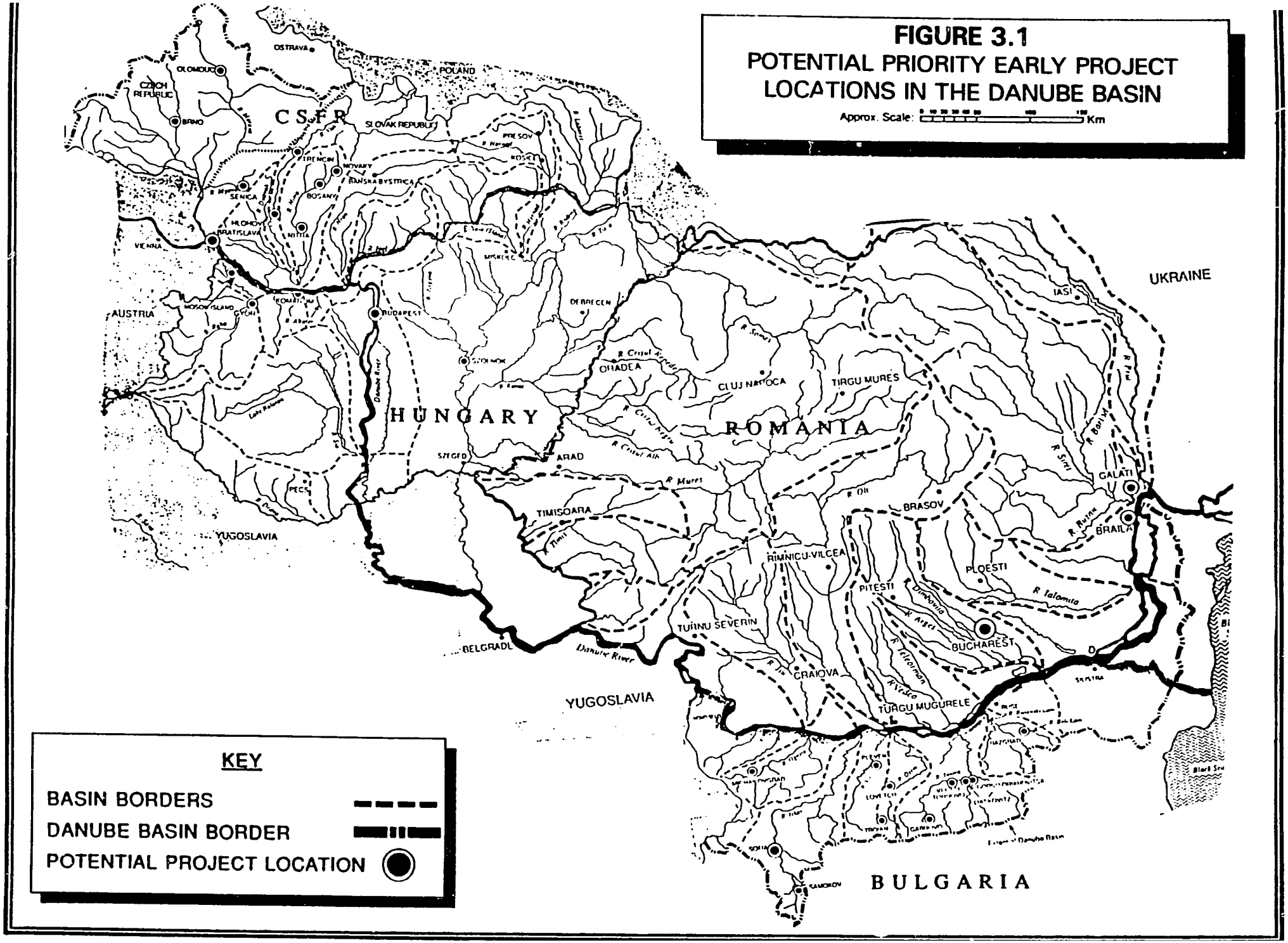


FIGURE 3.1
POTENTIAL PRIORITY EARLY PROJECT LOCATIONS IN THE DANUBE BASIN
Approx. Scale:
Km
CSFR
CZECH REPUBLIC
SLOVAK REPUBLIC
POLAND
OSTRAVA
OLOMOUC
BRNO
TRENCIN
NOVARY
BANSKA BYSTRICA
PRESOV
KOSICE
SENICA
BOSANY
NITRA
BRATISLAVA
VIENNA
AUSTRIA
MOSON ISLAND
GYOR
KOMARNO
BUDAPEST
MISKOLC
DEBRECEN
SZOLNOK
HUNGARY
SZEGED
ARAD
PECS
TIMISOARA
YUGOSLAVIA
BELGRADE
Danube River
ORADEA
CLUJ NAPOCA
TIRGU MURES
ROMANIA
IASI
UKRAINE
GALATI
BRAILA
BRASOV
RIMNICU-VILCEA
PITESTI
PLOESTI
BUCHAREST
TURNU SEVERIN
CRAIOVA
TURGU MUGURELE
YUGOSLAVIA
BULGARIA
KEY
BASIN BORDERS
DANUBE BASIN BORDER
POTENTIAL PROJECT LOCATION

- The possibility of financing combined municipal and industrial pollution reduction in the short term as internationally assisted public projects, based on collection of revenues from users, without requiring capital investments (by industries) whose longevity is in many cases doubtful (and also without conflicting with the longer term goal for industries to pretreat or treat their own wastes).

Among the high-priority pollution reduction measures to be considered for such urban areas should be the following:

- Chemically enhanced primary treatment as a low-capital-cost alternative to secondary treatment where the latter does not exist,
- Capacity expansion for overloaded or bypassed treatment plants,
- Improved methods of sludge treatment and disposal,
- Rehabilitation and upgrading of existing treatment facilities,
- Completion, with design changes where appropriate, of partially completed plants on which construction has been halted for lack of funds,
- Reduction of infiltration and inflow,
- Improved operations and maintenance, and
- Combinations of the above.

In addition, where urgently needed industrial wastewater pollution projects are implementable in today's economic and industrial climate, those projects should also be given high priority.

3.1.2 Selection Criteria

In consideration of the above, the following selection criteria were used:

- Existing known or potential impact on health, taking into account the number of persons at risk and the toxicity of chemicals believed to be present;
- Actual or potential damage to a resource, such as groundwater, at a scale that could affect the demands on or quality of surface waters;
- Readiness to proceed, including central and local government indications of priority and in terms of existing organizational structure and demonstrated staff skills;
- A significant benefit is available from the project even if others do not proceed (suggesting, for example, that upstream projects would tend to have priority over downstream ones);
- Large benefit in relation to cost (such as when facilities already substantially completed have been held up because of lack of funds to complete construction); and

- Inclusion of projects covering as wide as possible a range of sizes and probable investment needs.

These criteria are not exactly the same as those that might be used to prioritize long-term development project opportunities for pollution reduction and/or infrastructure completion. To this extent, the prioritization indicated herein differs from some of the priority lists prepared by the four governments. To the extent that the team was made aware of them, such governmental priorities were taken into account, especially in terms of inclusion or exclusion of projects. However, the relative rankings within the country lists proposed below are not necessarily identical to overall pollution control investment priorities that the governments may have indicated to various donor agencies, for example. Numerous important projects are not included simply because the team did not have the opportunity to study them. Thus, the lists and prioritizations below should be treated as a series of suggestions for the possible funding of projects but not for the exclusion of any project.

The proposed projects are identified by the urban or industrial pollution source in each case, not by basins or parts of basins (except for purposes of location). (See Table 3.1 for division of priority projects by country and level of urgency and Table 3.2 for information on the 15 first-priority projects noted in Table 3.1.) In some cases, the rational solution of the problems may require basinwide studies. However, except insofar as such studies can be incorporated into the needed preinvestment feasibility studies, the priority projects herein proposed for consideration are included on the basis that lengthy basinwide pollution and strategy studies will not be needed for the projects (although they may be needed to resolve subtler issues that affect other projects in the same river basins).

3.2 Bulgaria

3.2.1 General

A key factor in the establishment of priorities in Bulgaria was the water shortage in that country and the difficulty of finding alternative sources in the event of serious contamination of water supplies.

3.2.2 Emitters and Emissions

The principal sources of pollution considered in the identification of high-priority, early projects in Bulgaria included the following (see Figure 3.2):

- The city of Sofia (at a high level in the basin of the Iskar River), which encompasses a wide range of industries and has in its water supply catchment area the town of Samokov, both with limited wastewater treatment;
- Towns, including industries, in the upper reaches of the rivers that feed the Danube in Bulgaria and that pollute water used for urban potable supply; and

Table 3.1
Potential Priority Early Projects

Country	FIRST PRIORITY		SECOND PRIORITY		THIRD PRIORITY	
	Basin	Project	Basin	Project	Basin	Project
Bulgaria	Iskar	Sofia and Samokov	Osem	Troian and Lovetch	Ogosta	Michailovgrad
	Vit	Pleven	Rusenski Lom	Razgrad		
	Jantra	Gabrovo and Veliko Tornovo	Jantra	Gorno Oriahovitsa and Liaskovetz		
CSFR*	Danube	Istrochem (Bratislava)	Váh	Hlohovec and Leopoldov	Danube	Bratislava, central left bank
	Váh	Trenčín	Nitra	Koželužne tannery (Bošany)	Dudvah	Senica
	Nitra	Novaky industry	Danube	Bratislava, right bank	Morava	Brno
	Morava	Olomouc				
Hungary*	Danube	Györ and Moson Island	Danube	Budapest, north system	Danube	Komárom
	All	Fuel-contaminated groundwater	Tisza	Szolnok		
			Altalar	Tata		
Romania	Jiu	Craiova	Olt	Rimnicu-Vilcea	Danube	Municipal treatment needs in Braila and Galati
	Olt	Govora (Rimnicu-Vilcea)	Danube	Industries in Braila and Galati		
	Arges	Pitesti and Bucharest				

* This analysis of potential high-priority basins was one of a number of pieces of information provided to donors in early May 1992, to assist them in deciding on future basin studies involving potential investments. Although the Hornad basin in Slovakia and the Sajo basin in Hungary were not addressed in the WASH study, other parties determined that these two basins are highly polluted. Hence, the donors concluded that they are worthy of further study.

Table 3.2
Summary of Top-Priority Projects

Country	Basin	Project	Population	Flow, MLd[1]	Type of Industries/Project Elements
Bulgaria	Iskar	Sofia	1,200,000	520	Metals, machines, chemicals, textiles, wood, foods/two interceptors, treatment rehab, sludge management
	Iskar	Samokov	47,000	30	Limited industry/further treatment to protect Sofia's water supply reservoir, possible nutrient removal, disinfection
	Vit	Pleven	130,000	108	Animal feed, sugar, oil refinery, slaughterhouse, poultry, dairy, winery, metal finishing/pretreatment, municipal treatment to remove oily waste
	Jantra	Gabrovo	90,000	79	Machines, food, electronics/interceptor for industrial flows, treatment upgrading, sludge management to protect Jantra headwater
	Jantra	Veliko Tomovo	90,000	46	Chemicals (manganese waste)/treatment upgrading, sludge processing equipment
CSFR	Danube	Istrochem	Industrial	21	Rayon, fertilizer, explosives, propylene, polymers/biological treatment added to existing physical/chemical treatment
	Váh	Trenčín	54,000	70	Yeast, alcohol, textiles, building materials, furniture, equipment repair/full treatment of yeast and alcohol waste, new right-bank treatment plant, sludge treatment repair at left-bank plant
	Nitra	Novaky	Industrial	36	Power, PVC plastics/control of arsenic leaching from ash disposal site, restructuring of PVC processing and industrial treatment
	Morava	Olomouc	102,000	53	Food, chemicals, pharmaceuticals/upgrade of existing treatment plant, additional new treatment plant
Hungary	Danube	Györ, Moson Island	120,000	60	Machines, textiles, processed food, alcohol, galvanizing/pretreatment for distillery, completion of Györ and five regional treatment plants to protect groundwater in coarse alluvium
	All	Fuel spills	NA	NA	Dumped or leaked fuels at 300 former military sites/emergency control over migration in aquifers, removal and possible reuse of fuels
Romania	Jiu	Craiova	317,000	500	Chemicals, cars, electrical machinery, food, alcohol, bricks, cement, power/ completion of interceptor and municipal treatment plant, rehabilitation of chemical-plant treatment facilities
	Olt	Govora	Industrial	275	Caustic soda, 70 petrochemicals, machines, power/reduction of brine discharges to the Olt, waste minimization, rerouting of flows or new pretreatment plant for one of three flow streams
	Arges	Pitesti	175,000	150	Oil refinery for fuels and plastics, dyes, beer, rubber, electric motors, chemicals, furniture, meat, wine, cars/upgrading of refinery's treatment, nutrient removal at city's treatment plant
	Arges	Bucharest	2,300,000	1500	Paints, beer, furniture, leather, drugs, textiles, machines, food, trams, electronics, power/completion of 2,000 MLd treatment plant

[1]Dry-weather wastewater flow or treatment capacity; 3.78 MLd (Megaliters per day) = 1 mgd (million U.S. gallons per day)

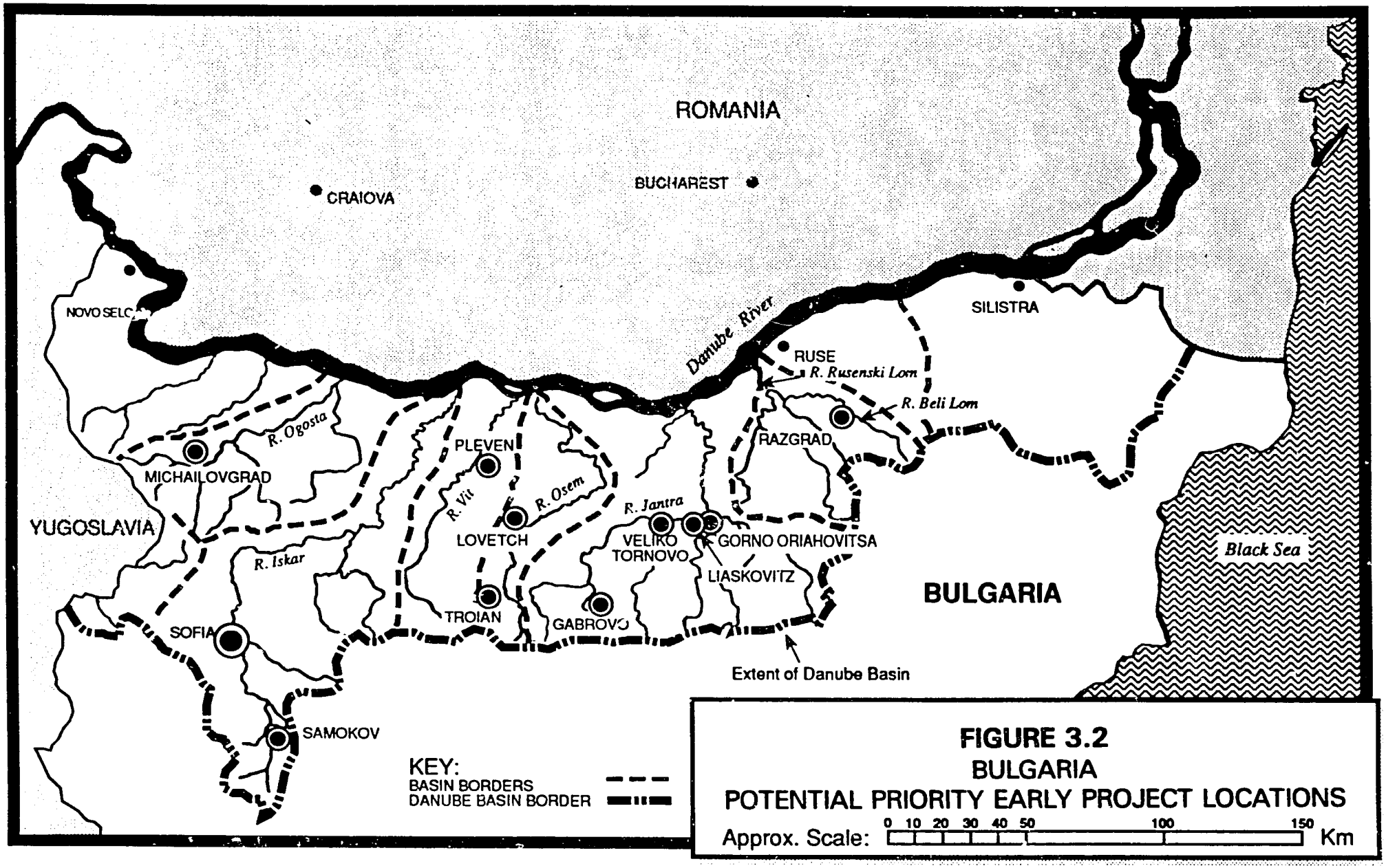


FIGURE 3.2
BULGARIA
POTENTIAL PRIORITY EARLY PROJECT LOCATIONS

- Towns, including industries, in the middle and lower reaches of the river that feed the Danube and that pollute water used or otherwise usable for irrigation.

A major source of water pollution that is not included in the projects listed below is drainage from animal feedlots. This is a major pollution source in Bulgaria, especially in the lowland areas near the Danube. The primary reason for not addressing this pollution source is that solution of this problem is a tributary basin issue and not one that can be well defined and prioritized within the limitations set out above for this study. Also not studied was the industrial city of Ruse, located on the Danube and known to be a significant contributor to the pollution of the Danube. This city was not brought to the team's attention as a potential priority matter, but it could have high priority from a Danube basin viewpoint.

3.2.3 Findings on High-Priority Early Needs

The potential high-priority project locations studied follow:

- In the Ogosta River basin: Michailovgrad
- In the Iskar River basin: Sofia and Samokov
- In the Vit River basin: Pleven
- In the Osem River basin: Troian and Lovetch
- In the Jantra River basin: Gabrovo/Veliko Tomovo and Gomo Oriahovitsa/Liaskovetz
- In the Ruse Lom River basin: Razgrad

On the basis of the available information, each of these potential immediate projects can be placed in one of three levels of priority, as follows:

- First priority: Sofia and Samokov, Pleven, and Gabrovo and Veliko Tomovo
- Second priority: Troian and Lovetch, Razgrad, and Gomo Oriahovitsa and Liaskovetz
- Third priority: Michailovgrad

Descriptions of the conditions, needs, and principal issues relating to the above locations are presented in Appendix B. Following are brief outlines of the key conditions and needs.

Sofia and Samokov

Sofia is the largest city in Bulgaria (population of 1.2 million) and it includes much industry. The Iskar is a small river and one of the most heavily contaminated of the Bulgarian Danube tributaries, primarily because of inadequate interception and treatment of Sofia's wastewater. The Iskar's water quality impacts seriously on irrigation use and restricts potable use of alluvial underflow. An existing treatment plant needs substantial upgrading. Samokov is in the Sofia water supply catchment and needs additional and improved wastewater treatment.

Pleven

There is a petroleum refinery in Pleven (population of 130,000), which has a new biological wastewater treatment plant. Oily wastewater from the refinery is reported to have overwhelmed the new city treatment plant within a few months of its start-up. Below Pleven, there is irrigation use of the river flow and potable use of the river's underflow. The withdrawn water shows evidence of organic and oil contamination.

Gabrovo and Veliko Tornovo

These cities (combined population of over 180,000) include many industries and have treatment plants that need upgrading. Organic substances and manganese from industries in the cities are reported to be detectable in water supplies drawn from the downstream river underflow. Their effects on the river and underflow quality are compounded by the downstream impacts of Gomo Oriahovitsa and Liaskovetz (see below).

Troian and Lovetch

These towns (combined population of 75,000) have severe water supply shortages and no wastewater treatment. Lovetch has only two hours of supply each day and is prevented from using river underflow because of contamination from untreated wastewater from the heavily industrialized Troian. Irrigation use of the Osem River water in this area is affected, and fish no longer exist in the deoxygenated water.

Razgrad

Razgrad has a population of 50,000 and includes a large pharmaceutical factory and other industries. The source of potable water for the town is alluvial groundwater abstracted from below the town. The quality of this water, which is also used by downstream villages, is affected by wastewater discharges. It is reported to have significant levels of nitrates, ammonia, manganese, and iron. The existing wastewater treatment plant needs substantial upgrading or replacement.

Gorno Oriahovitsa and Liaskovetz

These contiguous towns have a combined population of 50,000 and major food and other industries. They have no wastewater treatment. The industrial effluents carry large quantities of sugar, organic matter, iron, and oil to the river. Pretreatment facilities at the industrial plants are minimal. The river acts as an open sewer, and irrigation use of the river water is not now possible. Organic substances and nitrates, as well as manganese from chemical plants in Veliko

Tomovo (see above), are reported to be detectable in potable groundwater sources downstream.

Michailovgrad

This town (population of 52,000) includes a wide range of food and other industries. It has a shared upland water supply source. The river acts as an open sewer, and the water is deoxygenated below Michailovgrad. Were it not for its condition, the river would be used for water supplies.

3.3 The CSFR

3.3.1 General

The search for high-priority projects in the CSFR was limited to the basins of the Morava, Váh, and Nitra rivers and the Bratislava vicinity, both in recognition of the time available for travel from Bratislava and because this was suggested as a basic strategy by the Slovak Commission on the Environment.

3.3.2 Emitters and Emissions

The principal sources of pollution in the area studied include the following (see Figure 3.3):

- The cities of Bratislava and Brno, which are the second- and third-largest cities in the CSFR (population of 440,000 and 400,000, respectively) and have substantial levels of industrial activity; both have operating wastewater treatment plants for a large portion of their wastewaters;
- Smaller cities and towns in the tributary basins, many of which contain food, metal finishing, chemical, and other industries, some with and some without treatment; and
- Industries, not connected to town sewer systems but in some cases located in or near towns, including chemical, tanning, and other industries, and power generation plants burning soft coal, some with insufficient treatment.

3.3.3 Findings on High-Priority Early Needs

The potential priority project locations on which specific data were collected are listed below:

- In Bratislava: Istrochem (a chemical factory on the left bank of the Little Danube); the Central municipal plant serving the left bank portion of the city and also discharging to the Little Danube; and the Bratislava right bank development that has a partially completed treatment plant;

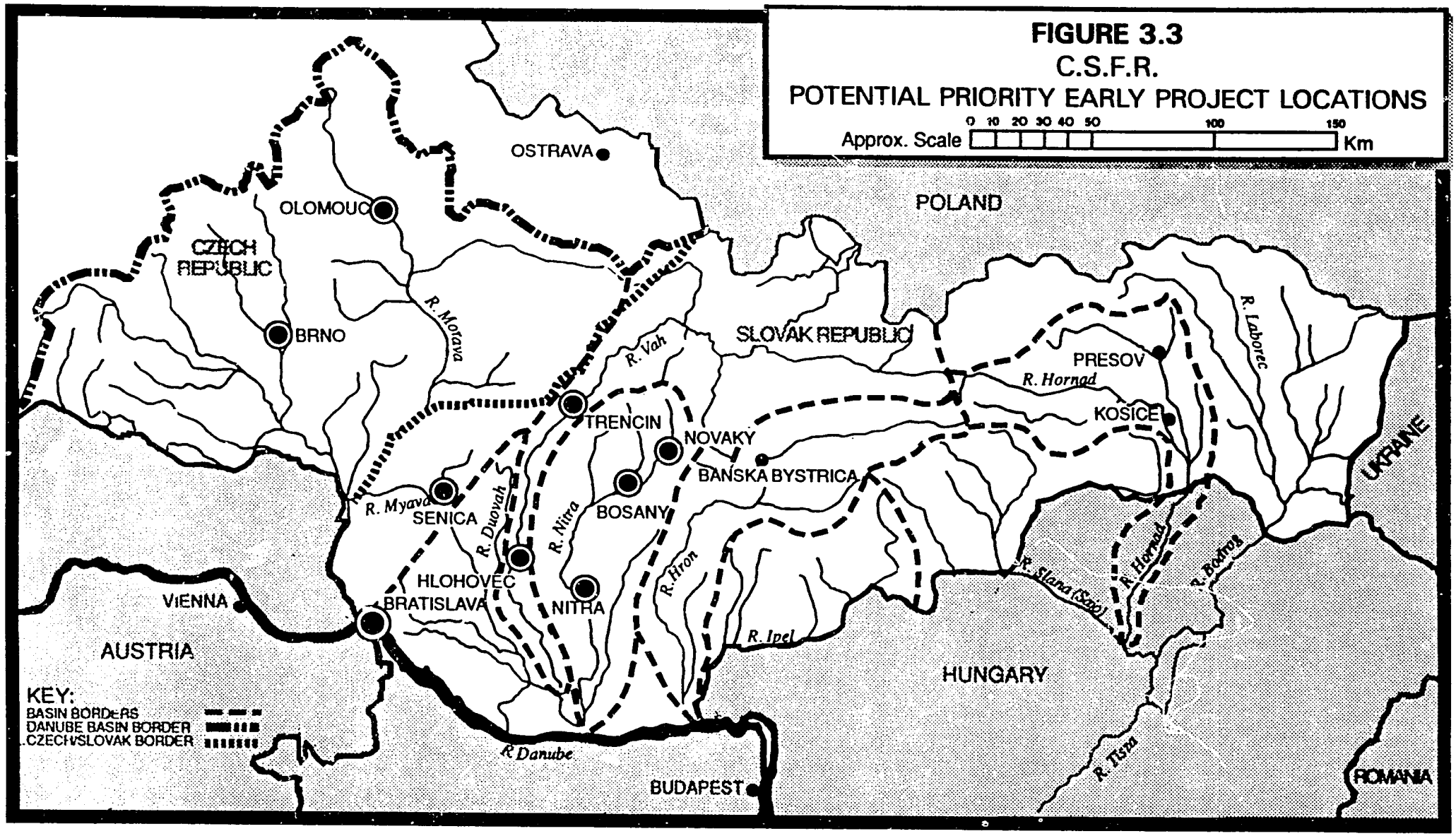


FIGURE 3.3
C.S.F.R.
POTENTIAL PRIORITY EARLY PROJECT LOCATIONS
Approx. Scale
0 10 20 30 40 50 100 150
Km
OSTRAVA
POLAND
OLOMOUC
CZECH REPUBLIC
BRNO
R. Morava
R. Vah
SLOVAK REPUBLIC
PRESOV
R. Hornad
R. Laborec
KOSICE
TRENCIN
NOVAKY
BANSKA BYSTRICA
UKRAINE
R. Myava
SENICA
R. Duovah
R. Nitra
BOSANY
R. Hron
HLOHOVEC
BRATISLAVA
NITRA
R. Slana (Sajo)
R. Hornad
R. Bodrog
VIENNA
AUSTRIA
R. Ipel
HUNGARY
KEY:
BASIN BORDERS
DANUBE BASIN BORDER
CZECHSLOVAK BORDER
R. Danube
R. Tisza
BUDAPEST
ROMANIA

- In the basin of the Morava River: Brno and Olomouc (both of which are in the Czech Republic), which contain a wide range of industries; and Senica, which contains a synthetic fiber factory;
- In the basin of the Váh River: the city of Trenčín, which produces yeast/alcohol, textile products (cotton), and building materials and has a major mechanical equipment repair workshop; and the towns of Hlohovec and Leopoldov, which also have substantial industry, including metal finishing, pharmaceuticals, and wire making; and
- In the basin of the Nitra River: a thermal power plant and a large chemical industry at Novaky, a tannery at Bošany, and the city of Nitra, which has a wide range of industrial development.

On the basis of the available information, each of these potential projects can be placed in one of three levels of priority, as follows:

■ First priority:	Istrochem in Bratislava; Trenčín; the thermal power plant and chemical factory at Novaky; and Olomouc
■ Second priority:	Hlohovec and Leopoldov, the Koželužne tannery in Bošany; and the Bratislava right bank development
■ Third priority:	Bratislava Central left bank development; Senica, including the fiber factory; and Brno
■ Other:	Nitra

Information on the conditions, needs, and issues relating to the above locations is included in Appendix B. Brief summaries are given below.

Bratislava

There are three key pollution locations in Bratislava: the Istrochem chemical factory; the Central municipal treatment plant; and the almost-completed treatment plant serving Petrzalka, the newer right bank residential extension of Bratislava. Istrochem contributes substantial amounts of dissolved solids, sanitary wastewater, and a wide range of chemical substances to the Danube in a location where there is potential to affect water supplies drawn from the vitally important aquifer in the alluvium under Corn Island. Saving this aquifer may also require upgrading Bratislava's Central treatment plant for nutrient removal, particularly nitrates.

Trenčín

This city, including surrounding villages, has a population of about 60,000 and contains major industrial development, especially food industries. An existing treatment plant treats the greater part of the city sewage flow. The Váh River quality is impacted and has the potential to affect the quality of the alluvial underflow, which is one of the most important potable water sources in western Slovakia. A separate treatment plant is planned for the principal wastewater-

producing food industry and another is planned for the part of the city on the right bank of the Váh River, at present lacking treatment.

Novaky

Novaky is a town of 12,000 population; it includes a thermal power station and a large chemical factory. A key problem is the leaching into the groundwater, and thence into the river, of arsenic from lagooned soft coal ash at the power plant. Potable use of the water in the Nitra River at many downstream communities is prevented by the water's arsenic content.

Olomouc

Olomouc has approximately 102,000 inhabitants and is located on the upper Morava River. The town is heavily industrialized and includes food, pharmaceutical, and chemical industries. A wastewater treatment plant serves part of the town. Parts of the sewer system are seriously dilapidated. The population equivalent of all wastewaters is over 500,000, about five times the actual population. Only 85 percent of the total flow receives primary treatment and 51 percent receives secondary treatment. The efficiency of the plant is also very low. Below Olomouc, the character of the river is devastated. The waters of the Morava are used for irrigation and industrial purposes, and they are also reported to influence shallow groundwater used for public water supplies. Olomouc is by a large margin the largest contributor of BOD to the March-Morava river system. A project has been prepared for the construction of a new treatment plant.

Hlohovec and Leopoldov

The wastewater from Hlohovec and Leopoldov (population of about 33,000) has a substantial component of industrial wastes from pharmaceutical, food, electroplating, and other industries. There is no treatment and minimal industrial pretreatment. Downstream from these towns, potable water supplies are taken from the receiving river (the Váh) by several towns. A wastewater treatment plant is planned.

Bošany

The wastewater from the large Koželužne tannery in Bošany carries chromium and high levels of BOD and COD to the lower Nitra River. There is a biological treatment plant at the tannery. The primary sludge has a chromium content of 25,000 mg/kg. The factory plans to recover and recycle chromium within the factory. This is expected to reduce the chromium level in the primary sludge to less than the standard for agricultural use. The previously lagooned and dried sludge, and organic sludge components, will remain to be dealt with.

Senica

This town has a population of 21,000 and is located on a small subtributary of the Morava River. It includes a large synthetic fiber factory, not connected to the sewer system, and provides sewerage service to a wide range of other industries. A new wastewater treatment plant for the town, to replace the existing overloaded and outdated facility, is under construction but a shortfall of funds for its completion is reported. The fiber plant has a wastewater treatment facility, to which it plans to add biological treatment. The effluent's dissolved solids are a significant pollution problem, impacting on downstream irrigation use of the rivers. There is understood to be a potential for contamination of the underflow of the lower March-Morava River, used for urban potable water supplies, by organic substances from this and other industries in the basin.

Brno

Brno is located in the Czech Republic, on the Svratka River, in the Morava River basin. The city includes machinery, textile, chemical, and food industries. In the older, central area, the sewers mostly date from the last century and are in very poor condition. The Ponávka Stream, which enters the sewer system, is to be diverted in 1992. The average per capita dry-weather flow is 450 Lcd. The full dry-weather flow is treated. The treatment plant has been upgraded and new mechanical equipment has been installed. Planned improvements to the system include the connection of surrounding villages and replacement of the sludge treatment facilities. The Brno water supply system has serious problems. Supply is taken from several sources, all of which are inadequate. Plans call for constructing a 60-km pipeline to bring water from the Vir Reservoir.

3.4 Hungary

3.4.1 General

The Hungarian government is in the process of developing a new list of priorities for water pollution control, replacing a former list, which featured eight cities requiring new or improved wastewater treatment facilities. The search for high-priority projects in Hungary began with the older list, and modifications were based on current conditions and discussions with government officials and private consultants.

3.4.2 Emitters and Emissions

The principal sources of water pollution that were studied follow (see Figure 3.4):

- Fuel, dumped at former Soviet military bases, floating on top of the groundwater and gradually spreading and threatening potable groundwater sources;
- Budapest, the capital city, where less than 15 percent of the wastewater receives adequate treatment, thus endangering downstream bank-filtered water supplies along the Danube;
- Communities in northwestern Hungary within or near Moson Island (formed by the main Danube and the Moson branch), which include the city of Győr and nearby communities and industrial developments; Komárom, located on the Danube downstream from Moson Island; and Tata, on a former recreational lake, which drains to the Altalar River; and
- Communities in the Tisza River basin, including Szolnok and nearby industries in the central portion of the basin. (The Miskolc industrial region, in the northern portion of the Tisza, and Szeged, in the southern portion, are known to be major sources of pollution, but are under study by others and were not considered in detail in this study.)

Nitrates from excessive use of inorganic fertilizers have caused high concentrations of nitrates in many public drinking supply wells in Hungary. This is discussed in the "Hungary Technical Report" in Volume III and also in Appendix B.

3.4.3 Findings on High-Priority Early Needs

On the basis of the available information, each of the potential projects can be placed in one of three levels of priority, as follows:

- First priority: Győr and other Moson Island communities and industries; the fuel-contaminated groundwater at selected former military installations
- Second priority: Budapest, particularly the expansion of the existing North Budapest treatment plant; Szolnok on the Tisza River; and Tata on the Altalar River
- Third priority: Komárom

Information on the conditions, needs, and issues relating to the above locations is included in Appendix B. Brief summaries are given below.

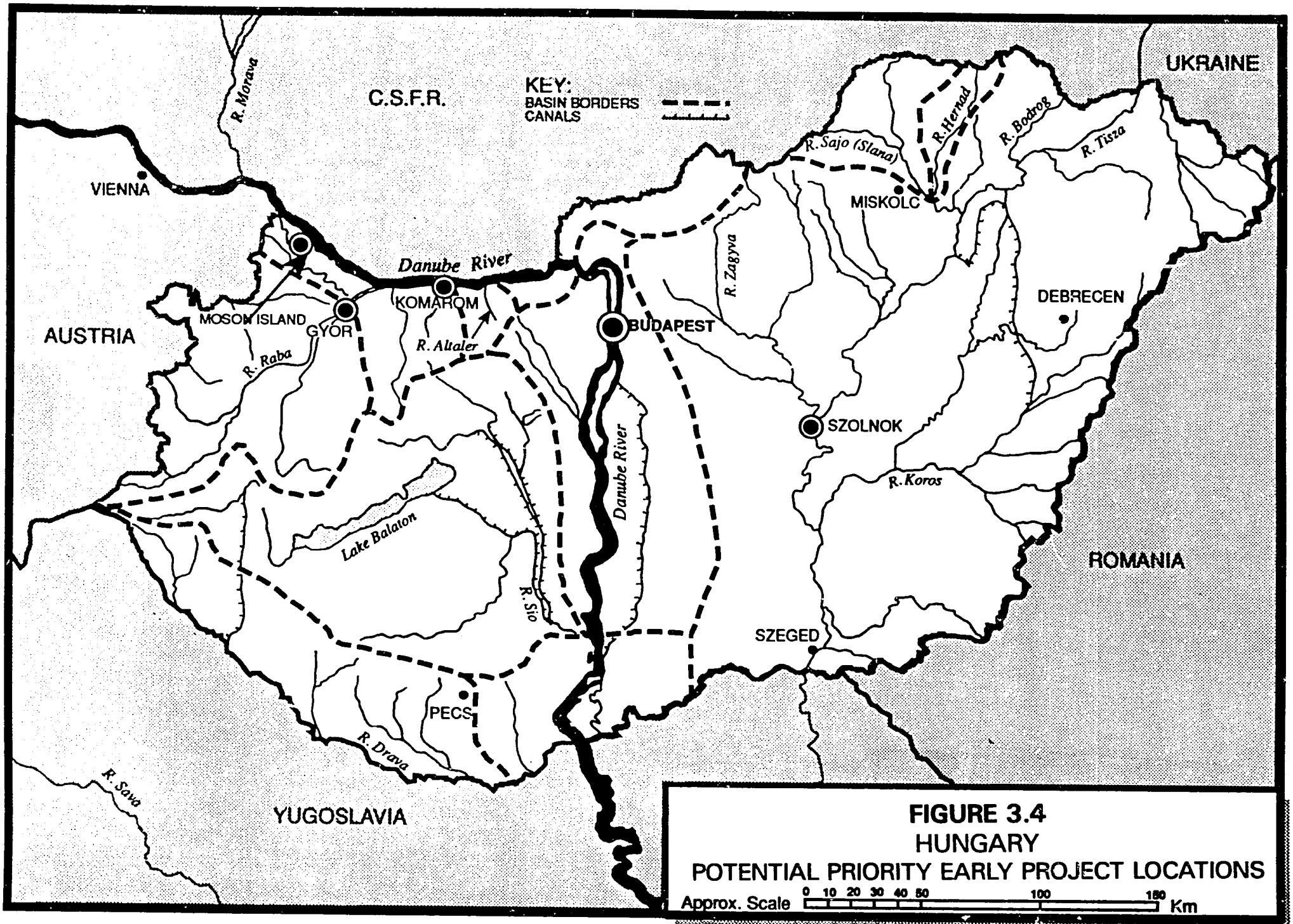


FIGURE 3.4
HUNGARY
POTENTIAL PRIORITY EARLY PROJECT LOCATIONS

Moson Island

Public drinking water is taken from coarse gravel aquifers, which are highly susceptible to wastewater pollution. Györ contains 120,000 people and is reported to be the largest industrial center in Hungary (producing machinery, textiles, processed food, and alcoholic beverages). A county wastewater master plan has identified about 16 communities on the island requiring wastewater treatment. Construction of the Györ wastewater treatment plant has been halted by lack of funds.

Fuel-Contaminated Groundwater

Fuel contamination of groundwater was mentioned as a high-priority issue in virtually every meeting with environmental protection officials. Two studies are currently under way: a PHARE inventory of groundwater pollution in 24 areas where groundwater supplies are at risk; and a nationwide study on remediation of hazardous-waste sites funded by the Trade and Development Program (TDP) of the U.S. Department of Commerce.

Budapest

The city contains about 2.1 million people, and it accounts for 40 percent of industrial production in Hungary. Only 15 percent of the wastewater flow of about 1 million cmd receives biological treatment. Although the Danube can assimilate the organic oxygen-consuming loads, ammonia concentrations are high in the late fall season, and sludge deposits are formed seasonally downstream in the vicinity of bank-filtered water supplies (although there is little evidence of toxic material or heavy metals reaching the water supplies). A TDP study on full utilization and expansion of the North Budapest plant, by extending its service area and expanding the plant capacity by three times, is in the process of negotiation and possible approval.

Szolnok

Planning, construction, and operation of wastewater facilities are well advanced in four cities of the Tisza basin: Miskolc, Debrecen, Szentes, and Szeged. Flows from the CFSR and northern Hungary portions of the Tisza enter the Kiskore Reservoir, where heavy metals are settled out and organic wastes are assimilated. At present Szolnok (population of 80,000) is the only remaining city where wastewater collection and treatment problems have not been addressed. Industries include a slaughterhouse, pulp and paper mill, sugar refinery, and chemical plant. An interceptor has been built and a treatment plant site set aside, but final design of the treatment plant has not been accomplished due to a lack of funds from the central government. Pollution impacts include fish kills, health risks to irrigating farmers, anaerobic conditions caused by sugar refinery wastes, groundwater pollution in unsewered areas of the city, and loss of the former recreational uses of the river (swimming and boating).

Tata

The Altalar basin is small (460 sq km), but its water quality is degraded by manufacturing and food-processing industries and effluent from two wastewater treatment plants serving 200,000 people. The EPA has been cooperating with the Ministry of Environment since 1990 in assisting an active local environmental association that has developed a clean-up strategy and effective institutional relationships with the ministry and the county of Komárom. The EPA has developed a preliminary feasibility study to rehabilitate Lake Tata for swimming, through a demonstration project using constructed wetlands as a treatment technology. Recreational benefits have been estimated to exceed costs by a factor of 9:1.

Komárom

A town of 20,000 located on the Danube downstream from Moson Island, Komárom was included in the government's outdated priority list because, in part, it would be affected by the Gabcikova-Nagymóros power/navigation project. Unless the CSFR should proceed unilaterally to divert flows away from the main branch of the Danube, wastewater from Komárom should not have a major impact on water quality or on recreational and other water uses downstream.

3.5 Romania

3.5.1 General

Projects considered as candidates for high-priority preinvestment studies include industries and municipalities in the basins of the Jiu, Olt, Arges, and lower Danube rivers. Potential candidates not considered include pulp and paper mills in northeastern Romania and several major cities and industries in basins in western Romania that discharge into Hungary. Time and other considerations precluded evaluation of those problems. Large animal feedlots, containing up to 300,000 pigs or cows, are also a major pollution source, but they were not studied in detail. The potential priority projects evaluated were identified from discussions with officials of several agencies in Bucharest.

3.5.2 Emitters and Emissions

The principal sources of pollution studied are as follows (see Figure 3.5):

- Bucharest, the national capital and largest city, which contains about 12 percent of the national population and 18 percent of the industrial activity;
- Smaller cities and towns that also contain significant industrial developments (petrochemical, chemical, breweries, and others); and

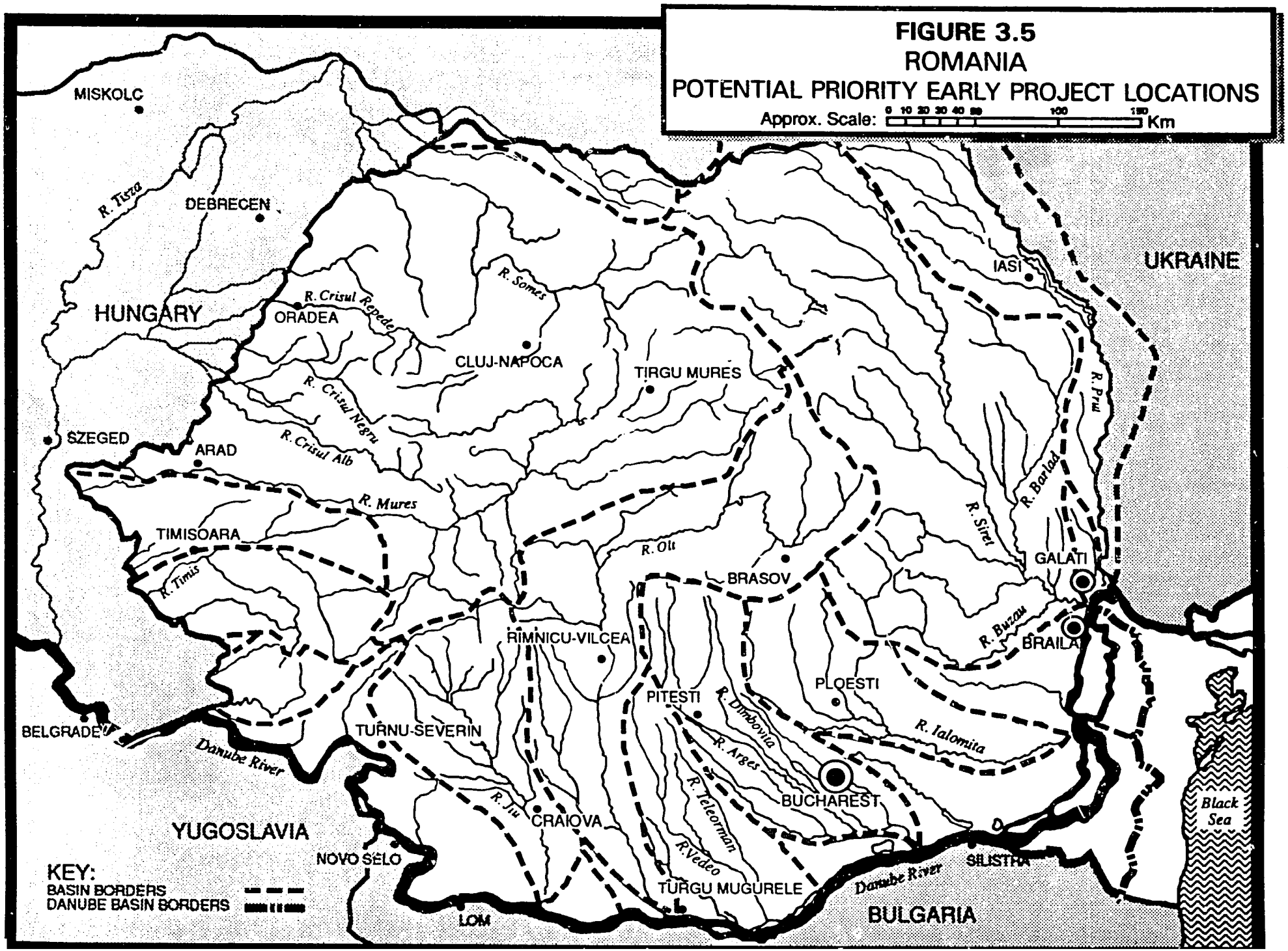


FIGURE 3.5
ROMANIA
POTENTIAL PRIORITY EARLY PROJECT LOCATIONS
Approx. Scale: 0 10 20 30 40 50 100 150 Km
MISKOLC
DEBRECEN
R. Tisza
HUNGARY
ORADEA
R. Crisul Repede
R. Somes
CLUJ-NAPOCA
TIRGU MURES
R. Crisul Negru
R. Crisul Alb
SZEGED
ARAD
R. Mures
TIMISOARA
R. Timis
R. Olt
BRASOV
RIMNICU-VILCEA
PITESTI
R. Dimbovita
R. Arges
R. Teleorman
R. Vedeo
TURNU-SEVERIN
BELGRADE
Danube River
R. Jiu
CRAIOVA
YUGOSLAVIA
NOVO SELO
LOM
TURGU MUGURELE
BUCHAREST
PLOESTI
R. Ialomita
R. Buzau
BRAILA
GALATI
R. Siret
R. Barlad
R. Prut
IASI
UKRAINE
Danube River
SILISTRA
BULGARIA
Black Sea
KEY:
BASIN BORDERS
DANUBE BASIN BORDERS

- Industrial platforms or complexes, not connected to town sewer systems, including petrochemical, chemical, pulp and paper, and steel industries.

3.5.3 Findings on High-Priority Early Needs

The potential priority project locations on which specific data were collected follow:

- In the Jiu River basin, the city of Craiova and the chemical platform within the city;
- In the Olt River basin, the city of Rimnicu-Vilcea and the nearby Govora industrial platform;
- In the Arges River basin, the city of Pitesti and a petrochemical plant in the upper watershed, and Bucharest in the lower watershed;
- Along the Romanian side of the Danube River, the cities of Turgu Mugurele, Braila, and Galati, each containing major industrial developments (producing fertilizer, pulp and paper, and steel, respectively).

On the basis of the available information, each of these potential projects can be placed in one of three levels of priority, as follows:

- First priority: Craiova (including the chemical platform), the Govora industrial platform in Rimnicu-Vilcea, Pitesti (including the petrochemical plant), and Bucharest
- Second priority: Rimnicu-Vilcea and industries in Braila and Galati
- Third priority: municipal treatment needs in Braila and Galati

Wastewater treatment for a fertilizer factory in Turgu Mugurele, and for the municipality, while needed, are not considered high-priority early projects.

Information on the conditions, needs, and issues relating to these potential projects is included in Appendix B. Brief summaries are given below.

Bucharest

The World Bank is undertaking a water supply and wastewater master plan study, which may conclude that the partially built wastewater treatment plant can be completed at a relatively small cost, given that it will remove the organic pollution caused by a population exceeding 2 million and by a broad variety of industries.

Craiova

A municipal treatment plant is partially built to serve the current population of 317,000, and a trunk sewer to the plant site is partially completed. The industrial treatment plant at a large

chemical plant is in poor condition and in need of upgrading (if the chemical plant itself proves to be economically viable).

Rimnicu-Vilcea and Govora Industrial Platform

Salt brine from production of caustic soda has a major impact on downstream potable water use and irrigation in the Olt River basin, and a significant portion of the industrial wastewater from organic chemical production receives no treatment or inadequate pretreatment. The municipal plant (which serves 110,000 people) is overloaded and suffers from intermittent power supplies and a shortage of operating staff.

Pitesti

Nutrients are not removed in the existing municipal plant serving 175,000 people, and several intervening reservoirs promote eutrophication and seasonal algae blooms in the Arges River, which supplies Bucharest. The oil refinery/petrochemical plant in Pitesti is having problems providing adequate treatment of its wastewater, although impacts are mitigated by discharging effluent to a small tributary that bypasses Bucharest.

Braila

This city of 250,000 has no wastewater treatment plant, and the city sewer system receives pretreated flows containing cyanide from a metallurgical plant. A combined wastewater treatment plant for a pulp and paper plant and a cellulose fiber plant is in need of expansion and upgrading. Significant dilution in the Danube reduces the documented impacts of pollution from Braila, but the city's location near the head of the Danube Delta leaves open the possibility of damage to the delicate ecology within the wildlife protection area that has been established.

Galati

A major steel mill, among the world's 10 largest, employs 50,000 in this city of 326,000 people. Should the steel mill prove economically viable, considerable upgrading of its wastewater treatment appears warranted, based on relatively large discharges of cyanide, phenols, and ammonia. The city has no wastewater treatment plant. As in the case of Braila, pollution from Galati may affect drinking water supplies from the Danube downstream and have an impact on the ecology in the Danube Delta.

Chapter 4

INSTITUTIONAL ISSUES

This chapter summarizes the results of detailed studies of institutional conditions and needs within the water quality management subsectors of the countries under study (see Volume II, "Institutional Studies"). The focus here is on institutional capabilities to plan, finance, and manage water and wastewater programs and the institutional requirements for operating DEMDESS. The chapter closes with the study team's conclusions and recommendations regarding institutional capacity to operate DEMDESS and key areas in which continued institutional strengthening is required.

4.1 The Institutional Context in the Water Quality Management Subsector

4.1.1 Purposes of Institutional Studies

As part of DEMDESP, the WASH team conducted institutional studies of each of the four participating countries. One purpose of the studies was to gain an understanding of institutional conditions and roles in the water quality management subsector and develop written profiles of each country for use during the project and for future reference (see Volume II). Another purpose was to determine how effectively the sector was working and what improvements might be needed that bilateral and multilateral lending institutions could address or would require as conditions for lending or other donor activities. The third purpose was to determine what would be required and what was available within the institutional subsystem to develop DEMDESS, particularly what data were available, where they resided, and how they were gathered. Finally, it was important to determine what prospects existed within the sector for decision making and analysis and who the key people and institutions might be to operate a decision support system.

Volume II provides the detailed institutional studies of the four countries participating with the WASH team in the development of DEMDESS. Each study describes the water quality management subsector of the environmental sector in each country. The primary point of inquiry was the institutional capacity to manage and control wastewater point source discharges into the Danube River and its tributaries in each country. Of particular interest were those tasks required to manage a successful water quality control program using DEMDESS. Also of interest was how water quality management and pollution control in general were being treated institutionally in each country. The essential question addressed was whether each country had in place those structures, policies, and mechanisms necessary to managing water quality relating to Danube basin pollution.

In each country, issues arose that must be addressed in order to enhance or continue the development of emissions management in the institutional area. Section 4.2 summarizes issues common to all countries. Volume II treats each country specifically.

4.1.2 Methodology

The WASH team conducted individual interviews in each country with professionals representing a broad cross-section within central, regional, and local agencies, as well as private groups and voluntary organizations. The team also collected and reviewed available written sources on each organization and its laws, regulations, and duties. An information-gathering format was used to conduct the studies (see Volume II, Appendix A). In each of the participating countries, the same list of questions was given to key contact persons in the ministry of environment (or its equivalent) and in technical institutes. (In Hungary, a consultant was engaged to find the answers to the questions.) The key contact persons were interviewed several times, and the information they provided was further extended and enriched by additional interviews and written materials. Finally, a draft profile of each country was informally reviewed by a representative of the ministry of the environment in each country at the Institutionalization Workshop conducted in May 1992 in Dubravka.

The institutional studies involved information collection and review in the following areas:

- Sectoral background: recent history, relation to the Danube River system, basic population
- Roles and responsibilities at central, regional, and local/municipal levels
- Descriptions of how the major tasks required in the sector are being conducted:

  Primary management tasks—

  - planning
  - financing
  - setting policies, standards, and regulations
  - program implementation

  Sector-specific tasks and issues—

  - data collection
  - data analysis
  - planning based on data
  - design
  - setting tariffs

- issuing permits
- monitoring discharge activities
- inspecting plants, sampling, etc.
- financial management (collecting/administering funds)

4.1.3 Definition of Institutional Issues

As used here, the term *institution* refers to organizational arrangements and management activities and policies within the water quality management subsector. The term *issues* refers to problems and concerns identified during this study in regard to each of the three. Of particular significance are the areas of regulations and controls, because they are key areas of management that require attention. As well, improvement is needed in human resources development, planning, creation of policy, and legislation.

4.1.4 Institutional Requirements

Water quality management requires that a minimum set of institutional structures and policies be in place. As noted above, during the process of conducting the individual country studies, a series of issues and requirements surfaced that were common to all four countries. During the December 1991 DEMDESP Planning Workshop conducted by the WASH team at Visegrad with representatives of ministries of environment, technical institutes, and nongovemmental organizations (NGOs), a discussion question asked, What are the institutional requirements for effective water quality management and poilution control in your countries? Figure 4.1 presents a series of questions that should be considered in determining institutional performance in the water quality management subsector. The questions were developed from the institutional studies and the results of the Project Planning Workshop.

4.2 Findings on Sectoral Performance

4.2.1 Overview of Institutional Conditions and Needs

Overall conditions in the countries studied indicate a quickly shifting institutional picture that mirrors the economic and political changes taking place in Central and Eastern Europe. This is a time of rapid change and a time of great opportunity. All of the countries studied are reorganizing their environmental sector at all levels. Devolution to municipal and county agencies is taking place (in most countries), while formerly state-supported management and service structures are moving toward commercial operations, either as privatized or as semiautonomous entities. For example, Bulgaria has turned over all water and wastewater management to municipal government. Local entities have the option of operating or forming limited shareholding companies with the utilities or designing some other option, such as

Exhibit 4.1

Questions to Consider in Determining Institutional Performance in the Water Quality Management Subsector

Industrial Policy

- Is preference given to enterprises that minimize pollution or to actions taken to stimulate changes in industrial processes to minimize pollution?
- Do industries or policies require pretreatment of discharges?
- Is the polluter liable for the effects of pollution, or is the cost of downstream corrective action borne by the downstream water user?
- Are incentives in place (taxes, duties, concessions) that would make it attractive to invest in pollution control or abatement?
- Do regulations require that the cost of production incorporate wastewater treatment, or is industrial wastewater treatment left to the municipality? Is any of the municipality's cost recovered?

Treatment Capacity and Skills

- Is municipal wastewater treatment capacity sufficient to reduce polluting effluents?
- Are sufficient skills in place to operate treatment plants?
- Do coordinated linkages exist among polluters, municipal controls and treatment, and water and wastewater management?

Financial Policy

- Do policies ensure sufficient user charges to maintain infrastructure and conduct effective operation of wastewater treatment at municipal or regional plants?
- Who might be able to finance capital improvements and can municipalities demonstrate financial feasibility or sustainability?

Regulatory/Legal Criteria

- Are the standards and norms in place sufficient for permit and regulatory processes to be conducted at appropriate levels and with appropriate control targets (municipal, industrial, agricultural)?
- Do standards sufficiently limit pollution load allocations to protect water uses downstream?
- Does enforcement work? Do regulators have sufficient power and sanctions, equipment, and personnel to ensure compliance?

Public Awareness/Social Criteria

- Is information open to the public and are efforts made to inform citizens of their choices, rights, and obligations?
- Are public education programs and activities available to inform the public?

Appropriate Sectoral Planning and Coordination

- Is a planning process in place that uses models and instruments to develop and evaluate plans for sectoral improvement and to develop regulations and policies?
- Are goals set and understood at appropriate river basin, local, regional, and national levels?
- To what extent is planning conducted using the river basin or other appropriate management unit? Are river basin structures in place? Do they need to be?
- Does coordination exist among the institutions that manage or control pollution in a particular river basin?

contract management. Hungary has done the same with utilities formerly under the control of county government, and it is now decentralizing regional water companies that have been operated by the state. In Romania, the Ministry of Environment has reorganized twice in the past two years and has separated the functions of environmental monitoring of water quality

from river basin management. The same separation of functions has occurred in Hungary, Bulgaria, and the CSFR.

New policy tools for regulating pollution are being developed, including new environmental legislation, revised standards, and better monitoring tools. The Slovak Commission on the Environment is preparing new legislation specific to water quality control. Bulgaria has recently prepared new regulations that give tax incentives to industry if they recycle by-products or institute improved pretreatment for wastewater. Bulgaria and Romania are also preparing revisions of environmental legislation that will tighten the allowable limits of specific pollutants and greatly increase fines for exceeding them.

Changes in industrial and economic conditions have led old industries to close and new ones to open to seize new opportunities. Still, many old, highly polluting industries remain, and they must be dealt with while balancing economic, social, and environmental needs. Yet Bulgaria, Hungary, Slovakia, and Romania have placed priority on the removal of toxic wastes by industry. Bulgaria and Hungary have well-functioning industrial pretreatment programs that far exceed their capabilities in municipal wastewater management.

The consequences of industrial changes for regulatory agencies are that previous trends in the quantity and composition of effluent into receiving waters are changing, and new programs for incentives to decrease pollution are possible and needed. Yet, it is not clear which industries will survive in the next few years.

Now is the best possible time to create systems and tools, such as decision support systems, because there is a readiness to try new ideas and establish improved bases for water quality management in a time of change. The payoff for creating such tools can be large because important decisions can be made better.

4.2.2 Financial Issues

The investment need is great in the four countries; tariffs are low and other sources of finance are scarce. Because of the emphasis of the past 40 years on economic production and specialized industrialization to meet the interlocking needs of a Socialist military and economic bloc, most enforcement policies aimed at managing pollution were given low priority. In particular, funding for programs for municipal infrastructure were neglected. Consequently, the water quality management sector needs large investments in physical improvements and institutional strengthening, yet current economic conditions severely limit revenue generation from taxes or other sources. Thus, local revenue mechanisms, such as property taxes and bond issuance, must be developed in all four countries as well.

Tariff policies will not generate sufficient revenue to begin to meet needs or repay, or even service, debt on soft loans. The water and wastewater subsector is heavily subsidized. Tariffs are too low to support even the operation of the subsector in most instances. For example, in Sofia, Bulgaria, the monthly charge for combined water and sewerage is .50 leva (U.S. $0.02). The average public employee eams 1,200 leva per month. In Budapest, Hungary,

the average family cost is 20 forints for water and sewerage (about U.S. $0.37). In Slovakia, the charge is, on average, 20 korunas per month (U.S. $0.71), and the average family income is about 3,800 korunas. Notwithstanding these relatively low rates, tariffs have been raised at least twice in each of the four countries in the past year. In Hungary, the legislature has set an upper limit of 60 forints per month per household connection.

In general, people are accustomed to paying low rates for utilities and public services. Moving toward an approximation of the real cost of water and wastewater treatment will be necessary if sectoral improvements are to be financed.

4.2.3 Management

All of the countries studied were well aware of what has to be done to manage water quality effectively, and most had in place a structure to accomplish it, including a system to monitor point source emissions and a sanction-and-control structure. There is a long history in most of the countries of water quality research and programs and policies to address pollution, even though past policy implementation and resources have not effectively addressed sectoral needs. Implementing enforcement actions, creating the changes, and financing the solutions to reduce pollution, however, will be difficult, however, given the economic and political realities and the history of management practice.

While institutional requirements are understood in the four countries, human resources development requires a new management perspective to remedy deficiencies. For example, until recently environmental monitoring has been closely allied with water management (mostly the same agency), and water management has been linked to natural resources management (forestry). Reorganization and decentralization have now separated these roles, but the same universe of individuals is mostly in control of policies and they are accustomed to vertical management structures. In some countries, lumber, pulp mills, and wood products (polluting industries) were under the same ministry as drinking water and river basin management. River basin authorities manufacture and sell pipe made from gravel from river-beds. The income from pollution fines on industry and municipalities currently is needed to support jobs in river basin authorities, environmental inspectorates, and the ministry of environment. This "fox minding the chickens" phenomenon creates an institutionalized disincentive to creating quick and effective change within the sector.

Developing the capacity to manage with a newly devolved institutional structure will require training staff to use planning tools and management information and to operate with a new entrepreneurial spirit that requires cost-effectiveness and bottom-line thinking. Sectoral utilities have been operated as state companies, where budget management and control, cost monitoring, and management information systems were not used. Budgets were "sent down" from central ministries; managers were not required to use management tools and did not have the authority or essential capacity to act as managers. The ability to manage public dialogue and interactions among competing public constituencies (industry, citizen groups, local

government) is a new skill area for many whose experience is in vertically operated, state-controlled agencies.

Staff are not sufficiently skilled in operating wastewater treatment plants (in some countries such staff have not existed in great numbers), nor in water quality monitoring (sampling and laboratory practice and analysis) in some countries.

4.2.4 Decentralization

As noted above, all four countries have begun decentralization with varying degrees of devolution or delegation to local structures. In many cases care has not been taken to provide for the transition. Devolution to municipal and regional levels requires more than assigning responsibility downward; resources must also be reassigned and preparatory training must take place. For example, in interviews with local mayors in Bulgaria, it became clear that water and sanitation, environmental control, and utility management planning had never included local participation. In addition, local officials could not answer questions about how to finance wastewater treatment or conduct tariff reviews because such questions had never been asked before at that level (and certainly would not have been openly discussed if they were). Similar examples exist for all four countries studied.

Municipalities are in no condition to finance, plan, or manage the water and wastewater subsector without help. Sectoral operations were previously funded from the central budget; state water companies, operating at centralized and regionalized levels, had normative and operational control. Now, municipalities and/or local water companies must devise tariffs and collect revenue based on a commercial orientation, obtaining the full cost of operations without recourse to the central budget. They must provide and maintain skilled operational staff and seek contracts for technical services. These are relatively new functions for them. It will require time and training and the creation of a broader source of municipal revenue if the situation is to be normalized. Intermediate structures (e.g., regional water companies with full autonomy to charge for services) may provide more economies of scale, but they are being decentralized, which creates new burdens on local government.

4.2.5 Sectoral Coordination

In the process of sectoral reorganization, the issue arises of the appropriate level for planning and coordinating water quality management for river basins. Attention to overall sectoral coordination and management with a focus on the river basin (or appropriately defined management levels for planning and control) is needed in some of the countries reviewed. Currently, river basins in Bulgaria are divided up (based on old political jurisdictions) among several agencies. In Slovakia, where a river basin authority exists, the focus is on water resources management (dams, flood control, channel maintenance) not on a basinwide view of water matters or water quality management. In Romania, river basin management has been reorganized and decentralized under a mandate to be self-sufficient. And in Hungary, river

basin management is shared between the Ministry of Environment and the National Water Authority. This arrangement does not include representation from major industrial polluters, except in one basin, where a community organization was set up as an association to include representatives from government, industry, the municipalities, and local citizens. With this one exception in Hungary, the mechanisms for taking a basinwide approach to problems were not evident.

Roles tend to overlap. The move in the past two years has been to attempt to separate roles. Environmental quality control, for point source emissions and for in-stream water quality (sampling, standards, and sanctions) is assigned to environmental ministries, while water resources control and basin management are the responsibility of water management institutions and river authorities. Responsibility for potable water supply and wastewater treatment has gone to municipal, limited holding companies, and/or regional water utilities. How can a problem that is interdisciplinary, interagency, and international be managed with good coordination and appropriate planning? How can a problem-solving and implementation focus be provided that will assign responsibility to the units where the necessary information resides? How open should information be? Who makes decisions, who carries out planning? The current situation brings with it some role confusion and overlap.

Sectoral problems and needs are interlocking. Each party to water use is interested in and must deal with water quality management, most have laboratories, each receives a portion of pollution fines and taxes, and each issues or manages a permit process for either withdrawing water or discharging effluent. The cost of providing potable water is often linked to source and availability within a river basin structure, where maintaining the quality of sources is regulated by entities different from the water providers.

The adoption of DEMDESS as a tool for data sharing and for common options analysis will be yet another element that requires coordinated action. It is hoped that it will also help to pull interested parties together when common needs to solve a problem exist or alternative solutions require action and commitment by all parties. Institutional development activities to clarify roles and set up coordination mechanisms are needed in all four countries.

4.2.6 Industrial Pollution Control Policies

Industrial pollution control policies are needed that will find solutions that provide the basis for an appropriate balance between competing needs without resorting to overly punitive measures. Each of the four countries is now searching for this balance through legislation that is under development. Past policies have heavily favored state industrial enterprise, but the basic management structure for effective monitoring and control exists to implement new policies and laws as they are made.

As discussed above, the industrial structure of the East European countries is in a state of flux; many industries have shut down or are operating at much reduced levels. Some industries will not survive as competition becomes the norm. Conversely, unusual opportunities for the establishment of new industries will arise.

A rare opportunity now exists in Eastern Europe for shaping the future industrial structure in environmentally responsive ways. DEMDESS should be able to assist policy analysis by analyzing the cost of treatment options for industry and comparing pollution allocation scenarios. Strategies that place industry on the defensive and polarize rather than create helpful exchange are expensive for a government to implement and produce unnecessary conflict. Policies are needed that emphasize incentives and that contain a wide range of options for product, process, by-product, and treatment. Solutions are required that strike an acceptable balance among opposing needs. In the process, it will be important to have dialogue, citizen involvement, and exchanges among interests that lead to positive, helpful programs.

4.3 Institutional Requirements for Operating DEMDESS

4.3.1 A Structure for Monitoring and Data Gathering

A number of positive conditions exist within the sectoral structures for operating a decision support program in the countries studied. As well, constraints are evident that will limit the expansion, development, and use of DEMDESS.

DEMDESS requires a structure for monitoring, data gathering, and data analysis that has the capacity to allow reasonable analyses for planning and sufficient data to control point source emissions using sanction programs. Confidence in the data requires capacity for some independent analysis sufficient to verify normal administrative routines for collecting samples.

In most of the countries, administrative routines exist for sampling in-stream river points on a monthly basis, and a system exists for periodic sampling of municipal and industrial point sources. The DEMDESS demonstration basin effort used the data from those structures and in some cases, additional data were gathered as a check against records.

Some areas will require improvement. While most large industries have reporting requirements and conduct their own analyses, more frequent sampling by governments and some verification by independent laboratories of the self-monitoring that industries now conduct would provide improved data reliability. Many industries are sampled only once or twice a year, some less. Municipal wastewater sampling is too often left completely to the treatment plant laboratory with no independent verification.

Laboratory capacity and testing equipment exist for the current administrative routines, but the equipment is old and supplies are not always available. This further limits the reliability of data. Increased laboratory capacity will be needed to improve the routine monitoring system if sampling frequency is increased. Equipment should be updated and sufficient transport provided for collecting samples.

Enhanced monitoring networks and equipment will make DEMDESS more accurate, more predictive, and more useful. These steps are critical to long-term success. Comprehensive

monitoring programs will require upgrading of sampling, testing, and training programs. Computers and sampling equipment are also needed.

4.3.2 Computer Program Operational Skills and Equipment

Sufficient capacity for data management using the DEMDESS relational data base and resident programs is a basic requirement for operating DEMDESS. It was not expected that a sophisticated tool such as DEMDESS would necessarily have precedent within the institutions studied. However, skills to learn how to use and assist in the development of the DEMDESS computer architecture and program were desirable. Additionally, skills to use the data base software once data inputs and programs were designed were needed. One early task was to locate this capability within an operation that was accessible to government by direct means or by contract and that could provide computer analysis in water quality management.

In each country technical institutes exist that have well-trained staff with the capacity to learn how to operate DEMDESS. For full use of the tool, practice and some bridging activity will be required to complete the process of skill and knowledge transfer. These are specified in Chapter 6.

Equipment sufficient for prototype model development exists. However, in each country, a network of agencies that will use DEMDESS for administrative routines and special analysis is emerging. These agencies will need computers with sufficient memory to operate DEMDESS.

4.3.3 Capacity for Decision Analysis

At the beginning of this effort, a set of entities interested in participating in and using a decision support program had to be identified if DEMDESS was to be developed and eventually be useful as an informational and analytic tool. During the DEMDESS developmental process, the concepts of *user* and *client* emerged (see Chapter 5, Section 5.3 for more on these terms). A *user* has a computer with DEMDESS installed in it and regularly uses its program to meet work-related needs. A *client* has occasional need for information or analyses that one of the users can provide. The user group has emerged over the course of the project to include the following two levels:

- The water quality section in the ministry of environment has proven to be the key unit for receiving the DEMDESS system and managing its use within each country. It is this group that advises national policymakers (legislative bodies, top officials of executive branch agencies) and conducts overall sectoral policy and planning in most instances.
- Operational and management bodies that plan, control, and regulate water quality (ministry of environment units, river basin authorities, potable water companies) are at the next level of user. Of this group, the planners and the regulators have specific functions for which the capacity to record and manipulate data is important.

Data management entities such as technical institutes, information centers, and laboratory centers have been assigned the responsibility of working on the computerization of the DEMDESS tool. They have been called *system analysts*, and sometimes *operators* during discussions with the four countries.

Primary users and operators have been identified and were at various stages of awareness and involvement at the time this report was written. During the DEMDESS developmental process, finding and working with a primary user and a system operator in each country was the first priority. The concept of an expanded network of users and clients is emerging and needs more promotion. Potential users need to know more about DEMDESS and have developmental input and access to the system. Primary institutional/policy-level people in the ministries of environment have been briefed on what the system can do. They are very hopeful, but they are still waiting to see if DEMDESS will be truly useful. There will be a need for follow-on orientation of decision makers to enable them to define and use decision-analysis scenarios and tools. This type of management is relatively new in the four countries.

4.4 Conclusions and Recommendations on Institutional Issues

4.4.1 Capacity to Operate DEMDESS

The basic institutional structure and capacity exist for DEMDESS implementation now. Operationalizing the system will require a number of specific steps, which are outlined in Chapter 6. Improvements made in institutions relating to decision analysis, coordination, communication among entities, and the capability to monitor data will enhance the use of DEMDESS. If the DEMDESS program is to work as a management tool, an information system, and a decision-analysis tool, it must become useful, understood, and integrated into the normal routines of institutions. At the policy level, DEMDESS should assist in policy analysis leading to tariff reform, review of regulations, and other uses, but that will require that policymakers learn how to use the applications. Orientation will be required for decision makers in how to use decision support tools such as DEMDESS.

At the moment of turnover to the countries involved, DEMDESS has an immediate use as a data base for monitoring pollution control and the application of sanctions. Additionally, the decision-analysis elements of the system can become significant if users learn to make use of them for this purpose.

It would be ideal if DEMDESS eventually evolved from the demonstration basin program developed during the few months of the WASH activity to a data base that covers most of the river basins in all countries along the Danube.

In sum, as a tracking tool for enforcement actions, DEMDESS need only be applied. If the system is expanded to include more basins, each country will be able to use it for the many purposes defined in Chapter 5

4.4.2 Future Institutional Strengthening for the Sector

Given institutional conditions within the four countries, it will be important to prepare them for improved sectoral management before entering into expensive capital investments to "clean up pollution," particularly if large commitments are made on international loans requiring foreign-exchange repayments. Preinvestment studies should focus on institutional needs and river basin pollution conditions. This will help further define the dimensions of the problem and the need, and it will provide specific program designs for interventions. Subsequent interventions should include institutional efforts to improve the foundations for sectoral management and long-term problem solving. The dimensions of the institutional issues will require a series of efforts aimed at improvement in the short and long term. Continued institutional study and the design of specific institutional interventions in each country will be needed.

The key areas for continued sectoral improvement in the four countries are outlined below:

- **Human resources development in water quality management**: Training programs specifically designed to meet the management and planning needs of the water quality subsector in Eastern Europe should be designed and implemented. Such programs should focus on management practices that use information and decision support systems, that deal with public and interinstitutional dialogue and communications, and that provide skills in entrepreneurial and cost-management practice.

- **Role clarity and sectoral coordination**: Each of the four countries should carefully reexamine decisions relating to agency roles and duties that have been made under the transitional pressures of the past two years. Institutional analyses are needed to define optimal ways to set up coordination mechanisms, eliminate role overlap, and provide clear mechanisms for obtaining permits for discharges and water quality control activities. Alternatives should be put forth and decided on in country for the involvement of all parties (industries, municipal agencies, private citizens, ministries) interested in the management of river basins. The objective should be to find a model that does not duplicate efforts and allows for coordinated actions that work.

- **Appropriate laws, sanctions, and enforcement policies:** All four countries are in various stages of revising their laws and policies. These positive efforts have been supported with technical assistance from EPA and other entities. A positive use of the experience gained to date would be to develop mechanisms among the riparian countries for sharing ideas and experiences. A useful role for the EPDRB would be to develop workshops and conferences to review lessons learned before legislation is passed in each of the countries during the next year.

- **Linking monitoring and laboratory improvement programs to DEMDESS:** Efforts are under way within the bilateral donor community to provide enhanced laboratory and monitoring equipment to each of the four countries involved in this study. These efforts should be coordinated to ensure that the DEMDESS program is

integrated into these efforts. Computer equipment for full operation of a decision support system will also be important. The EPDRB's working group on data management should specify what is needed in a comprehensive way so that the dimensions of the need can be estimated and measures can be taken to ensure appropriate capacity.

- **Setting tariffs to pay for the cost of water and wastewater:** Tariff studies should be undertaken in each country so that appropriate fees can be set for water and wastewater. The principle of the "polluter pays" should apply to municipal discharges, as well as industries, so that appropriate incentives are applied and a source of sectoral finance is developed. Municipal governments particularly are in need of technical assistance in this regard because this is a new area for them.

Chapter 5

THE DANUBE EMISSIONS MANAGEMENT DECISION SUPPORT SYSTEM (DEMDESS)

This chapter provides an overview of the structure and status of DEMDESS and its potential uses as a decision support tool. The following topics are discussed: a general water quality management framework for large river basins; the design of DEMDESS and the information that can be stored and analyzed using the system; the principal clients and users of DEMDESS; and the status of DEMDESS in each of the four study countries. The *User Manual* provides more detailed information on the structure of DEMDESS; Chapter 6 provides more detailed information on the current status and future development of DEMDESS.

5.1 The Need for Emissions Management

The need for emissions management can be best described by defining the relationship of emissions management to the overall water quality management framework. Figure 5.1 presents in graphic form the three subsystems within a water quality management framework, which is applicable to the Danube River basin or any other large river basin. The three subsystems, in summary, are as follows:

- **The Emissions Subsystem:** This subsystem includes all point and nonpoint sources of emissions, such as municipal, agricultural, and industrial wastewater, treated effluent, stormwater, and groundwater.
- **The Environment and Impact Subsystem:** This subsystem includes the environment and other entities that are affected by the emissions. Water quality and quantity and water uses are the major concerns in this subsystem.
- **The Institutional Subsystem:** This subsystem includes all the organizations and individuals that together define the rules and physical interventions by which the emissions subsystem is controlled.

The three subsystems are highly interrelated, and the interrelationships occur at a large number of physical points and other interfaces. For example, thousands of diverse upstream pollutant sources impact the water quality at a given river section, and the regulations and organizations that control either the sources or the water use are many. Formulating regulatory policies, planning technical interventions, and organizing related institutions in such a large and complex system require a decision support system.

A *decision support system* is an information system that is designed to assist decision makers. It does so by presenting to them the best available and most relevant information on which to base their decisions. It does not make decisions, and it will inevitably omit certain judgmental

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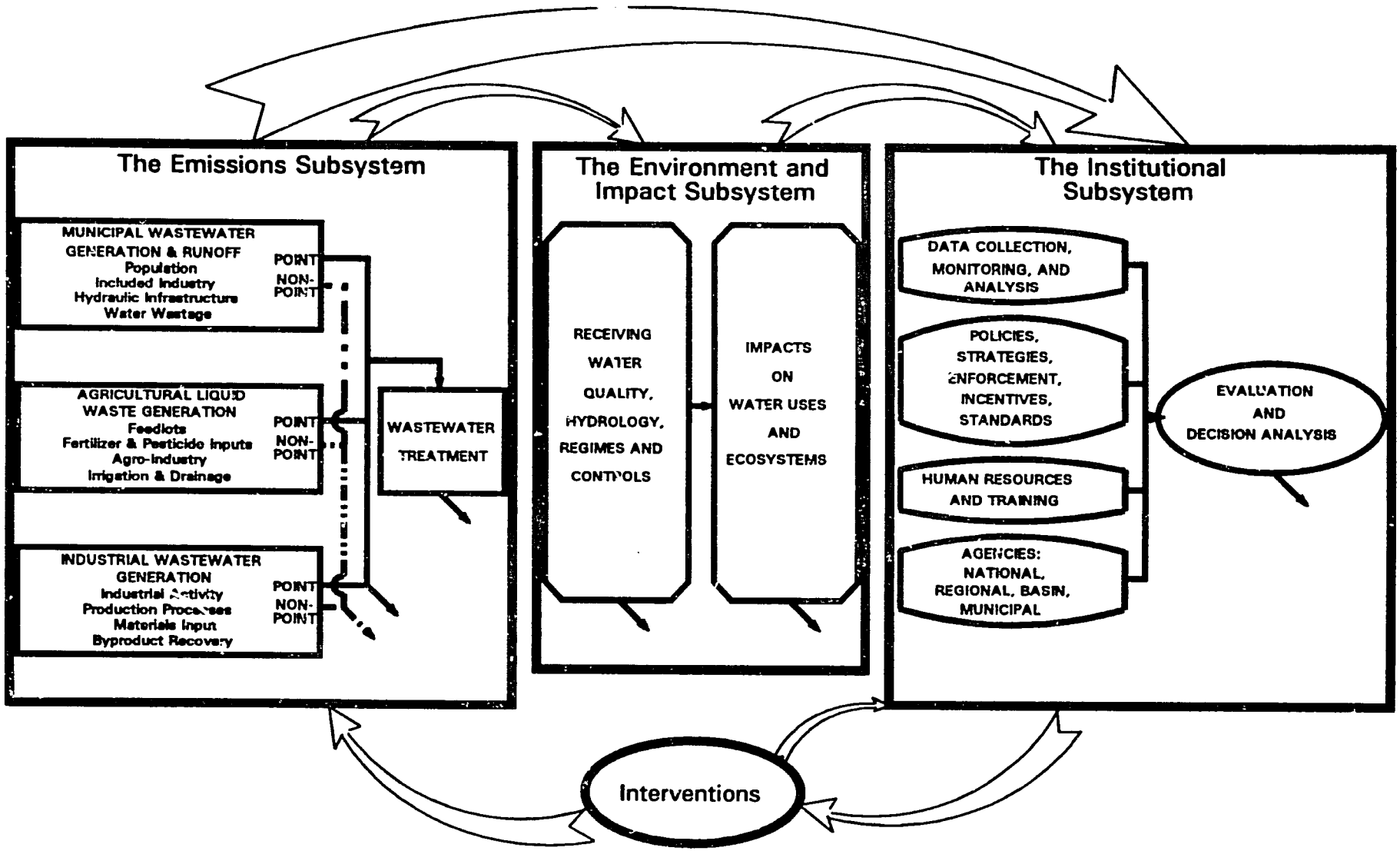

FIGURE 5.1—WATER QUALITY MANAGEMENT FRAMEWORK

aspects that cannot easily be made explicit or reduced to formal analysis. However, it combines large amounts of basic data, technical procedures for analyzing those data, the processing power of modern computers, and efficient techniques for presenting information in easily understandable form.

A decision support system enhances the effectiveness of decision makers in three ways. First, it relieves them of time-consuming and technically demanding data reduction tasks, thus allowing them to focus directly on the key aspects of the decisions they are called on to make. Second, it employs sophisticated analytic methods to explore the implications of information, implications that might otherwise be missed. Third, it organizes and presents findings in forms that are easily and readily understood.

5.2 The Design of DEMDESS

The Danube Emissions Management Decision Support System (DEMDESS) is designed to assist decision makers who are concerned at some level with affecting the discharge of pollutants into the Danube River or its tributaries. It is intended to be a part of a larger decision support system that covers the entire field of water quality management in the Danube River basin (perhaps eventually all water management, or even all environmental management). Although it is closely related in concept to these broader concerns, its immediate focus is the direct or indirect discharge of pollutants, a topic that has received less attention in some countries than ambient water quality conditions, health effects, and other major aspects of water quality management.

Policies designed to achieve an appropriate level of water pollution control for the Danube River and the Black Sea must focus primarily on limiting discharges or emissions of pollutants into the Danube and its tributaries. Nonconservative pollutants can be assimilated and conservative and nonconservative pollutants can be diluted, but assimilation and dilution cannot be the cornerstones of pollution control policy because they have only a limited capability to reduce pollution damage. Reduction of emissions must be the main instrument of pollution control policy, and emissions themselves are the strategic variables in DEMDESS.

Although its focus is emissions, DEMDESS must address all the subsystems of the water quality management framework (Figure 5.1) to be an effective decision support system. The framework reflects the ways in which emissions are generated, the effects they produce, and the institutional control subsystem through which water quality can be managed. Full implementation of a decision support system encompassing all of the subsystems of this conceptual framework will present to decision makers the full implications of the pollution control policy and investment options among which they may choose. Interventions such as constructing wastewater treatment plants are initiated according to a certain regulatory policy. Such policies and their application must consider pollution effects and costs. For example, regulations to require a uniform standard of biological treatment for all municipal wastewaters in a country would have immense cost implications and would not necessarily achieve desired

water quality in all waters at minimum cost. Alternatives to such a policy must be evaluated, and DEMDESS is a useful tool for doing this.

A decision support system can help in the formulation of cost-effective policies by estimating water quality and the economic and financial impacts of various options. Another significant policy issue is phasing of interventions. Interventions that provide the highest pollution reduction for investment should be identified by a decision support system and given high priority. The interventions need not always be structural or "end-of-pipe," however. Nonstructural interventions are often the most effective solution. For example, effluent standards that address key pollutants, backed up by monitoring and enforcement, will affect in-factory procedures for waste management, as well as treatment decisions, and may also induce changes in processes. Taxing (or removing subsidies on) certain raw materials, such as metals, would encourage their recovery in industrial processes, and they would then be less likely to end up in wastewater emissions.

DEMDESS is designed to be "data driven." It can store and analyze a large data base to represent existing conditions. Using the existing data base as the departure point, DEMDESS can simulate and analyze various regulatory and technical emissions control scenarios in terms of water quality and economic and financial impacts under today's conditions and expected future conditions.

DEMDESS was developed using the commercially available relational data base application development program, Paradox®, which was chosen because of its compatibility with other data base software (e.g., dBASE® and SQL®), its analytic power, its economy in use of computer memory, and its reporting capabilities. The program consists of data tables, queries (which express the questions asked of the data), and scripts (which define queries and computations on the data with a simple programming language).

The design of DEMDESS is described in block diagram form in Figure 5.2. The *User Manual* should be referred to for a more detailed and technical overview. DEMDESS consists of six subsystems: Reach, Emissions, Treatment, Water Quality, Regulatory, and Institutional. The six subsystems are more detailed and specific breakdowns of the subsystems of the framework presented in Figure 5.1, except for the Reach File, which defines the river network.

The Reach Subsystem is central to the design and operation of DEMDESS. It alphanumerically defines every river segment in terms of its basin (Danube) and subbasins (tributaries to the Danube and their tributaries), and it also defines stations on the river segments, in kilometers. The Reach Subsystem is the "conduit" that connects various subsystems, for example, by bringing together for comparison the cumulative emissions load at a given river reach and station, the resultant water quality, the relevant in-stream water quality regulation, and the regulatory authority. The Reach Subsystem can also be used to connect DEMDESS to other data systems, such as in-stream hydrologic and water quality models and data bases.

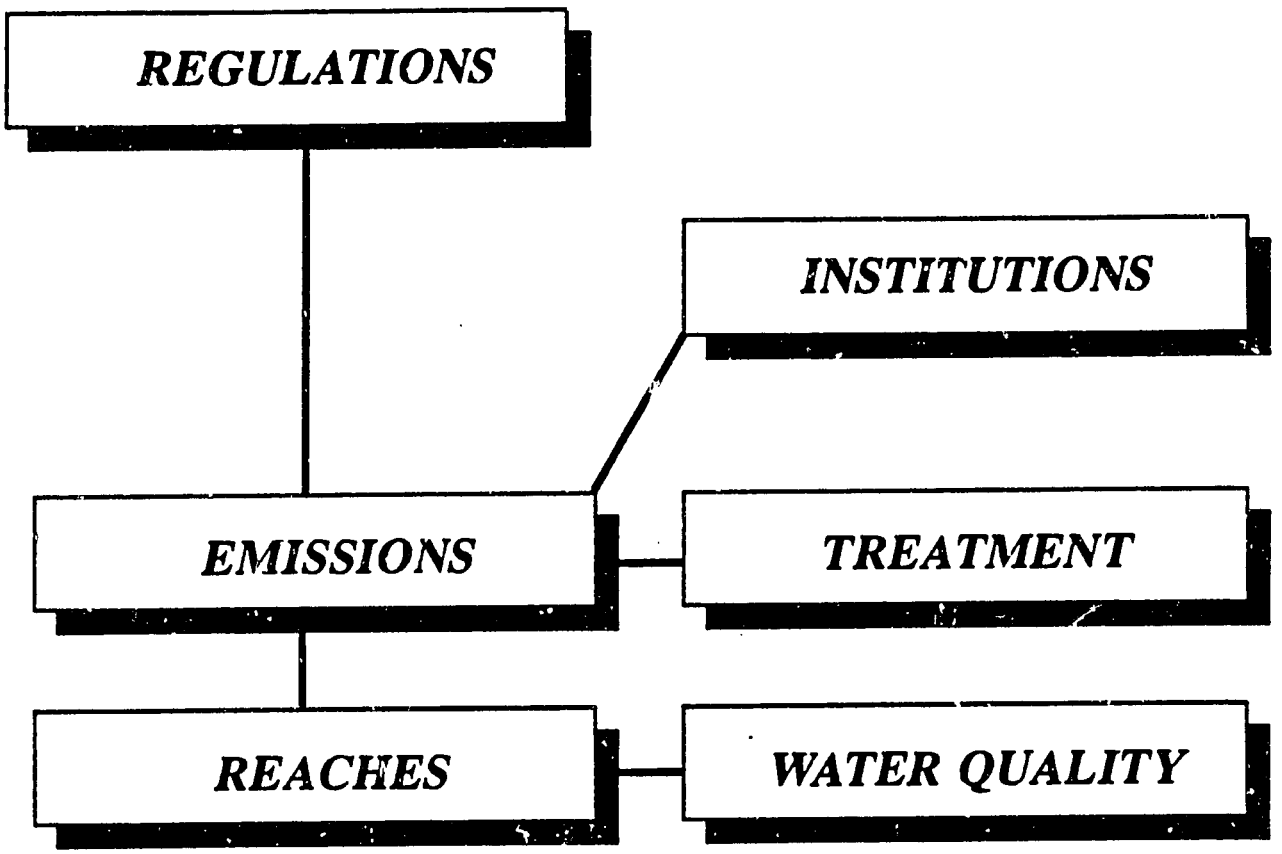

FIGURE 5.2—ORGANIZATION OF DEMDESS

The Emissions Subsystem contains data on emissions, such as type, pollution parameter, quantity, and sampling date, and emission sources, such as industrial sector, location, and size (population, sales). Scenarios can be developed by selecting or adding to existing emissions. The Water Quality Subsystem contains in-stream monitoring data, monitoring sites, and water quality modeling coefficients. The Treatment Subsystem contains data on treatment efficiency and coefficients for cost and economic and financial functions. The Regulatory Subsystem contains water quality and discharge standards and data on related fines and taxes. The Institutional Subsystem contains data on control authorities, such as river basin authorities, and is connected to the Emissions Subsystem. Institutional data are also included in other subsystems.

DEMDESS provides the results of a regulatory and technical intervention scenario in terms of modified emissions quality, in-stream quality, and financial costs. Costs can be given individually for each pollution source or all sources, or they can be aggregated by sector. Per capita costs and sectoral costs can be provided to evaluate the regional or national economic impacts of scenarios. These analytic features are built with the query and scripting (programming) features of Paradox®.

As noted, DEMDESS is a data-driven system, and the effort that goes into programming analytic procedures is only a fraction of the effort needed for data collection and development. The analytic questions that are answered by DEMDESS currently are limited in number and constitute a demonstration of the kinds of questions that can be handled. The flexibility, adaptability, and simplicity of the query and scripting features are important to the enhancement and future utilization of the system. Also, DEMDESS currently focuses on limited areas of the water quality management framework, but with the above-described Reach Subsystem and scripting capabilities, it has the inherent capability to link easily to many other areas of water quality management.

5.3 The Decision Makers and the Users

The term *clients* is used to denote those decision makers who are likely to benefit from the information provided by DEMDESS. Potential clients exist at many levels in the water quality control hierarchy. Among them are policymakers, planners, and regulators. Each of these potential client types has specific information needs, which are often quite different from those of other potential clients. (A fourth client type, facility and system managers, is likely to require information that is more site specific and operationally oriented than is that provided by DEMDESS.) Potential clients and their information requirements may be characterized as follows:

- **Policymakers** in any of the four participating countries within which DEMDESS has been implemented: These policymakers include legislators and the top officials of the pollution control ministries in the four countries. The effectiveness of such policymakers will be greatly enhanced if they can request information on and be shown the effects of various alternative policies that are available to them. Also

included in this category are international organizations, such as the Danube Commission and EPDRB.

Policymakers, whether in the ministries or the legislature, will be assisted by a decision support system that identifies and compares the widest possible range of practically available policy options. One of the significant shortcomings of most policymaking institutions is that they have too narrow a focus or definition of options. DEMDESS can assist policymakers in considering a broad range of policy options. Examples of such policy options include standard setting and enforcement by fines, effluent charges, subsidies, and compliance scheduling.

Policymakers are primarily interested in data with a high degree of aggregation, particularly for formulating policies at the national level. DEMDESS can provide information with a high degree of aggregation.

- **Planners** in any of the four participating countries: In this context, planners are those individuals whose role is to achieve established policy goals to the maximum extent possible, given available resources. Quite often, planning in the water quality management sector is organized on a river basin level, reflecting the substantial interdependencies within a basin and the lesser water quality interdependencies between a basin and the areas outside it. Thus, planners will most often be found within river basin or regional organizations in the four countries, although they may also be found at the subregional (subbasin) level. International donor and lending agencies are also included in this category of potential DEMDESS clients because they, too, are interested in the evaluation of specific potential development projects.

  Planners examine investment and other strategic options below the policy level. They implement policies in a national, regional, local, or basin context. Planners require greater disaggregation and greater detail than do policymakers, but less detail than is required by regulators. Unlike policymakers, they seek information about site-specific dischargers and facilities. Unlike regulators, they need not see detailed information about the operation of existing dischargers and facilities.

- **Regulators** in any of the four participating countries: The role of a regulator is to attain compliance with established rules, whether ambient, performance (discharge), or design standards, or other rules. Regulators will most often be found at the local level, usually as agents of regional or national regulatory agencies. Regulation necessarily occurs on a site-specific, thus local, basis.

  In order to serve a diverse mix of decision makers who call on DEMDESS intermittently as they need information, an entity must exist to maintain DEMDESS on a continuous basis. The term *user* denotes this entity. At least one system user must exist in each country. The responsibilities of the people in such a group include assembling and assessing data, maintaining the data base, interacting with decision makers, formulating new queries, and expanding and improving the system. In each country, there should be a primary user, which would also be the focal point for both

national and international coordination of the system. This would be an office within the ministry of the environment or its equivalent. While it may perform some of the functions through a subcontract with an institute or other technical entity, the ministry must maintain positive control of DEMDESS. This primary user may have multiple clients at the national and lower levels.

As agreed at the Institutionalization Workshop (see Appendix A), the functions of the primary user should include the following:

- responding to policy changes by the parent ministry
- establishing topics and procedures for regular reporting by other users in the country
- providing public information
- responding to requests for special reports
- providing technical assistance and training for other users in the country
- establishing default data
- conducting ongoing system development
- protecting legal ownership and sensitivity of information

Other users (an office within, or serving, a regional or basin authority, for example) are likely to be closely associated with a single client, but they may provide services for other clients on request.

5.4 General and Country-Specific Status of DEMDESS

The structure of DEMDESS is now initially specified and incorporated into a framework of Paradox® data tables, queries, and scripts. However, before DEMDESS can be used in a specific application (whether at the river basin, country, or international level), the application-specific data that are to be analyzed must be added to the basic structure. In other words, the basic DEMDESS structure is similar to a set of mathematical equations that contain variable names and relationships but no values for those variables. The user must add all of the empirical information needed to apply DEMDESS to a specific situation or purpose.

The DEMDESS structure will no doubt be expanded and linked to other decision support systems in the future, as DEMDESS is called on by decision makers at all levels to answer additional questions. It will also be applied to an increasing number of geographic areas, in its current form and as it is expanded. At present, implementation of DEMDESS has been initiated in one demonstration river basin in each of four Danubian countries (Bulgaria, the CSFR, Hungary, and Romania). The degree of implementation in each of the basins differs, largely due to differences in data availability among the four sites. In each case, the river basin chosen for initial demonstration purposes was one that had a number of water quality problems, so that the the application would be valuable in itself. However, the river basins

were chosen as well because better data were available for them than for some other basins in each country. The demonstration applications can thus be useful not only for setting emissions control priorities within the subject basins but also for setting data collection priorities elsewhere in each country and for exploring policy options more completely than would be possible on a countrywide basis.

5.4.1 Bulgaria

The Jantra River basin was chosen to be the initial demonstration basin in Bulgaria. It was also the initial application within which the DEMDESS structure evolved, as WASH team members and their Bulgarian colleagues created the concrete implementation of the DEMDESS conceptual framework developed earlier in the project. Work began in November 1991, and the results of an intensive, special data collection effort in the basin were incorporated. Thus, the data used in this application are unusually complete. Consequently, the Jantra application is the most developed and the most completely tested of the four demonstrations.

The pollution parameters currently included in the Jantra application are BOD and total suspended solids (TSS). Current ambient and emissions standards are included. A limited policy analysis comparing alternative levels of taxes (effluent charges) and fines (for exceeding standards) was conducted at the request of the Bulgarian Ministry of the Environment, which must soon recommend new levels to the legislature.

Bulgaria has made a major commitment to use DEMDESS as a primary tool for water quality management. Existing water quality data systems are to be converted to DEMDESS, which will now be the official water quality management data base for the country. All Bulgarian streams and basin boundaries were digitized as part of the DEMDESP in order to facilitate this changeover.

5.4.2 CSFR (Slovak Republic)

The Slovak Commission on the Environment chose the Nitra River basin as its demonstration basin. Work to implement this decision began in February 1992. The Slovak water quality data base is a high-quality one, and software routines to convert that information into Paradox® files have been written and the conversion accomplished. Work on the incorporation of the Slovak institutional parameters (fines and standards) is now in process. The system has been demonstrated for about 30 technical experts from Slovak water agencies. Although it is not yet ready to support client requests, the Slovakian application is well advanced.

5.4.3 Hungary

The Altalar River basin was chosen as the demonstration basin in Hungary. This choice was made in April 1992. Consequently, DEMDESS implementation in this basin has just begun. Fines and water quality standards information have been entered into the data base, but other pertinent data have yet to be entered. Obviously, use of the DEMDESS system by Hungarian clients lies in the future.

5.4.4 Romania

The Arges River basin was chosen as the demonstration basin in Romania. Work began in February 1992 on this application. Water quality data collection in Romania was spotty until 1992. However, a new system for data collection and maintenance was designed and implemented in 1992, and future prospects are encouraging. Software for converting the Romanian water quality data, as they accumulate, into Paradox® format has been written. Although only limited sample data have yet been entered in this application, the system will be ready to receive and utilize data as the new data collection system makes them available. No client analyses have been performed in Romania, and none will be performed soon, due to the lack of reliable water quality and emissions data.

Chapter 6

DEMDESS MAINTENANCE AND DEVELOPMENT

As outlined in Chapter 5, use of DEMDESS has been tested with data from one river basin in three of the study countries, and testing has been initiated in the fourth country. This chapter summarizes the status of DEMDESS implementation and identifies the steps that must be taken to make DEMDESS a fully operational tool. The final section of the chapter presents the study team's specific recommendations on the completion and future use of DEMDESS.

6.1 Status and Understanding of DEMDESS

6.1.1 Initial DEMDESS As a Starting System

The DEMDESS effort was described as a very good first step by most of the participants in the Institutionalization Workshop held at the end of May 1992. This assessment was based on the following factors:

- A system design is in place that includes data compatibilities programmed to interface, both nationally and internationally, with most existing data bases.
- DEMDESS stores information in an interchangeable, standardized format; it can perform the tasks of data storage and manipulation for multiple uses and multiple users in each country.
- DEMDESS can be used to conduct cost, institutional, and other analyses that facilitate responding to queries about the impacts of various possible interventions.

The above features provide a basis for data management and planning support. To develop and test DEMDESS, real data on one demonstration basin in each of three countries and some experimental analyses have been conducted to determine least-cost treatment plant construction programs that would result from application of alternative fine and subsidy scenarios. (Work on a demonstration project in the fourth country was initiated in April 1992.) Given the short duration of DEMDESP, this is a positive achievement.

A further positive indication is that EPDRB has found DEMDESS useful, and by popular demand from the participating countries, it has incorporated DEMDESS into its program as a way of making international linkages for data management.

The demonstration basin process used in program development showed that DEMDESS can answer with ease the questions it was designed to answer. Because the system is data driven, improving the first attempt at data entry and expanding data collection beyond the demonstration basins are very important for establishing DEMDESS as an operational tool that can adequately reflect real-world issues. Testing and proving the system will require

substitution of additional, updated, and verified data to complete the initial activity in each country.

6.1.2 Status of Implementation

If DEMDESS is to operate as a "live" program and be used to its potential, more effort will be required in the immediate future. If it is to reach more of its potential as a decision support tool, follow-up actions will be necessary over the next one to two years. (Short- and long-term requirements are described in this chapter.)

At the conclusion of the WASH technical assistance in July 1992, each country sponsor of DEMDESS was sent a DEMDESS "package" that included a set of tailored software for installation in the relational data base it previously received. Each country's program includes data for one demonstration river basin. Data were entered on the demonstration pilot basin to the extent available. Each country was also given a *User Manual* that describes how to use the system. (Chapter 5 described the detailed uses and the status of DEMDESS installation in each country.)

An operating entity in each country has been identified and each has either a very rudimentary understanding of the tool or, in one country, an initial understanding of how to use it. As yet, no country has a full understanding of the analytic uses (option- and decision-analysis scenarios) of the tool or can perform extensive manipulations of the program's capabilities, nor have personnel been trained in this. And, while the documentation developed will provide some help, it will not provide sufficient detail to serve as a user's manual for decision makers. The primary system operator will have instructions on the use of the currently programmed software. The more experienced analysts (with a few weeks of experience) will be able to use DEMDESS to assist in management or planning.

Eventual use of DEMDESS will require a coordinated effort and a management structure for its maintenance. This process will require an interaction between clients and users in which use determinations are specified and scenarios are programmed for analysis. Some options-analysis scenarios have been programmed, but the need for others will emerge over time.

6.1.3 Ownership, Users, and Level of Understanding

DEMDESS is based on the relational data base program Paradox® and the related spreadsheet program Quattro Pro®. One copy of each of the programs has been purchased for each country, but rights in this software are retained by Borland International in terms of the license agreement for each software package. Copying, duplicating, selling, or using the product contrary to the license agreement is not permitted.

The images, scripts, and objects that constitute DEMDESS have been created by the WASH team, funded by the U.S. government, with participation by personnel of the ministries (or commissions) of environment of some of the assisted countries. Thus, DEMDESS and its

concepts, methodologies, and routines (except the basic software, Paradox® and Quattro Pro®) are public property, the distribution and use of which are a matter for A.I.D. and the ministries (or commissions) of environment of the participating countries to decide.

The data used in DEMDESS, to the extent that they have been provided by the governments, remain the property of those governments. In some cases, these data have or will have been obtained by the governments under circumstances that require the protection of proprietary rights (for example, the rights of industries) in the data.

Each country has a ministry office that has official recognition as the focal point that will manage future DEMDESS use and expansion in the country. These ministry focal points (or ownership) units, or technical institutes working under contract to them, have been fully involved in DEMDESS development and have a good conceptual understanding of the system's capabilities and what needs to be done to install it, develop it, and expand its use. However, understanding how to use the tool in practical ways for decision analysis will require additional training and use.

Beyond the primary users in ministry offices, who will be able to use DEMDESS for policy analysis and for guidance on investments, there will be other users who should incorporate DEMDESS into their administrative routines as a data base management tool. As agreed in the institutionalization Workshop, such users include the following:

- regional environmental inspectorates (for monitoring, fines, and sanctions)
- river basin authorities (for basin management and planning purposes)
- chief inspector sections in ministries (for data collection and management of countrywide pollution control activities)
- NGOs, local associations, legislators, and others, who can request data and ask for analyses.

The above entities and individuals have had some exposure to the concept of DEMDESS in a few cases, but as a "user world" this group has not yet been involved beyond serving as a source of information for system design purposes. A great deal of promotion and explanation is necessary for these groups as a first step, and training will be required for the installation and full use of the system for administrative routines.

6.2 The Ideal Future for DEMDESS

To make DEMDESS more than a demonstration effort and realize the considerable potential the system has, a very aggressive priority program for DEMDESS use must be planned and conducted. Within the next year of DEMDESS's operation, each country should have accomplished the following:

- Expanded DEMDESS to cover all, or most, river basins as a part of a national data base system and harmonized it with existing information networks;

- Incorporated DEMDESS as a part of its national monitoring, sanctions, administrative, and management routines at the level of various operational users, such as river basin authorities and environmental inspectorates;
- Used the system at higher levels for options analysis and decision support for short- and long-range planning;
- Used DEMDESS data and options-analysis programs to assist in dealing with multilateral donors, for review of lending programs, and to support prefeasibility analyses; and
- Included and developed a local group or network of agencies that actively use the system and have provided information to others who have needs for occasional analyses, reports, and information; such clients would include NGOs, water authorities, and municipalities.

6.3 Next Steps

6.3.1 Overview

There is a long way to go to realize the best-case scenario for DEMDESS. Much remains to be done if DEMDESS is to become operational, and there are various levels of need and of use for operations. Future needs fall into the following six categories of activity:

- Bridging to initial use,
- Operating DEMDESS in selected priority river basins,
- Incorporating DEMDESS, in a staged manner, into operational routines for data base management at inspectorate and operational offices,
- Expanding DEMDESS to all basins in each country and to full operational and decision/policy use,
- Establishing country- and basinwide system maintenance and improvement, and
- Developing international uses and linkages.

The above activities are not necessarily sequential for implementation purposes once DEMDESS has been installed and is running (completion of the "bridging" activity). Some activities can proceed simultaneously, and each has a variable priority from different points of view. Each brings with it tasks and resource requirements and can be planned and budgeted as activity areas for follow-up in a second phase of DEMDESS program activity.

6.3.2 Bridging to First-Level Use

As a very first step, each country should designate an official DEMDESS coordinator within its ministry of environment, who will serve as a focal point person/unit that will manage this part of the program, contract for services for system operation, and promote the use of and safeguard DEMDESS. Terms of reference should be written for those portions of the program that can or should be contracted locally.

The bridging activity is intended to transfer the DEMDESS system to each country and put it to beginning use as a tool. The major activities include

- completing the short-term installation and use activities listed in Exhibits 6.1 and 6.2;
- setting up a DEMDESS operational responsibility with a ministry coordinator and technical support unit, and a budget for its initial use and expansion;
- developing an initial work plan; and
- designing and providing orientation/training sessions for the three primary groups (policymakers, operations-level users, and system analysts/operators) in how to make the best use of DEMDESS.

The orientation and installation activities listed above will require some technical assistance from the system designers. Exhibit 6.1 lists specific key DEMDESS follow-on activities required for the short term to ensure that DEMDESS is installed and working. Exhibit 6.2 provides a summary of DEMDESS status by country and actions required to complete installation. Both exhibits are located at the end of the chapter.

6.3.3 Operating DEMDESS in Selected Priority River Basins

The next round of activity within EPDRB will include conducting prefeasibility studies in selected key river basins in each country. This activity will be conducted by the World Bank, the European Bank for Reconstruction and Development (EBRD), and A.I.D. working together in cooperation with a common format, and it will be a prequisite for investment activity. For each of the studies, data analysis will be required. If each country is able to place a priority on the installation and expansion of DEMDESS, the system could be used to assist in this effort. DEMDESS is a perfect tool for the upcoming analytic work that each country will require. It is also reasonable to be able to use DEMDESS for review of pilot investment actions that are funded in the short term.

The desirability of the above for EPDRB is clear. One of its goals is to have a data base in place that can be used for analysis in a variety of ways and that is compatible with existing information routines. If the multilateral agencies working with EPDRB believe in DEMDESS and advocate its use in these studies, prefeasibility efforts could be joined with DEMDESS installation and use in the selected priority basins, and resources could be shared. This will be possible if the following required actions are taken:

- **DEMDESS installation is completed:** The activities listed in Exhibits 6.1 and 6.2 for each country must be completed so DEMDESS can be used in the basins for which data have been entered and expanded to include new ones.
- **Two rounds of data review and updating are conducted:** To ensure that DEMDESS has been properly installed and tested, it is necessary to review the data, incorporate additional data, and verify that the data are reasonably accurate.
- **Policy tools are completed and expanded:** A beginning set of policy tools has been designed and installed in the DEMDESS program (refer to Chapter 5). For expansion of the system in the demonstration basins, the analyses required must be specified and the analytic programs designed and checked against data in the system.

6.3.4 Incorporating DEMDESS into Operational Routines

Incorporation of DEMDESS, in a staged manner, into operational routines for data base management at inspectorate and operational offices will be required as another phase of follow-on activity. Some of these activities can be conducted in conjunction with the final bridging work required to install DEMDESS. If technical assistance is provided to explain DEMDESS and demonstrate its use during the bridging activities, the user community can also be involved in this and begin to learn about the ways in which DEMDESS can serve their administrative-routine requirements. Short-term meetings and demonstrations will be required in each country for this.

In addition, expansion of DEMDESS to all basins in each country and full operational and decision/policy use can be accomplished, at the initiative of each country, once DEMDESS is incorporated into operational routines.

Some of the specific actions required are listed below:

- Define a suite of standard routines for regular use by users. This includes incorporating existing data bases on sanctions, taxes, and fines with the programs installed in DEMDESS in each country. Uses for river basin authorities will have to be explored and programmed.
- Develop and test a "QUAL II"-level water quality model to fulfill a major requirement in the decision support process.
- Work with users at the policy level to demonstrate and validate policy-analysis tools. Specific orientation in how to use DEMDESS should incorporate demonstration and use of the existing policy-analysis options in DEMDESS and the design of additional scenarios, which will have to be defined as policy-level users become accustomed to using DEMDESS.
- Update the *User Manual* periodically to incorporate new policy options and the routines that are developed.

- Respond to questions about how to use and improve the system. The DEMDESS system designer should have time available for Bitnet® consultation over the next two years.

6.3.5 Establishing International Use and Linkages

During the period of DEMDESS development, it was not possible to work in Yugoslavia because of the civil war taking place there. It will be important to expand DEMDESS into Yugoslavia and other countries along the Danube in a subsequent round of activity, as soon as it is safe to work in Yugoslavia and a structure is in place there and in other countries to work with.

During the Institutionalization Workshop in Dubravka in May 1992, a number of the countries represented expressed satisfaction with the type of practical workshop exchanges that took place. It will be important to the future of the DEMDESS program to continue international exchanges and workshops. As each country becomes more expert with the use of DEMDESS, a natural learning process will take place at the different levels of DEMDESS use, and valuable information can be exchanged among users.

6.4 Recommendations for DEMDESS Completion and Future Use

The needs and future uses of DEMDESS have been described above. The following summarizes the team's recommendations for DEMDESS completion and future use:

- An international donor should fund the bridging activity to complete DEMDESS installation and initial use as outlined in Exhibits 6.1 and 6.2. This activity should continue throughout 1992 and into 1993, as needed.
- A.I.D. should use DEMDESS in any prefeasibility work it undertakes as part of the next round of activities to assist EPDRB and incorporate the required bridging and installation development of DEMDESS into that work.
- Beyond these two major items, a donor should provide for a small amount of DEMDESS maintenance activity, including periodic updating of DEMDESS manuals and occasional responses to problems that arise with the system over the next two years. Presumably after this, each country will have the capacity and familiarity to continue DEMDESS on its own.
- Multilateral lenders working with United Nations Development Program funding for EPDRB should also adopt DEMDESS for prefeasibility work and fund technical assistance to continue DEMDESS expansion to the pilot basins they are working with. If each country is requested to use DEMDESS in this work and in its own action plans for the EPDRB, DEMDESS will be used. Additionally, the requirements for improved data management and monitoring will be specified and acted on. This will ensure that DEMDESS is installed in most major basins in each country.

- EPDRB, through its Project Coordination Unit, should continue long-term support of the data management capabilities of DEMDESS and sponsor periodic workshops and training in system use and decision analysis using the DEMDESS system.

Exhibit 6.1

Short-Term Follow-On Activities Required for DEMDESS

1. Provide telephone, fax, and Bitnet® user support for answering questions, debugging, validation, additional data loading, and data entry routines, as required of the system designer.

2. Provide initial maintenance of the DEMDESS design, including harmonization of standards and maintaining a single data base design for all four countries.

3. Provide support to the Environmental Program for the Danube River Basin, especially the Committee on Information Systems and Data base so the immediate applications of, and future needs for, DEMDESS are understood.

4. Provide marketing and outreach to users in each country so they understand what will be required for DEMDESS use and begin to work with it. Activities include demonstration sessions and briefings. Activities may also include marketing and outreach in Washington, D.C., to the Agency for International Development, the World Bank, and the Environmental Protection Agency.

5. Expand the initial residing options-analysis scenarios with some general enhancement and additions, such as "best available treatment" standards, international standards, and improved water quality and costing models. Such options should be derived from user requests.

6. Update and improve the DEMDESS *User Manual* once it has been issued and worked with. New programs that are developed will have to be incorporated.

7. Provide technical assistance for integration with INFODANUBE, CORINE, the various geographic information systems that are under consideration, and country-specific data bases.

Exhibit 6.2

Summary of DEMDESS Status, by Country, June 1992

I. Bulgaria

A. Current Status

Bulgaria is the farthest along with the development of DEMDESS of the four countries. The pilot river basin selected was the Jantra, and work started in November 1991. Most of the major components of DEMDESS are in place for the Jantra, and a full policy-analysis component for municipal treatment has been built. The pollutants that have been loaded in full are biochemical oxygen demand (BOD) and total suspended solids (TSS). Emissions and water quality data from the routine inspectorate reports as well as a special study conducted in 1991 are loaded. Water quality standards, including in-stream and emissions standards, are loaded for the major pollutants. The current water quality standard for each river segment in the Reach File is also in DEMDESS. Data on taxes and fines are also loaded for major pollutants. A special effort was undertaken to digitize the major streams and basin boundaries for all of Bulgaria.

Bulgaria has made a major commitment to using DEMDESS as a primary tool for water quality management. It is stopping work on the existing routine administrative systems and is going to use DEMDESS directly. These factors make the expansion of DEMDESS to other basins and, ultimately, to the whole country feasible over the next one or two years.

B. Software Developed for the Bulgarian DEMDESS

1. Conversion of the river network to the Reach File.
2. Conversion of the in-place administrative routines for emissions and in-stream water quality.
3. Data entry and loading of the special study data.
4. Transformation, display, and manipulation of the digitized streams and basin boundaries. The graphics software is built from an existing U.S. system, "PC Reach File (PCRF)." The version for DEMDESS is named "PC Reach File - Danube (PCRFD)."
5. A policy analysis component that was used for demonstration at the May 1992 Institutionalization Workshop, including a menu-driven system to run the analyses and display the results.

C. Key Data Gaps

1. Data for pollutants other than BOD and TSS in many of the tables, especially FINES and WQSTDS (water quality standards).
2. Water supply data.
3. Detailed data on existing treatment plants (may be in place as of June 1992).

D. Key Next Steps (not necessarily in order)

1. Data entry and loading of software for the routine administrative data.
2. Conversion of the National River Kilometer Network to the DEMDESS Reach File.
3. Linkage of the digitized streams to the Reach File.
4. Linkage of the dischargers and water quality sites to the Reach File.
5. Technical support for enhancing the data and analyses in the Jantra basin, especially validation of data and applications.

(cont'd)

Exhibit 6.2 (cont'd)

6. Entry of Bulgaria-specific costing data.
7. Technical support in using DEMDESS and Paradox®.

II. Slovakia

A. Current Status

The demonstration river basin selected was the Nitra. The existing administrative routines in Slovakia are excellent and comprehensive in terms of organizing the dischargers, emissions, water quality, river network, and Reach-specific modeling parameters. Work started in February 1992 with visits to the primary data sources as well as important users. Machine-readable data on existing emissions, the river network, water supply, and hydrologic and modeling parameters have been provided for the Nitra basin. The dischargers, emissions, water quality, and river network have been converted to DEMDESS. The software for converting these data bases is presumably general so that it can be readily applied over all of Slovakia. Some of the water quality standards have been entered. Work on TAXES and FINES has begun, but it will require further clarification in the next phases. A demonstration for approximately 30 technical staff was held at the Water Research Institute (WRI) and included people from WRI as well as the Slovak Commission on the Environment (inspections and sanctions), the Slovak Hydrometerological Institute, and regional inspectorates.

B. Software Developed for the Slovak DEMDESS

1. Conversion from the Slovak River Kilometer Network to the Reach File.
2. Conversion of the Slovak discharger data base to DEMDESS, including linkage to the Reach File.
3. Conversion of the in-stream water quality data base to DEMDESS, with manual linkage to the Reach File.

C. Key Data Gaps

1. TAXES, FINES, and PERMITS need more data.
2. Current Reach-specific water quality standards classification.
3. Several detailed items concerning the dischargers, including population served and industrial classification. Much of this information may be in the system as of June 1992, but some gaps will probably remain.

D. Key Next Steps

1. Completion of the conversion of the currently supplied data with one or two iterations with Slovak staff to validate the data.
2. Filling the data gaps noted above.
3. Technical support, including development of standard policy-level analyses for the Slovak Commission on the Environment.
4. Marketing and outreach.

III. Hungary

As of the end of May 1992, Hungary had not assembled the data needed to set up the prototype system. Agreements were made at the May Institutionalization Workshop for this work to be completed in June and sent to WASH for completion. The time required will push the Hungary installation beyond the June 20 deadline, and follow-on activity will be required to begin DEMDESS. A memorandum of understanding was exchanged between the WASH system designer and the system designer of the Research Center for Water Resources Development on May 27, 1992. (cont'd)

Exhibit 6.2 (cont'd)

IV. Romania

A. Current Status

Work on DEMDESS in Romania started in February 1992 and continued with a visit by the WASH team in April 1992. Romania has been developing new administrative routines for collecting and reporting emissions and water quality data. Much of the work done in Romania has been in designing the conversion processes to utilize these new routines as the data become available. Emissions and in-stream water quality standards have been entered into DEMDESS for many of the parameters. Work on the TAXES and FINES tables has just begun. Romania has a standardized river network with a numbering system that all dischargers and in-stream water quality sites use. This standardized network currently exists in hard copy only. For the demonstration basin, the Arges, the data have been entered and special software written to convert the standardized system data into a Reach File. The Romanians have entered basic data for some dischargers into DEMDESS. The WASH team has extracted specific data for selected major dischargers from the country reports and entered those data in DEMDESS. The new administrative routines are very well designed and will prove to be very effective data sources for DEMDESS as the data come back to the Research and Engineering Institute for Environment (REIE). Current water quality standards on a Reach-specific level have not been entered. Significant efforts have been made to review the DEMDESS design with the Romanian technical staff and to enhance the design to incorporate specific Romanian requirements.

Because the administrative routines are new and without available data, comprehensive filling out of DEMDESS was not feasible by June 1992. However, the prospects for DEMDESS in the Arges as well as other basins are excellent over the next one or two years.

B. Software Developed for the Romanian DEMDESS

1. Data entry routines for Romania's data entry system.
2. Conversion of the copy to the Reach File.
3. Preliminary design of the data conversion from the new administrative routines to DEMDESS.

C. Key Data Gaps (not necessarily in order)

1. TAXES and FINES.
2. Reach-specific water quality standards.
3. Data from the new administrative routines, which are the primary source of emissions and water quality data.
4. Romanian-specific costing data.

D. Key Next Steps

1. Loading the new administrative routine data.
2. Technical support and continuing work on incorporating practical uses of DEMDESS.
3. Getting staff outside REIE involved in providing data and using DEMDESS.

Chapter 7

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

7.1 Pilot Projects

7.1.1 General Conclusions

In terms of nonconservative pollutants, such as BOD_5 and bacteria, the Danube River has a high assimilative capacity compared with pollution loads. However, many of the tributaries and subtributaries have low flows and severely limited capacity to assimilate or dilute the existing imposed loads. In addition, large quantities of conservative pollutants are entrained in benthic deposits or carried into the Black Sea Delta.

In addition to pollution of tributaries, the principal actual or potentially serious impacts of industrial and municipal pollution include the following:

- effects on bank-filtered water supplies
- possible entry of toxic substances into the food chain
- effects of salts on irrigation and agriculture
- fuel contamination of potable aquifers

In many cases, urban areas that include major industrial concentrations already collect both industrial and domestic wastewater. Given the uncertain viability of most industries, however, early capital investment in pollution reduction is likely to be limited. It appears more likely that, pending the introduction of industrial waste reduction through process changes or pretreatment, early reduction of such components as heavy metals could be achieved by municipal treatment. Fees levied against industrial dischargers could be used to fund such treatment.

Regarding Hungary specifically, dumped fuel remains a major pollution problem. Given the country's great use of groundwater and the deleterious effect that the passing of time has on clean-up efforts, this problem demands consideration as a pollution investment priority.

The WASH team concluded that efforts to identify high-priority, feasible, early investment opportunities should be directed primarily toward (a) reducing surface water pollution from urban areas that include heavy industrial concentrations, (b) urgently needed industrial wastewater pollution projects that are implementable in today's economic and industrial climate, and (c) identifying and remediating major fuel leaks and spills at former military installations that threaten groundwater supplies. Potential projects were identified from discussions and information provided by local experts in each country, and project sites were visited to the extent permitted by time constraints. See Figure 3.1 on page 38 for the locations of the potential projects.

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In consideration of the above, the following selection and ranking criteria were used:

- known or potential impact on health
- actual or potential damage to a critical resource, such as groundwater
- readiness to proceed
- significant human health or economic benefit, even if other projects in the same basin do not proceed
- large benefit in relation to cost
- inclusion of projects with a wide range of sizes, types, and costs

Table 3.1 on page 41 shows the three levels of priority among which potential projects are divided. On page 42, Table 3.2 further details the 15 top-priority projects proposed and listed in Table 3.1.

7.1.2 Projects in Bulgaria

The principal sources of pollution of surface waters in the Bulgarian portion of the Danube River basin are as follows:

- The capital city of Sofia (population of 1.2 million), which contains a wide range of industries, some of which are served by the municipal sewerage system, and has in its water supply catchment area the town of Samokov;
- Towns, including industries, and separate industries in the upper reaches of the Danube tributaries that pollute water used (or which otherwise would be used) for urban potable supply; and
- Towns, including industries, and separate industries and animal feedlots in the middle and lower reaches of these rivers that pollute water used or otherwise usable for irrigation.

On the basis of the available information, each of the potential immediate projects can be placed in one of three levels of priority, as follows:

- First priority: Sofia and Samokov, Pleven, and Gabrovo and Veliko Tornovo
- Second priority: Troian and Lovetch, Razgrad, and Gorno Oriahovitsa and Liaskovetz
- Third priority: Michailovgrad

7.1.3 Projects in the Czech and Slovak Federal Republic

The principal sources of pollution in the CSFR portion of the Danube basin include the following:

- The cities of Bratislava (population of 440,000), on the Danube, and Brno (population of 400,000), in the Morava basin, which are the second- and third-largest cities in CSFR and have substantial levels of industrial activity;
- Smaller cities and towns, including industries, in the tributary basins; and
- Industries not connected to town sewer systems.

On the basis of the available information, each of the potential projects brought to the attention of the team can be placed in one of three levels of priority, as follows:

- First priority: Istrochem (a chemical factory) in Bratislava, Trenčín, the thermal power plant and chemical factory at Novaky, and Olomouc
- Second priority: Hlohovec and Leopoldov, the Koželužne tannery in Bošany, and the Bratislava right bank development
- Third priority: Bratislava central left bank development; Senica, including the fiber factory; and Brno

7.1.4 Projects in Hungary

The principal sources of water pollution in Hungary include the following:

- Fuel, dumped at former Soviet military bases, floating on top of the groundwater and threatening potable groundwater sources;
- Budapest, the capital city, which has a population of about 2.1 million, and about 40 percent of the industry in the country;
- Other communities and industries in central and northwestern Hungary, including those within or near Moson Island (formed by the main Danube and the Moson branch), which is a major source of bank-filtered water supplies;
- Communities and industries in the Tisza and Drava river basins; and
- Agriculture.

Excessive use of inorganic fertilizers has caused high concentrations of nitrates in many public drinking supply wells in Hungary.

On the basis of the available information, each of the potential projects reviewed by the team can be placed in one of three levels of priority, as follows:

- First priority: Győr and other Moson Island communities and industries; the fuel-contaminated groundwater at former Soviet military installations
- Second priority: the North Budapest wastewater treatment plant and collection system; Szolnok on the Tisza River; and Tata on the Altalar River
- Third priority: Komárom

7.1.5 Projects in Romania

The principal sources of pollution in Romania are as follows:

- Bucharest, the national capital and largest city (population 2.2 million), which is the site of about 18 percent of the industrial activity in the country;
- Smaller cities and towns, many of which also contain significant industrial developments (petrochemical, chemical, breweries and others);
- Industrial platforms or complexes, not connected to town sewer systems, including petrochemical, chemical, pulp and paper, and steel industries; and
- Animal feedlots.

On the basis of the available information, each urgently needed project that was evaluated can be placed in one of three levels of priority, as follows:

- First priority: Craiova (including the chemical platform), the Govora industrial platform in Rimnicu-Vilcea, Pitesti (including the petrochemical plant), and Bucharest
- Second priority: Rimnicu-Vilcea and industries in Braila and Galati
- Third priority: municipal treatment needs in Braila and Galati

7.2 Institutional Issues

7.2.1 Capacity to Operate DEMDESS

The basic institutional structure and capacity now exist for DEMDESS implementation in Bulgaria, the CSFR, Hungary, and Romania. Improvements are needed, however, in various sectoral institutions regarding decision analysis, coordination, communication among entities, and the capability to collect and evaluate data. If the DEMDESS program is to work as a management tool, an information system, and a decision-analysis tool, it must become understood and integrated into the normal routines of institutions. At the policy level, there must be an understanding of the system's capabilities and potential applications. Orientation will therefore be required for decision makers in how to use decision support tools such as DEMDESS.

The current status of implementation in the four countries is summarized below.

- **Bulgaria** is fully committed to DEMDESS as a key data management, reporting, and policy tool. This support extends to the regional inspectorate level for the entire country. The Ministry of Environment has made significant resource commitments, including staff time, office space, equipment support, and briefings to the minister. The Danube "focal point" and staff have devoted substantial efforts in support of the system. In fact, total cooperation has been provided at all levels. The high level of support and existing technical capability virtually assures the institutionalization of DEMDESS, especially with continued A.I.D. support.

- **Slovakia** has all of the conditions necessary to institutionalize DEMDESS. Top-level management views DEMDESS as a potentially key policy tool for the COE (Slovak Commission on the Environment). The COE has been able to coordinate, access, and cooperate effectively with the Water Research Institute, the Hydrometeorological Institute, and the regional water authorities. Additionally, Slovakia has excellent existing administrative routines for supporting the DEMDESS data requirements. Preliminary technical "buy-in" in the institutes has occurred through well-attended technical presentations. Institutionalization of DEMDESS will occur if it is used as a key tool in the prefeasibility studies and development of policy-level analyses for the COE. On a technical level, DEMDESS is bringing together several independently, well developed national data bases.

- **Hungary** has bought into DEMDESS to the extent that the Ministry of the Environment and Regional Planning (MERP) has spent money to develop the Altalar Pilot Basin demonstration; MERP paid Vituki for the technical support. Vituki has tentatively bought into DEMDESS as a valuable technical analysis tool. Institutionalization of DEMDESS is certainly possible; it depends upon management and financial support from MERP or others.

- **Romania** has provided an institutional home at REIE (the Research and Engineering Institute for Environment). There are many changes taking place in the Ministry of Environment, but REIE will probably remain a stable, powerful supporter. Romania in general is very short of resources, but valuable commitment of staff time has been generously provided by the institute in support of DEMDESS. Institutionalization of DEMDESS is possible with steady support and tangible demonstration of use in the prefeasibility studies.

At the moment of turnover to the countries involved, DEMDESS will have an immediate use as a data base for monitoring pollution control and the application of sanctions. Additionally, the decision-analysis elements of the system can become significant if users learn to make use of them for this purpose.

In sum, there are no major institutional constraints on the use of DEMDESS as a tracking tool for enforcement actions. DEMDESS need only be applied using existing administrative routines.

7.2.2 Future Institutional Strengthening

Given institutional conditions within the countries studied, it will be important to prepare them for improved sectoral management before entering into expensive capital investments to "clean up pollution," particularly if large commitments are to be made on international loans requiring foreign-exchange repayments. Preinvestment studies should focus on nonstructural as well as structural needs. It will be important to design improvement measures to deal with such issues as cost recovery, waste reduction, operations and maintenance, and management systems and procedures. For some municipal entities, privatization will be an important component of preinvestment studies. At central regional levels, broader institutional efforts will be needed to improve the foundations for sectoral management and long-term problem solving. The dimensions of the institutional issues will require a series of efforts aimed at improvement in the short and long term. Continued study of sectoral institutions and the design of specific institutional interventions in each country will be needed.

The key areas for continued sectoral improvement in the four countries are outlined below:

- **Human resources development in water quality management:** Training programs specifically designed to meet the management and planning needs of the sector in Eastern Europe should be designed and implemented. Such programs should focus on management practices and decision support systems; the collection of reliable and appropriate information; procedures that include public and interinstitutional dialogue and communication; and training programs that provide skills in entrepreneurial and cost-management practice.

- **Role clarity and sectoral coordination:** Each of the four countries should carefully reexamine decisions relating to agency roles and duties that have been made under the transitional pressures of the past two years. Institutional analyses are needed to define optimal ways to set up coordination mechanisms, eliminate role overlap, and provide clear mechanisms to issue and monitor permits for discharges and water quality control activities. Alternatives need to be put forth and decided on in each country for the involvement of all parties (industry, municipal, private citizens, ministry) interested in the management of river basins. The objective should be to find a model that does not duplicate efforts and allows for coordinated actions that work.

- **Appropriate laws, sanctions, and enforcement policies:** All four countries are in various stages of revising sectoral laws and policies. These positive efforts have been supported with technical assistance from the EPA and other entities. A positive use of the experience gained to date would be to provide mechanisms among the riparian countries for sharing ideas and experiences. A useful role for the EPDRB would be to develop workshops and conferences to review lessons learned before legislation is passed in each of the countries during the next year.

- **Linking monitoring and laboratory-improvement programs to DEMDESS:** Efforts are under way within the bilateral donor community to provide enhanced

laboratory and monitoring equipment to each of the four countries involved in this study. These efforts should be coordinated to ensure that the DEMDESS program is integrated into these efforts. Computer equipment for full operation of a decision support system will also be important. The EPDRB's working group on data management should specify what is needed in a comprehensive way so that the dimensions of the need can be estimated and measures can be taken to ensure appropriate basic capacity.

- **Setting tariffs to pay for the cost of water and wastewater:** Tariff studies should be undertaken in each country so that appropriate fees can be set for water and wastewater. The principle of the "polluter pays" should apply to municipal discharges, as well as industries, so that appropriate incentives are applied and a source of sectoral finance is developed. Municipal governments particularly are in need of technical assistance in this regard because this is a new area for them.

7.3 DEMDESS

7.3.1 Current Status

The DEMDESS effort was described as a very good first step by most of the participants in the Institutionalization Workshop held at the end of May 1992. This assessment was based on the following factors:

- A system design is in place that includes data compatibilities programmed to interface, both nationally and internationally, with most existing data bases in the four countries studied.
- DEMDESS stores information in an interchangeable, standardized format and operates on personal computers, the most common computer platform in Eastern Europe. It can perform the tasks of data storage and manipulation for multiple uses and multiple users in each country.
- DEMDESS can also perform cost, institutional, and other analyses that facilitate responding to queries about the impacts of various possible interventions.

Other DEMDESS advantages include the following:

- Use of DEMDESS as a tracking tool for enforcement imposes no major institutional constraints. As mentioned above, DEMDESS takes full advantage of existing emissions-related data bases. Most of the system's data are taken from current administrative routines. Additional data that DEMDESS needs can be reasonably gathered from paper reports; such data includes standards, taxes, and fines.
- DEMDESS includes the primary components necessary for emissions management and decision support: information on existing emissions, water quality, waste treatment effects, costs of treatment, regulations, and institutional relationships.

- DEMDESS integrates the above data in a format that is specifically designed for diagnostic evaluation, alternative emission scenario analysis, and policy support. It is important to note that in most cases, such critical data integration had not previously existed operationally.
- No other systems currently available for Eastern Europe perform the operational integration and analysis that DEMDESS does.
- DEMDESS is designed with the future in mind: the system is open to the use of new information, new analysis techniques, and new technologies as they become available. For instance, GIS can link with DEMDESS.
- DEMDESS is primarily based on water quality and emissions management techniques and principles that have evolved over the past 20 years in the United States. DEMDESS adapts some of these techniques to meet Eastern Europe's particular emissions management requirements in a straightforward and logical manner.

These features provide a basis for data management, even if DEMDESS is not used as a planning tool. Testing DEMDESS with real data from demonstration basins showed that DEMDESS can answer the questions it was designed to answer.

7.3.2 Application and Expansion

Because the system is data driven, improving the first attempt at data entry and expanding data collection beyond the demonstration basins are very important for establishing DEMDESS as an operational tool that can adequately reflect real-world issues. Testing and proving the accuracy of the system will require substitution of additional, updated, and verified data to complete the initial activity in each of the participating countries.

Eventual broader use of DEMDESS will require a coordinated effort and a management structure for its maintenance. This process will require an interaction between management and operators in which uses of the system are specified and scenarios are programmed for analysis. Some options-analysis scenarios have been programmed, but the need for many more will emerge over the first year of use.

Within the next year of DEMDESS operation, each country ideally should have accomplished the following:

- Expanded DEMDESS to cover all, or most, river basins as a part of a national data base system and harmonized it with existing information networks;
- Incorporated DEMDESS as a part of its national monitoring, sanctions, administrative, and management routines at the level of various operational users, such as river basin authorities and environmental inspectorates;
- Used the system at higher levels for options analysis and decision support for short- and long-range planning;

- Developed a national network of user and client groups, coordinated by a primary user at the national level.

In addition, it is hoped that international donors and EPDRB will find DEMDESS useful as a way of forging international linkages for data management. Widespread adoption, however, will depend on the speed with which EPDRB's task force on data management accepts DEMDESS or recommends alterations or alternatives to it.

Future needs for DEMDESS fall into six categories of activity:

- Bridging to initial use,
- Operating DEMDESS in selected priority river basins,
- Incorporating DEMDESS, in a stage manner, into operational routines for data base management at inspectorate and operational offices,
- Expanding DEMDESS to all basins in each country and to full operational and decision/policy use,
- Establishing country- and basinwide system maintenance and improvement, and
- Developing international uses and linkages.

7.3.3 Recommendations for Support of Application and Expansion

Detailed steps for the immediate and future use of DEMDESS were described in Chapter 6. The following summarizes the recommendations made:

- A one-year bridging activity should be undertaken by an international donor to support DEMDESS installation, debugging, validation, and initial use, as outlined in Exhibits 6.1 and 6.2.
- A.I.D. should strongly consider the use of DEMDESS in any prefeasibility work it sponsors as part of the next round of EPDRB activities.
- Multilateral lenders considering the funding of pilot projects under the EPDRB should also encourage the use of DEMDESS as a standard data base to support preinvestment studies. If this is done, it will not only assist in the preparation of projects, but will also help define the requirements for improved monitoring and data management and ensure that DEMDESS is installed in most major basins in each of the participating countries.
- An international donor agency could consider supporting a small amount of DEMDESS maintenance activity, including periodic updating of DEMDESS manuals and occasional responses to problems encountered with the system over the next two years.

- EPDRB, through its Project Coordination Unit, should continue long-term support of DEMDESS and improvement of its data management capabilities through periodic workshops and training in system use and decision analysis.

7.3.4 Alternatives to DEMDESS

Alternatives to DEMDESS should certainly be considered; it is possible that better ways exist to meet Eastern Europe's emissions management and decision support needs. Alternatives to DEMDESS must perform essentially the same functions as DEMDESS, however, or they will fail to meet these needs.

DEMDESS has been built using a set of requirements developed by the WASH team in conjunction with the host country requirements. If the requirements for emissions management change significantly, DEMDESS should be reevaluated along with other alternatives.

Some alternatives to DEMDESS are not emissions management systems. For instance, GIS is not an emissions management tool; rather, it is a system for displaying and analyzing geographical information. GIS can provide data to a decision support system and can help display such information, but it is not an emissions management/decision support system in itself.

Appendix A

SCOPE, METHODOLOGY, AND KEY ACTIVITIES

A.1 Scope of Work

The scope of the WASH team's task assignment is included as Attachment A.1.

A.2 Methodology

A.2.1 General

The overall approach taken was to maximize the involvement of country personnel in all aspects of the assignment. To ensure this, the team scheduled its time to work primarily in the four assisted countries. Time spent in the United States was limited to little more than that needed for initial team planning, midterm client briefing and related planning for the second stage of the work, final preparation of this report, and provision of WASH Operations Center support and A.I.D. contact.

To take advantage of work on point-source data management that had already been done by the Ministry of Environment in Bulgaria, initial work on the modeling aspects of the assignment, from late September through early December 1991, was concentrated in Sofia. To take advantage of communications and other logistical considerations, Hungary was the principal base of operations for the team in the period from early December 1991 through mid-April 1992. A Project Planning Workshop was held in Visegrad, Hungary, in December 1991. However, for the purposes of establishing system design and data needs, evaluating pollution conditions, studying institutional issues, working with local subcontractors, and making site visits, all team members spent substantial time in each assisted country. The final field work, including holding a wrap-up Institutionalization Workshop, was done in the CSFR.

The number of work days spent in each country was as follows:

Team Member	Bulgaria	Hungary	CSFR	Romania	U.S.A.[a]	Total
Team Leader	34	52	22	17	26	151
Comp Spec'st/ San. Engr.	15	26	22	19	33	115
Economist	12	16	25	16	16	85
Institutional Spec'st	16	24	22	10	45	117
Industrial Wastes Engr.	12	18	18	12	47	107
Data Base Spec'st	30	26	19	12	26	113
Other Professionals[b]	-	18	23	3	90	134
Total	**119**	**180**	**151**	**89**	**283**	**822**

[a] Includes international travel time and time spent in Brussels (Task Force Meeting) and Vienna (International Institute for Applied Systems Analysis).

[b] Includes a workshop facilitator, workshop logistics managers, consultants, and WASH Operations Center staff.

A.2.2 Data Collection

Data used in this project consisted mainly of material in the hands of government agencies, supplemented by the views of various experts (see A.4 below). Visits of inspection were made to several locations and facilities in each country, but no measurements or wastewater analyses were made as part of this study.

The technical data required for the development of the DEMDESS, primarily relating to a pilot basin in each country, had to be collected from several agencies, generally including not only the state environmental authorities but also ministries responsible for water, industry, and economy, as well as basin authorities. The collection of such data was performed entirely by the counterpart environmental authorities and not by the WASH team. There work was supplemented by extensive team interviews with responsible officials and other professionals.

Local consulting firms were retained in the four countries to prepare technical reports on water pollution conditions, emissions, and emitters. (These technical reports are presented in Volume

III.) A consulting firm was also retained in Hungary to prepare a report on institutional conditions in the sector in that country.

In addition, EPA reviewed materials prepared by the team on potential early projects and provided comments and assistance on relative risks and prioritization.

A.2.3 DEMDESS Development

The development of the initial DEMDESS (that is, the system as it would exist at the end of the WASH team involvement in mid-1992) was performed in two distinct stages.

In Stage 1, preliminary data, primarily in relation to the Lom River basin, already existing in computer files were made available by the Bulgarian Ministry of Environment. The WASH team, working closely with staff of the Bulgarian Center for Environmental Management, developed a partial prototype model on a desktop computer owned by the center and on a WASH team "386" laptop. This prototype was demonstrated, and served as the basis for development of and agreement on concepts for the initial model, at the Project Planning Workshop in Visegrad in early December 1991. The team then prepared a concept paper, which embodied and focused the understandings of the workshop and provided a clear guideline for initial DEMDESS development in Stage 2. The concept paper was subsequently presented and discussed at a meeting with A.I.D., EPA, and other personnel in the Washington, D.C., area in late January 1992.

In Stage 2, each of the four governments selected an institute to act as the focal point for DEMDESP, including acting as counterpart to the WASH team and providing a "home" for DEMDESS. Each counterpart institute, in consultation with its environmental authority, selected the demonstration basin to which initial data collection and modeling would be oriented. The counterpart institutes collected the data needed, both from their own sources and from other ministries and agencies, such as ministries of water, industry, and economy, and from regional water and environmental authorities. The WASH team worked with staff of each counterpart institute in turn to continue development of the initial system to reflect (a) the types and levels of data available and predicted and (b) the decision-making support expected to be required. The DEMDESS functions (but not the data from other countries) were shared by the team at various stages of prototype development with each institute as it provided data.

In late May 1992, an Institutionalization Workshop, co-sponsored by A.I.D. and the Slovak Commission on the Environment, was held in Dubravka, Slovakia. The workshop was attended by representatives of the four participating countries, plus Austria, Croatia, Slovenia, and Yugoslavia, and by multilateral and bilateral donor agencies and selected NGOs. The key areas of discussion were the application, integration, and further development of DEMDESS, and the countries' needs for donor support for the system and to implement identified high-priority pilot projects. (For further details, see A.3.2 below.)

The application of the system to realistic decision options was demonstrated for the selected basin in Bulgaria and CSFR. On the basis of these exercises, and the results of the Institutionalization Workshop, the final version of the initial model was prepared and distributed, with preliminary documentation on its use, in late June 1992. The WASH team also prepared a user manual for the system.

A.2.4 Institutional Studies

Individual interviews were conducted by all WASH team members with professionals in each country representing a broad cross-section within central, regional, and local agencies, as well as private groups and voluntary organizations. Available written sources of information on sectoral organization, laws, and regulations, and duties was also collected in each country and reviewed.

An information-gathering format was used to conduct the institutional studies (refer to Volume II, *Institutional Studies*, Appendix A). In each country reviewed, the same list of questions was given to key contact persons in the ministries of environment and in research institutes. In Hungary, a consultant was engaged to find the answers to the questions. The key contact persons were interviewed several times, and the information they provided was further extended and enriched by additional interviews and written materials.

Finally, a draft profile of each country was reviewed by a representative of the ministry of the environment in each country at the Institutionalization Workshop, conducted in May 1992 in Dubravka, to correct any misstatements of fact.

The results of these activities are individual country institutional sectoral profiles (in Volume II) that provide the basis for the findings in Chapter 4 of this report. The institutional information was also integrated into the DEMDESS computer base and is used for portions of the decision-analysis programs. The following is included in the country profiles:

- Sectoral background: recent history, relation to the Danube River system, basic population
- Roles and responsibilities at central, regional, and local/municipal levels
- Descriptions of how the major tasks required in the sector are being conducted
- Several case studies on municipal or regional institutions
- Identification of areas that require attention to improve sectoral performance

A.2.5 Evaluation of Early Investment Needs

Interviews were held with officials with responsibility for pollution control and for water and wastewater systems development at the national or republic level in each country to ascertain current intentions regarding assignment of pollution-reduction priorities. Interviews and facility inspections were then conducted in municipalities, and in some cases in industrial complexes, to gain an understanding of the issues and needs regarding water pollution, its impact on water uses, and the corrective actions needed.

Subcontracts were entered into with local consulting firms to prepare reports addressing the assessment of water pollution within each country's segment of the Danube basin; evaluation of municipal, industrial, and other emissions and emitters; and high-priority actions required.

In the United States, EPA reviewed early drafts of the descriptions and proposed rankings of high-priority, early projects, taking into account available information on relative risks. Its staff provided valuable advice and suggestions.

Screening criteria were developed for early high-priority projects and the potential point sources known to the team in sufficient detail were tested against them in order to identify a prequalifying list in each country. No attempt was made to compare projects across national boundaries. The resulting lists are not exhaustive; other urgent needs exist that were not addressed by or brought to the attention of the team. For each listed project, known issues needing evaluation during preinvestment studies were also identified.

A.3 Summary of Workshop Results

A.3.1 The Project Planning Workshop

A.3.1.1 Overview

A two and one-half day Project Planning Workshop was held at the Hotel Silvanus, Visegrad, Hungary, December 9-11, 1991. Nine individuals representing Bulgaria, Hungary, Romania, and Slovakia, two resource people, and the six WASH team members participated in the workshop. The meeting facilitator was provided by WASH (see list of participants, Attachment A.2).

The workshop was designed to present, discuss, and debate a conceptual framework and computer model that would eventually lead to the development of a wastewater emissions data management model for the Danube River.

The objectives of the workshop included interaction and collaboration among the participants; agreement on needs, terminology, approaches, methodologies, and a forward program for the project; agreement on goals for and expected benefits from the decision support system and the model; common understanding of the types of data and the resources needed to develop the model and make it operational, using the partial prototype model as a starting point; and development of an agreed-upon forward program through mid-1992.

Specific issues discussed included the conceptual framework for the project and the structure of the emissions data management system; classification systems, parameters, and thresholds, and how they should be dealt with in the system and in related reports and proposals; the data that would be collected and used by each country in early 1992; the program for the development and initial use of the system; key institutional issues and follow-up needed to complete the institutional analysis; whether, when, and how other riparian countries might be encouraged to participate; the need for a wrap-up workshop; and what to do next.

A.3.1.2 Workshop Design

The workshop was organized to stimulate discussion and information sharing among the country representatives, WASH team members, and resource persons. Short presentations, plenary group discussions, and a number of small group discussion sessions encouraged active deliberation on the policy and institutional issues as well as the technical issues pertaining to the conceptual framework and water quality management model.

A.3.1.3 Workshop Results

The results of the Project Planning Workshop included the following:

- Each country group identified a home for the decision support system, or agreed to get a decision on the home in the next month.
- Each country, in conjunction with the WASH team, identified the forward tasks for the next several months.
- Agreement was reached on the general functions of DEMDESS, including a number that had not been envisaged in the prototype. Agreement was also reached on the types of technical and institutional/policy parameters that should be provided for in the model.
- Representatives agreed to share information with the WASH team on other projects that might have overlap or require linkage with DEMDESP.
- All agreed that DEMDESS should be designed to allow (but not to demand) sharing of information between countries and to provide a compatible system of identifying data. All also agreed that the Danube Convention should be the goal for how data are to be shared in the future.
- The group agreed that DEMDESS should be as flexible as possible to allow for expansion in the future.
- The group decided that a final workshop would be held in the last week of May to "wrap up" the initial model and discuss the future development and use of the decision support system.

- The group agreed on a name for the project—DEMDESP—Danube Emissions Management Decision Support Project.

A.3.2 The Institutionalization (Wrap-Up) Workshop

A.3.2.1 Overview

A three day wrap-up workshop on DEMDESP was held at the Hotel d'Alfonz, Dubravka, Slovakia, May 24-27, 1992. Twelve individuals representing Bulgaria, CFSR, Hungary, and Romania participated in the workshop, along with the WASH team members and five donor representatives/resource persons. In addition, Croatia, Slovenia, and Yugoslavia each sent one representative as an observer. The workshop facilitator was provided by WASH. (See Attachment A.3, DEMDESP Institutionalization Workshop Participant List.)

The overall purpose of the wrap-up workshop was to discuss and develop plans for the institutionalization, use, and continued development of DEMDESS in each country, and to provide an opportunity for the countries to present their short-term investment priorities and needs to the donor agencies.

Issues discussed during the workshop included country-specific application plans for DEMDESS; how DEMDESS fits into the overall environmental program of each country; institutionalization requirements, including identification of users and clients; expansion of the geographical and topical coverage of DEMDESS within each country; international needs for the system; communication and coordination needs, both nationally and internationally; ownership of programs and data; priorities for early pilot projects; and country needs for donor assistance.

A.3.2.2 Workshop Design

The workshop was designed to stimulate discussion and information sharing among the participants. Short presentations were made for information-sharing purposes, with time for questions and answers. Substantial use was made of small-group discussions, country-specific discussions, and presentation and discussion of small-group reports in plenary sessions. These discussions were designed to encourage active deliberation on how DEMDESS could contribute to the water quality planning and management of the Danube River basin in the future (both near and long term), and on needs and plans to institutionalize DEMDESS.

The special session for representatives from donor and lending agencies on the final day of the workshop provided an opportunity for each country to present its specific plans for DEMDESS and its priorities for early pilot projects needing donor assistance.

A.3.2.3 Workshop Results

Representatives from Bulgaria, the CSFR, Hungary, and Romania expressed strong support for the continued development and institutionalization of DEMDESS in their countries, and they identified specific applications they are planning that will use the system.

Definitions of users and clients were developed, which led to a consensus that there would be multiple users within each country. The conclusion was that a coordination and communication network is needed. The key functions of the primary user in each country were identified.

The participating countries identified specific uses to which the system is to be put in the short term and indicated preliminary timetables for expansion from the demonstration basins to full national coverage. They all requested continued A.I.D. support for DEMDESS, and they were advised to their requests this in writing.

Potential international applications of DEMDESS were identified as a major strength of the system. The representatives from Croatia, Slovenia, and Yugoslavia expressed interest in using DEMDESS in their country's water management programs.

It was agreed that international information-sharing and planning workshops should be held periodically and that a newsletter should be started to share the benefits of lessons learned and provide ongoing collaboration and coordination of DEMDESS-based pollution control activities in the basin.

Upcoming EPDRB activities were discussed among European Community, donor, and country representatives and the goal of using DEMDESS to support EPDRB was set. Keeping this concept in focus is a role for the country focal points and members of the EPDRB monitoring and information expert group.

A.4 List of Persons Interviewed

The following is a partial list of the persons interviewed by the WASH team during the course of the study:

Bulgaria

Ministry of Environment

Eng. Branimir Natov, Deputy Minister of Environment
Dr. Nedyo Petkov, Chief, Environmental Policies and Strategy Division
Dr. Ilya Natchkov, Senior Research Associate, Center for Environmental Monitoring
Eng. Ivan Milushev, Research Associate, Center for Environmental Monitoring
Dr. Ognian Velev, Black Sea Department

Sofia Water Supply and Sewerage Systems
Eng. Stefan Tzigarski, General Manager
Bulgarian Academy of Sciences
Dr. Borislav V. Georgiev, Head, Fluvial and Hydrophysical Processes in Rivers and Reservoirs

Principal Organization for Hydraulic Construction (Hydrostroy)
Eng. Georgi Najdenov, President
Eng. Tanu Tanev, Director, Overseas Construction Department

Water Engineering Ltd., Sofia
Eng. Avram Radev, President
Eng. Peter Stoychev, Consultant

A.I.D.
Mr. Jerry Zarr, Representative to Bulgaria
Mr. John R. Babylon, Deputy to the A.I.D. Representative
Dr. James E. Harrington, Coastal Zone Management Consultant

The CSFR

Slovak Commission on the Environment
Dr. Ivan Zavadsky, Director, Department of Water Protection and Balance
Ing. Milan Matuška, Head, Water Protection Division
Dr. Jaroslav Drako, International Department
Dr. Daniel Geisbacher, Chief Inspector, Slovak Inspectorate on Environment, Department of Water Pollution Control

Slovak Hydrometerological Institute
Dr. Ivan Kunsch, Deputy Director for Hydrology
Ing. Boris Minárik, Chief Computer Specialist
Mr. Ivan Svitok, Data Base Specialist

Ministry of Forests and Water
Ing. Bretislav Hambek, Director, Water Management Department
Ing. Karol Tilandy, Director, Department of Foreign Relations
Ing. Jankovic Jaroslav, Director, Water Management Department
Ing. Samik Kazimin, Water Quality Specialist and Assistant

Water Research Institute, Ministry of Forests and Water
Dr. Ján Lehocky, Deputy Director
Dr. Pavel Hucko
Ing. Zdena Jurčíkova, Department of Wastewater Treatment Technologies
Dr. Miroslav Sajdlik, Head, Department of Hydraulics
Dr. Anna Zekeová, Water Quality Control Department

T.G. Mazaryk Water Research Institute, Brno
Ing. Ladislav Pavlovský, Head of Department
Ing. Petr Kříž, Water Quality Specialist

District Water and Sewerage Authority, Bratislava
Ing. Pavel Mikláš, Sewerage Specialist

District Water and Sewerage Authority, Trenčin
Ing. Milan Topoli, Managing Director

Slovenský Hodváb (Fiber Factory), Senica
Ing. Ján Sališ, Manager of Technical Development
Dr. František Džubas, Central Laboratory Manager

Istrochem s.p., Bratislava
Ing. Mária Bučková, Environmental Manager

Hydropol, Bratislava
Ing. Rudolf Polak, Principal

Centre of Eco-Information & Terminology Ltd.
Dr. Pavla Stančiková, Director

A.I.D.
Ms. Pat Lerner, Representative to Slovakia

Hungary

Ministry of Finance
Mr. Josef Nador, Advisor
Mr. Miklos Koloszar, Chief Counselor for Environment

Parliamentary Commission on Environmental Protection
Dr. Nándor Rott, Chairman

Ministry of Environment and Regional Policy
Dr. Péter Ottlik, Head, Division of Water, Soil and Air Protection
Dr. Sandor Kisgyörgy, Head of Division, Water Quality
Eng. István Tökés, Head, Department for International Cooperation and Information
Dr. András Diósi, Deputy Director, Program Management Department, PHARE Environment Unit
Ms. Eszter Szövenyi, Senior Officer, Department for International Relations
Ms. Mária M. Galambos, Senior Officer, Department for International Relations

Regional Environmental Inspectorate (MERP), North Transdanubian Region, Györ
Dr. Miklos Pannonhalmi, Head, Department of Hazardous Waste
Dr. Lajos Horváth, Head, Department of Water Quality

National Environmental Authority, Ministry of Environment
Dr. Robert Reinegar, Director
Dr. Pál Varga, Deputy Director

Institute for Environmental Management (KGI), Ministry of Environment
Dr. István Endrédy, Director General
Dr. János Zlinszky, Deputy Director General
Mr. Lászlo Szabó, Department Manager, International Relations
Dr. Agnes Horvath, Director, Institute for Environmental Protection
Dr. Petér Pasztö, Head, Water Pollution Control Section, Institute for Environmental Protection

Oviber Consulting Engineering Co., Ministry of Environment
Dr. Lajos Zsámboki, General Manager
Dr. Ferenc Szabó, Deputy General Manager
Eng. István Kemény, Deputy General Manager

National Water Authority, Ministry of Telecommunications, Transport and Water Management
Dr. Phil. László Kóti, Director, Department of International Relations
Mr. Kálmán Papp, Deputy Director, Department of International Relations
Ms. Márta Neszmélyi, Head of Section, Department of International Relations
Eng. Sándor Jóbbágy, Water Resources Department

Research Center for Water Resources Development
Dr. Ödön Starosolszky, Director General
Dr. Kálman Morvay, Head, Department of International Cooperation and Information
Dr. György G. Pintér, National UNDP/WHO Project Director
Dr. János Fehér, Senior Research Associate
Dr. Ferenc László, Senior Research Associate

Ministry of Industry and Trade
Dr. Árpád Bakonyi, Head, Department of Environmental Management
Dr. Mária Magdolna Dénes, Senior Advisor
Eng. Ágnes Fekete, Environmental Manager
Ms. Eszter Pásztó, Expert on International Environmental Affairs

Municipality of Budapest
Dr. Károly Oszkó, Head, Department of Public Utility Works

Metropolitan Sewerage Works, Municipality of Budapest
Eng. Ferenc Vörös, Director
Eng. Károly Darvas, Technical Director and Chief Engineer
Eng. Tamás Oszcly, Manager of Pump Stations and Treatment Plants
Dipl. Eng. Béla Deák, Head, Technical Development

Municipality of Györ
Eng. Ferenc Németh, Chief Engineer

County of Györ-Moson-Sopron
Eng. János Körmendy, Chief Architect
Eng. János Farkas, Water Supply Manager

Szolnok Water and Sewerage Committee
Dr. Kázmér Kaposvári, Director
Eng. Géza Kovács, Technical Director

Tata Environmental Protection Association
Dr. Lazlo Fulop, Director
Mr. Attila Csaba, Research Engineer

Regional Environmental Center
Eng. Marta Szigetti, Senior Researcher
Eng. Liam Donohue, Booz Allen & Hamilton, Advisor
Dr. Irene Murphy, INFODANUBE Project

Innosystem Environmental Management Ltd.
Dr. Veronika Major, Executive Director
Dr. Pál Benedek

Aqua-Mélyépterv International Ltd.
Eng. Sándor Jobbágy, Managing Director

A.I.D.
Dr. Larry Cohen, Science Advisor
Eng. Ferenc Mélykúti, Program Specialist

Romania

Ministry of Environment
The Honorable Marcian Bleahu, Minister of Environment
Dr. Ioan Jelev, Secretary of State
Dr. Petre Márcuţá, Subsecretary of State
Ing. Mihai Lázárescu
Dr. Speranta Ianculescu, Director, Ecological Impact Assessment Department

Research and Engineering Institute for Environment, Ministry of Environment
Dr. Vladimir Rojanschi, Scientific Director
Ing. George Dulcu, Head, Water Resources and Environmental Economy Department
Dr. Corneliu A.L. Negulescu, Head, Wastewater Department

Environmental Protection Agency, Pitesti, Ministry of Environment
Ing. Albu Anca-Lucia

Parliamentary Commission for Ecological Equilibrium and Environmental Protection
Dr. Dan Gabriel Manoleli, Principal Senior Scientist

Ministry of Industry
Eng. Alexandru Jarana, General Director, Ecological Division

Ministry of Health, Institute of Hygiene and Public Health
Dr. Manole Cucu, Director
Dr. Ioana Jacob, Head of Water Hygiene Department

Romanian Waters Authority
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Attachment A.1

WASH TASK 271 SCOPE OF WORK

Purpose

In order to support future Danube River basin management, in collaboration with representatives from Bulgaria, the Czech and Slovak Republic, Hungary, and Romania, the purposes of the study were to

- Create a method for inventorying and managing data related to the Danube River and its tributaries on point-source wastewater discharges, with provision for future addition of nonpoint data;
- Identify conditions and needs related to national, regional, and municipal wastewater management institutions and their authority and capability to act;
- Demonstrate the use of this method in specific subbasin and provide for its incorporation by others into future data management and modeling efforts.
- Identify high-priority investment needs.

Major Outcomes

The intended outcomes comprised system, institutional, and general outcomes, as follows:

- System outcomes
  - A methodology for collecting and managing data on discharges and dischargers, including provision for identifying facilities and processes, together with illustrations of its application to specific subbasins within selected countries, including provision for future addition by others of nonpoint data;
  - Annotations of existing maps to show generalized land use and population concentrations and other key load points, all based on existing data and projections by others, with preliminary quantification of discharges to the extent feasible; and
  - Recommendations on priority investment needs based on preliminary information on discharges, water quality, and water uses, and subject to the results of preinvestment studies.

- Institutional outcomes
  - Macro descriptions of sectoral arrangements and authorities at regional and municipal levels for each country, including responsibilities and tasks in the sector;
  - An analytic framework for evaluating Danube River water quality management and discharge control institutions;
  - Several case descriptions in each country of subcomponents of the institutional system; and
  - Recommendations on key characteristics of the needed institutions.
- General outcomes
  - Agreement by the four countries on the system and how to use it;
  - At least one technical and one planning person in each country who understands, feels ownership of, and can use the system;
  - Guidance on how to incorporate the system into future decision making; and
  - Guidance on future development of the system and its uses.

Tasks

The study was to be conducted in two stages, which were to include the following tasks:

Stage 1

- Attendance by two team members at the Danube River Basin Expert Meeting to be hosted by the Bulgarian Academy of Sciences in Sofia on September 24-25, 1991;
- Establishing contacts in the four countries at representative or decision-making and technical expert levels;
- Identifying and hiring technical experts, and possibly coordinators, from each of the countries;
- Developing, in consultation with representatives of the four countries and in coordination with other ongoing programs, standardized definitions of effluent parameters and industrial classifications;
- Conducting data reconnaissance and establishing a methodology for the collection of detailed data on discharges and institutional arrangements and constraints;
- Developing a concept for the discharge data management system and presenting it for discussion at a regional workshop; and
- Holding a regional workshop involving the four countries in Budapest or Sofia.

Stage 2

- Presenting the results of and conclusions from the above tasks at a midterm progress meeting in the Washington, D.C. area;
- Obtaining existing discharge data, and data on associated activity and population levels and institutional arrangements and constraints, making optimal use of the efforts of nationals of the four participating countries;
- Designing the data management system, including a computational methodology for the calculation of discharge coefficients and for the prediction of discharges on the basis of alternative scenarios of economic conditions, activity levels, and discharge coefficients, with provision for the incorporation of nonpoint discharge data when they become available;
- On the basis of selective visits to municipal and other dischargers, and of review of calculated discharge coefficients, evaluating the quality and consistency of the data;
- Taking into account the relative discharge loadings and their locations in relation to the river system and potential future scenarios, evaluating the relative importance of discharges and identifying high-priority investment needs for their reduction;
- Conducting a regional workshop to present the system and facilitate coordinated future use of the system in relation to other ongoing activities;
- Preparing reports; and
- Conducting a final debriefing in the Washington, D.C. area.

Deliverables

The study team was to prepare the following:

- A draft and final project report presenting
  - methodology
  - outline of the system
  - relationship of the system to future basin management
  - recommendations for preinvestment studies
  - country annexes presenting discharge and institutional data summaries
- Documentation on the discharge data system

- A draft and final concept report
- A midterm progress report
- Brief progress reports, as appropriate

Attachment A.2

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Attachment A.3

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Appendix B

HIGH-PRIORITY EARLY PROJECTS: KEY ISSUES FOR PREINVESTMENT STUDIES AND DETAILS OF POTENTIAL PROJECTS

B.1 General Issues

B.1.1 Need for Preinvestment Studies

Before capital funding can be obtained from an international lending agency for a major water sector project, preinvestment studies are generally required in order to justify the project and show its "bankability." The objectives of such studies generally include the following:

- Providing a rational basis for a decision whether to proceed with the project,
- Demonstrating the feasibility and sustainability of the project,
- Presenting an implementation action plan, and
- Providing support for applications to lenders for capital funding.

B.1.2 Preinvestment Study Elements

Typically, there are two key stages of preinvestment study: the prefeasibility study and the feasibility study. Under normal circumstances, the prefeasibility study would follow or accompany some level of analysis of the conditions, needs, and priorities associated with the possible project(s). In the current context, in which the purpose is to identify early demonstration projects under circumstances in which strategic studies for the Danube basin have not been performed, it was necessary to combine preliminary basin and project studies at the prefeasibility stage.

The purposes of prefeasibility studies in the water sector include the following:

- Verifying that important pollution reduction needs exist within the study area, based on evaluation of health and environmental impacts and risks;
- Establishing criteria for prioritizing the actions needed to reduce pollution;
- Revealing the general interfaces and relationships among wastewater disposal and such other activities and factors as water supply, agricultural runoff and drainage, and other sources of water quality degradation;
- Identifying the key institutional and financial problems that may hinder pollution reduction and indicating whether solving them is likely to be feasible;
- Identifying one or more projects that are likely to be feasible and should proceed, as well as the issues that should be studied in more detail at the feasibility analysis stage;

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- Establishing a preliminary concept of project staging and preparing preliminary, order-of-magnitude estimates of cost for the first stage.

The World Bank, EBRD, and A.I.D. are working together to prepare a model scope of work for such prefeasibility studies.

Each funding agency has its specific requirements for the content of feasibility studies in the water sector, but they typically include the following:

- Information on the physical, demographic, industrial, social, health, water use, wastewater production, environmental, economic, and financial conditions surrounding the proposed project;
- Identification and evaluation of the sources of such information and provision of such new primary data as may be needed to establish reliability;
- Identification of the problem or problems that create the need for the project, and of the issues that should be dealt with if the project is to succeed (that is, for the project to be initially implementable and sustainable over time);
- Identification of alternative available programs, schemes, or systems that could solve the key problems and comparisons of their effectiveness, relative economic costs, implementability, and impacts in such areas as health, environment, technology, operability, socioeconomics, financing, and institutional needs;
- Development of the preferred alternative to show its key technical features, important provisions to be included in designs and equipment specifications, requirements for operations and maintenance, and the proposed stages of construction and their costs;
- Feasibility analysis of the program, particularly the initial part to be funded; this encompasses economic and financial feasibility (including financial and tariff projections for a period that is usually 10 years beyond the completion of construction), environmental impact evaluation (including definition of needed mitigating measures), institutional feasibility evaluation (including recommended organizational, legal, staffing, training, and operational measures to ensure feasibility), and assessment of project risks; and
- Development of a proposed implementation plan.

Pilot demonstration projects to be implemented in terms of the components of the EPDRB's Short Term Actions must include not only physical works but also the industrial and policy reforms essential for effective project financing, implementation, and operation.

B.1.3 Common Study Elements

Preinvestment studies for urban and industrial wastewater systems should address water supply and wastewater collection, treatment, and disposal. For urban systems that collect industrial wastewaters and that are creating pollution problems requiring urgent attention, common preinvestment study elements include the following:

- The sources, quantities, and characteristics of the wastewaters generated;
- Urban and industrial water consumption, wastage, needs, and conservation opportunities, including losses due to water system and service connection leakage; wastage on consumers' premises; leakage in common systems in apartment buildings; usage, leakage, and wastage from district heating systems, where they exist; fire fighting and other municipal uses; and inadequacies in metering and meter reading;
- Demographic, economic, industrial, urban development, and land-use trends, including the viability and economic capability of key polluting industries;
- The extent, condition, and functioning of existing water supply, treatment, and distribution facilities, and of existing wastewater collection, conveyance, treatment, and disposal facilities; the impact of design, condition, operation, and maintenance of existing facilities on their effectiveness and environmental effects; and the extent and effects of such factors as water losses, infiltration of groundwater into sewers, admission of rainwater into sewers, toxic or other substances that form deposits in sewers or inhibit biological activity, and hazards to operating personnel;
- The existence and extent of environmental impacts due to water supply and wastewater systems, including potential health risks, particularly water source contamination, adverse effects or inadequacies of water treatment, and pollution of surface water, soil, and groundwater, taking into account pollution from other sources;
- The capabilities, methods, problems, and financial condition (including effectiveness and methods of revenue collection) of water supply and wastewater system management organizations;
- Projections of population; urban, economic, and industrial development; service needs; water demands and wastewater production and their geographical distribution; water source and wastewater source and disposal needs; and water and wastewater quality characteristics;
- Alternative or supplementary water source development and facilities; need for facility extensions, improvements, replacements, and installations for water supply, treatment, and distribution and for wastewater collection, conveyance, treatment, and disposal;
- Comparison of the functional, economic, environmental, and other aspects of alternative water and wastewater treatment objectives and methods, including comparison of alternative facility locations and processes, possible staging of objectives and capacity provision, and options for safe and acceptable treatment and disposal of

sludge, for example, by agricultural use joint landfilling with municipal solid wastes or by incineration; and

- Provision for in-factory, on-premises, and systemwide water and by-product conservation measures and improved pretreatment (both facility construction and operation) of industrial wastes, including proper sludge disposal; and provision for the enforcement and other measures needed to have them implemented.

For individual industries or industrial platforms, common water and wastewater preinvestment study elements will be as above except for the omission of urban and municipal references and with other adjustments to reflect the particular situation.

The above is intended only as a bare listing of outline points. Actual scopes of work would be based on the needs and intentions of owners and potential lenders and on a wide range of local factors.

B.1.4 Common Issues

In the following sections of this appendix, specific problems are presented that would have to be addressed in preinvestment studies for individual projects in the four countries under discussion. However, some important problems are common, to a greater or lesser degree, to all the identified projects and should be addressed during the planning or implementation phases for all capital projects in the water sector being considered for early implementation in the four countries under discussion. Such common issues are as follows:

- *The need to select high-impact components for early implementation:* Given the difficult financial conditions that exist in the four countries, careful prioritization and staging of recommended improvements are critical. A key factor in such prioritization and staging of project components is the benefits to be achieved in regard to water quality and actual or imputed impacts on health due to downstream water uses, taking into account the relative effects of pollution from other sources. It is important to identify for immediate implementation those measures that will yield significant early benefits in protecting or enhancing health and the environment.

- *The adequacy and reliability of data:* Available data vary in regard to their completeness, up-to-dateness, and reliability, both between and within countries. In some cases there appears to be some confusion between data collection goals and actual performance. Budgets for data collection have been extremely limited, so that, for example, the effects of wastewater peaking, batch operations, and variations in receiving water flows are generally not well represented. Demographic data vary in quality, and socioeconomic information seems very limited. Some primary data collection is likely to be needed in every case at the feasibility study stage.

- *The need for high-quality construction and equipment:* Many of the existing wastewater facilities visited by the WASH team showed evidence of poor quality and installation of equipment, and malfunctioning equipment. In the better plants visited,

major efforts had been made to replace malfunctioning equipment. In some plants poor-quality civil construction was also seen. Equipment of the types used in wastewater treatment plants is made in Eastern Europe but until now, as reported to the team, in some cases it has tended to have a very short life, sometimes because of the use of improper, inexpensive materials. There will inevitably be a desire on the part of governments to award equipment contracts to local companies and a tendency for such companies to make very low bids in order to obtain lifesaving business. Similarly, construction firms may tend to make very low bids on the basis of their past experience in this sector. Project sustainability will require (a) excellent functional designs, (b) positive control over the quality of civil construction, and (c) procedures that will ensure the provision and proper commissioning of high-quality equipment. Such procedures could, for example, include prequalification requirements that call for demonstrated successful experience, where necessary, in the form of international joint ventures and special provisions in warranty and suppliers' maintenance requirements.

- *The need for sound bases for operations:* The operations and maintenance that are vital to the sustainability of wastewater projects are dependent on human resources, equipment, and the funds to support them. Staffing, training, and operational support appear from the team's observations to have suffered because of the lack of emphasis given in the recent past to environmental concerns. They are at present seriously impacted by lack of funds. System expansions and improvements will generally require planned operational improvements. However, all such planning is dependent on reliable sources of funds. The need for user revenue sources to fund system operations is a vital key to project feasibility, and it is well recognized as such by all the managers interviewed by the team. Repayment of capital loans is equally important and in general will be completely or partially dependent on local sources. The comparison of funding and revenue options and presentation of feasible financing plans will be at the heart of the needed feasibility studies.

B.2 Potential High-Priority Early Projects

B.2.1 Overview

The projects below were identified by government personnel or by the WASH team as having substantial benefits if undertaken early on and as not being dependent for justification on the completion of longer range monitoring programs. The information provided is based on interviews, visits by members of the WASH team to some of the project locations, and the country reports prepared by WASH Project subcontractors and presented in Volume III to this report. Each of the projects would require preinvestment studies to confirm whether early action to implement the project is in fact justified. In the larger cities discussed, an early project could cover only one or a few of the problems that exist, with action on others being deferred, although preinvestment studies in general should address the overall situation in each location to permit development of a staged action program.

For each suggested project location, the material presents the background of the proposed project, the basis for its inclusion, and key issues to be addressed in preinvestment studies. All of the information presented is subject to confirmation. The list of issues to be addressed is not exhaustive; it includes only issues that came to the attention of the team during its limited studies. Additional information on conditions in some of the locations discussed here can be found in the technical report for each country in Volume III.

The potential projects discussed below for each country are not presented in priority order. They are organized by river basin and discussed within each basin from higher to lower levels of priority. For suggested priority ordering, refer to Chapter 3 in the main body of this report.

B.2.2 Projects in Bulgaria

B.2.2.1 Michailovgrad

Background

Michailovgrad is located in the upper part of the Ogosta River basin. It has a population of about 52,300 and a wide range of industries, including a dairy factory and a poultry slaughterhouse. It is the second-largest town in the basin, exceeded in size only by Vratse, which has a population of about 75,500. Vratse is located upstream from Michailovgrad, as is a copper mine, which releases copper and heavy metals into the river and contributes heavy metals to sediments in an irrigation reservoir near the town. The total urban population of the basin (excluding villages) is approximately 200,000. Vratse has a wastewater treatment plant, but Michailovgrad does not.

The water supply systems of Michailovgrad and Vratse are supplied from a shared upland reservoir. The Michailovgrad water supply system has barely adequate supply and very high distribution losses, on the order of 45 percent.

About 72 percent of the population of Michailovgrad is served by sewers, and about 50 percent of that of Vratse. The sewers carry sewage and rainwater. A trunk sewer is needed to carry wastewater from the Michailovgrad system to the site for the treatment plant. Designs have been prepared for the trunk sewer and treatment plant, but they should be reviewed and updated.

The river acts as an open sewer—the water is deoxygenated below Michailovgrad. Irrigation use of the river water is impacted. Were it not for its condition, the river would be used for water supplies.

Basis for Inclusion

There are two reasons for assigning a high priority to early investment in Michailovgrad:

- The serious and direct impact of wastewater disposal in Michailovgrad on the condition of the Ogosta River and

- The water shortage and high losses in Michailovgrad.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Michailovgrad are the justification for and feasibility of early investment in, for example, one or more of the following:

- A trunk sewer and wastewater treatment plant for Michailovgrad, taking into account the plans previously prepared;
- First-phase replacement of parts of the water distribution systems;
- Upgraded water metering and meter reading programs;
- Improved management and revenue collection systems, including programs of consumer relations and tariff reconstruction; and
- In-factory waste conservation measures and pretreatment facilities for industrial wastes.

B.2.2.2 Sofia and Samokov

Background

Sofia has a population (as of the most recent census, that of 1986) of 1,201,500. It has substantial industrial activity, including metallurgy, machinery industry, manufacture of chemicals, textiles and wood products, and food industries. It is located in a basin at an elevation of approximately 500 m above sea level and near the head of the Iskar River. Its water supply is from dammed, snow-fed sources. Approximately 95 percent of the combined (i.e., wastewater and rainwater) sewer network has been constructed. A small part of the population is served by septic tanks. There is a wastewater treatment plant, which is overloaded. Primarily because of malfunctioning equipment, the plant, designed as a conventional activated sludge plant, performs inadequately.

Samokov is located in the Sofia water supply catchment, above the main raw water reservoir and about 40 km from Sofia. It had a 1986 population of about 47,100. Part of the wastewater flow from Samokov is untreated. When full, the reservoir retains about a one-year supply of water, but after several dry years (as at present) retention is reduced substantially, which introduces the possibility of wastewater impacts on the Sofia water supply.

The water supply of Sofia is drawn from two reservoirs, the Iskar and Beli Iskar reservoirs. The former was constructed for urban potable supply. The latter was constructed for industrial water supply, irrigation, and power generation but because of water shortage, it is now used entirely for urban and industrial supply. A third reservoir was designed, but construction was stopped because of environmental objections. The water withdrawn for urban and industrial use averages approximately 860 MLd (10 cu m/s) and consumption is approximately 560

MLd (6.5 cu m/s). Water use is approximately one-third domestic and two-thirds industrial. The domestic rate of consumption is estimated to be 170 Lcd. The existing 70-year-old treatment plant has a capacity of 4 cu m/s; a new plant (8 cu m/s) is under construction. In the Iskar basin, as for the whole of Bulgaria, there is an overall shortage of water under current usage patterns.

The water distribution system is made of asbestos-cement and unlined steel pipes. The water is aggressive, which leads to serious corrosion. System losses are estimated at 30 to 35 percent. The distribution system has about 3,500 km of pipelines, about half of which are said to need replacement. There is a centralized district heating system.

The sewerage system of the city of Sofia is in generally good condition in most of the city, but it is old and deteriorated in the city's center. It is inadequate for combined flows, and parts of it are operated under pressure during storms. In some areas the groundwater table is high and there is significant infiltration. Within the municipal area, the collected wastewater is approximately 60 percent domestic and 40 percent industrial, for a combined dry-weather flow of about 520 MLd. Also within the greater metropolitan area are independent wastewater collection systems at the Kremikovtsi Metallurgical Complex (total wastewater production of 285 MLd) and the town of Elin Pelin (population of 2,300), each having its own treatment facilities, and at the town of Slivnitsa (population of 8,800). The city sewerage system has a total length of 1,557 km. Two more main interceptors are needed to serve about 30 percent of the collection system.

The wastewater treatment plant of Sofia is of conventional activated sludge (diffused air aeration) design. Its design capacity is 500 MLd. The inflow has an average BOD_5 of 118 mg/L and suspended solids of 98 mg/L. It has screening, grit removal, primary sedimentation tanks, aeration tanks, secondary sedimentation tanks, sludge digestion, and vacuum filtration. The original equipment was of Soviet origin. The design incurs unnecessarily high energy demands. The civil works and mechanical facilities are in poor condition. Replacement sludge vacuum filters were installed 10 years ago but are no longer in use. The scum removal system is inappropriate and ineffective. Virtually all the equipment is in need of replacement. Wet sludge is dumped in disused mines with alternate layers of slag but a permanent method of disposal is needed. Space limitations make landfilling of sludge difficult. The plant effectively removes only 65 percent of BOD_5 and 40 percent of suspended solids. There is very little dilution of the Sofia treatment plant effluent in the river below the outlet.

The wastewater discharge from Samokov causes high nitrate and phosphorus levels in the Iskar Reservoir, with consequent algal development, taste, and odor problems in the Sofia supply and the possibility of trihalomethane creation after chlorination. (Ozonation is to be included in the new water treatment plant.) The water of the Iskar River is used many times over before it reaches the Danube. The irrigation needs of the Sofia basin are no longer met because of the urban and industrial water demands. There are several hydropower plants in the lower valley and construction of others is under consideration. However, corrosion and erosion are problems in the existing plants because of the quality of the water.

Nitrates from the effluent from Sofia are said to have been detected in potable groundwater sources in the lower Iskar Valley. In the section of the Iskar River from Sofia through the Sofia Gorge, towns that would draw potable supplies from the Iskar River but for its quality, instead take water from side streams, which have generally inadequate flows to meet the needs. Irrigation needs in the Iskar Valley are said to go unmet because of the unacceptability of the quality of the water. The pollution impacts, which appear from analytic, anecdotal, and observational evidence to be real, need to be evaluated.

The management and operation of the Sofia water supply and wastewater systems are the responsibility of the Sofia Water Supply and Sewerage Systems. This authority is semiautonomous and is a special case in Bulgaria. Water rates and wastewater surcharges have been increased several times in the past two years, but they are still totally inadequate to cover the cost of effective operations.

Basis for Inclusion

The following are reasons for assigning a high priority to early solution of some of the problems of this system:

- The large number of people in Sofia who would be subject to any health impact on Sofia's water supply from improper wastewater disposal at Samokov;
- The proportionately high impact of this large city on the condition and use of the Iskar River (compared with that of mixed urban and industrial wastewater discharges on other Bulgarian Danube tributaries);
- The potential for upgrading and expanding the existing Sofia wastewater treatment plant at lower unit cost than for providing complete new facilities, as would be needed at many other problem locations;
- The water-short conditions in the Sofia area and the very high leakage losses from the water distribution system; and
- The existence of a functioning water and wastewater operating entity in Sofia and the relatively greater economic base compared with other cities, which creates a higher likelihood of success.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Sofia and Samokov are the justification for and feasibility of early investment in, for example, one or more of the following:

- Rehabilitation and improvement (possibly including the addition of nutrient removal) of the existing Sofia wastewater treatment plant;
- First-phase replacement of parts of the water distribution system;

- Extended wastewater collection and treatment for Samokov;
- An upgraded water metering and meter reading program;
- Improved management and revenue collection systems, including a program of consumer relations and tariff reconstruction;
- In-factory waste conservation measures and improved pretreatment of industrial wastes; and
- Sludge incineration.

B.2.2.3 Pleven

Background

Pleven has a population of about 130,000 and is located in the catchment of the Vit River. About 86 percent of its population is served by sewers. Pleven has a wide range of industries, including animal feed production, sugar production, a refinery, a slaughterhouse, a poultry works, a dairy factory, a winery, and several metal finishing works. It is the largest town in the Vit basin, which has a total urban population of about 169,000.

The sewers carry sewage and rainwater. There is a new 108-MLd biological wastewater treatment plant serving the town (mechanically aerated activated sludge). In its first few months of operation, it is reported to have achieved removal of about 95 percent of BOD_5 and 70 percent of suspended solids. However, a few months after start-up it became overwhelmed by oil from the refinery, part of the wastewater from which enters the sewers. The refinery has a pretreatment facility, which includes oil flotation and sand filters. Most of the industries are reported to have pretreatment facilities but their operation is said to be questionable.

Below Pleven, there is potable and irrigation use of the river underflow. The withdrawn water shows evidence of organic and oil contamination. The route of the oil contamination (whether through contaminated municipal effluent, sewer system leakage, or direct refinery effluent discharge) is not known.

Pleven is fully served by a water distribution system, but the groundwater supply is inadequate. In summer, water is sometimes available for only two hours a day. Available alternatives are groundwater supply from near the Danube, which raises potential water quality issues, and a joint upland reservoir with Troian and Lovetch, which has been objected to by some environmentalists because of possible ecological impacts.

Key problems are the impacts of the oil refinery's wastes on the quality of the groundwater supply and the need to augment the very limited supply of potable water. The municipal wastewater treatment plant is not fully loaded. Part of the sewerage system is not connected to the plant, and the system is lacking interception facilities to take advantage of the existence of the plant. The plant and its operation require upgrading, as do those of the refinery's pretreatment facility.

Basis for Inclusion

The reasons for assigning a high priority to early investment in Pleven are the following:

- The serious and direct impact of wastewater disposal in Pleven and its industries on the city's limited water supply source;
- The serious water shortage in Pleven;
- The potential for a large benefit from a relatively small investment in interceptors and upgrading of municipal wastewater treatment and industrial pretreatment.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Pleven are the following:

- Alternative supplementary water sources for Pleven, including an upland source to be shared with Troian and Lovetch and supplementary groundwater sources, and
- The justification for and feasibility of early investment in, for example, one or more of the following:
  - Putting the wastewater treatment plant into full operational condition, including adding sludge-drying facilities;
  - Provision of additional wastewater collectors to utilize the treatment plant more fully;
  - First-phase replacement of parts of the water distribution systems;
  - Upgraded water metering and meter reading programs;
  - Improved management and revenue collection systems, including programs of consumer relations and tariff reconstruction; and
  - In-factory waste conservation measures and improved pretreatment facilities and facility operation for industrial wastes.

B.2.2.4 Troian and Lovetch

Background

Troian is located in the upper part of the Osem River basin. It has a population of about 26,000. Lovetch is about 30 km downstream from Troian and has a population of 49,000. Both towns generate very significant industrial wastes. They are the two largest towns in the

Osem River basin and their combined population is about 75 percent of the total urban (excluding villages) population of the basin.

About 49 percent of the population of Troian is served by sewers, and about 65 percent in Lovetch. The sewers carry sewage and rainwater. There is no wastewater treatment. Within Troian are 14 industrial enterprises, including chemical, wood products, food, and other industries and a slaughterhouse. In Lovetch are a slaughterhouse and tanning, food, and other industries.

A biological wastewater treatment plant was designed for Troian and site preparation was started by Hydrostroy, the construction arm of the Ministry of Construction, but construction was interrupted or abandoned for lack of funds. An 18-month study has just been started by the Peace Corps and the Institute for Sustainable Communities (ISC), with the aim of developing an action plan for industrial wastewater pretreatment.

The river acts as an open sewer—the water is deoxygenated between the towns and below Lovetz. Irrigation use of the river water is not possible now and fish no longer exist in the river. Were it not for its condition, the river would be used for water supplies.

The water supply systems are from upland run-of-river sources, although Lovetch takes part of its supply from a spring. Groundwater in this area is very deep and very limited in quantity. Shortage of water supply creates very severe problems in both towns, but especially for Lovetch, which has only two hours of supply each day. Groundwater that could have been used by Lovetch has been contaminated with nitrates and heavy metals by the wastewaters discharged to the river by Troian.

A joint upland storage reservoir for Troian, Lovetz, and Pleven was designed and construction was started, but residents of a 400-person village located downstream from the dam site stopped construction by blocking the passage of trucks to the site. The water distribution systems, as for all cities and towns in Bulgaria, are of asbestos-cement and unlined steel pipes, with galvanized steel service connections. The steel pipes suffer extensive corrosion and permit high leakage losses, on the order of 30 to 50 percent.

Basis for Inclusion

The reasons for assigning a high priority to early investment in Troian and Lovetch are as follows:

- The serious and direct impact of wastewater disposal in Troian on water supply for Lovetch;
- The serious water shortages in both towns, but especially in Lovetch; and
- The serious impacts of wastewater disposal from both towns on the river and its potential users.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Troian and Lovetz are the following:

- The information collected in and conclusions drawn from the Peace Corps/ISC study, and
- The justification for and feasibility of early investment in, for example, one or more of the following:
  - Provision of a wastewater treatment plant for each town, taking into account the plans previously prepared for Troian;
  - First-phase replacement of parts of the water distribution systems;
  - Upgraded water metering and meter reading programs;
  - Improved management and revenue collection systems, including programs of consumer relations and tariff reconstruction; and
  - In-factory waste conservation measures and pretreatment facilities for industrial wastes.

B.2.2.5 Gabrovo and Veliko Tornovo

Background

Gabrovo and Veliko Tomovo are located in the upper reaches of the Jantra River. They have populations of about 90,000 and 93,700, respectively, out of the total urban population of 332,000 in the Jantra basin. They generate significant industrial wastes, including from machinery, food, and other industries. They are separated by 40 km and have wastewater treatment plants. They are upstream from Gomo Oriahovitsa and Liaskovetz (see B.2.2.6 below), whose wastewaters are untreated.

Both cities are partially sewered, and the Gabrovo plant is underutilized because an interceptor along one bank of the river has not been completed. The sewers carry sewage and rainwater. Industrial wastes are reported to comprise about half of the dry-weather flows. Many industries have pretreatment facilities, including screening, aerated grit removal, primary sedimentation tanks, mechanically aerated activated sludge, secondary sedimentation tanks, and sludge digestion.

In the Veliko Tomovo plant, the sludge digestion structures were built, but lack of funding prevented the purchase and installation of sludge processing equipment. Sludge drying beds were provided, but they are too small to handle raw sludge under the prevailing climatic

conditions. As a result, the primary sedimentation tanks are not in operation, and the degritted flow is fed directly into the aeration basins.

The dry-weather design capacities, treated flows, and BOD and suspended solids removal of the treatment plants are approximately as follows:

ESTIMATED TREATMENT PLANT CAPACITIES

Plant	Capacity	Treated Flow	BOD Removal	Suspended Solids Removal
	(MLd)	(MLd)	(%)	(%)
Gabrovo	79	30	94	92
Veliko Tornovo	46	22	89	88

The treatment plants are in marginal condition and need new equipment and upgrading. The Tornovo plant is reported to need substantial reconstruction.

Organic substances, manganese from chemical plants in Veliko Tornovo, and nitrates from wastewater discharges from Gorno Oriahovitsa are reported to be detectable in potable groundwater sources downstream from Gorno Oriahovitsa.

Water supply for both cities is from dams, with conventional rapid sand filtration, and is limited in capacity. The water supply systems, as for all cities and towns in Bulgaria, have distribution systems of asbestos-cement and unlined steel pipes, with galvanized steel service connections. The steel pipes suffer extensive corrosion and permit high leakage losses, on the order of 30 to 50 percent.

Basis for Inclusion

The reasons for assigning a high priority to early investment in Gabrovo and Veliko Tornovo are as follows:

- The poor condition of the Jantra River and the resulting restrictions on its use, as well as the significant contribution the river makes to the overall pollution of the Danube, compared with other Bulgarian rivers (other than the Iskar);
- The pollution load on the Jantra River from uncollected and untreated wastewaters from these two cities, together with the poor condition of the existing treatment facilities;
- The urgent need for sludge drying facilities in both towns; and

- The water-short conditions in the area and the very high leakage losses from the water distribution systems.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Gabrovo and Veliko Tornovo are the justification for and feasibility of early investment in, for example, one or more of the following:

- Upgraded and expanded wastewater treatment plants, including facilities for sludge management;
- Expanded wastewater collection facilities;
- First-phase replacement of parts of the water distribution system;
- An upgraded water metering and meter reading program;
- Improved management and revenue collection systems, including a program of consumer relations and tariff reconstruction; and
- In-factory waste conservation measures and improved pretreatment (both facilities and operation) of industrial wastes.

B.2.2.6 Gorno Oriahovitsa and Liaskovetz

Background

Gorno Oriahovitsa and Liaskovetz are located on the middle reach of the Jantra River. They are contiguous towns, have a combined population of approximately 50,000, and generate very significant industrial wastes. They are downstream from the larger towns of Gabrovo and Veliko Tornovo, which have wastewater treatment plants (see B.2.2.5 above).

About 90 percent of the population of Gorno Oriahovitsa (41,000) is served by sewers, and in Liaskovetz, about 75 percent. The sewers carry sewage and rainwater. There is no wastewater treatment.

Within Gorno Oriahovitsa are a slaughterhouse, a chemical factory, a railway headquarters (including rolling stock maintenance and repair facilities), and other industries. There is also a large sugar beet factory, with a BOD_5 load in its effluent equal to that of the sewage from about 150,000 people. (The total urban population in the Jantra basin is 332,000.) In Liaskovetz is a large winery as well as other industries. Industrial wastes constitute about two-thirds of the total wastewater flow in the two towns.

The industrial effluents bring large quantities of sugar, organic matter, iron, and oil to the river. Pretreatment facilities at the industrial plants are minimal. They include the following:

- An oil separator at the slaughterhouse;

- A settling tank and filter press at the chemical factory;
- Mud and oil separators at the engine maintenance workshop in the railway yards; and
- At the sugar beet factory, screening, settling, and filtration of recycled conveyance and washing waters; and vacuum filtration and lagooning of process waters (with the vacuumed sludge being dumped into the lagoon).

The river acts as an open sewer—the water is deoxygenated. Irrigation use of the river water is not now possible. Organic substances and nitrates, as well as manganese from chemical plants in Veliko Tornovo, are reported to be detectable in potable groundwater sources downstream.

The water supply systems, as for all cities and towns in Bulgaria, have distribution systems of asbestos-cement and unlined steel pipes, with galvanized steel service connections. The steel pipes suffer extensive corrosion and permit high leakage losses, on the order of 30 to 50 percent.

Basis for Inclusion

The reasons for assigning a high priority to early investment in Gorno Oriahovitsa and Liaskovetz are as follows:

- The very poor condition of the river and the severe restrictions on its use, as well as the significant contribution that it makes to the overall pollution of the Danube, as compared with other Bulgarian rivers (other than the Iskar);
- The relatively high impact of these towns and their industries on the condition and use of the Jantra River (compared with those of other urban and industrial wastewater discharges to this river);
- The potential for providing biological treatment of combined urban and pretreated organic industrial wastewaters at lower unit cost than for providing separate biological treatment facilities; and
- The water-short conditions in the area and the very high leakage losses from the water distribution systems.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Gorno Oriahovitsa and Liaskovetz are the justification for and feasibility of early investment in, for example, one or more of the following:

- Provision of a central wastewater treatment plant, including facilities for sludge management;

- First-phase replacement of parts of the water distribution system;
- An upgraded water metering and meter reading program;
- Improved management and revenue collection systems, including a program of consumer relations and tariff reconstruction;
- In-factory waste conservation measures and improved pretreatment of industrial wastes; and
- Completion of sewer service in Liaskovetz.

B.2.2.7 Razgrad

Background

Razgrad is located near the source of the Beli Lom River, in the basin of the Ruse Lom River. It has a population of about 49,500 and a wide range of industries, including a pharmaceutical factory, a slate factory, and a slaughterhouse. It is the largest town in the basin, which has a total urban population of about 93,000.

Razgrad is partially sewered. The sewers carry sewage and rainwater. An old biological wastewater treatment plant serves the town. It needs renovation or replacement and the addition of sludge drying facilities. The plant is reported to be achieving about 60 percent removal of suspended solids and negligible BOD removal.

The slaughterhouse wastes are discharged to the town sewers, but they are reported to contribute only about 5 percent of the total BOD load on the town plant. Wastes from the pharmaceutical plant (which have a BOD about equal to that for all the rest of the town's wastewater, including domestic and industrial components) are pretreated in flow-equalization and settling facilities before being discharged into the influent of the town treatment plant. Biological treatment is to be added to the factory treatment plant at the expense of the factory. The slate factory's wastes are discharged to the river after mechanical and biological treatment.

The source of potable water for the town is alluvial groundwater below the town. The quality of this water, which is also used by downstream villages, is affected by wastewater discharges. The water is reported to have significant levels of nitrates, ammonia, manganese, and iron.

Basis for Inclusion

The reasons for assigning a high priority to early investment in Razgrad are as follows:

- The serious and direct impact of wastewater disposal in Razgrad on the town's limited water supply source and that of downstream villages and
- The possibility of achieving significant benefit at moderate cost by upgrading the existing wastewater treatment plant.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Razgrad are the following:

- Alternative or supplementary water sources for Razgrad, Popovo, and downstream villages and
- The justification for and feasibility of early investment in, for example, one or more of the following:
  - Putting the wastewater treatment plant into full operational condition, including adding sludge drying facilities;
  - First-phase replacement of parts of the water distribution systems;
  - Upgraded water metering and meter reading programs;
  - Improved management and revenue collection systems, including programs of consumer relations and tariff reconstruction; and
  - In-factory waste conservation measures and improved pretreatment facilities and facility operation for industrial wastes.

B.2.3 Projects in the CSFR

B.2.3.1 Bratislava

Background

Bratislava is the capital of the Slovak Republic, and it has a rich cultural and political history. The population numbers about 440,000, most of whom live in the older portion of the city on the left bank (northern side) of the Danube. About 100,000 people live in Petrzalka, a more newly developed area on the right bank. On the eastern downstream side of the city, the Danube branches to form Corn Island, with the Little Danube flowing on the northern side. The city's Central wastewater treatment plant at Vrakuna discharges into the Little Danube. Construction of a separate wastewater treatment plant to serve Petrzalka has been undertaken but has not been completed.

Bratislava contains two large industrial complexes of concern to water pollution: Istrochem and Slovnaft. The enterprise Slovnaft successfully operates a chemical/biological treatment plant, which discharges to the Danube. The Istrochem factory provides physical/chemical treatment for its wastewater, and pumps the effluent about 10 km to the Little Danube. Expansion of the Istrochem plant and provision of biological treatment appear warranted. Thus, in the

following discussion, Bratislava's municipal wastewater problems and Istrochem's wastewater problems are discussed separately.

- Bratislava Municipality

Construction of the Bratislava combined sewer system began in 1902, and it currently contains 600 km of sewer ranging in size up to 3,200 mm. The service area extends about 30 km along the northern side of the Danube. Flows up to 6 cu m/s are carried by gravity to the Central sewage treatment plant at Vrakuna on the left bank of the Little Danube, several kilometers downstream from the branching of the Big Danube. Flows into the Little Danube are regulated at 30 cu m/s to dilute the treated effluent from the plant. Pump stations serve small, outlying portions of the service area, and stormwater overflows are provided at several locations to limit flows to the plant to a dilution ratio of 2:1 during storms.

Effluent quality from the Central plant is sufficient to maintain aerobic conditions in the Little Danube, but nutrient removal is planned in the future because algae production in the stream is considered excessive; nitrates in groundwater on Corn Island are seen as a problem by the Slovak Hydrometeorological Institute. A second treatment plant is under construction to serve the area south of the Danube river, for the Petrzalka portion of the city, and is designed for an equivalent population of 487,000. By comparison, the existing plant is designed for an equivalent population of 1,090,000. The population equivalent for industrial and nondomestic wastewater is based on a per capita BOD_5 load of 54 g/day.

The combined (stormwater/sewage) sewer system will be retained and enlarged over time. It is believed that the quality of stormwater is poor and requires treatment to protect the Danube.

The Central wastewater treatment plant is designed for an average daily flow of 260,000 cu m/day (3 cu m/s), and currently receives an average flow of 2 cu m/s. During storms, it can treat up to 6 cu m/s. The WASH team visited the plant's control room, headworks, aeration basins, and secondary clarifiers. The plant appears to be well designed, well equipped (mostly German suppliers), and well operated; it is also modern (completed in 1986). The first design of the plant was by Hydroconsult Bratislava, and subsequent refinements were made by Hydroprojekt Brno. Influent BOD is only 150 mg/L, indicating a possible need for sewer rehabilitation to reduce groundwater inflow in the older, low-lying parts of the sewer system.

Influent to the plant at the time of the team's visit was relatively fresh smelling and dilute. Five large-diameter screw pumps are provided, and two were in operation; the inclined channels have been covered with corrugated galvanized sheeting, presumably to provide shade and prevent thermal warping of the screws. Mechanical screens are followed by 12 primary sedimentation tanks containing Dorr mechanical scrapers and skimmers. Aeration

basins use fine-bubble dispersed air through a Scandinavian-supplied system of "candles" made from porous polyethylene plastic.

Sludge processing is by thermophilic digestion at 38 degrees C, followed by dewatering to 26 percent dry solids on belt filter presses. Equipment for additional heat drying and pelletizing of sludge was installed, but the market for pelletized sludge did not develop. Short-term contracts with farmers allow disposal by delivery to farms or cooperatives. They have also tried composting sludge as a 10 percent additive to municipal solid waste and spreading sludge to assist forestation.

Heavy metals in the sludge have not been a problem, except when petrochemical wastes enter the system. Meeting EC regulations may require incineration of sludge. The sludge has been tested as a source of thermal power and is said to have the same fuel value as brown coal at 40 percent dry solids. The use of newer model belt filter presses to produce dryer sludge is under consideration. Biogas from the digesters is currently used for heating and pelletizing of sludge. Biogas and dried sludge may be used for power production, depending on the local market and costs of power transmission from the plant.

- Istrochem

The Istrochem factory is located in the eastern part of Bratislava, approximately 8.5 km north of the Little Danube. It produces viscose fiber (rayon), agricultural fertilizer, industrial explosives, propylene fiber, and polymers. The raw materials include cellulose, polypropylene, phosphoric acid, sulfuric acid, phenols, and aniline.

The factory has 4,600 employees. Sixty percent of human wastewater from the factory goes to the city sewer system and 40 percent goes to the factory wastewater treatment plant. Wastewater from part of the factory is brought to the treatment facility by tanker truck.

Before construction of the existing wastewater treatment plant, the pH of the discharge was 2.0 and less, and the effluent included organic substances and metals. The wastewater is treated by grit removal, oil skimming, equalization when needed, and chemical neutralization. The sludge is thickened, which increases the sludge solids from 2 to 6 percent, and dried in plate filters, bringing the solids content to 40 percent. Sludge production averages about 6 T/day of dry solids. The sludge is reported to contain at least 130 chemical constituents. It is trucked for landfill to a site 50 km away.

The existing treated effluent amounts to 7.5 million cu m/year and includes the following:

TREATED EFFLUENTS

Item	Quantity T/year	Quantity mg/L
BOD_5	1,400	185
COD	4,100	550
Diss. solids	380	50
Susp. solids	23,000	3,100
Oil products	23	3.0
Chlorides	5,200	685
Sulfate	6,900	910
Inorganic salts	1,745	2,300

The effluent also contains organics, metals, and other toxics, but they are not tested for. The design capacity of the treatment plant is 500 L/s, but actual flow is reduced to 240 L/s. The plant has an operations and maintenance staff of 32, including laboratory staff, plus the operations manager. There are automatic measurement and central reporting systems for flow and pH.

The addition of biological treatment has been studied and designs are being prepared for a 300-L/s plant. The expected cost of adding biological treatment is about Kcs 300 million. The cost of treatment will increase from the current Kcs 6/cu m to 20 Kcs/cu m. The reasons for adding biological treatment are stated by factory staff to be (a) the effects of effluent on river underflow quality after damming of the river at Gabčíkovo and (b) fees and fines levied on the discharge, which have increased to Kcs 30 to 40 million/year. With the construction of the new treatment facilities, management intends to discharge all human wastewaters to the city sewers in order to reduce costs. A source of capital for the new treatment facilities has not been identified.

Effluent is currently discharged through an 8.6-km gravity pipeline to the Little Danube. A new 11.7-km force main has been constructed to carry the wastewater to the main stem of the Danube, but it has not yet been put into service. The additional length is primarily due to the unavailability of space along the same route as the older pipeline. The new pipeline is of fiberglass, with a 50-year guarantee, and costs Kcs 300 million.

Basis for Inclusion

The reasons for assigning a high priority to early improvement of effluent quality from Istrochem include the following:

- The importance of groundwater beneath Corn Island (between the main stem of the Danube and the Little Danube) as a source of potable supply drawn from the Danube underflow;
- The presence of organics and metals in the effluent, which, even after dilution in the Little Danube flow of about 30 cu m/s, pose a health risk in the river underflow; and
- The expectation that this factory will continue in operation at this location.

For municipal wastewater from Bratislava, there are several reasons for assigning a high priority to improvement of facilities:

- The possible need for nutrient removal in the Central plant to improve groundwater quality beneath Corn Island, in addition to improvements gained by upgrading of Istrochem's treatment, and
- Completion of the right-bank southern treatment plant serving Petrzalka, which can b provided at a low cost compared with the cost of constructing completely new plants, as at other locations.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Istrochem (which should preferably be studied along with conditions and needs relating to wastewater treatment and disposal for the Slovnaft chemical factory and for the right bank part of Bratislava) are the following:

- Possible and recommended in-factory water and waste conservation measures;
- Environmental system management methods and problems, related financial issues and recommended enforcement and oversight measures; and
- The justification for and feasibility of early investment in, for example, one or more of the following:
  - Upgraded and expanded wastewater treatment, including facilities for sludge management;
  - In-factory process changes to reduce the emission of contaminants and to improve water and by-product recovery;
  - Functionally and economically optimized treatment, or disposal to the city sewers, of human wastewater from the factories; and
  - Improved wastewater quality and impact monitoring both for operational control and for environmental oversight purposes.

B.2.3.2 Brno

Background

The city of Brno is located in the Czech Republic, on the Svratka River, about 40 km above its entry point into the Dyje River, which then flows about 48 km before entering the Morava River about 55 km above its discharge point into the Danube.

Brno is the third-largest city in the CSFR, with a population of about 400,000. The city includes machinery, textile, chemical, and food industries.

Other substantial polluters on the Svratka River include Tišnov (10,000 population and a paper mill) upstream from Brno, and Židlochovice (3,500 population and a sugar factory) downstream.

The city is fully sewered and all of the included industries are connected to the city sewer system. Most of the system carries wastewater and rainwater. In the older, central area, the sewers mostly date from the past century and are of brick construction and in very poor condition. Plain concrete sewers built between 1900 and 1950 are also in poor condition. Newer sewers are of vitrified clay or reinforced concrete. Some main trunks have been reconstructed in the past ten years. Infiltration of groundwater is reported not to be a serious problem. However, the Ponávka Stream does enter the sewer system. It is to be diverted this year.

The average per capita dry-weather flow is 450 Lcd. The full dry-weather flow is treated in a plant that includes activated sludge treatment, sludge digestion, and mechanical drying of sludge. The influent BOD_5 is 20,585 kg/day from residential and general urban sources and 13,699 kg/day from industry. The effectiveness of the treatment plant is 90 percent in BOD removal and 92 percent in suspended solids removal. The treatment plant has been upgraded and new mechanical equipment has been installed. There is no nutrient removal.

Industrial wastewaters are required to be pretreated, in particular for removal of heavy metals. Planned improvements to the system include the connection of surrounding villages and replacement of the sludge treatment facilities.

Above Brno, the water of the Svratka River is used for drinking water production even though it does not meet the standard for this purpose. Below Brno, the river is heavily polluted not only by wastewater from Brno but also by the flow from the Litava River and wastewater from Židlochovice. The Svratka River below Brno is one of the most heavily polluted waterways in the Czech Republic.

The Brno water supply system has serious problems. Supply is taken from several sources, including a polluted surface stream and two distant groundwater systems. These sources are inadequate. Plans call for constructing a 60-km pipeline to bring water from the Vir Reservoir. This will be for potable purposes and the existing surface water supply will then be relegated to utility water. Dual distribution systems already exist and the secondary system will be extended. In some areas the dual systems extend into apartment buildings.

There is a district heating system (for heating only, not for hot water supply). A system for obtaining hot water from the nuclear power station 30 km away was started and then abandoned because of the expected short life of the pumping facilities.

Basis for Inclusion

The reasons for assigning a high priority to early solution of some of the problems of this system are as follows:

- The large number of people in Brno who would be subject to health risks in the event of any failure of treatment of the polluted surface water supply source;
- The very heavy pollution, with little dilution, of the Svratka River by treated wastewater from Brno;
- The potential for upgrading and expanding the existing Brno wastewater treatment plant at lower unit cost than for providing complete new facilities, as would be needed at many other problem locations;
- The very poor condition of the older parts of the sewer system, including frequent cave-ins and blockages, and the potential risk to the public;
- The existence of a functioning water and wastewater operating entity in Brno and the relatively greater economic base compared with most other cities in the CSFR portion of the basin, which indicates a higher likelihood of success.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Brno are as follows:

- The feasibility, benefits, and costs of repairing, reconstructing, or replacing old and deteriorated parts of the sewer system;
- The urgency of need for, and any potential alternatives to, the introduction of water supply from the Vir Reservoir and expansion of the dual water distribution systems;
- Industrial pretreatment effectiveness and effluent monitoring adequacy; and
- The justification for and feasibility of early investment in, for example, one or more of the following:
    - Rehabilitation and improvement (possibly including the addition of nutrient removal) of the existing Brno wastewater treatment plant;
    - First-stage reconstruction, rehabilitation, or replacement of part of the city's sewer system;

- Construction of a pipeline and treatment facilities to bring water from the Vir Reservoir;
- Extension of the secondary water distribution system using partially treated surface water;
- An upgraded water metering and meter reading program;
- Improved management and revenue collection systems, including a program of consumer relations and tariff reconstruction;
- In-factory waste conservation measures and improved pretreatment and monitoring of industrial wastes; and
- Sludge incineration or co-disposal with solid wastes.

B.2.3.3 Olomouc

Background

Olomouc a town of approximately 102,000 inhabitants, is located on the upper Morava River, about 230 km from the river mouth at the Danube. The town is heavily industrialized and includes food, pharmaceutical, and chemical industries.

The town is fully sewered. A wastewater treatment plant serves part of the town but not the Hodolany industrial district. The sewer system is combined (wastewater and rainwater), and parts of it have inadequate capacity. Older parts of the system are of brick and are seriously dilapidated. Reconstruction of some trunk sewers has begun.

Average dry-weather flow is 53,000 cu m/day, or 520 Lcd. The BOD_5 of the influent to the treatment plant totals 28,800 kg/day, of which 83 percent is from industry. That is to say, the population equivalent of the total wastewater arriving at the treatment plant on a BOD basis is approximately 480,000. The total population equivalent of all wastewaters is over 500,000, about five times the actual population. Some of the industrial wastes are pretreated and some are not.

The flow receiving mechanical treatment averages 47,000 cu m/day, of which only 28,750 cu m/day receive biological treatment. The total average flow is 56,200 cu m/day, which means that only 85 percent of the total flow receives primary treatment and 51 percent receives secondary treatment. The efficiency of the plant is also very low; it is reported to achieve about 33 percent BOD_5 removal and 44 percent suspended solids removal.

Upstream from Olomouc, the Morava River has been preserved essentially in its natural condition. Below Olomouc, the character of the river is devastated. The effects of pollution from Olomouc are reported to be significant as far downstream as the Dyje River, approximately 125 km away. The waters of the Morava are used for irrigation and industrial purposes and they are also reported to influence shallow groundwater used for public water

supplies. Olomouc is by a large margin the biggest contributor of BOD to the March-Morava River system; its annual contribution is approximately 5,800 T/year of BOD_5 compared with the next largest contributor with about 2,500 T/year. (Brno contributes approximately 2,000 T/year.)

A project has been prepared for the construction of a new treatment plant. The designed average daily flow is 57,000 cu m/day and the designed population equivalent is 429,000. The proposed program includes the provision of primary treatment and sludge digestion in the first stage and diffused-air-activated sludge and mechanical sludge dewatering in a second stage. Contractual commitments are reported to have been made for the first-stage civil works, including an inlet trunk sewer.

Basis for Inclusion

The reasons for assigning a high priority to early solution of some of the problems of this system are as follows:

- The potential health risk to consumers of groundwater in the lower Morava basin and the fact that Olomouc is the largest single source of pollution of the Morava River;
- The lack of control of industrial discharges to the sewer system and to the river in Olomouc; and
- The multicriteria analysis conducted by the Czech Water Resources Institute, on the basis of which Olomouc was ranked the most urgently in need of correction among the 30 Morava basin wastewater sources analyzed, and this by a substantial margin over the next most urgent.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Olomouc are the following:

- The key contaminants that need to be removed or controlled taking into account health risks and other impacts;
- The economic, environmental, and other effects of alternative levels of in-factory wastewater reduction, segregation, and pretreatment or treatment (taking into account staging possibilities) and the means by which to implement and monitor the most appropriate mix of in-factory and central treatment;
- The feasibility, benefits, and costs of repairing, reconstructing, or replacing old and deteriorated parts of the sewer system; and
- The justification for and feasibility of early investment in, for example, one or more of the following:

- Construction of an appropriately designed and staged new wastewater treatment plant, together with appropriate in-factory wastewater management measures;
- First-stage reconstruction, rehabilitation, or replacement of part of the town's sewer system;
- A loss and wastage reduction program for the water supply system; and
- Improved monitoring, management, and revenue collection systems, including a program of consumer relations and tariff reconstruction.

B.2.3.4 Senica

Background

The town of Senica is also located in the basin of the March-Morava River, within the Slovak Republic. It has a population of about 21,000, of which 16,000 have sewer service. A major industry, not connected to the town sewer system, is a fiber ("silk") factory. Other industries, which do have sewer service, include a dairy factory, a soft drink factory, building materials manufacture, a laundry, and vehicle service establishments.

Water supply to the town is provided from two locations, each combining springs and wells and each providing water to a smaller town near the source as well as to Senica. Within Senica, the entire population receives direct water supply service, and 95 percent of residential premises are metered. The remainder, mainly older single-family houses, pay a fixed rate for water. Apartments in residential high-rise buildings are not individually metered. Water losses are estimated at 17 percent, and wastage is believed to be high. In 1991, this led to low pressures in the system, although in 1992 the increased price of water (Kcs 1.5 versus the former Kcs 0.6 per cu m) appears to have had the effect of reducing wastage and increasing pressures. Water wastage is regarded as the biggest problem in the water supply and sewerage infrastructure of Senica. There is a district heating system, which draws water from the public supply.

The wastewater system is reported to be in generally good condition. Sewers are of reinforced concrete and are laid entirely above groundwater. The collected volume of wastewater averages 55 L/s (1.7 million cu m/year). The current load, on a BOD_5 population-equivalent basis (at 60 g/capita/day), is as follows:

Domestic (actual)	17,784
Industrial (estimated)	29,956
Total	**47,750**

The combined domestic and industrial wastewater has an average 420 mg/L of BOD_5 and suspended solids. The dairy factory has pretreatment facilities, but its effluent quality exceeds the basis for its discharge permit.

Senica has a trickling-filter treatment plant with a design capacity of 32 L/s. Part of the flow is bypassed around the plant. Effluent BOD_5 and suspended solids average 60 and 70 mg/L, respectively. Expected completion in 1993 of a new housing complex will further add to the overloading of the treatment plant. A new activated sludge treatment plant, to replace the existing facility, is under construction. It is to include screening, grit removal, flow measurement, skimming, compressed-air aeration, final sedimentation tanks, sludge thickening, sludge digestion, and gas storage. The originally intended completion date was December 1992, but that has been extended to April 1993 because of the new housing development.

The effluent is discharged to the Teplicska River, which is a small stream that is a tributary of the Myjava River, which in turn discharges to the March-Morava River a short distance upstream from the point where the March-Morava is entered by the River Dyje, in the basin of which is Brno, the second-largest city in the CSFR. Also discharged to the Myjava is the wastewater from the town of Myjava (population 15,000), which includes plumbing and furniture manufacturing plants, which discharge chromium in their wastewaters.

The construction of the new treatment plant for Senica is funded primarily from the central government's budget. The Slovakian Environmental Fund has been asked to provide a small part of the needed funds. In order to advance the completion of construction of this facility, the government has transferred funds to it that had been earmarked for construction of a new Morava River water treatment plant for the town of Kuty. There is still a shortfall of funds. The town pays for a discharge permit and also pays fines for exceeding the effluent quality limits specified in the permit.

Within Senica is a fiber factory (Slovensky Hodvab), which currently produces 3,000 t/year of viscose and 10,000 t/year of polyester rayon. The possible production of polyester industrial fibers is under study. The fiber factory's water supply is taken from a reservoir on the Teplicska River, the Myjava River, and wells. The factory, which is not connected to the town sewerage system, has a wastewater treatment plant, including standby flow equalization, chemical neutralization, and chemical sludge dewatering. The wastewaters include high dissolved solids (largely sulfate and chlorides), high COD and BOD, and zinc. The dissolved solids are a significant pollution problem and impact on downstream irrigation use of the rivers. In the Teplicska, the sulfate level above the effluent discharge point is about 90 mg/L, increasing to about 400 mg/L below the town and fiber factory discharge points. The BOD_5 is said to be five times higher after receiving these wastewaters. There is the potential for contamination of the underflow of the lower March-Morava River, used for urban potable water supplies, by organic substances from this and other industries in the basin.

As a result of some past efforts to force the plant to change or close down for environmental reasons, some changes are planned. These include construction of a biological treatment facility for the polyester and human wastewaters, production process changes, discharge of part of the wastewater by deep-well injection to replace oil extracted in the area, and reduction of the amount of zinc discharged by chemical precipitation. The possibility of recovering sulfate for detergent production is also under study. An immediate need is to resolve the difficulties

in disposing of sludge, which is currently plate filtered and landfilled, or lagooned. A physical-chemical system (110 L/s) for the viscose wastewater and a biological treatment facility (70 L/s) for human wastes (currently 2,400 employees) and polyester wastewater are planned. The funds for this have not been completely secured.

Basis for Inclusion

The reasons for assigning a high priority to early improvement of effluent quality from Senica, including the fiber factory, are as follows:

- The high priority given to the solution of these problems by the Slovak Commission on the Environment, based in part on the fact that potable water supplies are drawn from the March-Morava underflow and on the presence of organics and metals in the factory effluent, which, together with effluent from other sources in the basin, poses a potential health risk in the river underflow;
- The expectation that the fiber factory will continue in operation at this location;
- The partial commitment already made to the funding and construction of the new town treatment plant; and
- The problems of water distribution related to wastage of water in the town.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Senica, including the fiber factory and other industries, are the following:

- Possible and recommended in-factory waste conservation measures;
- Environmental system management methods and problems, related financial issues, and recommended enforcement and oversight measures; and
- The justification for and feasibility of early investment in, for example, one or more of the following:
  - Urban and industrial wastewater treatment, including completion of facilities already under design or construction but needing additional funds;
  - In-factory process changes to reduce the emission of contaminants and to improve water and by-product recovery;
  - Functionally and economically optimized wastewater management systems, including industrial wastewater pretreatment as appropriate;
  - Improved wastewater quality and impact monitoring both for operational control and for environmental oversight purposes; and

- Water wastage controls in the town, including possible economic incentives.

B.2.3.5 Trenčín

Background

Trenčín is located on both banks in the middle reaches of the Váh River. A population of about 140,000 (comprising 93 percent of the city's population of 60,000 and about 80 percent of the population of surrounding villages) is provided with piped water supply. Two separate wastewater systems, one for each bank of the river, serve the city only.

The population served by the sewer system is about 45,000 on the left bank and 9,000 on the right bank. Industries connected to the left bank system include food and other industries and have a population equivalent (at 60 g/capita/day of BOD_5) of about 105,000. Those connected to the right bank system, including a yeast and alcohol factory, textile (cotton) industries, building materials enterprises, furniture manufacturers, and a large mechanical equipment repair facility, have a population equivalent, on the same basis, of about 71,000. The effluent from the yeast/alcohol plant can have a BOD_5 level as high as 5,000 mg/L. Sometimes the raw material (molasses) is dumped into the sewer.

The design capacity of the left bank biological wastewater treatment plant is 44,689 cu m/day and a population equivalent (BOD_5 basis) of 150,000. There is an immediate problem with sludge treatment in that the existing centrifuge dewatering equipment is out of service for need of a replacement part. In the meantime, wet sludge is being trucked to farms for disposal.

The BOD_5 of the collected right bank wastewater in 1991 averaged 646 mg/L, but now it is less because of reduced production at the yeast/alcohol plant. A right bank treatment plant has been planned. The design criteria are now being changed to allow for full treatment of the yeast/alcohol plant wastewater at the factory. This decision results from the factory's decision to treat in order to minimize discharge permit fees and fines and reduces the population equivalent to be handled at the city plant from 80,000 to 42,000.

The current discharges to the Váh have significant pollution effects. Fish existing above Trenčín do not occur downstream. The alluvial material on the right bank of the Váh provides the most important potable groundwater resource in Slovakia after Com Island in the Danube. Because of a change in the standards for cadmium, the effluent now fails to meet the standard in this respect.

The water supply of Trenčín is from the river-bank alluvium and spring sources and is chlorinated. The groundwater is subject to agricultural pollution and shows evidence of fertilizer contamination immediately after every heavy rainfall. Eighty percent of the distribution system is made of cast iron, but recent extensions have been of polyvinylchloride (PVC) up to 200 mm in diameter. Steel is used for high-pressure pipelines. Old service connections are of cast iron, some of galvanized steel. More recently, PVC and polyethylene have been used for service connections. The eight individual water sources all have pH values in the range of 6.9

to 8.0 and do not create any significant corrosion problems. Even the oldest pipes are in good condition. The quantity of water supplied is 450 L/s, including 380 L/s to the city.

There are several district heating systems, serving apartment blocks, that are connected to the water supply system. These provide not only heat but also hot water and account for 70 percent of the water consumed. The hot water systems are in some cases metered and more meters are being installed. Income from the heating systems is important to the water authority, which has not tried to limit this use of water. Of the total supply, 40 percent is taken by industry, but this figure is changing in a downward direction.

Basis for Inclusion

The reasons for assigning a high priority to early improvement of effluent quality from Trenčín include the following:

- The high priority given to the solution of these problems by the Slovak Commission on the Environment, based in part on the fact that potable water supplies are drawn from the Váh and its underflow and on the presence of organic substances that may form carcinogens or be direct health risks;
- The partial commitment already made to the funding and construction of the new city treatment plant; and
- The existence of an effectively functioning water and wastewater management program, including an industrial wastewater control and monitoring program.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Trenčín are the following:

- Possible and recommended in-factory waste conservation and treatment measures and the resulting effects on central wastewater treatment needs and
- The justification for and feasibility of early investment in, for example, one or more of the following:
  - Urban and industrial wastewater treatment, including completion of facilities already under design or construction but needing additional funds, and
  - A loss and wastage reduction program for the water supply system.

B.2.3.6 Hlohovec and Leopoldov

Background

Hlohovec and Leopoldov are in the lower part of the basin of the Váh River, on the left and right banks, respectively. They have a combined population of 32,800. Hlohovec includes pharmaceutical and wire manufacture and a large laundry. The total BOD_5 population equivalent is approximately 65,000 (at 60 g/capita/day). The average BOD is about 320 mg/L. About 25 percent of the flow is industrial, and there is minimal pretreatment at the main industries.

Sewers are of vitrified clay or reinforced concrete. They have been installed mainly since 1952 and are generally in good condition. Only the reinforced-concrete main trunk sewer alongside the river is below groundwater level. There is reported to be no significant infiltration.

Downstream from Hlohovec and Leopoldov, water supplies for Galanta, Sala, and Sered are drawn from the river underflow. These towns also draw part of their supplies from under Corn Island in the Danube. There is apparently no evidence yet of any problems. Water is taken from the Váh for irrigation. Some villages below Hlohovec are said to be taking water for potable supply directly from the Váh. Toxic metals are assumed to occur in the wastewater because of the electroplating activities in Hlohovec.

A wastewater treatment plant has been designed for Hlohovec and the nearby town of Leopoldov. The effluent will go to the Váh River. The plant, which is intended to be located on the right bank, will be owned and operated by the West Slovakia Water and Sewerage Authority. It is to be designed to achieve a high level of removal not only of BOD_5 but also of nitrate. Funds for construction are to be provided by the water authority and from the government's budget. Plant start-up is planned for 1996. The project includes, in addition to the treatment plant, enlargement of the left bank pump station, a river crossing for wastewater from Hlohovec, and a main trunk sewer.

Domestic water consumption averages 211 Lcd and the total is 405 Lcd. There is over 25 percent leakage loss. The main supply pipeline crosses under the Váh River and it leaks. Consumption is falling as the price of water increases, which is now Kcs 1.5/cu m for water plus 1.5/cu m for domestic wastewater and 5.7/cu m for industrial wastewater. Industries in Hlohovec have supplementary private water supplies.

Basis for Inclusion

The reasons for assigning a high priority to early reduction of polluting emissions from Hlohovec include the following:

- The high priority given to the solution of these problems by the Slovak Commission on the Environment, based in part on the fact that potable water supplies are drawn from the Váh and its underflow and on the presence of organics and metals in the effluent, and

- The partial commitment already made to the funding and design of the new town treatment plant.

Key Issues To Be Addressed

Key issues that should be addressed in preinvestment studies for Hlohovec include the following:

- Possible and recommended in-factory waste conservation measures;
- Water and wastewater system management methods and problems, related financial issues, and recommended enforcement and oversight measures; and
- The justification for and feasibility of early investment in, for example, one or more of the following:
  - Town wastewater treatment, including completion of facilities already under design but needing funds;
  - In-factory waste reduction and pretreatment measures;
  - Improved wastewater quality and impact monitoring both for operational control and for environmental oversight purposes; and
  - Water loss and wastage reduction measures in the town.

B.2.3.7 Novaky

Background

Novaky is a town of 12,000, located in the upstream portion of the Nitra watershed. A coal-fired power plant at Novaky has disposed of the ashes since 1966 in a slurry pipe, which empties into a lagoon formed from the ash slurry. Transporting the ashes in a water slurry is a wasteful use of water. Of greater concern, the water leaches arsenic from the ashes and carries it into the groundwater and thence into the Nitra River. The arsenic concentrations in the Nitra are sufficient to prevent potable use of river water or groundwater downstream from Novaky. The banks of the lagoon have failed three times and allowed large quantities of arsenic into the river.

There is also a PVC chemical plant in Novaky. No details were provided for the team by the factory. A new wastewater treatment plant is proposed for the chemical plant. Information on 1991 and expected 1995 wastewater quality after treatment, treatment costs, and fines paid was, however, provided by the Slovak Commission on the Environment. Effluent quality is described below:

EFFLUENT QUALITY

	1991 Levels		1995 Levels *	
Item	**mg/L**	**kg/day**	**mg/L**	**kg/day**
BOD_5	151	2,560	12	440
COD	457	7,600	33	1,190
Suspended solids	3,360	69,650	1,662	59,400
Chlorides	1,770	36,800	816	29,200
Oil products	7.1	105	0.47	16.7
	L/s	**cu m/day**	**L/s**	**cu m/day**
Flow	360	31,000	414	35,700
pH	8.4		6.5-8.5	

* Estimated

Restructuring of production processes is proposed, along with the treatment improvements, in order to reduce wastewater emissions. The fines currently paid total approximately Kcs 14 million per year. The expected cost of treatment per cubic meter is approximately Kcs 8, or slightly over Kcs 100 million per year, compared with about Kcs 26 million today.

Basis for Inclusion

The Novaky plant is included because of the very high level of concern about it expressed by the Slovak Commission on the Environment and because of the apparent readiness of the factory, which is understood to have had discussions with EBRD, to proceed with the implementation of major improvements.

Key Issues To Be Addressed

Key issues that should be addressed in preinvestment studies for Novaky include the following:

- Impacts on the Nitra River and its underflow and on the uses and users of these waters, due to both the chemical factory and the thermal power plant, and
- The justification for and feasibility of early investment in, for example, one or more of the following:

- In-factory process changes to reduce the emission of contaminants and to improve water and by-product recovery;
- Improved wastewater treatment facilities for the chemical factory and the adjacent power plant;
- Measures to improve the handling and disposal of ash at the power plant and to minimize the leaching of arsenic into water bodies;
- Measures to provide for effective operation and maintenance of the new facilities and adherence to agreed in-factory procedural changes; and
- Improved wastewater quality and impact monitoring for environmental oversight purposes.

B.2.3.8 Bošany

Background

In the town of Bošany, in the lower Nitra River basin, is a large tannery (Koželužne). The tannery's wastewater, which is discharged to the Nitra River after treatment, contains chromium and high levels of BOD and COD. The final sludge has a chromium content of 25,000 mg/kg of dry solids.

About 90 T/day of leather, for clothing, furniture, and so on, is produced from cattle, calf, pig, and sheep skins. The level of production was formerly 140 T/day. After hair removal with lime, the tanning process uses chromium hydroxide. This produces 10,000 cu m/day of effluent with a pH of 3.3. Factory water supplies are taken from the Nitra River (2.9 M cu m/year) for processing, the town system for potable use (0.3 M cu m/year), and groundwater for heating and steam production (0.4 M cu m/year).

The volume of wastewater produced is 11,000 cu m/working day and 4,000 to 5,000 cu m each Saturday and Sunday. Key wastewater quality indicators are listed below:

KEY WASTEWATER QUALITY INDICATORS

Parameter	Before Treatment (mg/L)	After Treatment (mg/L)
BOD_5	900	65 (1991) 45 (now)
COD	3,500	250
Chromium	-	not measured
Suspended solids	4,000	80

(cont'd)

Dissolved solids	4,500	2,300
Dissolved inorganic solids	-	2,200
Chloride	1,100	1,100
Alkalinity	-	-
pH	8.7	8.0
NH_3	35 (varies)	38-78

The treatment plant was designed for a flow of 22,000 cu m/day and provides screening (2 cm spacing), grit removal, flow balancing, sedimentation (23-hour detention: originally designed for 14 hours), two-stage activated sludge with nutrient (phosphoric acid) added in the first stage and aeration periods of one hour in the first stage and eight hours in the second stage, and final sedimentation. The waste activated sludge is taken to a gravity thickener with lime addition. The waste/primary sludge mixture is then dewatered by either a filter press (which has some problems) or a belt press before landfill disposal. The solids content of the final sludge is as follows: belt, 30 to 35 percent; lagoon, 15 to 30 percent.

A contract was reported to have been executed with an Italian firm to provide for recovery of the chromium within the factory. This is expected to reduce the chromium level in the primary sludge to less than 1 mg/kg, which is the standard for agricultural use, and to recover about 20 percent of the total amount of chromium used in the factory. The cost is expected to be met partly from the Slovakian Environmental Fund and partly from the resources of the factory.

Basis for Inclusion

The reasons for assigning a high priority to early improvement of effluent quality from the Bošany tannery include the following:

- The high priority given to the solution of the Bošany problem by the Slovak Commission on the Environment, based in part on the fact that potable water supplies are drawn from the Nitra underflow and on the presence of organics and chromium in the factory effluent, which, together with other sources of effluent in the basin, pose a potential health risk in the river underflow;
- The expectation that the factory will continue in operation at this location; and
- The partial commitment already made to the funding and construction of improvements to the factory treatment plant.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for the Bošany tannery are the following:

- Environmental system management methods and problems, related financial issues, and recommended enforcement and oversight measures; and
- The justification for and feasibility of early investment in, for example, one or more of the following:
  - In-factory process changes and wastewater segregation and reduction,
  - Wastewater treatment process and operational improvements, and
  - Improved wastewater quality and impact monitoring both for operational control and for environmental oversight purposes.

B.2.3.9 Nitra

Background

Nitra is an economic and cultural center of 80,000 to 110,000 people, located on the Nitra River. The river has very low natural streamflows in the summer and no flow-regulation reservoirs in the upper portion of the basin. The natural streamflow at Nitra is estimated at 3.2 cu m/s, but this flow is often exceeded by upstream industrial discharges. The city is served by a 1965 wastewater treatment plant of 19,000-cmd capacity and overloaded by flows of 26,000 to 36,000 cmd over recent years. The city of Nitra was expanded by construction of tall apartment buildings, without expansion of the wastewater treatment plant. A new plant (having a capacity of 50,000 to 60,000 cmd) sharing the same expanded site is under construction, but available hard-currency funds are insufficient to complete the plant. Industries are producing wastewater that is not biodegradable; norms for pretreatment of industrial wastewater have not been established.

The Nitra water supply and wastewater authority has a staff of 275 and serves an area containing 23 municipal water supply systems. Until the 1950s, Nitra used bank-filtered water supplies, but they were abandoned as a result of arsenic and chromium contamination by industrial discharges upstream from Nitra. Three distant sources (30 to 70 km away) are currently used, and a project to take water from the Danube is planned for completion by about 1998. In the water supply system, leakage and metering losses are small, estimated at 16 percent. Total metered water supply is about 16 M cu m/year, and the estimated wastewater flow is 14 M cu m/year, which indicates that a large percentage of the population is served by sewers. Industries produce transport equipment, soft drinks, beer, and wine; the total industrial wastewater flow is estimated at 11.5 M cu m/year.

The existing Nitra wastewater treatment plant was not in operation at the time of the team's visit because a new raw-wastewater pump was being installed. It was reported that all the equipment, within the plant was operational, that staffing was sufficient, and that the plant has a reliable dual power supply. The plant has sludge digestors.

Basis for Inclusion

The reasons for assigning a high priority to early improvement of effluent quality from Nitra include the following:

- The relatively high priority given to the solution of these problems by the Slovak Commission on the Environment;
- The partial commitment already made to the funding and construction of the new city treatment plant; and
- The existence of an effectively functioning water and wastewater management program, including an industrial wastewater control and monitoring program.

Key Issues To Be Addressed

Issues to be considered in a preinvestment study for Nitra should include the justification for and feasibility of early investment in, for example, one or more of the following:

- Construction of an appropriately designed and staged new wastewater treatment plant, together with appropriate in-factory wastewater management measures;
- First-stage reconstruction, rehabilitation, or replacement of part of the city's sewer system;
- A loss and wastage reduction program for the water supply system; and
- Improved monitoring, management, and revenue collection systems, including a program of consumer relations and tariff reconstruction.

B.2.4 Projects in Hungary

B.2.4.1 Budapest

Background

The Budapest metropolitan area contains 22 municipalities or districts, divided by the Danube River into the Buda (western) and Pest (eastern) communities, which together contain more than 2 million people. The wastewater authority monitors 600 industrial emitters, which together account for 60 percent of the wastewater flows in Budapest and 40 percent of the industry in Hungary. Of the total wastewater flow of about 1 million cmd, only 15 percent

receives biological treatment prior to discharge to the Danube; about 75 percent receives coarse mechanical treatment (coarse screens, grit removal), and about 10 percent receives no treatment at all.

The North Budapest plant treats 85,000 cmd and serves the northern Pest side of the river; the plant was built in 1980 to treat domestic wastes and a concentration of industrial discharges (including chromium from a leatherworks), with the objective of protecting the Budapest section of the Danube downstream from the plant. The South Budapest plant treats about 75,000 cmd and serves the southern Pest side; the purpose of the plant is to protect the Soroksar branch of the Danube, which branches from the Danube to form Czepel Island to the south of Budapest. The Budakeszi plant treats less than 2,000 cmd from three tuberculosis sanatoriums, and three smaller plants were built in the 1970s for outlying portions of the service area and are still in operation. Flows from the central Pest side receive only coarse mechanical treatment; flows from the Buda side discharge through 23 outfalls to the Danube and receive essentially no treatment.

The North Budapest plant has a Stage 1 capacity of 140,000 cmd; plans call for expanding it three times this capacity to serve a larger portion of northern and central Pest and also the northern Buda area. Based on a site visit, it seems apparent that the plant is well managed, operated, and maintained. The plant design and equipment were Soviet in origin, and the plant developed slowly—mechanical treatment in 1980, followed by biological treatment in 1985. Design modifications and replacement of equipment were required over the past 10 years and completed in 1991. These included installation of new blowers, electrical motors, and instrumentation and replacement of porous plates in the aeration basins by a system of piped diffused air using Hungarian-made polypropylene porous candles. In addition, vacuum filters for sludge dewatering were replaced by a German chamber press, which produces a much dryer cake (40 percent solids). Plant operation is by three crews of 15, one crew per shift, and each crew managed by an engineer. Disposal of undigested sludge, screenings, and grit is to a temporary landfill in an area northeast of Pest, which can be improved and expanded to last 10 years. A sludge drying system is in the planning stage, with the dried sludge to be co-incinerated with refuse in the North Pest incinerator. In the recent period of economic transition and industrial stagnation, the strength of the wastewater has declined, from an average BOD_5 of 440 mg/L in the mid-1980s to about 200 mg/L at present.

The total service area of the Budapest wastewater authority covers 526 sq km. The wastewater collection system contains about 3,700 km of sewer, of which 95 percent carries stormwater and wastewater. Ninety-five percent of the service area receives public water supply, but only 70 percent of households are served by sewers. The wastewater authority operates tanker trucks to remove septage from on-site septic tanks serving the remaining 30 percent of households. In addition, the authority operates 11 large manned sewage pump stations at overflow points, and 111 smaller automated pump stations within the collection system. The oldest portions of the sewer system were built in the eighteenth and nineteenth centuries, but the first portion built in accordance with a comprehensive sewerage plan was that for the central Pest area in 1912. The older sewers are deteriorating, and an estimated 300 to 400 km need rebuilding. Lack of funds limits the rebuilding program to about 6 km of sewer per

year (primarily by installing fiberglass liners). A further problem is lack of stormwater pumping capacity when the Danube is at flood stage. At one pump station, the dry-weather flow is 1 cu m/s and existing pump capacity is 1.5 cu m/s, while the peak wet-weather flow is 8.5 cu m/s.

The wastewater authority falls under the jurisdiction of the Public Works Department, which reports to the lord mayor of Budapest. Fees are obtained from a surcharge of 9.5 forints/cu m on water bills, in addition to the 10.5 forints/cu m received for water supply. Legislation was introduced in the Parliament in 1991 to allow a total charge of 60 forints/cu m, but it has not been passed. Water losses due to unmetered connections and meter underregistration are reported to be less than 10 percent of drinking water production, which is excellent. In the first half of 1991, total revenues amounted to 1 billion forints, which was less than the operating costs for the same period. Part of the deficit was made up by the manufacture of plastic pipe sold locally and by revenues from a contracting department.

The impacts of Budapest's wastewater on downstream conditions in the Danube include difficulties in treating Budapest's drinking water at the Czepel Island waterworks, seasonal deterioration in the quality of bank-filtered drinking water supplies, industrial spills into the Danube, sludge deposits affecting bank-filtered supplies, and eutrophication in the Soroksar branch of the Danube. These are discussed briefly below.

The Czepel Island waterworks draws water through bank-filtered wells from the Danube. A highly complex treatment chain, including ozonation and granular activated carbon, is to be added to overcome difficulties in water treatment. Biological tests have indicated that chlorination sometimes increases the toxicity of Danube water. Causes of treatment problems include uncontrolled discharges of poorly treated industrial wastes from Budapest, including phenols and other chemical and oily wastes, and mercury occasionally exceeding the limit of 1 µg/L in the Danube, although the origin and behavior of mercury in the Danube require further study.

The bank-filtered supplies from the wells north of Budapest are affected seasonally by ammonia, nitrates, iron, and manganese; the iron and manganese are leached from the soil when the water passes through anaerobic sediments before reaching the wells. Winter is the worst period because low flows mean lower dilution of industrial effluents and nitrification ceases, which leads to ammonia levels up to about 2 mg/L. Bacteriologically, late summer and autumn are the worst periods because low flows and high temperatures lead to high counts in the river water, and the low water levels increase the velocity through the strata thus reducing self-purification.

A 1983 report on the health impact of the Danube's water quality indicated that about 30 pollution incidents occurred per year, mostly due to oil, which closed the surface water intake at the North Budapest water treatment plant for about 300 hours per year. At that time, it was necessary to post an observer on Szentendre Island north of the city to watch the Danube for oil slicks. The 1988 national water quality report contains a map showing the location of a similar number of pollution incidents in 1988.

The slope and flow velocity of the Danube decline below Budapest, and sludge deposits are formed seasonally in the vicinity of bank-filtered supplies. Although the sludge deposits may contain high concentrations of heavy metals from industrial emissions, there is little evidence thus far that the quality of the bank-filtered water supply has been affected.

The South Budapest wastewater treatment plant discharges into the Soroksar branch of the Danube, which forms Czepel Island. Flows into the Soroksar are controlled by a dam and lock and typically are limited to about 30 cu m/s. Nutrients in the effluent of about 0.9 cu m/s from the South Budapest plant contribute to eutrophication and algae blooms in the Soroksar branch. Groundwater beneath Czepel Island is high in nitrates. The plant contains three modules, one of which has been rebuilt recently; a second module has been modified to provide phosphate removal.

Previous plans to improve water pollution control include a master plan in 1962 and a development plan for the period 1976-1990. Very recently, a definitional mission for a proposed study funded by the Trade and Development Program (TDP) of the U.S. Department of Commerce was completed in November 1991. An updated master plan outlining four alternative development plans was prepared by the municipality, assisted by two local consulting firms, and submitted in January 1992. The preferred alternative would include expansion of the North Budapest plant; construction of a new central plant on Czepel Island, which would discharge into the main stem of the Danube; and construction of two new plants in the south Buda area. The South Budapest plant would not be abandoned, but its flows would be diverted to the main stem of the Danube. Political objections have been raised to this alternative, and the mayor of Czepel Island has threatened to withdraw from the metropolitan area rather than allow the central plant to be built. On March 25, 1992, the local consultant to this WASH Danube study indicated that the municipality is planning to ask that the scope of the TDP study be limited to a feasibility study for the potential service area of the North Budapest plant, pending the resolution of the political aspects of a metropolitan plant.

Basis for Inclusion

The reasons for assigning a high priority to early solution of some of the problems of the Budapest system are as follows:

- Budapest, which accounts for 20 percent of Hungary's population and about 40 percent of its industry, is the largest source of wastewater pollution in the country; reducing the pollution from this source would be a major contribution to the international program to reduce pollution of the Danube River.
- Budapest has recently been selected as the site of the 1996 World Exposition, celebrating 1100 years since the settlement of Budapest by the first Hungarian se[illegible]; investment in water pollution control would underscore Hungarian confidenc[illegible]n planning for a cleaner future environment and ensure a cleaner Danube in view of the bankside grounds of the exposition.

- The wastewater authority of Budapest has a proven record of good operation and maintenance, and it should continue to play a leading role in water pollution control and in advising other municipalities.
- Upgrading and expanding the existing North Budapest wastewater treatment plant can be accomplished at lower unit cost than for providing complete new facilities, as would be needed at most other problem locations.
- The relatively greater economic base of Budapest, compared with other cities, means a higher likelihood of success.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Budapest are the justification for and feasibility of early investment in, for example, one or more of the following:

- Rehabilitation and improvement (possibly including the addition of nutrient removal) of the existing wastewater treatment plants;
- First-phase replacement of parts of the water distribution system;
- An upgraded water metering and meter reading program;
- Improved management and revenue collection systems; including a program of consumer relations and tariff reconstruction;
- In-factory waste conservation measures and improved pretreatment of industrial wastes; and
- A long-term program for sludge treatment and disposal.

B.2.4.2 Moson Island Communities

Background

Moson Island is formed by the main stem of the Danube and the Moson branch in northwest Hungary, on the border with Slovakia. Public drinking water is obtained from bank-filtered supplies and wells, located within a coarse sand and gravel surface aquifer, which is highly susceptible to the effects of wastewater pollution. The fragile condition of the groundwater is aggravated by several hydraulic factors: flows in the Moson branch are very low or nonexistent during low-flow periods for the main-stem Danube; during floods, water ponds in the Moson branch as a result of backwater effects from the main-stem Danube downstream from the island; and continued construction or use of completed works in the controversial Gabčikovo-Nagymáros project (involving the diversion of the main-stem Danube into a man-made canal in Slovakia) would eliminate essentially all flows into the Moson. Should the project be abandoned, pollution control for the main-stem Danube would remain a priority in order to

enhance the recreational and conservation values in the region of the Danube Bend downstream, which has been developed for tourism and is an area of great scenic beauty.

- Győr and Neighboring Villages

  The city of Győr has a population of 120,000 and is reportedly the largest industrial center in Hungary; it produces machinery, textiles, processed food, and alcoholic beverages. The estimated wastewater flow is 60,000 cmd, half from industry, discharged into the Moson branch of the Danube. The county of Győr has sponsored a wastewater master plan for Győr and about 16 other towns within the county. Implementation of the plan has been slowed by lack of funds and essentially limited to construction of the Győr wastewater treatment plant. Facilities completed to date include preliminary treatment facilities (coarse screens, aerated grit removal) which are in operation, and the civil works for aeration (by diffused air applied in a modified carrousel tank) and secondary clarification. Sludge treatment (designed but not funded) is to be by digestion, belt dewatering, and drying beds.

  Only 70 percent of the city is sewered, and the remainder is served by septic tanks and soakaways; some areas have nightsoil service. Seepage from the unsewered areas menaces the groundwater supplies. The sewer system carries wastewater and stormwater. A distillery produces 15,000 cmd of wastewater with no pretreatment, which results in a high BOD_5 of 400 mg/L at the Győr treatment plant site. For industries whose wastewaters cannot be treated biologically, 70 percent provide pretreatment.

  For neighboring communities, five wastewater treatment plants are planned ranging in size from 800 to 8,200 cmd. The largest community has an overloaded plant, which receives flows from heavy industry, including bauxite, machinery, and galvanizing operations. No sludge treatment is provided, and toxic sludge from the plant is tipped illegally in the countryside, polluting the groundwater.

- Komárom and Neighboring Villages

  Komárom is located on the Danube, upstream from an area of traditional summer homes and recreational use of the river for bathing and sport fishing. Komárom has a population of 20,000, essentially all served by public water supply and a combined sewer system. Szony, a nearby suburb of 1,500 houses, has a separate sewer system under construction, to be completed by 1993. Planning is under way to provide sewers for a western suburb of summer homes and villagers. A slaughterhouse discharges to the sewer system and is the biggest industrial problem. An oil refinery has its own biological treatment plant and discharges to the river, as does a brewery in Szony. A textile plant may go out of business. Two areas (a former monastery and a former military barracks) are being promoted for major new developments: an industrial park for businesses and refugees to be relocated from Hong Kong and a recreational area.

  Designs for a 4,520-cmd treatment plant were prepared, but the chief engineer of Komárom believes the first-stage capacity should be 6,000 cmd so as to include Szony.

An eventual capacity of 12,000 cmd is needed to accommodate western and eastern suburbs. Thus, there is an apparent need to update the wastewater development plans for Komárom and vicinity before proceeding into construction. Originally, Komárom was one of eight cities in Hungary on a priority list for construction of wastewater treatment plants (including Győr and Szolnok), but no funds were received to proceed with plant construction. However, interceptors to the plant site are virtually completed.

Basis for Inclusion

The reasons for assigning a high priority to early solution of some of the problems of these systems are as follows:

- Should the CSFR begin operation of the Gabčikovo hydroelectric project, flows to the Moson branch of the Danube and main-stem Danube would be curtailed; the effects of water pollution would be magnified and could create a crisis in obtaining safe drinking water supplies from the fragile surface aquifer and bank-filtered supplies.
- Boating and sport fishing on the Danube downstream from Komárom would be protected.
- Providing treatment for Komárom is expected to encourage the provision of additional wastewater treatment on the opposite side of the Danube, particularly within the Váh basin.
- The industrial economic base of Győr appears stable and growing.
- Considerable investments have already been made in wastewater collection and conveyance to plant sites.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for the Moson Island communities, Győr, and Komárom are the following:

- The probable flows and levels of, and effects and fate of contaminants in, the Danube underflow and connecting groundwater and
- The justification for and feasibility of early investment in, for example, one or more of the following:
  - Construction of regional or local wastewater treatment plants for a combination of domestic and industrial wastewaters,
  - First-phase replacement of parts of the water distribution system,
  - An upgraded water metering and meter reading program,

- Improved management and revenue collection systems, including a program of consumer relations and tariff reconstruction, and
- In-factory waste conservation measures and improved pretreatment of industrial wastes.

B.2.4.3 Groundwater Quality Protection and Remediation

Background

Groundwater is the major source of drinking water in Hungary; only 9 percent is obtained from surface waters. Pollution of groundwater is therefore a major issue in protection of public health. Two sources of pollution are of major importance: fuel dumped at Soviet military bases when they were abandoned and a buildup of nitrates and ammonia from overapplication of inorganic fertilizers and from seepage from on-site wastewater disposal systems in unsewered villages.

Cleanup of dumped fuels is an urgent problem at many of the approximately 300 former military sites. As an example, a major spill is known to have occurred at Debrecen, where the fuel is 60 cm deep overlying the groundwater table. Over time, the fuel layer will spread laterally and become thinner and more difficult to clean up. Soluble organics will move from the fuel layer into the groundwater, rendering it impotable. Remediation of dumped-fuel sites has been included in the scope of a TDP project that is aimed at hazardous waste issues for Hungary as a whole. The PHARE program has funded a project to prepare an inventory of groundwater pollution in 24 areas menaced by high risks to water supply. (PHARE has also proposed, and received approval for, a 4.4 million ECU [European Currency Units] basinwide survey of soils, sediment, and groundwater in all the Danube countries.) Fuel contamination of groundwater was mentioned as a high-priority issue in virtually every meeting the WASH team had with high-ranking officials involved in environmental protection.

The buildup of nitrates in groundwater is a problem in all of the Danube countries included in this study. Documentation of the extent of the problem is given in the "Technical Reports" for Slovakia and Hungary (see Volume III). In Hungary there is a strong correlation over the period 1970-1982 between the tons of nitrate fertilizer used each year and the concentration of nitrate found in the Danube and in bank-filtered supplies. Drinking water quality standards cannot be met in 400 of the 2,500 settlements in Hungary, most often because of high nitrate levels. In villages without sewers, the provision of public piped water supply has given rise to a wastewater disposal problem, with an increase in groundwater levels and a buildup in ammonia and nitrogen by seepage from on-site disposal systems. While the focus of this report is on prioritizing emissions problems from industries and municipalities, there is a limit to what can be accomplished by control of point-source emissions alone; due attention must also be given to water pollution from agricultural runoff and excessive use of fertilizers.

Basis for Inclusion

Reasons for assigning a high priority to groundwater quality protection and remediation are as follows:

- It is urgent that dumped fuels be cleaned up quickly before the damage becomes irremediable and while the clean up can be accomplished economically.
- It is also urgent that nitrates in the Danube and its tributaries be reduced to protect bank-filtered water supplies. (As shown in the "Hungary Technical Report," Volume III, nitrate levels in the Danube increased from 1 to 10 mg/L in the 1970-1982 period, and averaged 12 mg/L in the Tisza River in the 1981-1985 period. These values are close to the limit of 15 mg/L, at which infants can be affected.)
- Reduction of nitrates in groundwater may require many years and involve changes in farming methods and regulation of fertilizer application. Thus, it is important that initial actions be taken now, in order to get the process under way.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for groundwater quality protection and remediation are the following:

- Identification of the former military sites where dumped fuels are potentially a problem, and subsurface investigations at those sites to determine the extent of the problem;
- Identification of drinking water supplies at risk from dumped fuels;
- Determination of protective and remediative alternatives and associated costs at dumped fuel sites and prioritization of sites to form a program for site remediation;
- Identification of the causes and geographic distribution in the buildup of nitrates and development of regulatory and institutional measures to reduce the use of inorganic nitrate fertilizers; and
- Development of a program of rural sewerage improvements to reduce groundwater pollution and drainage problems in villages.

B.2.4.4 Lower Tisza River Communities

Background

The Tisza River is a major tributary of the Danube, with a drainage area upstream from Hungary that includes portions of Slovakia, Romania, and Ukraine; it flows from Hungary into Yugoslavia before entering the Danube. The Slovak and Romanian tributaries are polluted

entering Hungary, and further pollution is added within Hungary by various industries and by Miskolc (population 230,000). As pointed out in the "Hungary Technical Report" in Volume III, Hungary adds a relatively higher pollution load to the Tisza River than it does to the Danube or Drava rivers; for example, Hungary adds 65 percent to the incoming COD load in the Tisza, but only 20 percent to the incoming COD load in the Danube. However, the water quality in the lower Tisza is greatly improved after passing through the Kiskore Reservoir, where heavy metals are settled out in the sediments and organic wastes are assimilated.

Planning, construction, and operation of wastewater treatment facilities are well advanced in four cities of the Tisza basin: Miskolc, Debrecen, Szentes, and Szeged. In Miskolc the flow is about 90,000 cmd, for which primary treatment capacity of 140,000 cmd is available and a first module of 70,000 cmd of secondary treatment capacity is under construction. Design of a second module, sludge digestion and dewatering, is being financed by the PHARE program. Debrecen (population 210,000) provides primary treatment to 80,000 cmd and is building a first module with a secondary treatment capacity of 40,000 cmd; raw primary sludge is currently applied to agricultural land, and improved sludge handling and disposal must be addressed in the future. Szentes (population 32,000) has a 6,600-cmd plant, which needs expansion. Szeged (180,000 people) is planning to build a 120,000-cmd plant and add 150 km of sewers, using foreign capital and with construction by a Danish firm (contract under negotiation).

The city of Szolnok is the remaining large city within the Hungarian Tisza basin, and it has significant problems in wastewater collection and treatment. The city contains 80,000 people and several large industries are within or near the city: a slaughterhouse, a pulp and paper mill, a sugar refinery, and a chemical plant. The sewer system serves 60 percent of the population, and an interceptor (2.2 m in diameter) for the future treatment plant site is within 500 m of being completed. The interceptor and plant site have been built in accordance with an engineering report, but final design of the treatment plant has not been accomplished due to a lack of funding. The current plan is to build a first-stage capacity of 40,000 cmd, with provision for an equal-sized second-stage expansion in the future.

The local water and wastewater agency has a staff of 1,400 and is responsible for the city and county of Szolnok; the county contains 426,000 people. In an interview, agency staff expressed concern about organic micropollutants in the surface water supply from the Tisza; in addition to taste and odor problems from phenols and eutrophication within the upstream Kiskore Reservoir, traces of pesticides and herbicides were detected in grab samples. The pollution arrives in waves, which makes it difficult to control the water treatment plant successfully. The agency sees a need to add activated-carbon filtration and ozonation to the existing 40,000-cmd water treatment plant. In other respects the water supply system is in satisfactory condition; water losses are limited to about 10 to 15 percent.

The impacts of water pollution from Szolnok include fish kills from lack of dissolved oxygen; health risks for farmers using the Tisza for irrigation; disgusting conditions within the city on a tributary receiving wastes from the sugar factory; groundwater pollution in unsewered

portions of the city; and the need to use very deep wells (100 to 800 m deep) for water supply to downstream villages. Streamflows in the Tisza have been declining over the past 20 years, which aggravates the water pollution problem. Prior to World War II, the river was safe for swimming at Szolnok, and recreational use of the river is an intended objective of providing wastewater treatment for Szolnok.

Basis for Inclusion

The reasons for assigning a high priority to early solution of some of the problems of this system are as follows:

- Szolnok is the only major city on the Tisza without an active design or construction program to provide wastewater treatment.
- The responsible agency has a proven record of providing water supply to the inhabitants of the county.
- The industrial economic base of the city appears viable and able to support its share of the costs of water pollution control.
- Extension of the sewer system and provision of wastewater treatment will provide noticeable improvements in the urban environment of the city and in water quality conditions in the Tisza River.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Szolnok are the justification for and feasibility of early investment in, for example, one or more of the following:

- Construction of a regional wastewater treatment plant for a combination of domestic and industrial wastewaters,
- An upgraded water metering and meter reading program,
- Improved management and revenue collection systems, including a program of consumer relations and tariff reconstruction, and
- In-factory waste conservation measures and pretreatment of industrial wastes.

B.2.5 Projects in Romania

B.2.5.1 Craiova

Background

Craiova is a major city of 317,000 located on the Jiu River. It is a historical and cultural center with several national universities, and by all appearances, it is a thriving and well-functioning metropolis (with clean streets, buildings in good repair, and continuous heat and electricity, for example, but intermittent water supply).

The WASH team also found the Craiova Agency for Supervision and Protection of the Environment (ASPM) to be exceptional. It has a well-managed, proactive, and knowledgeable team, which is pushing local industries to protect the environment. The agency provided an extensive tour of water and wastewater facilities within the city and a visit to a botanical garden and zoo, and it had on hand a useful set of maps, graphics, and schematics during several interviews. For the chemical platform in Craiova, the agency also provided a summary (in Romanian) of data on production, employment, industrial water supply, wastewater treatment, and emissions (to the air, water, and land).

Total wastewater flows are estimated at 500,000 cmd, of which 56 percent is industrial. Industries produce chemicals, cars, electrical machinery, food, alcoholic beverages, bricks, cement, and thermal power. Ten of the major industrial plants have wastewater treatment plants; a brewery does not. The city's wastewater treatment plant has been designed but only partially built.

Municipal water supply is obtained from five sources: 90,000 cmd from a protected mountain source 120 km away, beyond Tirgu Jiu; 90,000 cmd from a water supply canal, which requires treatment; 17,000 cmd from a well field near the Jiu River, which requires treatment for iron removal; 12,000 cmd from the Gioroc River; and about 9,000 cmd from another groundwater source. The water supply canal and water treatment plant are operated by an autonomous authority, which is also responsible for heating.

Sites visited by the WASH team follow the water supply canal from its origin on the Jiu River, and the wastewater canal that parallels the water supply canal, along the eastern side of the river. The sites, which are described in sequence below, include the following:

- The canal headworks on the Jiu River;
- The potable water treatment plant supplied by the canal;
- The chemical platform, which draws water for some of its needs from the water supply canal and discharges treated effluent into the wastewater canal;
- The brewery which reportedly had no wastewater treatment;
- The wastewater canal, after it has received all of the industrial and domestic wastewater; and

- The municipal wastewater treatment plant site.

The canal headworks consist of a large weir across the river at the northern edge of the city, and about 10 parallel channels to trap coarse sediments. The Jiu River at this point is highly turbid. Coal mines in mountain communities totaling 200,000 population are reported to have turned the river black. Tirgu Jiu, a major city of 150,000 people located upstream, provides no wastewater treatment. Fifteen years ago the Jiu River was clean, but now all the fish have been killed by pollution. A very large ash disposal site from power generation is adjacent to the canal, and may be leaching heavy metals into the canal. Siltation in the Jiu River is a problem downstream from the weir; river water levels are rising, and river water is leaking into the wastewater canal. This in turn is making it difficult for wastewater from the chemical platform to enter the wastewater canal by gravity.

The 96,000-cmd portable water treatment plant is in poor condition. It contains circular concentric tanks of nonconventional design for sedimentation and coagulation, followed by 14 rapid sand filters. The influent turbidity reaches 1,900 JTU, and the effluent turbidity over several months was recorded to be 5 or 6 JTU. The operators and laboratory personnel at the plant made a plea for foreign financial assistance and said that they distrusted their own measurements: very little of the instrumentation and chemical-dosing equipment is workable, the laboratory equipment is old and of primitive design, jar tests are conducted with jury-rigged equipment, staff cannot buy reagents for the laboratory, and there is a lack of money for alum, lime, and chlorine. As a result, the chlorine residual leaving the plant is only 0.1 mg/L. The chemical platform contains a large chemical plant, Doljchim S.A., and an adjacent large thermal power plant. Doljchim uses 9,600 cmd for potable supply from the municipal treatment plant, and it treats an additional 120,000 to 180,000 cmd for industrial process water drawn from the water supply canal. High-purity industrial supply comes from three smaller treatment plants, which produce a total of 36,000 cmd of demineralized water.

Doljchim employs 4,000 to 5,000 workers; it produces NPK inorganic fertilizer and a range of inorganic and organic chemicals. Raw materials include methane gas and potash. At full capacity the plant needs 200,000 cmh of methane, but at present it can only buy 60,000 cmh from Russia in hard currency, and nearby gas fields can only supply 17,000 to 30,000 cmh (higher in summer). The plant was built in three stages, 1963-1964, 1973-1975, and 1980-1985. Total production capacities for each product, in 1,000 t/year, are summarized below:

DOLJCHIM PRODUCTION PLANT

Inorganic Chemicals	Capacity	Organic Chemicals	Capacity
Ammonia	700	Acetaldehyde	60
Ammonium acetate	374	Acetic acid	90
"Azotic" acid	723	Acetylene	60

NPK fertilizer	600	Anhydride acetate	10
Urea	400	Butanol	28
Other	3.75	Butyl acetate	12.5
		Ethyl acetate	7.5
		"Imidizol"	0.5
		Methanol	210
		Nicotinic acid	112
		Polyvinyl alcohol	0.5
		Vinyl acetate monomer	40
		Vinyl acetate polymer	33

Doljchim representatives reported three major problems regarding water pollution:

- Urea production creates a wastewater with high ammonia concentrations, which in turn promotes eutrophication and algae blooms in the Jiu River.
- Acetylene production from methane gas produces black smoke, and water is used to collect the particulates out of the stack gas, which in turn creates a major source of polluted water.
- Several production processes create heavy metal residues—zinc, chromium, copper, and mercury.

Discussion on the black-smoke pollution was somewhat confused, and the following is offered as a possible explanation of the problem. In the original plant, Dorr-Oliver filters were used to remove the particulates, but this system could not be maintained under conditions during the Ceausescu regime. An incinerator was tried next, but it required too much energy. Finally, Russian technology was applied, in which the black smoke is passed through a water column to remove the particulates. The problem is apparently that large quantities of water are required, and the particulates cannot be removed from the wastewater.

Pretreatment facilities associated with many of the production streams are performing adequately. Exceptions include the following:

- Settling of residues from vinyl acetate production is not working well.
- Mercury is released in aldehyde production, and a small plant to recover the mercury for reuse is only 50 percent efficient. Doljchim tried resins but found them too expensive; it was offered an alternative process by Levitit of Holland but had no funds for implementation.

The main Doljchim wastewater treatment plant provides mechanical, chemical, and biological treatment to the pretreated wastewaters. It has been built in three stages, corresponding to the production facilities. The combined-process schematic for the entire plant covers a wall 3 m wide and 2 m high in the plant administration building and indicates a "spaghetti bowl" of piping that connects about 100 unit processes. The team made a brief visit to the newest treatment plant, completed in 1985. From a carefully selected vantage point near the headworks, from which no photographs were allowed, it was apparent that very little of the equipment was operational. One of two primary settling tanks was out of service, and both of the secondary settling tanks were empty. A request to visit the aeration basins was denied because half of the aerators do not work and need replacement. This apparently does not matter, because the concentration of toxics is high and has deactivated the bacteria in the activated sludge process.

The explanation offered for conditions at the plant was that Doljchim is in serious financial difficulty and can only afford to pay 2.5 percent of its budget for labor; the wastewater treatment plant has a staff of only 20 operators for a very complex plant. Wages are very low (about U.S. $35 a month), and this has caused a high turnover in labor for what is seen as a low-prestige job. One outcome of "democracy" has been a loss in worker discipline; workers are unwilling to follow orders, particularly from experienced managers who were in place under the previous regime. To overcome this problem the technical director of the plant wears the same type of dilapidated clothing as the workers and follows the technique of "managing by walking around."

The annual emissions (t/year) in the treated effluent are reported to be 4,182, ammonia; 6,848, acetate; 6,586, BOD_5; 15,220, COD-Cr; 2,520, suspended solids; 1.8, mercury; 457, zinc; and 5.63, copper.

Plans to modernize the Doljchim plant include the following:

- Modernize or replace the pretreatment facilities, to include ammonia recovery;
- Install a centrifuge to remove "black-smoke" particulates and change to an electrostatic precipitator for air pollution control at a later date;
- Change the flow path of wastewater created in producing diesel fuel; and
- Install an autoanalyzer for air pollution control, to limit the current use of water for removal of black smoke (at an estimated cost of 1 million French francs).

At the brewery, the plant manager initially insisted that the brewery did not cause any pollution. At the insistence of staff from the Environmental Inspectorate, the appropriate technician was located. The brewery at one time had a treatment plant, which included sedimentation and decanting, but it is out of order and essentially abandoned. According to the brewery's records, the wastewater flow is 2,850 cmd, and the range in suspended solids is 250 to 300 mg/L; no data were available on COD or BOD_5, but typical values of BOD_5 in Romania for brewery wastewaters are reportedly in the range of 500 to 600 mg/L. The

Environmental Inspectorate said its data showed a much stronger waste, but the data were not available at the meeting.

The representatives from the Environmental Inspectorate estimated that 95 percent of the population is served by sewers, and that a major portion of the wastewater canal is been converted into a covered box culvert. The only portion of the wastewater canal the study team saw was a section near the future wastewater treatment plant, where the wastewater was flowing in an unlined ditch for at least 2 km to either side of the vantage point.

The Craiova wastewater treatment plant has a designed dry-weather flow of about 200,000 cmd and a wet-weather peak flow of 860,000 cmd. The flow in the wastewater canal was estimated visually to be in the range of 400,000 to 500,000 cmd, during a period of snow melt. The dry-weather flow is estimated at 160,000 cmd. The plant was in the very early stages of construction when funds ran out. Items completed include an access road, site clearing and grading, electrical service, one small tank, a start on the administration building, and a small construction camp.

The Environmental Inspectorate reported that the Jiu River is heavily polluted downstream from Craiova and that the river is "dead" to mouth at the Danube. Three animal feedlots downstream from Craiova contribute a heavy organic load from 100,000 pigs. At the largest feedlot, containing 60,000 pigs, a wastewater facility designed for 10,000 pigs is not functioning. (The pig-raising industry is largely for export to Germany.)

Basis for Inclusion

The reasons for assigning a high priority to early solution of some of the wastewater-management problems of Craiova and the Doljchim chemical platform are as follows:

- The very poor condition of the Jiu River, currently considered "dead" from organic and chemical pollution;
- Pollution by toxic, oily, and organic chemical wastes from the chemical plant;
- The urgent need for protection of the drinking water supplies to downstream communities along the Jiu and Danube;
- The possibility of completing the Craiova treatment facilities at a somewhat lower unit cost than that for providing complete new facilities, as would be needed at most other problem locations; and
- The apparent long-term viability of the industrial base of the local economy, which enhances the potential implementability and sustainability of environmental improvements.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Craiova and the Doljchim chemical platform are the justification for and feasibility of early investment in, for example, one or more of the following:

- Replacement and reinforcement of parts of the water distribution system,
- An upgraded water metering and meter reading program,
- Completion of the municipal plant and upgrading of industrial wastewater treatment plants,
- Improved management and revenue collection systems, including a program of consumer relations and tariff reconstruction,
- In-factory waste conservation measures and improved pretreatment of industrial wastes, and
- Facilities for appropriate sludge treatment and disposal.

B.2.5.2 Rimnicu-Vilcea

Background

Rimnicu-Vilcea is an industrial city of 110,000, located on the Olt River, about 60 km northwest from Pitesti. A major industrial platform, Govora, employs 15,000 workers and is located 12 km downstream from Rimnicu-Vilcea. Salt from local salt mines and petroleum from the Pitesti oil field are used in two chemical plants. The industrial wastewater discharged into the Olt River includes brine, which has a deleterious effect on irrigation and municipal water supply downstream on the Olt and Danube. The high salt content in Olt River water has led to its reputation as a "dead" river, considered to be the most highly polluted in Romania. However, it has also been said that dilution of the brine is adequate during many parts of the year and that drinking water standards are generally met.

- Govora Industrial Platform

  Govora stretches for about 5 km in a strip about 2 km west of the Olt River. The major employers are two chemical plants, Oltchim S.A. and Uzinele Sodice Govora S.A. (USG). Machines, hot water heaters, and thermal power (250 megawatts using coal and natural gas) are also produced. Other, smaller industrial platforms exist in the county of Vilcea. Wastewater from industries within the Govora platform enters three lines: Line 1 goes to a biological treatment plant owned by Oltchim, which receives payments from other users; Line 2 is the so-called "clean" water line, which is heavily polluted by illegal or inadvertent

industrial discharges; and Line 3 terminates in lagoons for treatment and storage of residues and in water in storage for controlled releases into the Olt. Water quality samples taken by the Environmental Inspectorate in December 1991 indicated the following:

GOVORA WATER QUALITY

Water Quality Parameter	Line 1, Biological Treatment	Line 2, "Clean Water"	Line 3, Lagoon
Flow (cmd)	14,100	249,400	11,850
pH	7.8	9.7	13
Chlorides (mg/L)	156	1,347/1,200	42,540/77,000
Ammonia (mg/L)	--	17.5	49.5
Sulphate (mg/L)	--	104/400	--
Mercury (mg/L)	--	.0037/.005	--
Effluent BOD_5 (mg/L)	80		
Effluent COD (mg/L)	100		
Effluent TSS (mg/L)	166		

Salt is conveyed from the mines to the platform by pipeline as a strong brine (300 g/L). It was reported that salt in natural runoff from the area is not a significant factor in pollution of the Olt River, although the Ministry of Environment believes it must be taken into account. Chlorides in the Olt upstream from Govora were reported as 50 mg/L in a flow of 100 cu m/s; at Govora the streamflow was reported as 60 cu m/s.

A more significant factor is the river regulation at 20 reservoirs along the Olt (of which two-thirds are upstream from Govora) for purposes of peak-load hydropower and irrigation. If the brine from the lagoons could be paced exactly to the river flow of 60 cu m/s, the increase in chlorides in the river water would be about 175 mg/L (assuming 77,000 mg/L in a flow of 12,000 cmd from the lagoons). This might prove to be marginally acceptable, although the low-permeability, clayey soils in the irrigated areas downstream are reported to be highly susceptible to structural changes caused by salty water. The current mode of reservoir operation is not attuned to environmental considerations, nor to the preservation of active volume in the reservoirs. During a single daytime visit by the WASH team, a major tributary of the Olt was bone-dry in one period and a raging torrent in a second period. High velocities during power peaking are eroding sediments from the riverbed and filling the reservoirs quickly. The lack of storage for industrial emissions prevents pacing their discharge to match the highly variable river

flows. A more sensible approach might be to change the hydropower operations to base-load power and low variability in flows, at least for the six reservoirs within the county of Vilcea.

Oltchim S.A. employs 7,000 workers, and produces 70 chemical products, ranging from caustic soda and chlorine (by mercury cathode electrolysis) to chlorinated hydrocarbons (including pesticides and herbicides). Production processes and equipment were imported. Oltchim is planning plant changes, including changing from electrolysis to reverse osmosis and installation of incinerators for burning toxic residues from chlorinated hydrocarbon production. Oltchim is joining with overseas suppliers and marketers to form an international association for lindane production in an environmentally safe manner. Using an infusion of foreign capital, it plans to reduce residues to 4,000 T/year. This includes the introduction of U.S. technology for oxo alcohols (epoxy resins from epichlorhydrene) to eliminate all residues from this process. Four lagoon cells (3.6 ha surface area), which are used to store organic residues, will be covered with soil or the residues burned. The Research and Design Institute for Wastewater Treatment, under the Ministry of Industry, is conducting a four-year study on the sources and magnitudes of industrial emissions in the Olt basin. Oltchim's assessment is that it has the technical capability to reduce pollution and lacks only an appropriate combination of governmental and foreign funding.

The capacities, existing utilization, and future plans for the various Oltchim products are summarized below:

OLTCHIM PLANT PRODUCTION

Product Type	Installed Capacity, T/Year	Existing Utilization, Percent of Capacity	Future Plans
PVC	175,000	60	Unchanged
Caustic Soda (NaOH)	400,000	60	300,000 T/year to reduce chlorine air emissions
Solvents, including carbon tetrachloride	40,000	60	May stop in 1993
Oxo alcohols	63,000	60	Higher, using new technology
Phosgene	8,000	10	Limited by pollution and availability of phosgene from another chemical plant
Pesticides	8,000	0	Stopped mid-1991
HCH pesticides	10,000	0	Stopped mid-1991
Lindane	0	0	800 T/year exported to USA

The USG plant employs 3,000 workers and produces caustic soda (650,000 T/year capacity), sodium silicate (158,000 T/year, largest in Romania), zeolytes ("molecular sieve"), and low-phosphate detergents (small levels in 1991, plans to increase). The plant is currently operating at 60 percent of capacity, and half of the output is exported. The major residues produced are calcinates, which are precipitated on the bottom of lagoons occupying 165 ha; accumulated deposits now stand about 20 m above the land along the Olt River. The decant from the lagoons is high in chlorides (40,000 mg/L average, according to USG) which causes a 100 mg/L increase in chlorides in river water. In addition to the lagoons for precipitation of solids, 30 days of storage (500,000 cu m) in basins is used to keep the effluent flow paced to the highly variable streamflows. Organic wastes from toilets are discharged to the biological treatment plant.

At present, USG would prefer to pipe the salty decant from the lagoons a distance of 187 km to the Danube, in accordance with one of the alternatives examined in a Ministry of Environment study. The approximate cost would be 6 billion lei in current prices (about U.S. $20 million). The decant stream cannot be recycled into the plant, and crystallizing the salt would require high energy costs to go from 12 to 40 percent salt. Reverse-osmosis membranes have been studied, but their use would require foreign investment. The USG's use of water is about 10 cu m/T of product, which is considered efficient. USG believes that its plant is economically viable and that locating plants on the Mediterranean Sea or Arabian Gulf would have no clear economic advantage. Concerning its pollution problem, USG would welcome contact with consultants or pollution-equipment suppliers concerning techniques for recycling or reducing brine emissions and the associated costs, operational problems, and level of reductions obtained.

Within the Oltchim site, the WASH team visited a chemical neutralization facility and a chemical treatment facility. Diffused-air mixing at the neutralization facility appeared to be working well. The chemical treatment facility was relatively elaborate and included chemical neutralization, settling of precipitates, decanting, and release of volatile organics by air mixing. The flow was substantial and the effluent was milky brown and malodorous from organic chemicals. Part of the effluent from this plant is sent to the Oltchim biological treatment plant, and the remainder is discharged into the "clean" water channel (Line 2).

The Oltchim biological treatment facility (receiving flows from Line 1) has a capacity of 16,000 cmd and treats domestic wastewater generated within the platform amounting to 1,200 cmd. The head end of the plant is for physical-chemical treatment and includes a swirl concentrator, decant/settling tanks, and clarifiers. Biological treatment begins in a mixing zone of the aeration basins, where domestic wastewater and return activated sludge are mixed with the incoming chemically treated flows.

Fifty-four surface aerators are being replaced. The older design for mechanical aerators is also in use at the Arpechim oil refinery and at the Rimnicu-Vilcea municipal plant. The design uses gear wheels for speed reduction and a device to raise or lower the impeller to change the power consumption and oxygen input to the water. It was reported

elsewhere that the mean time between failure for this aerator is only about 2 months, compared with 15 years on an imported aerator from the United States. The impeller is shaped like those in the flocculation basins of water treatment plants, in which shearing of the floc is a primary consideration. In the newer design, the gear reducer is eliminated and the impeller contains blades more suitable for aeration. Such equipment has been developed in Romania through close collaboration between sewage treatment plant (STP) designers and equipment manufacturers, but without any opportunity to obtain licenses from, or make visits to, foreign suppliers having greater experience.

The biological plant appears to be working well; it achieves 90 percent removal of BOD_5 and suspended solids from a very strong waste (influent concentrations of about 1,600 mg/L). The chief operator and his laboratory staff displayed considerable enthusiasm and pride in the operation of the plant, and the effluent appeared clear and nontoxic to mosses and vegetation in the vicinity.

The "clean" water channel (Line 2) was examined by the team near the Olt River. It appeared to be as polluted as the raw chemical wastewater entering the biological STP.

The lagoons and basins (Line 3) were also examined, and they appeared to be well constructed and operated. The residue in the lagoons has the appearance of gypsum, and it is homogenous across the entire expanse of the 165-ha site. The residue was described in Bucharest as a calcinated sodium carbonate with high chlorides. No one could give a satisfactory answer as to whether the material has a commercial value for reuse. On the day of the team's visit, the downstream town that takes its drinking water from the Olt had requested that brine discharges be curtailed due to high chlorides in the reservoir near the town, and the basins were being filled from the lagoons with very little discharge to the river.

- Rimnicu-Vilcea Municipal Wastewater

The municipality operates a biological wastewater treatment plant with a capacity of 90,000 cmd, which is receiving 110,000 cmd, according to the plant manager. The Vilcea Environmental Inspectorate reported the plant capacity as 36,000 cmd, which is a better match with the population of the town. The plant contains coarse screens, grit channels, air flotation for grease removal, primary sedimentation, mechanical aeration, and clarifiers; sludge is digested, dewatered, and applied to drying beds. The influent of BOD_5 and COD is 90 and 300 mg/L, respectively, and the effluent was reported to be 20 and 65 mg/L.

Management of the plant falls under a public utility authority responsible for electricity, heating and hot water, water supply, and wastewater. The city is suffering severe shortages of water supply, electricity, and heat. The town takes its water supply from shallow wells 20 km away and from the Cheia River (after filtration and chlorination). A new water supply from 50 km away is under construction; about 10 km of pipeline were built before funding ran out.

Operation of the plant is severely hampered by power shortages and lack of operating personnel. Some power is generated from digester gas, but the plant has only five operators. Four workmen were in evidence during a team visit, and it seems apparent that the plant is shut down at night when power is not available. The return activated sludge entering the aeration basins was black and malodorous, and the sludge in the secondary clarifiers was bulking from methane production. However, the quality of construction was reasonable, and the plant (including the laboratory) seemed to be well maintained. The plant manager asked a number of technical questions (mechanical aeration versus diffused air, marketing of excess methane production) and was concerned and apologetic about the current performance of the plant.

Basis for Inclusion

The reasons for assigning a high priority to early solution of some of the wastewater-management problems of the Rimnicu-Vilcea municipality and the Govora industrial platform are as follows:

- The serious condition of the Olt River, currently considered "dead" from pollution by salt;
- Pollution by toxic, oily, and organic chemical wastes from the two Govora chemical plants;
- The urgent need for protection of the drinking water supplies of downstream communities along the Olt and Danube;
- The possibility of upgrading the existing treatment facilities at lower unit cost than for providing complete new facilities, as would be needed at most other problem locations;
- The conscientious and responsible management and operation of the existing treatment plants, which provides assurance that new or improved facilities would be used effectively; and
- The apparent stability of the industrial base of the local economy, which suggests that loans for capital improvements would be repaid and that funding of annual operations and maintenance costs would be sustained.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Rimnicu-Vilcea and the Govora industrial platform are the justification for and feasibility of early investment in, for example, one or more of the following:

- Replacement and reinforcement of parts of the water distribution system,
- An upgraded water metering and meter reading program,

- Expansion and upgrading of the existing municipal and industrial wastewater treatment plants,
- Improved management and revenue collection systems, including a program of consumer relations and tariff reconstruction,
- In-factory waste conservation measures and improved pretreatment of industrial wastes, and
- Facilities for sludge treatment and disposal.

B.2.5.3 Pitesti

Background

Pitesti is a city of about 175,000 on the Arges River, located about 100 km upstream from the Bucharest water supply intake. Biological treatment of municipal wastewater is provided, but without nutrient removal. A reservoir of 50 million cu m is located on the Arges River downstream from Pitesti, and the nutrient levels are sufficient to promote eutrophication in the reservoir and algae blooms, which affect Bucharest's water supply. Arpechim, the largest oil refinery in Romania, is located in Pitesti; its wastewater is treated and discharged into an adjacent stream, the Dimbovnicu River, which rejoins the Arges River downstream from Bucharest. The Pitesti and Arpechim wastewater systems are described separately below.

- Pitesti Municipal Wastewater

  The Pitesti wastewater treatment plant has a capacity of 150,000 cmd and was built in three stages (completed in 1967, 1972, and 1988). A new expansion of 43,000 cmd is under construction. Half of the flow is from industry, which produces dyes, beer, rubber, electric motors, chemicals, furniture, meat from a slaughterhouse, and wine. Twenty industries provide pretreatment of wastewater, but essentially all are poorly operated and at times affect the performance of the municipal treatment plant. The influent BOD_5 and suspended solids are in the range of 150 to 200 mg/L, and an effluent quality in the range of 15 to 30 mg/L is usually achieved.

  The combined sewer system delivers wastewater by gravity to the treatment plant, where an overflow chamber is provided to catch a portion of stormwater flows and large plug flows from industry. Coarse and fine screens are followed by grit and grease removal, primary settling, aeration by diffused air, and secondary clarification. Sludge is thickened (separately for primary and secondary sludge in Stage 2 and 3 facilities, and combined sludges in Stage 1 facilities), digested, thickened, and applied to drying beds. The drying beds do not perform satisfactorily, and there is currently a plan to install plate filter presses, which have been tested successfully on the sludge. By all appearances, the plant has been well designed and is well operated and maintained. Because of rapid fluctuations

in influent quality from industrial flows, plant staff expressed a need for better instrumentation and process control, including a computerized control room.

A study of nutrient removal was conducted two years ago, and tertiary treatment for removal of ammonia and nitrates was found to be too costly. Phosphate removal by coagulation and precipitation was also examined, but it was found to entail very high annual costs for chemicals—for example, at 1989 prices and exchange levels, the estimated construction cost was 100 million lei but the annual cost of chemicals was about 270 million lei. To protect Bucharest, the treated effluent could be pumped to the adjacent stream, which is the solution adopted by Arpechim and by another community 40 km downstream from Pitesti.

- Arpechim Oil Refinery

The Pitesti region contains one of the largest oil fields in Romania (the largest is at Ploiesti); between the two world wars, Romania was the largest oil producer in Europe. Domestic production has declined substantially, and it is now supplemented by imported oil through two pipelines from the Black Sea port city of Constanta. The Arpechim refinery and petrochemical plant, which was built in 1966-1969, can process 7 million T/year of petroleum; under current depressed economic conditions, this equals the total national consumption of petroleum. Two product streams, each with a capacity of 3.5 million T/year, are installed. The first consists of the classic products of an oil refinery: gasoline, aromatics, benzene, paraffins, and biopropanes. A second product stream produces high-density and low-density polyethylene and toluene; chemicals used for medicine, food production, and alcohol; ethylbenzene; carbon black; dimethyl toluene (a fiber used in textiles): styrene; polystyrene; a synthetic rubber that is resistant to oxidation; acrylonite; and cyanoril chloride (a herbicide). The plant is no longer producing methyl captane.

The plant employs 8,500 workers and occupies 1,000 ha. It contains 35 chemical/mechanical pretreatment facilities and three wastewater treatment plants. One of the units is for neutralization of hydrogen cyanide, at a rate of 6,000 cu m/hour; a typical flow from this unit is 2,700 cmd. In the original design of wastewater treatment facilities, the pretreated flows were directed to two treatment plants, one providing physical/chemical treatment and the second providing biological treatment also. Capacities are 900 and 800 cu m/hour, respectively.

Over the years, the product mix has changed and the two product streams have become mixed. A brief team tour of the biological treatment plant verified that the wastewater being received contains too much oily wastes to be susceptible to rapid biological treatment. It also seemed apparent that headwork facilities to skim floating hydrocarbons were in disrepair, which could contribute to problems in treatment. Screw pumps were inoperable, disabled by a rubbery compound that coated the screws, unpeeled in an irregular fashion, and created unbalanced loads and vibrations.

Since 1990, the Research and Engineering Institute for Environment has been doing research to regroup the product streams and separate them to get an optimal biodegradable wastewater. One year has been spent investigating each stream under different operating conditions; however, the 1990-1992 period has been one of abnormal, intermittent operation, which affects the treatability of the wastewater.

Flows from the three plants are sent to two lakes for polishing and then discharged to a small stream. This same stream also receives very salty water from oil-recovery operations and wastes from pork production. Arpechim would like to reuse the effluent from the two lakes for cooling water, but the effluent is high in phenols and organics; in addition, the slurries on the bottom of the lakes are fermenting as a result of inadequate biological treatment. For the three plants as a whole, sludge quantities are small and consist primarily of precipitates from chemical neutralization.

The Arpechim plant also has problems related to air pollution. Imported filter bags have been used to remove carbon black, but many of the bags are broken and there is a lack of hard currency with which to replace them. The plant in general is in need of modern technology for its main-line refining and petrochemical operations; this includes updating of incinerators for burning stack gases to reduce carbon monoxide and sulfur emissions. For particularly toxic liquid emissions, two incinerators are used to burn 40 cu m/hour of water; these require large amounts of fuel, and Arpechim would much prefer to use chemical, physical-chemical, or biological treatment of these wastes. It has examined the literature and is not sure that such technology exists. British Petroleum has obtained suitable results but at high cost.

Basis for Inclusion

The reasons for assigning a high priority to early solution of some of the problems of the Pitesti municipal and Arpechim industrial wastewater systems are as follows:

- The need for protection of the Bucharest water supply by reducing nutrient loads and algae blooms originating from the Pitesti wastewater;
- Pollution of the Danube by phenols and other organic wastes originating from the Arpechim wastewater;
- The potential for the Pitesti wastewater treatment plant to be upgraded to remove nutrients, or for the effluent to be redirected away from the Arges, at lower unit cost than for providing complete new facilities, as would be needed at most other problem locations;
- The apparent conscientious and responsible management of both treatment plants, which provides assurance that new or improved facilities would be used effectively; and

- The apparent stability of the industrial base of the local economy, which suggests that loans for capital improvements would be repaid and that funding of annual operations and maintenance costs would be sustained.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Pitesti and Arpechim are the justification for and feasibility of early investment in, for example, one or more of the following:

- Replacement and reinforcement of parts of the water distribution system,
- An upgraded water metering and meter reading program,
- Improved management and revenue collection systems, including a program of consumer relations and tariff reconstruction,
- In-factory waste conservation and segregation measures and improved pretreatment of industrial wastes in the city, and
- Appropriate facilities for sludge treatment and disposal.

B.2.5.4 Bucharest

Background

Bucharest is the capital and largest city in Romania; it had a population of 2.31 million in 1991. Bucharest also has an estimated 18 percent of the industry in Romania. Industries include paints, protective coatings, beer and other beverages, furniture, leather, tanning, drugs, textiles, machinery, food processing, trams, buses, radio, television, computers, and thermal power. The city is located on the Dimbovita River within the Arges basin, about 65 km upstream from the Danube River.

The city is faced with a complex series of problems in water supply and wastewater management. To address these problems, the World Bank is preparing to sponsor a Master Plan for water supply and wastewater, with Japanese funds. The Terms of Reference for the Master Plan have been developed, and the Regia General de Apa (RGA; the general authority for water and wastewater for Bucharest) will be the Romanian client.

Romania has been impoverished by grandiose projects that could not be completed or, if completed, could not perform adequately or for more than a brief period of time. The legacy of such problems with respect to the Bucharest water supply and wastewater systems is described briefly below.

- Bucharest Water Supply

Total water demand is about 1.79 million cmd, of which 1.3 million cmd is for potable use. About 40 percent of the potable water use is domestic. About half of the industrial use is needed, and the remaining half is wasted. The major industrial demand is from an industrial platform or zone located southeast of Bucharest, followed by industrial demands supplied from Lake Cernica, southeast of Bucharest. In addition, about half of the total supply is lost through leakage in the distribution system and through underregistration of meters manufactured locally. Until very recently, water prices were low and thus water wastage through consumers' leaking plumbing fixtures remains high. As a result, the gross per capita water consumption is high, on the order of 500 to 700 Lcd.

A major problem both in Bucharest and throughout Romania is low-quality water meters and other instrumentation manufactured locally. The government's desire to make Romania self-sufficient resulted in a prohibition against imported equipment. As a result, flow rates must be estimated from estimates of pump performance and hours of operation, and control over water treated processes (such as alum dosing and chlorination) is very poor. Within the past year the RGA has imported 2,500 large meters to begin addressing this problem.

Essentially all the flow in the Dimbovita River is taken for water supply and treated at the Arcuda water treatment plant, which has a capacity of 600,000 cmd and is usually operated under capacity. The western part of the city is supplied with water taken from the Arges River and treated at the Rosu water treatment plant (capacity 520,000 cmd, operating at 700,000 cmd). Groundwater provides about 230,000 cmd for domestic and industrial use, and Lake Cernica provides a low-quality supply of about 230,000 cmd for industrial use. On the Arges River, the new Ogrezeni treatment plant is under construction to achieve a first-stage capacity of 230,000 cmd, to be doubled or tripled in later stages; algae in the raw water during the warm season requires a complex treatment process, including ozonation at two points and activated carbon filters. In the existing treatment plants, algae blooms reduce filter runs to five or six hours, at which point half of the water treated is needed to backwash the filters.

Water transmission is by 6 major pump stations, which serve local networks, supplemented by 37 booster pump stations. An additional 270 pump stations are needed to supply tall apartment buildings. Deficiencies in pipe capacity result in low pressures of 4 to 5 m/head in many areas and intermittent rather than continuous service. Water service is poorest in the older, central parts of the city because Ceausescu prohibited digging up the streets to install larger pipes as the older, single-family homes were replaced by densely spaced tall apartment buildings.

The distribution system contains more than 2,500 km of water mains: 1,600 km of cast iron (CI), 700-km mains of steel, 200-km mains of asbestos-cement (AC) mains, and some reinforced-concrete trunk mains. Socket joints on CI pipe are sealed with rope and

lead, and many joints have been cracked or corroded by earthquakes and stray currents from tram lines; use of CI pipe was suspended in the late 1970s. The worst problems are with locally manufactured steel pipes with welded joints; water hardness prevents internal corrosion, but external corrosion from sandy clay soil destroys the pipe joints in less than five years. Twenty years ago AC pipes were high quality, but substitution of cheaper materials over time (shorter AC fibers) and health concerns have stopped any further use of AC pipe. German PVC pipe is made in Romania, but the maximum size of 110 mm has limited the use of PVC pipe in distribution systems, in which fire flow requirements dictate larger pipe sizes.

Metering of water use by individual customers would be a difficult objective to achieve. Much of the population lives in 400,000 apartments in tall buildings. Cold-water meters are installed for some buildings, but the plumbing layout within a typical building is such that as many as four water meters might be needed to measure consumption for each apartment unit. Hot water for heating and hot water withdrawal are provided from "electro-centrals" using waste heat from power generation. Water leakage and wasteful use from the hot-water distribution system are problems from the perspective of this study, but inadequate heating of apartments is a much greater problem for the residents of Bucharest.

- Bucharest Wastewater

The Bucharest sewer system carries wastewater and stormwater to the Dimbovita River. The system has been reconstructed to carry wastewater in two box culverts beneath the river; stormwater overflows in an open trapezoidal channel above the box culverts. The Dimbovita box culverts have a hydraulic capacity of 18 million cmd, approximately equal to the peak flow for a three-year storm runoff. A weir at the downstream end of the culverts allows diversions of up to 3.9 million cmd to the wastewater treatment plant, and the excess flow spills to the river. A series of six or seven weirs spaced along the trapezoidal channel maintain a minimum water level in the channel, using flows released from a lake at the upstream end. The water level in the lake is too high and has raised groundwater levels sufficiently to flood the basements of apartment buildings.

The Glina wastewater treatment plant, at the downstream end of the box culverts, was started in 1985, and the first of three 650,000-cmd modules is nearing completion. The initial motivation in building the box culverts and treatment plant was to provide clean water for a proposed ship channel to the Danube River in order to make Bucharest a major port. The plant has been designed to provide marginal secondary treatment with 2 million cmd passing through two modules rather than three. Processes include coarse screening, pumping, fine screening, grit and grease removal, primary settling, mechanical aeration, and secondary clarification. A good portion of the civil works has been completed, but very little of the mechanical and electrical equipment has been installed.

Sludge is to pass through thickeners, egg-shaped digestors, and plate presses; on-site storage for three to four months has been provided, along with a conveyor belt to a

railway siding. The plant is expected to produce 1,600 T/day of sludge at 30 percent dry solids. The original intent was to provide for agricultural reuse of the sludge, but that may be prohibited by the Ministry of Agriculture. A sludge disposal site has not yet been identified.

The Glina plant was originally designed for an influent BOD_5 of 170 mg/L, based on extensive pilot plant tests conducted in 1975-1978. As a result of lower production by food-processing plants in recent years, the strength of the wastewater has declined to 110 mg/L BOD_5. Under normal conditions, the BOD_5 is expected to be about 150 mg/L.

The impact of the untreated wastewater from Bucharest on river quality is very noticeable in the Dimbovita and Arges rivers, and in the Danube for at least 20 km downstream from the Arges confluence. The towns of Oltenita and Calarasi (and others farther downstream) take Danube water for their water supplies. A recent report by the Institute of Hygiene and Public Health shows mercury levels averaging 0.2 µg/L (compared with the allowable standard of 0.1 µg/L), and reaching as high as 1.3 µg/L. Zinc often exceeds the allowable limit of 0.6 mg/L. Coliform counts in the Arges consistently exceed 1 million/L, and in half of the samples from the Danube the limit of 100,000/L is exceeded. Faecal coliform counts are also very high; one-third of the samples exceed the limit of 50,000/L. The water treatment plants along the Danube perform very poorly, and as a result the faecal coliform found in filtered water is high; in one-third of the samples, the MPN exceeded 50/L. The Danube is used extensively for irrigation, and sampling has indicated high counts for coliform, faecal coliform, and faecal streptococci. In many downstream towns, the incidence of dysentery and viral hepatitis (type A) is higher than the national median. Cholera epidemics occurred in 1986 and 1988 in Cernavoda, Braila, and Tulcea; these could have been caused by wastewater from towns other than Bucharest.

Basis for Inclusion

The reasons for assigning a high priority to early solution of some of the problems of the Bucharest water and wastewater system are as follows:

- Bucharest is the largest source of wastewater pollution in the country; it accounts for 12 percent of the country's population and about 18 percent of the industry; reducing the pollution from this source would be a major contribution to the international program to reduce pollution of the Danube River;
- The major impact of Bucharest's wastewater on downstream water supplies and the related health risks;
- The Glina wastewater treatment plant can be completed at lower unit cost than for providing complete new facilities, as would be needed at most other problem locations; and
- The relatively greater economic base of Bucharest, compared with other cities, gives a higher likelihood of success.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Bucharest are the justification for and feasibility of early investment in, for example, one or more of the following:

- Completion of the ongoing construction of the Glina wastewater treatment plant, including modifications to accommodate use of imported equipment;
- Replacement and reinforcement of parts of the water distribution system;
- An upgraded water metering and meter reading program;
- Improved management and revenue collection systems; including a program of consumer relations and tariff reconstruction;
- In-factory waste conservation measures and improved pretreatment of industrial wastes; and
- Suitable facilities for sludge treatment and disposal.

B.2.5.5 Braila

Background

Braila is a city of 250,000 people, located on the Danube near the head of the delta; it has several major polluting industries. An overview of the conditions in Braila was given to the team by the director of the local environmental agency. The city does not have a treatment plant, and all wastes are discharged directly into the Danube. The city is carefully zoned and there are two industrial zones, one of which discharges directly into the city sewer system. Waste volumes are monitored and documented, including storm runoff. The main nondomestic sources of wastes are as follows:

- Pig farms: Three pig farms with 10,000 to 30,000 animals each discharge 700 to 2,000 cmd within the city limits. Two have mechanical (primary) treatment and one has biological treatment. They are all overloaded. There is also a very large pig farm outside the city limits.
- Power plant: The flow from the plant is about 3 million cmd, mostly cooling water. The quality is good, except for temperature. Process waters are neutralized and are settled in an Imhoff-type settler and then pumped into the cooling water return.
- Pulp and paper and cellulose fiber plants: The wastes from these two plants (on the same site) are discharged after mechanical and chemical treatment directly into the Danube. The total flow is 720,000 cmd, of which 430,000 cmd receives treatment. The combined effluent has the following characteristics (mg/L):

BOD_5	30-57
COD (Mn)	70-80
TDS	1,100-1,700
TSS	max 526 (limit = 200)
Phenols	max 1.62
Sulfur	6-13
Zinc	up to 14 (from fibers plant)

- Metallurgy industry: This industry is located in the industrial zone of the city and discharges into the city sewer system. The flow is 11,000 cmd, 1,600 cmd of which receive pretreatment. There are high amounts of iron and cyanide in the effluent due to insufficient treatment.
- Others: The industrial zone contains three other relatively significant sources of wastes: a furniture factory with small pretreatment units, a brewery, and a refractory materials plant (a main air pollution source). The brewery at one time produced feed for animals (gluten) on the state farms. Most of these farms are now closed and private farmers do not need the feed, so the gluten is discharged to the Danube. Also, the city water treatment plant discharges alum sludge into the Danube.

The local environmental agency has studied alternatives for Braila wastewater treatment. Two treatment plants are required, with capacities of 86,000 cmd for a south plant and 172,000 cmd for a north plant. The estimated cost for the north plant is 2 billion lei. The city sells water at 16 lei/cu m to domestic customers and at a higher price to industry.

The team visited the wastewater treatment facilities operated by the Dunacor Fibers Plant, which is located within the same industrial platform as the pulp and paper plant. The wastewaters from both plants are treated at one treatment plant run by Dunacor. The treatment plant has a capacity of 480,000 cmd. An equal flow is discharged without treatment from relatively less significant pollution sources.

The treatment plant contains coarse screens and settlers. Chemicals are added into the channels for coagulation, but there are no coagulation/flocculation tanks. A large number of parallel screening units were installed as the plant expanded in phases. Settlers were also added in phases. At the time of the team's visit, one of the settlers had been drained and was being cleaned to remove the sludge that accumulated over time. The scrapers of the settler do not do a complete job. The screens are cleaned manually and this was observed to take a lot of labor. It was apparent that Dunacor was trying to operate the treatment facilities as efficiently as possible. The sludge from the settlers goes to vacuum filters and is used as raw material for low-grade paper. The majority of the originally installed vacuum filters were removed to make room for three gravity microfilters and two screw presses imported from

Norway with 85 percent financing by a Norwegian bank. Pilot tests were made, and partial dewatering with gravity microfilters followed by final dewatering with screw presses gave good results. The main advantage is the energy savings.

The business outlook and the financing of environmental controls were also discussed. The Dunacor technical director believes the high quality of the fiber products makes them competitive in the world market. The world demand for artificial fibers is affected by the demand and supply for cotton fibers, however. Dunacor exports (in U.S. dollars) to many countries: exports totaled $24 million in 1989, $7 million in 1990, $8 million in 1991 and are estimated at $15 million in 1992. The plant employs 5,000 workers, 3,000 of whom are highly trained. Dunacor faces problems in updating both process and environmental control systems, but given the freedom and responsibility to do so, it can afford it. (One month's revenue of 2 billion lei would pay for a new treatment plant with a capacity of 20,000 cu m/hour.)

Basis for Inclusion

The reasons for assigning a high priority to early solution of some of the wastewater-management problems of Braila are as follows:

- The need for protection of the Danube and its delta from the direct discharge of a large municipal and industrial wastewater load;
- The need for protection of the drinking water supply at downstream communities along the Danube and in the delta; and
- The apparent viability of the industrial base of the local economy, which suggests that loans for capital improvements would be repaid and that funding of annual operations and maintenance costs would be sustained.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Braila are the justification for and feasibility of early investment in, for example, one or more of the following:

- Replacement and reinforcement of parts of the water distribution system,
- An upgraded water metering and meter reading program,
- Construction of the municipal wastewater treatment plant and upgrading of industrial wastewater treatment plants,
- Improved management and revenue collection systems, including a program of consumer relations and tariff reconstruction,

- In-factory waste conservation measures and improved pretreatment of industrial wastes, and
- Facilities for appropriate sludge treatment and disposal.

B.2.5.6 Galati

Background

Galati is a major city of 326,000 people located on the Danube at the head of the delta. It is the site of the CSG steel mill, which employs 50,000 workers. Information was provided to the team by engineers from the environmental agency responsible for Galati. There is no municipal treatment plant, and the sewer system is combined. The environmental agency inspects a 22-km section of the Danube. An upstream and downstream comparison of BOD levels shows an average of a 5 percent increase in the level of in-stream BOD_5.

The steel mill has a chemical and a metallurgical section. Wastewater from the chemical section goes through treatment and is then combined with wastewater from the metallurgical section before discharge to lagoons. The lagoon effluent in turn is discharged to two tributaries. During 1991 the pollution load from the mill (in T/year) was as follows:

TSS	4,376
Phenol	527
Cyanide	7.3
Ammonia	1,182
Iron	31.2
Flow	160 cmd

Production in 1991 was 50 percent of 1990 production. Available data on 1990 loads include (in T/year) the following:

Phenol	1,002
Cyanide	21
Ammonia	1,928
Iron	50

The mill is highly integrated and is one of the 10 largest in the world (capacity of 4 to 4.5 million T/year). The major pollution source is the coke plant, followed by the cast iron plant, the steel plant, and the final-products plant. Each of these and other plants that make up the steel mill is designed to have its own treatment plant. The investment for pollution control (air and water) has been 7 to 8 percent of total investment for the complex. World practice is

about 20 percent. CSG has an ongoing program to reduce the pollution. It is trying ozone technology for cyanide and biological treatment for phenol. It expects to solve the phenol problem in six to eight months.

CSG thinks that the business outlook is good; at present it cannot even meet domestic demand. Its general problems include Romanian equipment that is below standards and lack of financial control.

Basis for Inclusion

The reasons for assigning a high priority to early solution of some of the wastewater-management problems of Galati are as follows:

- Protection of the Danube and delta from the direct discharge of a large municipal and industrial wastewater load;
- Protection and quality enhancement of the drinking water supply at downstream communities along the Danube and in the delta; and
- The CSG steel mill, if it remains viable in the long term, would be a sound base for the local economy and would thus provide assurance that loans for capital improvements would be repaid and that funding of annual operations and maintenance costs would be sustained.

Key Issues To Be Addressed

Among the key issues that should be addressed in preinvestment studies for Galati are

- Potential impacts on the delta and its ecosystems and on the Black Sea and identification of the highest priority categories of pollutants;
- The justification for and feasibility of early investment in, for example, one or more of the following:
  - Construction of a municipal wastewater treatment plant and upgrading of industrial wastewater treatment plants,
  - Replacement and reinforcement of parts of the water distribution system,
  - An upgraded water metering and meter reading program,
  - Improved management and revenue collection systems, including a program of consumer relations and tariff reconstruction,
  - In-factory waste segregation and conservation measures and improved pretreatment of industrial wastes, and
  - Facilities for sludge treatment and disposal.

Appendix C

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