JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF WATERS, FORESTS AND ENVIRONMENT PROTECTION
ROMANIA

THE STUDY ON THE MASTER PLAN FOR WATER ENVIRONMENT MANAGEMENT ON THE PRAHOVA RIVER BASIN

FINAL REPORT

Vol. II : MAIN REPORT

MARCH 1999

CTI ENGINEERING CO., LTD.
IN ASSOCIATION WITH
CENTRAL CONSULTANT INC.

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The cost estimates in this Study are based on the price levels indicated below and expressed in Romanian Lei according to the following exchange rates:

US$1.00 = Romanian Lei 8800 = Japanese Yen 141.5

As of August 1998

PREFACE

In response to a request from the Government of Romania, the Government of Japan decided to conduct the Study on the Master Plan for Water Environment Management on the Prahova River Basin and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Naohito Murata, CTI Engineering Co., Ltd. and composed of members from CTI Engineering Co., Ltd. and Central Consultant Inc., to Romania, three times between December 1997 and March 1999. In addition, JICA set up an advisory committee headed by Mr.Kenichi Tanaka, development specialist, Institute for International Cooperation, JICA, between December 1997 and March 1999, which examined the study from special and technical points of view.

The Team held discussions with the officials concerned of the Government of Romania and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Romania for their close cooperation extended to the study.

March, 1999

Kimio Fujita
President
Japan International Cooperation Agency

March, 1999

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Sir:

LETTER OF TRANSMITTAL

We are pleased to submit herewith the Final Report for the Study on the Master Plan for Water Environment Management on the Prahova River Basin, Romania. The report contains the advice and suggestions of authorities concerned of the Government of Japan and the Japan International Cooperation Agency (JICA), as well as the formulation of the water environmental management plan for the Basin. Also included are the comments made by the Ministry of Waters, Forests and Environment Protection, and Self-managed Public Company Romanian Waters during the technical discussion on the Draft Final Report.

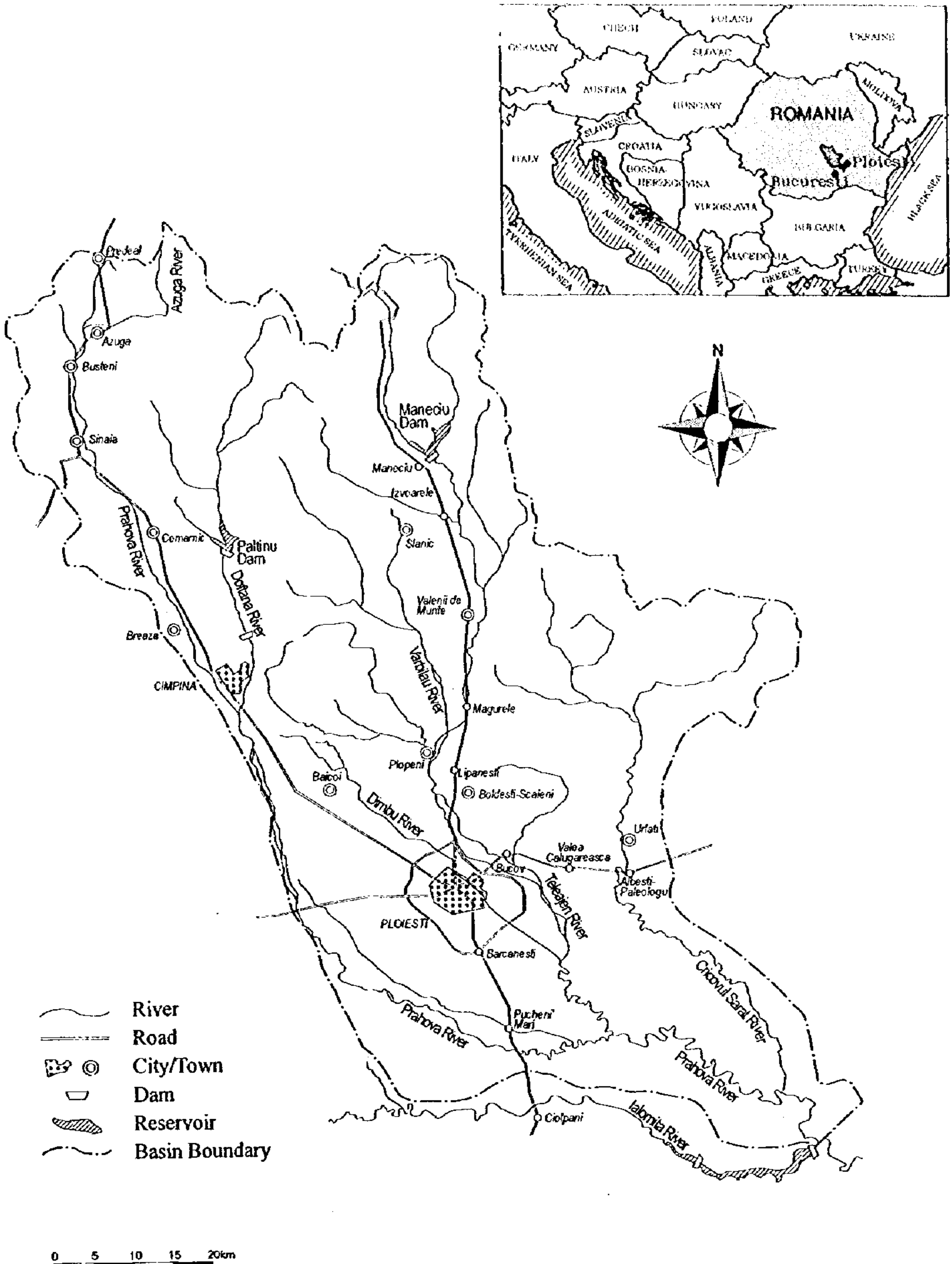
The Final Report presents the Master Plan for Water Environment Management on the Prahova River Basin. In view of the urgency and necessity of the water environmental improvement in the Basin, it is recommended that the Government of Romania should proceed with the feasibility study or project implementation of the priority projects selected in the master plan at the earliest possible time.

Finally, we wish to take this opportunity to express our sincere gratitude to the Government of Japan, particularly, JICA, the Ministry of Foreign Affairs, Environment Agency, Ministry of Construction and other offices concerned. We also wish to express our deep appreciation to the Ministry of Waters, Forests and Environment Protection, Self-managed Public Company Romanian Waters and other authorities concerned of the Government of Romania for their close cooperation and assistance extended to the JICA Study Team during the Study.

Very truly yours,

NAOHITO MURATA
Leader
JICA Study Team

Encl. : a/s



LOCATION MAP

COMPOSITION OF FINAL REPORT

VOL. I : SUMMARY REPORT

VOL. II : MAIN REPORT

VOL. III-1: SUPPORTING REPORT(1/2) (APPENDIX A TO D)

APPENDIX A SOCIO-ECONOMIC CONDITIONS AND LAND USE

APPENDIX B HYDROLOGY AND WATER USE

APPENDIX C RIVER WATER QUALITY AND POLLUTION MECHANISM

APPENDIX D DOMESTIC WASTEWATER TREATMENT

VOL. III-2: SUPPORTING REPORT(2/2) (APPENDIX E TO I)

APPENDIX E INDUSTRIAL WASTEWATER TREATMENT

APPENDIX F MONITORING SYSTEM AND ACCIDENTAL WATER POLLUTION

APPENDIX G LEGAL AND INSTITUTIONAL ASPECTS

APPENDIX H ENVIRONMENTAL EDUCATION

APPENDIX I ECONOMIC AND FINANCIAL EVALUATION

ABSTRACT

1. INTRODUCTION

The Prahova River Basin covers an area of 3,738 km^2 with a total population of 755,000 in 1997. The River, a secondary tributary of the Donau River, runs through the Prahova County located to the north of Bucharest City, the capital of Romania. It is much contaminated by organic and toxic pollutants, especially oil waste. The promotion of integral water environmental management is essentially necessary to solve the current water pollution problems.

In response to the request of the Government of Romania (GOR), the Japan International Cooperation Agency (JICA) of the Government of Japan conducted the Study on the Master Plan for Water Environment Management on the Prahova River Basin from December 1997 to January 1999. The objectives of the Study are:

(1) to formulate the master plan for water environment management on the Prahova River Basin for the target year 2015; and,

(2) to carry out technology transfer to the counterpart personnel of the GOR in the course of the Study.

2. RIVER WATER USE AND POLLUTION PROBLEMS

2.1 Existing Water Use and Supply

The total existing water use in the Basin is estimated at 212.5 million m^3/year with the following breakdown: domestic use of 80.1 million m^3/year, industrial use of 118.8 million m^3/year and agricultural use of 13.5 million m^3/year.

To meet the above water uses, the surface water of 160.0 million m^3/year and groundwater of 86.0 million m^3/year are extracted. The major water supply systems of the Basin are two (2) reservoirs, four (4) intakes, and the related water transmission mains and canals as shown in Fig. 1. They supply approximately 80% of the total extracted surface water to Ploiesti City and its surrounding areas for mostly drinking and industrial uses.

However, a large quantity of water loss is observed in the transmission mains of Romanian Waters (Voila-Ploiesti and Valenii de Munte-Ploiesti). It is roughly estimated at 32 million m^3/year or 30% of the total extracted water.

2.2 Pollutant Sources and Effluent Loads

The wastewater in the Basin is discharged into the rivers from 15 sewerage systems, 86 industrial sources and non-point sources. The sewerage systems collect the wastewater of 322,000 people or 43% of the total basin population and 82 industrial sources. There are 189 industrial pollutant sources in the Basin of which 86 sources are discharged into the rivers, 82 are discharged into the sewerage systems and the remaining 21 are disposed in the other ways.

The effluent pollution load will much increase according to the economic developments in the future if no water pollution control measures are taken. The total existing and future effluent pollution load to the rivers in the Basin are estimated as follows.

Source	Existing (1997)		Future (2015)	
	Wastewater Discharge (l/s)	Pollution Load BOD (ton/day)	Wastewater Discharge (l/s)	Pollution Load BOD (ton/day)
Sewerage	2,191	8.8	2,781	15.7
Industry	1,794	10.0	3,005	25.1
Non-point		14.0		14.4
Total	3,985	32.8	5,786	55.2

2.3 River Water and Wastewater Quality Standards

The Romanian national standards classify river water quality into three (3) categories by water use as shown below.

Category	Permissible Quality BOD (mg/l)	Scope of Water Use
I	5	Drinking water and other water requiring same quality level
II	7	Industrial water and other water requiring same quality level
III	12	Irrigation water and other water requiring same quality level

The other Romanian national standards stipulate that the quality of all wastewater discharged into river and sewerage system must be below 20 mg/l in BOD and 300 mg/l in BOD respectively.

All the drinking water and most of the industrial water in the Basin are extracted from the upper reaches of the rivers or underground where the water quality has no problem. The existing water uses in the middle and lower reaches affected by water pollution are all irrigation water except some industrial water in the middle reaches of the Prahova Main River. The river water quality of the Basin should maintain Category I in the upper reaches, Category II in the middle reaches of Prahova Main River and Category III in the other river sections.

2.4 Existing and Future River Water Quality

The river water quality in 2015, in case of with no water pollution control project, at the principal stations in the Basin is projected as follows, compared to the existing one. This future river water quality will be improved as also shown below when all the sewerage and industrial wastewater in the Basin are treated up to 20 mg/l in BOD in compliance with the national standards. For location of the principal stations, see Fig. 1.

(BOD mg/l)

Station	Location	Existing	Future W/O Project	Future W/ Project	Water Use	Standard
Cimpina	Exit of Prahova Valley	4.3	6.2	3.6	Recreation*	< 5
Nedelea	Upstream of Nedelea Weir	7.4	12.4	7.4	Industry/Agricul.	< 7
Prahova	Prahova Main Downstream	15.2	29.6	9.9	Agriculture	< 12
Moara	Teleajen Downstream	18.2	30.1	12.4	Agriculture	< 12
Ciorani	Cricovul Sarat Downstream	11.0	10.6	10.3	Agriculture	< 12
Adincata	Upstream of Ialomita Junction	14.2	23.5	10.1	Agriculture	< 12

*: Water contact recreation

3. PROPOSED MATER PLAN

The proposed master plan is targeted for the year 2015. It includes the following structural and non-structural proposals.

3.1 Development of Sewerage System and Industrial Wastewater Treatment

The proposed sewerage development includes the rehabilitation/development of treatment plants and the extension of sewer networks in 15 municipalities, and construction of a new sewerage system including treatment plant in one (1) municipality. The wastewater will be treated up to 20 mg/l in BOD. The sewerage served population of the Basin in 2015 is estimated as follows, comparing with the existing one.

Item	Existing (1977)	Future (2015)
Total Basin Population	755,000	815,000
Sewerage Served Population	322,000	394,000
Service Ratio (%)	42.6	48.3

Among the existing 189 industrial pollutant sources in the Basin, 24 sources do not need to be treated and 86 sources will satisfy the wastewater quality standards with no improvement of the existing treatment plants until 2015. Hence, necessary rehabilitation/extension of the existing treatment plants, and construction of new plants are proposed for the remaining 79 pollutant sources. The wastewater will be treated to meet the wastewater quality standards of not only organic substances but also toxic materials.

The total development cost and annual O&M cost of sewerage system and industrial wastewater treatment are estimated as follows.

Item	Development		Operation &Maintenance	
	Number of System/Source	Cost (US$ million)	Number of System/Source	Annual Cost (US$ million/year)
Sewerage System	16	46.7	16	2.6
Industrial Wastewater Treatment	79	49.8	165	14.5
Total	95	96.5	181	17.1

3.2 Strengthening of Monitoring System and Prevention of Accidental Water Pollution

There are a number of point sources in the Basin. The target river water quality of the Basin cannot be attained until the wastewater of all these point sources is treated to meet the quality standards.

The water quality monitoring system including reconstruction of the existing laboratory, water quality sampling/analysis and inspection of wastewater discharge should be strengthened to attain a satisfactory water management of the Basin.

The Basin has been affected by accidental water pollution 18 times since 1989. The most serious accident was the diesel oil leakage from the old pipeline running along the Doftana River. This kind of accident has been repeated eight (8) times over the entire distance of the pipeline, sometimes affecting the drinking water use in the downstream areas. For the pipeline route, see Fig. 1.

Replacement of this old pipeline for the important section with 15.7 km distance is proposed to prevent this accidental water pollution.

The total development cost and O&M cost of the monitoring system and accidental water pollution are estimated as follows.

Item	Development Cost (US$ million)	Annual O&M Cost (US$ million/year)
Monitoring System	1.82	0.95
Accidental Water Pollution	4.70	-
Total	6.52	0.95

3.3 Beneficial Effects and Financial Evaluation

The proposed water pollution control projects will produce the beneficial effects including (i) recovery of the existing water environment losses, (ii) prevention of the tourism income loss in the Prahova valley, (iii) cost saving of the industrial water use in the middle reaches of the Prahova Main River and (iv) prevention of agricultural production loss in the downstream.

When the marginal efficiency of the sewerage development project is assumed to be the financial internal rate of return (FIRR) = 10%, the sewerage beneficiaries of the Basin can bear one-third of the development cost and all the O&M cost. The remaining development cost must be borne by the central and local governments.

When the marginal efficiency of the industrial wastewater treatment project is assumed to be FIRR=10%, the industrial sector of the Basin should annually appropriate 0.7% of the sales amount for the development, and operation and maintenance of the industrial wastewater treatment.

4. RECOMMENDATIONS

4.1 Strengthening of Monitoring System

The Romanian Waters should perform more intensive monitoring on the quality of the wastewater effluents as well as river water to attain a satisfactory water environmental management of the Basin according to the Water Law.

However, the existing monitoring capacity of the Romanian Waters Prahova Office is insufficient in manpower and laboratory equipment. In addition to the manpower increase, urgent improvement of the laboratory is necessary to meet the increasing analytical works of water quality.

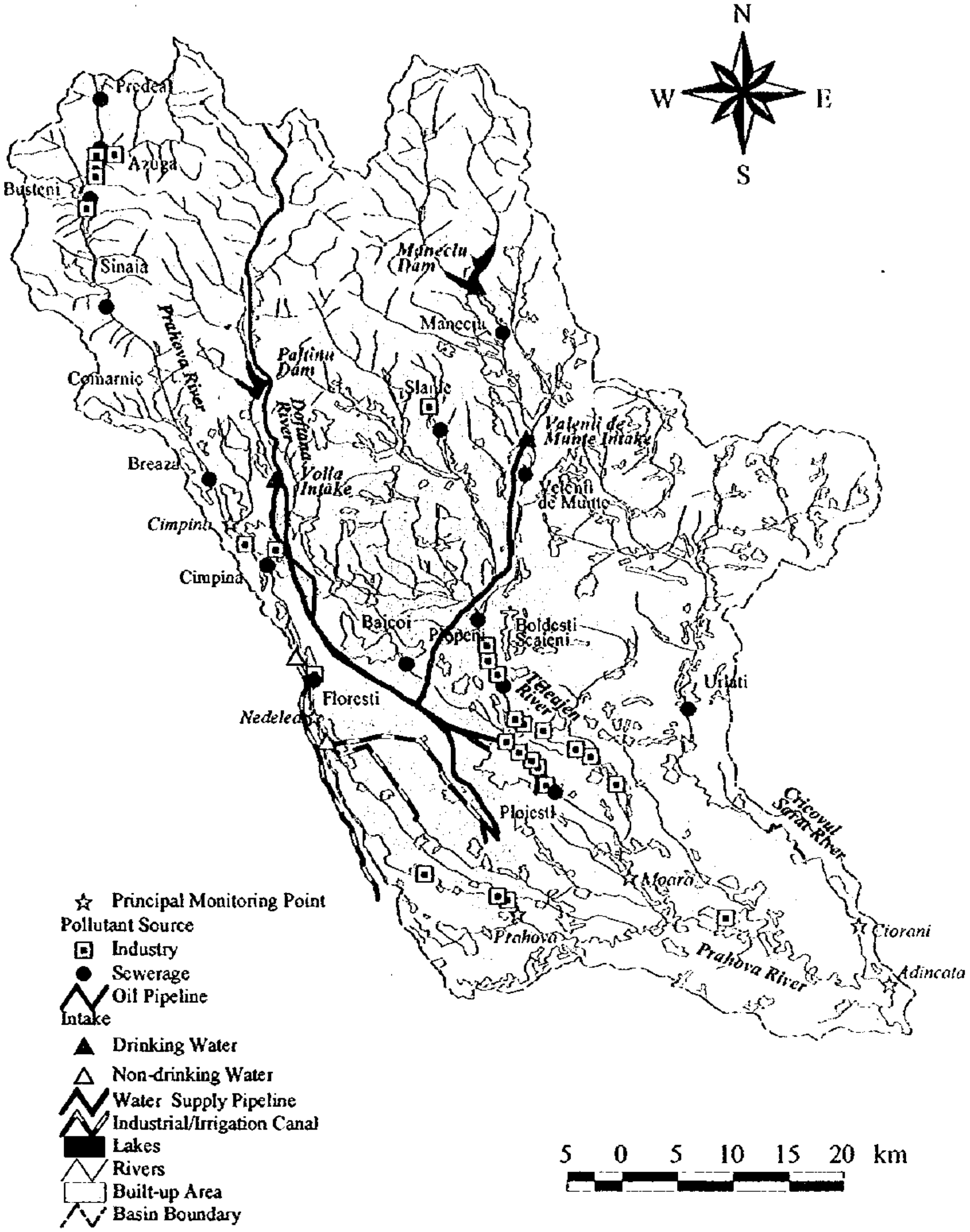
4.2 Project Implementation and Feasibility Study

(1) Feasibility study for the promotion of water management in the Basin should be conducted at the earliest time. The study includes establishment of an advanced laboratory, accidental water pollution control by replacing the oil leaking pipeline along the Doftana River, and prevention of water leakage in the transmission mains of the Romanian Waters.

(2) The Ploiesti City sewerage is the largest sewerage polluter of the Basin. It discharges 73 % of the total sewerage pollution loads or 34 % of the total sewerage and industrial pollution loads of the Basin in BOD. Feasibility study for the development of wastewater treatment has been completed. Early financial arrangements for the detailed design and for construction are necessary.

(3) The petroleum industry is the largest industrial polluter of the Basin. It discharges 73 % of the total industrial pollution loads or 39 % of the total sewerage and industrial pollution loads of the Basin in BOD. Early implementation of the feasibility study for the development of wastewater treatment is necessary.

(4) The sewerage developments of Cimpina City and Prahova valley are also necessary in view of the importance of the water uses in the Prahova Main River. Early implementation of the feasibility study for the developments of wastewater treatment is recommended.



STUDY ON THE MASTER PLAN FOR WATER ENVIRONMENT MANAGEMENT ON THE PRAHOVA RIVER BASIN	**Fig.1 Water Supply System and Pollutant Source**
JAPAN INTERNATIONAL COOPERATION AGENCY	

THE STUDY ON THE MASTER PLAN FOR
WATER ENVIRONMENT MANAGEMENT ON
THEPRAHOVA RIVER BASIN

MAIN REPORT

Table of Contents

LOCATION MAP

CHAPTER	**I**	**INTRODUCTION**	**1**
	1.1	Background of the Study	1
	1.2	Objectives and Area of the Study	1
	1.3	Implementation of the Study	2
	1.4	Composition of Report	3
CHAPTER	**II**	**STUDY AREA**	**6**
	2.1	Climate, Hydrology and River System	6
	2.2	Socio-economic Conditions	7
CHAPTER	**III**	**EXISTING RIVER WATER POLLUTION**	**15**
	3.1	Existing Monitoring System	15
	3.2	Existing Water Source and Water Use	17
	3.3	Existing Pollutant Source and Pollution Load	25
	3.4	Existing River Water Quality and Aquatic Life	43
	3.5	Analysis of River Water Pollution Mechanism	48
	3.6	Accidental River Water Pollution	57
CHAPTER	**IV**	**LEGAL, INSTITUTIONAL AND EDUCATIONAL ASPECTS**	**59**
	4.1	Legislative Framework	59
	4.2	Institutional Set-up	67
	4.3	Environmental Education, Public Awareness and Training	71
CHAPTER	**V**	**WATER DEMAND AND RIVER WATER BALANCE**	**77**
	5.1	Projected Future Water Demand	77
	5.2	River Water Balance	82

CHAPTER	VI	**PROJECTION OF RIVER WATER POLLUTION**	85
	6.1	Basic Assumptions for Projection of River Water Pollution.....	85
	6.2	Projection of Future Baseline Pollution Load Effluent	85
	6.3	Projected Future Baseline River Water Quality.........................	92
CHAPTER	VII	**PROPOSED MASTER PLAN**...	94
	7.1	Objective...	94
	7.2	Planning Target	94
	7.3	Development of Sewerage System...	96
	7.4	Development of Industrial Wastewater Treatment...................	100
	7.5	Improvement of River Water Quality	106
	7.6	Strengthening of Monitoring System and Prevention of Accidental Water Pollution..	106
	7.7	Legal and Institutional Recommendations	108
	7.8	Promotion of Public Participation in Water Environment Management	110
CHAPTER	VIII	**PHASING AND EVALUATION OF THE MASTER PLAN**	114
	8.1	Phased Program...	114
	8.2	Improvement of River Water Quality	117
	8.3	Economic Benefits	117
	8.4	Financial Analysis	120
	8.5	Impact of Economic Growth Change on River Water Quality..	124
CHAPTER	IX	**RECOMMENDATIONS**...	127
	9.1	Strengthening of Monitoring System..	127
	9.2	Project Implementation and Feasibility Study...........................	127

List of Tables

Table 3.1	Existing Laboratory in the Prahova River Basin	T1
Table 3.2	Surface Water Intake Volume	T2
Table 3.3	Inventory of Existing Sewerage System of Cities/Towns	T3
Table 3.4	Average Sewerage Effluent Quantity, Quality and Pollution Load during 1995-1997	T4
Table 3.5	Existing Baseline Sewerage Discharge and Influent/Effluent Quality	T5
Table 3.6	Existing Industrial Wastewater Discharge and BOD Load by Municipality	T6
Table 3.7	Existing Industrial Wastewater Discharge and BOD Load by Category	T7
Table 3.8	Existing BOD Load Effluent to River of Each Pollutant Source	T8
Table 3.9	Existing Average Wastewater Effluent Quantity and Quality of Selected Factories	T11
Table 3.10	Accidental Pollution Record	T12
Table 4.1	Public Awareness Activities by EPA Ploiesti	T13
Table 4.2	Environmental NGOs in Prahova County	T15
Table 5.1	Required Additional Surface Water Extraction	T16
Table 5.2	Existing and Future Probable River Flow Rates	T17
Table 6.1	Future Baseline Sewerage Discharge and Influent/Effluent Quality	T18
Table 6.2	Future Baseline BOD Load Effluent to River of Each Pollutant Source	T19
Table 7.1	Future Sewerage Served Population and Service Ratio	T22
Table 7.2	Future Sewerage Influent Discharge and Quality without Sewer Extension	T23
Table 7.3	Future Sewerage Influent Discharge and Quality with Sewer Extension	T23
Table 7.4	Salient Features of Proposed Sewerage Facilities	T24
Table 7.5	Project Cost for Sewerage Development	T26
Table 7.6	Wastewater Treatment Development of Industrial Establishments	T27
Table 7.7	Monitoring Parameters of Industrial Wastewater	T30
Table 8.1	Phased Program of Sewerage Investment and O&M Cost	T31
Table 8.2	Phased Program of Investment and O&M Costs of Industrial Wastewater Treatment	T32

List of Figures

Fig. 2.1	Prahova River Basin	F1
Fig. 2.2	Water Level Gauge Station and Water Quality Monitoring Point	F2
Fig. 2.3	Administrative Boundary in Prahova County	F3
Fig. 2.4	Land Use Map	F4
Fig. 3.1	Simulation Model Points and Blocks	F5
Fig. 3.2	Major Water Supply System in Prahova River Basin	F6
Fig. 3.3	Existing and Supplementary Water Quality Observation Point	F7
Fig. 3.4	Schematic Diagram for Simulation	F8
Fig. 3.5	Calibration of Water Quality Simulation Model	F9
Fig. 3.6	Existing and Future Baseline River Water Quality	F10
Fig. 3.7	Past Accidental Pollution Map	F11
Fig. 7.1	Future River Water Quality with Project	F12

Attachment

Minutes of Meeting for the Inception Report of the Study on the Master Plan for Water Environment Management on the Prohova River Basin M1

Minutes of Meeting for Progress Report (I) of the Study on the Master Plan for Water Environment Management on the Prohova River Basin M5

Minutes of Meeting for the Interim Report of the Study on the Master Plan for Water Environment Management on the Prohova River Basin M8

Minutes of Meeting for Progress Report (II) of the Study on the Master Plan for Water Environment Management on the Prohova River Basin M12

Minutes of Meeting for the Draft Final Report of the Study on the Master Plan for Water Environment Management on the Prohova River Basin M14

ABBREVIATIONS & GLOSSARIES

AGENCIES/ORGANIZATIONS

Apele Romane	:	Self-Managed Public Company Romanian Waters
EBRD	:	European Bank of Recovery Development
EPA	:	Environmental Protection Agency
EU	:	European Union
ICIM	:	Environmental Engineering Research Institute
ICPT	:	Cimpina Institute for Oil Research and Technology
JICA	:	Japan International Cooperation Agency
MNE	:	Ministry of National Education
MWFEP	:	Ministry of Waters, Forests and Environment Protection
NCEF	:	National Commission for Economic Forecasting
NCSD	:	National Center for Sustainable Development
NGO(s)	:	Non-Governmental Organization(s)
PHARE	:	Poland Hungary Assistance for Restructuring Economy
ROMSILVA	:	Romanian Forestry
UNDP	:	United Nations Development Programme

ACRONYMS

Ave.	:	Average
BOD	:	Biochemical Oxygen Demand
C.A.	:	Size of Catchment Area
COD	:	Chemical Oxygen Demand
EIA	:	Environmental Impact Assessment
FIRR	:	Financial Internal Rate of Return
El., EL.	:	Elevation
Fig.	:	Figure
GDP	:	Gross Domestic Product
GIS	:	Geographic Information System
HG	:	Government Decision
L.S.	:	Lump Sum
Max.	:	Maximum
Min.	:	Minimum
NTPA	:	Romanian Standard
O&M	:	Operation and Maintenance
SS	:	Suspended Solids
STAS	:	The national standards of Romania
VAT	:	Value Added Tax
Vol.	:	Volume
W.L.	:	Water Level

MEASUREMENTS/SYMBOLS

Units of Length

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer

Units of Weight

g, gr.	:	gram
kg	:	kilogram
t, ton	:	metric ton

Square Measure

m^2	:	square meter
ha, has	:	hectare, hectares
km^2	:	square kilometer

Units of Capacity / Cubic Measure

l, lt., ltr	:	liter
m^3	:	cubic meter
MCM	:	million cubic meter

Time

s, sec	:	second
min.	:	minute
hr	:	hour
yr	:	year

Compound Units

mm/hr	:	millimeter per hour
m/s	:	meter per second
km/hr	:	kilometer per hour
mg/l	:	milligram per liter
kg/d	:	kilogram per day
m^3/s	:	cubic meter per second
l/s	:	liter per second
m^3/yr	:	cubic meter per year
$m^3/s/km^2$	:	cubic meter per second per square kilometer
l/c/d	:	liter per capita per day

Others

MW	:	megawatt
%	:	percent
°C	:	Celsius
¥	:	Japanese Yen
$, US$	:	US Dollar

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The Prahova River, with an aggregate drainage area of 3,738 km^2, runs through the Prahova County that is located to the north of Bucharest City, the capital of Romania. It is a secondary tributary of the Donau River. The main river, originating on the Carpatian mountain range which has a peak elevation of more than 2,000 m, flows down the Prahova valley resort area in the upper reaches, the Ploiesti industrial area in the middle reaches, the agricultural area in the lower reaches and finally enters the Ialomita River, the primary tributary of the Donau River, at the southern end of the County.

The River Basin has been developed by various industrial activities for a long time, especially petroleum industry. Due to this industrial development, the River is much contaminated by organic and toxic pollutants. Oil waste causes the most serious damage on the water resources of the Basin. The scarce flow rate of the River further worsens the river water quality. In fact, no fishes are identified in the middle and lower reaches of the River. Promotion of the integrated water environmental management is essentially necessary to solve the current water pollution problems.

In response to the request of the Government of Romania (GOR), the Government of Japan (GOJ) decided to conduct the "Study on the Master Plan for Water Environment Management on the Prahova River Basin" (the Study). The scope of work for the Study was agreed upon between the Ministry of Waters, Forest and Environment Protection (MWFEP) of the GOR and the Japan International Cooperation Agency (JICA) in July 1997. In accordance with the scope of work, JICA dispatched the Study Team to Romania in December 1997.

1.2 Objectives and Area of the Study

1.2.1 Study Objectives

The objectives of the Study which were set up in the scope of work are:

(1) to formulate the master plan for water environment management on the Prahova River Basin for the target year 2015; and

(2) to carry out technology transfer to the counterpart personnel of the GOR in the course of the Study

1.2.2 Study Area

The Location Map gives the location of the study area. The study area covers the entire Prahova River Basin that has a drainage area of 3,738 km^2 upstream of the confluence with the Ialomita River.

1.3 Implementation of the Study

1.3.1 Study Organization

The Study was carried out by a Study Team commissioned by JICA, composed of experts from Japanese consulting firms headed by CTI Engineering Co., Ltd., in association with Central Consultant Inc. To review the findings of the Study, JICA organized an Advisory Committee.

MWFEP acted as the counterpart on the national level, while the Self-managed Public Company "Romanian Waters" cooperated with the JICA Study Team as a daily counterpart agency.

The members of the Advisory Committee and JICA Study Team, and the Counterpart Staff of MWFEP and Romanian Waters are listed in the tables below.

1.3.2 Study Schedule

In accordance with the schedule, the Study was started in December 1997 with completion in January 1999 inclusive of the Final Report. Field and home office studies, as well as reporting, were scheduled as mentioned below.

(1) Stage I (Field Work – mid-December 1997 to mid-March 1998)

The Inception Report was submitted by the JICA Study Team to MWFEP at the start of the Study in Romania and discussed with the concerned officials of Romania. The Report contained the study methodology and work schedule.

At the end of the Stage I, the Progress Report (I) was presented to MWFEP and discussed with the concerned officials of Romania. The Report covered analyses on the existing situation of socio-economy/land use, hydrology, water use, river water quality/pollution mechanism, water pollutant sources, monitoring system/accidental pollution and legal/ institutional aspects.

(2) Stage II (Home Office Work – mid-May 1998 to late June 1998)

The Study was continued in the home office in Japan to project the future conditions of socio-economy, water demand, pollution load generation and river water quality.

(3) Stage III (Field Work – early July 1998 to late September 1998)

At the beginning of Stage III, the Interim Report was presented to MWFEP and discussed with the concerned officials of Romania. The Report presented all the results of the studies in Stage I and Stage II.

During this stage, the water environmental improvement measures including sewerage and industrial wastewater treatment, strengthening of monitoring system and accidental water pollution control were prepared. Further, the other studies necessary for the water environmental management were also conducted. They included analysis of water balance, economic/financial analysis, legal/institutional recommendations and promotion of environmental education.

(4) Stage IV (Home Office Work – early October 1998 to mid-November 1998)

The Study was continued in the home office in Japan to prepare the master plan of water environment management for the Basin.

(5) Stage V (Field Work – mid-November 1998 to late November 1998)

The Draft Final Report was submitted to MWFEP and discussed with the concerned officials of Romania. The Report included all the results of the Study.

(6) Stage VI (Home Office Work – mid-December 1998 to late January 1999)

The Final Report was prepared and submitted to MWFEP.

1.3.3 Technology Transfer

Transfer of technical knowledge on water environment management to Romanian Waters counterpart personnel was carried out through the series of studies and meetings, as follows:

(1) Through the collaborative works on data collection of previous studies/statistics and interviews with people/government officials, the objective and importance of data collection were recognized.

(2) Through the joint observation of river and wastewater quantity/quality, its necessity and measures were understood.

(3) Through the check/review of the existing data and their filing system in Romanian Waters, the importance of proper data filing was recognized.

(4) Through the demonstration workshops, the importance of communication with people concerning water environment management was recognized.

(5) Through the report discussion meetings with the government offices concerned, details of the Project were confirmed.

(6) Through the seminars in Bucharest and Ploiesti, technical knowledge was imparted to the government personnel concerned.

1.4 Composition of Report

This Report consists of four (4) volumes, as follows:

Volume I : Summary

Volume II : Main Report

Volume III-1 : Supporting Report (1/2)

Volume III-2 : Supporting Report (2/2)

The Main Report presents the summarized results of all the studies.

The Supporting Report (Volume III-1) covers the following studies.

Appendix A : Socio-economic Conditions and Land Use

Appendix B : Hydrology and Water Use

Appendix C : River Water Quality and Pollution Mechanism

Appendix D : Domestic Wastewater Treatment

The Supporting Report (Volume III-2) covers the following studies.

Appendix E : Industrial Wastewater Treatment

Appendix F : Monitoring System and Accidental Water Pollution

Appendix G : Legal and Institutional Aspects

Appendix H : Environmental Education

Appendix I : Economic and Financial Evaluation

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3.	Mikio Tani	Water Pollution Control

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CHAPTER II STUDY AREA

2.1 Climate, Hydrology and River System

2.1.1 General Climate

Three (3) types of climate characterize the Prahova River Basin; i.e., mountain, hill and plain. Their average are summarized below.

	Mountain Climate	Hill Climate	Plain Climate
Annual Average Temperature	lower than 6°C	9-10°C	higher than 10°C
Average Annual Precipitation	1,000-1,400 mm	500-1,000 mm	550-600 mm

Seasonal variation of precipitation is not striking although a comparatively large rainfall is distributed in the summer season. The seasonal change of annual average precipitation at the representative locations is shown below.

(unit: mm)

Location	Winter (Dec.-Feb.)	Spring (Mar.-May)	Summer (Jun.-Aug.)	Autumn (Sep.-Nov.)	Annual
Sinaia	159	240	307	199	905
Cimpina	108	184	252	138	682
Cheia	132	202	303	192	829
Ploiesti	107	147	199	127	581
Valenii de Munte	108	164	224	140	636

2.1.2 River System

The Prahova River drains an area of 3,738 km^2 at the confluence with the Ialomita River. The Main River originating on the Carpathian mountain range at Predeal Town runs down through the Prahova valley after the Azuga River joins the left bank. It is further joined by the Doftana River to the left bank at Cimpina City immediately after passing through the Prahova valley. Thereafter, it flows down towards southeast through the Prahova fl[illegible] plain. After the Teleajen and Cricovul Sarat rivers join the left bank, it finally enters the Ial[illegible]iver at Patru Frati.

The river system is illustrated in Fig. 2.1. The salient features of the Main River and the major tributaries are summarized below.

River	Drainage Area (km^2)	River Length(km)	Riverhead El. (m)	Lower-end El.(m)
Azuga	89	23	1,600	940
Doftana	414	51	1,400	360
Teleajen	1,656	122	1,760	80
Dimbu	188	39	340	100
Cricovul Sarat	607	94	600	60
Prahova	3,738	193	1,100	60

For details, see Appendix B, Chapter I, 1.2.

2.1.3 River Flow Regime

The Romanian Waters observe the flow rate of the River at the 12 staff gauging stations listed below. The oldest record dates back to 1951. Location of the gauging stations is shown in Fig. 2.2.

Code	Station Name	River Name	Catchment Area(km^2)	Year Started	Remarks
111204	Busteni	Prahova	130	1993	
111210	Cimpina	Prahova	476	1962	
111215	Prahova	Prahova	984	1957	
111220	Adincata	Prahova	3,682	1951	
111405	Azuga	Azuga	83	1953	1957 -- 1959 suspended
111505	Busteni	Valea Cerbului	26	1958	
111605	Tesila	Doftana	288	1959	
111705	Cheia	Teleajen	39	1966	
111710	Gura Vitioarei	Teleajen	491	1959	
111715	Moara	Teleajen	1,434	1955	
111805	Varbilau	Slanic	42	1969	
112105	Ciorani	Cricovul Sarat	596	1966	
111606	A.C Paltinu	Doftana	334	1971	Paltinu Reservoir
111707	A.C. Maneciu	Teleajen	247	1990	Maneciu Reservoir

The river flow rate at Adincata (lowermost end of the River: 3,682 km^2) is estimated to be 11.67 m^3/s in drought time (95% flow), 14.31 m^3/s in low flow time (75% flow) and 24.23 m^3/s on average. The specific discharges of drought, low and mean flows are calculated to be 0.32 $m^3/s/100\ km^2$, 0.39 $m^3/s/100\ km^2$ and 0.66 $m^3/s/100\ km^2$, respectively.

The flow regime at the eight (8) main stations is calculated below.

(unit: m^3/s)

River	Station	C.A (km^2)	20 %	50 %	75 %	95 %	Min.	Ave.
Prahova	Busteni PH	130	4.54	2.09	1.27	0.43	0.29	3.22
Prahova	Cimpina	476	10.70	5.75	3.95	2.73	2.14	7.57
Doftana	Tesila	288	5.97	2.90	1.91	1.26	0.80	4.07
Prahova	Prahova	984	14.56	7.28	5.42	4.26	3.63	10.64
Teleajen	G. Vitioarei	491	5.65	2.28	1.24	0.70	0.47	4.02
Teleajen	Moara	1,434	11.34	6.93	5.38	4.52	3.97	9.33
Cricovul Sarat	Ciorani	596	1.50	0.85	0.56	0.35	0.21	1.35
Prahova	Adincata	3,682	31.27	18.46	14.31	11.67	10.15	24.23

2.2 Socio-economic Conditions

2.2.1 Existing Socio-economic Condition

(1) Administrative Units in the Basin

Prahova County consists of 100 units including two (2) cities, 12 towns and 86 communes. Among them, two (2) cities, 11 towns and 76 communes fully or partially fall in the Basin. On the other hand, one (1) town and six (6) communes of the neighboring counties are also partially located within the Basin. Then, the Basin covers two (2) cities, 12 towns and 82 communes, fully or partially. Locations of the administrative units of the Prahova County are shown in Fig. 2.3.

(2) Population in Prahova County and Basin

Prahova was the second largest populated county in the country in 1997 next to Bucharest. It counted 864,154 (3.8% of the national population of 22.60 million) with the second highest population density of 184.1 person/km^2 behind Bucharest.

The total population of the County has been declining by 0.2% - 0.4% every year since 1992. The decreasing rate is almost the same as that of whole Romania. During 1990-1997, the population has increased in only 24 administrative units among 100 units, while it has decreased in the remaining 74 administrative units. Ten (10) communes in the central-eastern area of the County have suffered from a population decrease of more than 10%. The southern part of the County is dotted with increased-population areas as opposed to the northern area.

The population of the whole county and major administrative units (2 cities and 12 towns) in 1990 and 1997 are compared as shown below.

City/Town	1990	1997	97/90
Prahova County	880,465	864,159	-1.9%
Ploiesti	259,014	253,414	-2.2%
Cimpina	40,473	40,904	1.1%
Azuga	6,457	6,256	-3.1%
Baicoi	20,344	20,292	-0.3%
Boldesti- Scaeni	11,687	11,583	-0.9%
Breaza	19,153	19,035	-0.6%
Busteni	12,988	12,053	-7.2%
Comarnic	14,274	13,576	-4.9%
Mizil*	17,473	17,175	-1.7%
Plopeni	9,659	10,315	6.8%
Sinaia	15,817	15,063	-4.8%
Slanic	8,115	7,382	-9.0%
Urlati	12,114	11,893	-1.8%
Valenii De Munte	13,893	14,005	0.8%

* outside the basin

The population of the Basin in 1997 is estimated at 754,995. For the population of each municipality located in the Basin, see Appendix A, Table A.1.1.

(3) GDP in Prahova County

The County has been sharing an important role to the Romanian economy. GDP of the County reached 2,082 billion lei or US$ 1,260 million in 1994, following Bucharest.

In 1994, industrial sector (including construction) shared more than 50% of the total GDP of the County. This share is much higher than the average of whole Romania (40%). Petrochemical industry production weighed approximately 50% of the total industrial production of the County from 1992 to 1995 and also in 1997 (data are not available for 1996). This share is very high compared to the average of whole Romania (9%).

Agricultural sector shared 12% of the total GDP of the County in 1994. However, this sector is relatively minor, compared with the agricultural sector of the other counties in Romania.

The total GDP and structure of GDP of the County in 1994 are compared to those of the whole country as shown below.

	GDP		Structure of GDP (%)		
	(billion Lei)	(million US$)	Agriculture	Industry	Services
Whole Country	49,795	30,090	21	40	39
Prahova County	2,082	1,260	12	53	35

Exchange rate : US$1.00=1,655.09 Lei

(4) Agriculture and Livestock

Agricultural area is more than 60% of the total area of the County. Crop land of 146,787 ha (approx. 31% of total area of the County) and wine yard of 10,449 ha (2.2%) spread in the central and southern areas of the County.

Major agricultural products are wheat, maize, sugar beet, sunflower, potato and grape. Agricultural production of the County has been increasing on the whole except sugar beet since 1991 although the land use has not changed during this period.

The crop production in 1997 is shown below in comparison to that in 1991.

(unit: ton)

Crop	1991	1997
Wheat	91,827	108,779
Corn	288,835	365,629
Potato	21,861	42,642
Sunflower	5,860	9,557
Sugar beet	103,631	23,771
Wine	41,839	53,607

Livestock in the County has been declining significantly since 1992. All the number of animals in 1997 has decreased to approximate 30% - 70% of that in 1991 as shown below.

(unit : 1,000)

Kind	1991	1997
Cow	103.7	71.3
Pig	245.0	157.8
Sheep and Goat	310.6	200.5
Hen	4,717.0	1,556.0

(5) Industry

Industry is the largest economic sector in the County, sharing more than 50% in GDP. The industrial structure of the County in 1995 is shown below in monetary term.

Industrial Activities	(%)
Petrochemical	52.2
Machines & Equipment	10.7
Chemical & Synthetic Fibers	6.9
Food & Beverage	5.4
Rubbers	4.3
Non-metallic Minerals	3.9
Electric & Thermal Energy, Gas & Water	3.7
Textile	2.5
Extraction of Energy Material	1.8
Other Activities	8.6
Total	100.0

At present, it is suffering from the privatization process spreading throughout Romania to be completed in 1999. Privatization with introduction of foreign investment is also spreading into big companies in Prahova County such as S.C. Petrotel S.A. Ploiesti, Heavy Bel Bearing Company, etc.

Number of employees in the industrial sector has been decreasing by 21% for 5 years from 170,047 in 1991 to 133,711 in 1996. In this situation, a significant increase of employment has occurred in petrochemical and transportation industries. Employees in all other fields have been decreasing.

(6) Tourism

Prahova has advantages for developing tourism, which will contribute to the economic growth of the County. In 1996, 407,656 tourists visited the County of which foreign tourists were 25,000. Approximately 70% of the total number of tourists visited Sinaia, Busteni and other resorts in the Prahova valley.

Many points for tourism are dotted in the northern mountainous area of the County. There are three (3) zones as main natural tourism resources in the County:

(a) Bucegi Massif (Bucegi Mountain) in the Prahova valley

(b) Ciucas Massif (Ciucas Mountain) in the Teleajen valley

(c) Resort area in the Doftana Valley

At present, 5,100 people are engaged in tourism, and this number is higher than that of other service activities such as banking, public administration, defense and telecommunications. In addition to this, the County has sufficient accommodation facilities for tourists. Its capacity is higher than Bucharest and the highest in Romania.

2.2.2 Existing Land Use

The statistical data on the existing land use of the Basin is available in the Cadastral Department of the County. The land use of each administrative unit is classified into eight (8) categories: arable land, pasture, hay land, vine yard, orchard, forest, water body and others. The existing land use of the County in 1996 was as shown below.

(unit: ha)

Arable Land	Pasture	Hay Land	Vine Yard	Orchard	Forest	Water Body	Others	Total
146,771	72,150	32,406	10,733	17,074	152,222	9,656	30,575	471,587

The spatial land use distribution of the County is shown on the cadastral map with a scale of 1:50,000, published by Institul de Geodezie, Photogrammetrie, Cartografie si Oraganizarea Teritoriului (Institute of Geodesy, Photogrammetry, Mapping and Territory Organizing). This map has not been updated since 1976. Hence, satellite image was analyzed to prepare the current land use map for the Basin.

A field survey was conducted to compare the actual land use condition with the color tone or pattern on the remote sensing image for each land use unit and to extract typical training samples from each land use unit. The field sample data are used for improving the accuracy of the land use map newly produced by satellite image analysis.

Based on the field survey, the present land use of the Basin is classified into the following seven (7) categories: current agricultural land, fallow land, pasture/hay land, forest, orchard, urban/built-up area and water body.

The Basin is divided into the following four (4) major sub-basins from the point of land use pattern: Prahova Main River Basin, Doftana River Basin, Teleajen River Basin and Cricovul Sarat River Basin.

Fig. 2.4 shows the current land use map prepared by the satellite image taken on July 2, 1995. Forest is the most predominant land use in the Basin and it occupies the northern mountain areas. Agricultural land including current agricultural land and fallow land is the second largest and it is distributed in the southern flood plain. Orchards are mostly located on the foot of the mountains and in the river valleys. Small agricultural lands are identified in the upper reaches of the respective rivers.

The current land use area estimated by the remote sensing analysis is summarized by sub-basin and by category as follows.

(unit:ha)

Land Use	Prahova Main		Doftana		Teleajen		Cricovul Sarat		Total	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Current Agricultural Land	33,750	31.8	35	0.1	31,627	19.1	7,355	12.1	72,767	19.4
Fallow Land	11,590	10.9	58	0.1	14,730	8.9	2,784	4.6	29,162	7.8
Pasture/Hay	14,742	13.9	10,440	25.2	30,875	18.7	11,876	19.6	67,933	18.2
Forest	42,831	40.4	30,101	72.7	77,525	46.8	32,323	53.2	182,780	48.9
Orchard	2,456	2.3	410	1.0	7,554	4.6	6,273	10.3	16,693	4.5
Urban/Built-up area	498	0.5	214	0.5	2,864	1.7	88	0.1	3,664	1.0
Water	209	0.2	169	0.4	395	0.2	28	0.1	801	0.2
Total	106,076	100	41,427	100	165,570	100	60,727	100	373,800	100

2.2.3 Projection of Future Socio-economy

(1) Population

Population growth rate of Romania is estimated at - 0.1 %/year from 1995 to 2010 by World Bank. Actually, the annual growth rate of the country has gradually decreased from - 0.2% to - 2.5% during 1992 - 1996.

On the other hand, the concentration of population to the urban area is accelerated in Romania as well as other European countries. The rate of urban population to the total population in Romania has increased from 46.2% during 1970-75 to 55.4% during 1990-95.

The future population of Bucharest was predicted in "The Study for Waste Disposal in Bucharest" conducted by JICA in 1995. The average annual growth rate of the population from 1995 to 2010 was predicted at 0.772%.

Purahova County is next to Bucharest and well-communicated by roads and railway. Ploiesti will become a satellite city of Bucharest in the future.

Considering this situation, the annual growth rate of population in the Basin is assumed to be 0.00% until the year of 2000 and 0.50% from 2001 to 2015 in this study.

The population of the Basin is projected to increase from 754,995 in 1997 to 815,000 in 2015.

(2) GDP

National Commission for Economic Forecasting (NCEF) has predicted GDP of Romania until the year of 2000 in early 1997. World Bank also forecast the growth rate until 2002 in 1994 (see, "ROMANIA, an Economic Update, April 1994"). Both predictions are compared below.

(World Bank Prediction)

Year	1995	1996	1997	1998-2002
Growth Rate	1.2 %	1.5 %	2.5 %	4.0 %

(NCEF Prediction)

Year	1996	1997	1998	1999	2000
Growth Rate	4.1 %	-6.5 %	0.0 %	Min.: 2.3 % Max.: 3.4 %	Min.: 3.5 % Max.: 4.9 %

Note : 1996 and 1997 are actual growth rates.

Romanian economy is struggling for the market economy through the privatization in various economic activities. This privatization is to be completed by the end of 1999, however, economic recovery has not yet appeared and privatization effects will be stabilized gradually after 2000.

Hence, annual growth rate of GDP in Romania is assumed to be 0.00% until the year 2000 and 4.2% (average of NCEF prediction) during 2001–2015 in this study. The same growth rates are applied for GDP of the Basin.

(3) Industry Production

NCEF has predicted the extension of industrial production in the country until the year of 2000 as shown below.

Year	Average 1991 - 93	Average 1994 - 96	1997	1998	1999	2000
Growth Rate	- 14.5 %	7.5 %	- 5.0 %	- 0.5 %	Min. 1.7 % Max.2.9 %	Min. 2.7 % Max.4.3 %

Note : 1991- 1997 are actual growth rates.

The industrial production which fell down at the beginning of 1990's recovered during 1994-1996, however, it is facing difficulty to grow at present. The waves of privatization have been lapping the industry rapidly in Romania, and activity in the industry has not yet been improved in 1997-98. Even if this privatization is completed by the end of 1999, it would take more time until production goes in full swing since modernization of equipment and improvement of the product's distribution system are necessary.

Based on the above discussions, the annual growth rate of industrial production in Romania is assumed to be 0.0% until the year of 2000 and 3.5% (average of NCEF prediction) from the year of 2001 to 2015 in this study. The same growth rates are applied for the Basin.

The industrial production of the Prahova County will increase from 10,696 billion lei (US$1,492 million) in 1997 to 17,917 billion lei (US$2,499 million) in 2015. (Note: Exchange rate in 1997 is assumed at US$1.00=7,168 Lei.)

(4) Livestock

Although the number of livestock has been declining continuously in the 1990's in the County as well as in Romania, this tendency has slowed down especially in the private sector year by year. However, this decrease will continue for some time in the future although the decreasing rate will become gradually smaller. On the other hand, per capita meat consumption will increase in accordance with the improvement of living standard in the future.

Considering the above decreasing and increasing factors, the growth rate of livestock number in the Basin is assumed to be 0.00% until the year of 2015 in this study.

(5) Number of Tourist

The tourism development plan for Sinaia that was prepared in 1995 by the Ministry of Tourism predicts the number of future tourists to Sinaia until the year of 2000. The growth rate of the number of tourists is estimated to be 5.5% for 1998, 5.3% for 1999 and 4.9% for 2000.

Year	1998	1999	2000
No. of tourists	222,600	234,500	246,000
Growth rate	5.5%	5.3%	4.9%

Since tourism is generally influenced by other economic activities, the annual growth rate of the number of tourists to the Prahova valley is assumed to be 0.00% until the year of 2000, and 5% during 2001-2015 in consideration of GDP and industrial production growth rates.

In 1996, 295,000 tourists visited the Prahova valley including Sinaia, Busteni and other areas. Number of tourists visiting the valley will increase to 612,000 in 2015.

CHAPTER III EXISTING RIVER WATER POLLUTION

3.1 Existing Monitoring System

(1) River Flow Rate and Water Quality

There are 12 staff gauging stations in the Prahova River System. The Romanian Waters Prahova Office operate all the stations. The oldest record dates back to 1951.

The Romanian Waters Prahova Office also monitor the water quality of the River System at 16 monitoring points. The monitoring points are classified into two (2) types, namely national level and local level. Monitoring is made once a month at the national level points, while every two (2) months at the local level points.

Number of monitoring parameters at both national and local level points is determined based on the river water quality. In clean river water sections, 20 general parameters are monitored. For significantly polluted river sections, 27 parameters including heavy metals, oil and detergents in addition to the general parameters are monitored. In seriously polluted river sections, S^{2-} is measured in addition to the above 27 parameters to analyze anaerobic condition of the river section.

The Romanian Waters Prahova Office has been keeping these water quality data since 1993 when it was established.

(2) Wastewater Effluents

The major pollutant sources of the Basin are factories, sewerage, livestock farms, hotels, hospitals and others. At present, 344 major pollutant sources are registered in King II database of the Romanian Waters Prahova Office. The Office monitors the wastewater of the above pollutant sources based on the water quality monitoring plan.

The monitoring was made at 109 outlets of 100 pollutant sources in 1997. The monitoring frequency changes from once a month for the pollutant sources with high flow rate to once a year for those with low flow rate, averaging 5.2 times a year. Number of the monitoring parameters varies from 10 to 21 with an average of 16.5.

The Romanian Waters Prahova Office has been keeping the wastewater quality data of pollutant sources in the Basin since 1993.

For location of the monitoring points of the river flow rate and water quality, see Fig. 2.2.

(3) Laboratory

There are several laboratories in the Basin for the analysis of river water/wastewater quality, and for the operation of drinking water purification and sewage treatment plants.

The Romanian Waters Prahova Office has four (4) laboratories; one (1) laboratory for river water/wastewater quality analysis in the head quarter, and three (3) laboratories for daily drinking water check in Maneciu, Valenii de Munte and Paltinu (Voila) water purification plants.

There are 16 municipal water supply and sewerage management organizations in the Basin. Among them, six (6) organizations have their own laboratories in their drinking water purification plants and sewage treatment plants respectively for check of the plant operation, and the remaining 10 organizations possess no laboratory. For name of the water supply and sewerage organizations provided with laboratory, see Table 3.1.

Further, the Environmental Engineering Research Institute (ICIM), MWFEP and Cimpina Institute for Oil Research and Technology (ICPT) of a private company "Petrom S.A." also conduct water quality analysis for their own purposes.

The above laboratories are not provided with sufficient manpower and equipment except ICIM and ICPT. Their capacities are assessed from the point of number of staff and equipment as shown in Table 3.1.

For the existing number of staff and equipment, see Appendix F, Table F.1.8 and Table F.1.9.

(4) Data Filing System

The King II Database System was developed for the water management of the Romanian Waters in 1994. All the branches and offices of the Romanian Waters use this system made by the FOX PRO for the water management works under their jurisdiction.

The database contains the following 14 files:

(a) Information on water consumers and pollutant sources
(b) Surface water intake
(c) Underground water intake
(d) Water supply networks
(e) Water supply purification plant
(f) Water distribution plant
(g) Wastewater treatment plant
(h) Wastewater discharge
(i) Water quality
(j) Monthly recorded water intake volume
(k) Monthly recorded water discharge volume
(l) Necessary water volume
(m) Flow rate measurement
(n) Pumps

There are various problems and inconveniences in using the existing King II database system. A new water management database software was established by the JICA Study Team to improve the existing King II database through discussions with the database experts in the Romanian Waters Prahova Office. The basic concepts for the improvement of the database software are summarized below.

(a) Database software "MS Access 97" for Windows 95 is used for the new database. It is widely used and is easy to import data from and export data to "MS Excel" and "MS Word".

(b) Master data is separately recorded in tables from other data for easy maintenance.

(c) "Menu", input forms and report forms are prepared so that anybody can easily input data with the least mistake in actual daily works.

(d) Name of water users and rivers are represented by code number more often so as to avoid mistake or confusion in spelling.

(e) All wastewater quality data that are kept by the Romanian Waters in the form of Excel file or just on paper will be input into a wastewater quality table of the new database.

(f) The FOX-PRO's "dbf" files for all tables are designed to be created from the "Menu" mentioned above in consideration of data compatibility with King II database in the headquarter and basin branch offices.

(5) GIS

In the Headquarter of the Romanian Waters, CARIS GIS software was introduced and is being tested to assess the effectiveness or usability of the GIS in the field and activities of water management. The Database Office of Romanian Waters Headquarter digitized and input data of only one sheet with a scale of 1 : 100,000 for the assessment. Extension of coverage areas and official use of CARIS GIS software for water management has not been decided.

3.2 Existing Water Source and Water Use

This Section establishes the existing water sources and water uses, and provides the basic data required for estimation of the future water demand in the Basin. The inventory of the existing water sources and water uses are prepared based on the King II database.

The increase of water demand in the future and, as a result, increase of surface water intake, will change the river flow regime in the Basin. Therefore, the existing and future water demands are estimated not only by administrative unit but also by hydrological simulation block (same as water quality simulation block in Section 3.5.2). For the simulation blocks, see Fig. 3.1.

3.2.1 Water Source and Supply

(1) General

There are three (3) major water uses of domestic, industrial and agricultural purposes in the Basin. Their water sources are classified into the following categories: (1) surface water, (2) groundwater, (3) drinking network water, and (4) industrial network water.

There are 217 water users consisting of five (5) systems (called as hydrotechnical system) of Romanian Waters, 29 municipal service companies and 183 industrial/agricultural establishments in the Basin. Romanian Waters is a wholesaler of water, therefore, the number of final water users is 212. Romanian Waters takes surface water at four (4) sites (Voila, Maneciu, Valenii de Munte and Nedelea intakes) and deep groundwater at one (1) location (Tinosu). The other 212 users extract water from either of the above four (4) sources and their combination.

In addition to the above water users, a number of municipal offices extract deep groundwater for their small/low-level water supply systems and many households pump up shallow groundwater individually.

(2) Water Source

(a) Surface Water

In the Basin, 38 water users extract surface water of 160 million m^3/year with the following breakdown.

Four (4) hydrotechnical systems of Romanian Waters take a total quantity of 124.5 million m^3/year from Doftana River at Voila, Prahova River at Nedelea, and Teleajen River at Maneciu and Valenii de Munte.

Nine (9) municipal service companies take a total volume of 15.7 million m^3/year. The companies and their water sources are shown below.

Municipal Company	Water Source
Predeal, Azuga, Sinaia, Comarnic	Prahova Main River or its tributaries
Valea Doftanei, Cimpina	Doftana River
Maneciu, Slanic, Valenii de Munte	Teleajen River or its tributaries

Twenty-five (25) industrial and agricultural establishments withdraw a total volume of 19.8 million m^3/year from Prahova Main, Azuga, Doftana, Teleajen and Cricovul Sarat rivers and their tributaries.

The surface water intake volume of the above systems, companies and establishments are shown in Table 3.2.

(b) Groundwater

A total volume of 86.0 million m^3/year is extracted from underground with the following breakdown.

(million m^3/year)

User	Extraction	Source
Romanian Waters	2.6	Deep
Municipal Service Companies	25.9	Deep
Industrial/Agricultural Establishments	50.1	Deep
Municipal Offices	2.8	Deep
Individual Households	4.6	Shallow
Total	86.0	

(c) Drinking Network Water

The drinking network water is supplied from part of the above-mentioned surface and groundwater. Hence, this water source is duplicated. The suppliers of the drinking network water are four (4) systems of Romanian Waters, 13 municipal service companies and eight (8) industrial/agricultural establishments. The drinking network water volume is 91.5 million m^3/year of which 39.8 million m^3/year is distributed for domestic use, 47.9 million m^3/year for industrial use and 3.8 million m^3/year for agricultural use.

(d) Industrial Network Water

Similarly, the industrial network water is supplied from part of the above-mentioned surface and groundwater. This water source is also duplicated. The suppliers of the industrial network water are one (1) system of Romanian Waters and three (3) industrial/agricultural establishments. The industrial network water volume is 5.4 million m^3/year of which 1.6 million m^3/year is distributed for industrial use and 3.8 million m^3/year for agricultural use.

(3) Major Water Supply System

Fig. 3.2 shows the major surface water supply systems of the Basin. They share approximately 80% of the total surface water supply in the Basin. The functions of the systems are summarized below.

(a) Water developed by Paltinu and Maneciu reservoirs is extracted from the Voila intake in Doftana River and Valenii de Munte intake in Teleajen River, and transported by the two (2) routes of transmission mains to Movila Vulpii station (located in the northern suburbs of Ploiesti City) for distribution to Ploiesti City and two (2) large factories (S.C. Petrobrazi S.A. and S.C. Petrotel S.A. Ploiesti). On the mid-way to the Movila Vulpii station, the water is also distributed to the local municipalities.

This system joins the groundwater pumped up by one (1) of the Romanian Waters water supply systems at Tinosu in the downstream areas of the Prahova Main River.

(b) Water is extracted from Prahova Main River at Nedelea intake and conveyed to S.C. Petrobrazi S.A. and F.E. Ploiesti for industrial use, and to the farmlands on the left bank of the Prahova Main River for irrigation purpose.

(c) Water is withdrawn from Prahova Main River at Calinesti intake for irrigation of the farmlands on the right bank of the Prahova Main River.

(4) Major Water Supply Structures

(a) Dam and Reservoir

Both Paltinu and Maneciu dams/reservoirs have multi-purposes of water supply, hydropower and flood control. Their salient features are shown below.

Item	Paltinu	Maneciu
Catchment (km^2)	334	243
Active Storage (million m^3)	53.7	50.0
Height (m)	108	75
Dam Type	Concrete Arch	Rockfill
Hydropower Capacity (kw)	10,200	12,000
Completed Year	1971	1994
Management Organization	Romanian Waters	Romanian Waters

(b) Intake

More than 15 intakes were constructed to supply domestic, industrial and agricultural water in the Basin. However, some of them are not functioning at present due to flood damage, expiration of structural life or intentional destruction. The features of the major active intakes are shown below.

Name of structures		Nedelea	Calinesti	Voila	Valenii de Munte
Location		Aricesti Rahtivani	Floresti	Brebu	Valenii de Munte
River		Prahova	Prahova	Doftana	Teleajen
Structure		H=12m, L=110m		H=14m, L=41m	H=14m
Discharge Capacity (m^3/s)	Irrigation	5.60	Ave(0.23), Max(2.8)		
	Industry	3.00		1.60	
	Domestic			1.85	1.20
	Total	8.60		3.45	1.20
Mangement Organization		Romanian Waters	RAIF*	Romanian Waters	Romanian Waters

*; RAIF: self-management company of land improvement

(c) Purification Plant

There are 13 purification plants in the Basin. Among them, two (2) purification plants of Voila and Valenii de Munte in the water supply systems connecting to Ploiesti City serve more than 300,000 people. The other plants serve the local municipalities. The salient features of the two (2) major plants are shown below.

Purification Plant	Voila	Valenii de Munte
Location	Voila	Valenii de Munte
Served Population	208,000	102,000
Capacity (l/s)	3,000	1,200
Treatment Method	Rapid Filtration	Rapid Filtration
Management Organization	Romanian Waters	Romanian Waters

(d) Water Transmission Main

There are eight (8) water transmission main pipes to convey water from the Voila and Valenii de Munte intakes to Ploiesti City and two (2) major factories through Movila Vulpii station. The salient features of the transmission main pipes are shown below.

Name	Length (Km)	Diameter (mm)	Capacity (l/sec)	Year Completed	Management Organization
Voila – Movila Vulpii 1	28.5	800	1,400	1975	RW
Voila – Movila Vulpii 2	28.5	1,000	1,600	1977	RW
Valenii-Movila Vulpii	30.0	1,000	1,200	1985	RW
Movila Vulpii – Ploiesti	7.0	1,000	900-1,000	1975	Ploiesti
Movila Vulpii – Brazi 1	29.0	1,000	800-900	1975	RW
Movila Vulpii – Brazi 2	29.0	1,000	800-900	1978	RW
Movila Vulpii – Petrotel 1	17.0	800	400	1976	RW
Movila Vulpii – Petrotel 2	17.0	600	400	1985	RW

Note; RW: Romanian Waters, Ploiesti: Ploiesti water supply/sewerage company

A new water pipeline with the same dimensions (length, size and capacity) as the existing one is under construction between Valenii de Munte and Movila Vulpii. The new pipeline will be completed in the year 2000.

3.2.2 Water Use

(a) Domestic Water

The Basin has a total population of 763,000 including piped water served population outside the Basin. Among them, 509,000 people (67%) are served by piped water and the remaining 254,000 people (33%) use shallow well water individually.

The existing total domestic water use is estimated at 80.1 million m³/year. This water is supplied from piped water and shallow well water. Further, the piped water consists of surface water, groundwater and drinking network water sources. The domestic water use by area and by water source is summarized below. Ploiesti City and its surroundings share 62.6% of the total domestic use.

(water volume unit : 1,000m³/year)

Area	Served Population	Unserved Population	Piped Water			Well	Total
			Surface Water	Ground-water	Network Water		
Ploiesti City & Surroundings	272,582	43,186	0	22,768	26,583	788	50,143
Floresti	5343	981	0	0	174	18	191
Cimpina City	36,814	4,090	3,942	0	2,934	75	6,951
Prahova Valley	67,161	18,176	2,807	2,511	3,194	332	8,843
Others	126,684	187,467	215	3,406	6,956	3,421	13,999
Total	508,583	253,901	6,964	28,685	39,840	4,634	80,124

Note : 1) Ploiesti and Surroundings include Aricesti Rahtivani, Barcanesti, Berceni, Blejoi, Brazi, Bucov, Paulesti, Targsoru Vechi communes.
2) Prahova Valley includes the upstream area of Cimpina City

For the existing domestic water use by municipality and by hydrological simulation block, see Appendix B, Table B.2.7.

(b) Industrial Water

The existing total industrial water use is estimated at 829.4 million m³/year of which 710.6 million m³/year (85.7 %) is re-use. Then, the real water use is

118.8 million m^3/year. The industrial water users take a total amount of 122.1 million m^3/year from the water sources of surface water, ground water, drinking network water and industrial network water. However, 3.3 million m^3/year is appropriated to other users.

The industrial water use by area and by water source is summarized below. Ploiesti City and the surrounding areas use 88.4% on gross water use basis (including reuse) or 67.4% on real water use basis (excluding reuse) of the total industrial water.

(unit: 1,000 m^3/year)

Area	Intake				Reuse	Supply to Others	Total Water Use
	Network Water (Drink-ing)	Ground-water	Surface Water	Network Water (Industrial)			
Ploiesti City & Surroundings	33,608	31,585	55	15,145	653,588	364	733,617 (80,029)
Floresti	2,182	3,787	0	0	13,418	0	19,387 (5,969)
Cimpina City	6,634	0	407	18	11,438	0	18,497 (7,059)
Prahova Valley	2,362	1,838	5,920	0	8,559	795	17,884 (9,325)
Others	3,162	11,021	3,602	818	23,604	2,176	40,031 (16,427)
Total	47,948	48,231	9,984	15,981	710,608	3,335	829,417 (118,809)

Note : 1) Ploiesti and Surroundings include Aricesti Rahtivani, Barcanesti, Berceni, Blejoi, Brazi, Bucov, Paulesti, Targsoru Vechi communes.
2) Prahova Valley includes the upstream area of Cimpina City
3) with parentheses are real water use

For the existing industrial water use by hydrological simulation block and by municipality, see Appendix B, Table B.2.8 and Table B.2.9.

Petroleum refinery is the largest industrial water user followed by electricity/gas supply industry. These two (2) industries share 89.0% on gross water use basis (including reuse) or 64.0% on real water use basis (excluding reuse) of the total industrial water use.

In the Basin, reuse of the industrial water has much advanced, reaching 85.7% on average due to the high reuse rate in petroleum refinery and electricity/gas supply industries. For the existing industrial water use by industrial activity, see Appendix B, Table B.2.10.

The existing reuse rates of typical industrial activities in the Basin are shown below, compared with those in Japan.

(water volume unit: 1,000 m^3/year)

Activity	Total Water Use	Reuse	Reuse Rate (%)	Reuse Rate in Japan (%)
Food/Beverage	3,900.3	340.3	8.7	32
Wood	2,918.7	2,288.7	78.4	14
Paper/Paper Products	10,821.7	5,371.7	49.6	43
Petroleum Refinery	445,031.0	390,007.	87.6	90
Chemicals/Chemical Products	6,436.0	2,429.0	37.7	82
Rubber/Plastic Products	944.5	219.5	23.2	75
Non-Metallic Mineral	711.0	261.0	36.7	73
Basic Metals	1,035.7	190.7	18.4	90
Metal Products Fabricated	8,037.7	5,572.7	69.3	51
Machinery/Equipment	28,012.3	19,950.3	71.2	65
Electrical	343.0	26.0	7.6	71
Furniture	177.7	32.7	18.4	15
Electricity/Gas/Water Supply	293,040.7	272,000.	92.8	-

(c) Agricultural Water

The existing agricultural water use amounts to 13.5 million m^3/year. The agricultural water users take a total amount of 16.5 million m^3/year from the water sources of surface water, ground water, drinking network water and industrial network water. However, 2.5 million m^3/year is appropriated to other users.

The agricultural water use by area and by water source is summarized below.

(unit: 1,000m^3/year)

Area	Intake				Supply to Others	Water Use
	Network Water (Drinking)	Ground-water	Surface Water	Network Water (Industrial)		
Ploiesti City and Surroundings	1,470	467	1,179	1,714	2,489	2,341
Prahova Valley	0	0	7,540	0	0	7,540
Others	98	1,026	449	2,063	0	3,636
Total	1,588	1,493	9,168	3,777	2,489	13,517

Note : 1) Ploiesti and Surroundings include Aricesti Rahtivani, Barcanesti, Berceni, Blejoi, Brazi, Bucov, Paulesti, Targsoru Vechi communes.
2) Prahova Valley includes the upstream area of Cimpina City

The water use of 7.5 million m^3/year in the Prahova valley is inland fishery in Azuga municipality. It completely returns to the Prahova River immediately downstream of the intake although it shares 55.8% of the total agricultural water use.

The agricultural activity is composed of inland fishery, livestock farm, irrigation and others. Out of the total agricultural water use, 55.8% is used for inland fishery and then, followed by irrigation of 23.9%.

The water use by agricultural activity and by water source is summarized below.

(unit: 1,000 m^3/year)

Activity	Intake				Supply to Others	Water Use
	Network Water (Drinking)	Ground-water	Surface Water	Network Water (Industrial)		
Livestock farm	161	855	202	1,443	0	2,661
Inland fishery	0	0	7,597	0	0	7,597
Irrigation	1,405	607	1,369	2,334	2,489	3,226
Others	2	31	0	0	0	33
Total	1,568	1,493	9,168	3,777	2,489	13,517

For the existing agricultural water use by hydrological simulation block, see Appendix B, Table B.2.11.

(d) Total Water Use

From the above discussions, the total existing water use is estimated at 923.1 million m^3/year of which the real water use (excluding industrial water reuse) is estimated to be 212.5 million m^3/year.

The water use by area and by category in the Basin is summarized below.

(unit: 1,000 m^3/year)

Area	Domestic Water	Industrial Water	Agricultural Water	Total Water Use
Ploiesti City & Surroundings	50,143	733,617 (80,029)	2,341	86,101 (132,513)
Floresti	191	19,387 (5,969)	0	19,578 (6,160)
Cimpina City	6,951	18,497 (7,059)	0	25,448 (14,010)
Prahova Valley	8,843	17,884 (9,325)	7,540	34,267 (25,708)
Others	13,999	40,031 (16,427)	3,636	57,666 (34,062)
Total	80,124	829,417 (118,809)	13,517	923,058 (212,450)

Note : 1) Ploiesti and Surroundings include Aricesti Rahtivani, Barcanesti, Berceni, Blejoi, Brazi, Bucov, Paulesti, Targsoru Vechi communes.
2) Prahova Valley includes the upstream area of Cimpina City
3) with parentheses are real water use

The water use in Ploiesti City and its surrounding areas share 85.2% on gross water use basis (including reuse) and 62.4% on real water use basis (excluding reuse).

3.2.3 Water Loss

Water loss in the Basin is caused by water leakage from the domestic water networks in the municipalities and from the water transmission mains.

According to the information of Romanian Waters, the existing water loss rate in the municipalities is in the range of 5% and 35% with an arithmetic average of 14% (see Appendix B, Table B.2.7). A relatively large water loss is generated in Sinaia (35%), Breaza (30%), Ploiesti (30%), Cimpina (25%), Valenni de Munte (25%) and Urlati (25%).

On the other hand, a significant water loss is identified in the above mentioned eight (8) transmissions [see, 3.2.1(4)]. According to the King II database, Romanian Waters extracted an average annual water quantity of 106,581,000 m^3/year from the Voila and Valenii de Munte intakes during 1995-1997, while they actually sold 74,672,000 m3/year to the users. The water loss in the transmission mains is estimated at 29.9%.

Romanian Waters estimated the water loss in the transmission main of Valenii de Munte to Movila Vulpii. They observed the intake volume from the river, local water use on the mid-way and inflow to Movila Vulpii during 1995-1997 as shown below.

Length (km)	30.0		
Pipe	ϕ 1,000 mm x 1, Concrete Pipe, Capacity = 1.2 m^3/s		
Observed Year	1995	1996	1997
Intake Volume (1,000 m^3)	38,640	38,068	37,763
Local Use on Mid-way (1,000 m^3)	3,207	3,445	3,238
Inflow to Movila Vulpii (1,000 m^3)	26,060	23,311	20,967
Water Loss (1,000 m^3)	9,373	11,312	13,558
Loss Rate (%)	24.3	29.7	35.9

0

From the above data and information, the water loss in the eight (8) transmission mains is estimated at 30% on average.

3.3 Existing Pollutant Source and Pollution Load

3.3.1 Domestic Wastewater

(1) Sanitary System of the Basin

The Basin covers two (2) cities, 12 towns and 82 communes of which two (2) cities, 11 towns (excluding Comarnic town) and two (2) communes are provided with sewerage system. Sanitary system of the remaining one (1) town and 80 communes is septic tank or latrine.

The municipalities served by sewerage system are listed below.

Municipality	Name of Municipality
City	Cimpina, Ploiesti
Town	Predeal, Azuga, Busteni, Sinaia, Breaza, Baicoi, Plopeni, Slanic, Valenii de Munte, Boldesti Scaieni, Urlati
Commune	Floresti, Maneciu

The sewerage systems except Azuga and Busteni are all provided with treatment plant. The wastewater of Azuga and Busteni towns is disposed by only sewer networks.

The total population of the Basin is estimated to be 755,000 in 1997. Among them, 322,000 or 43% is served by sewerage system and the remaining 433,000 or 57% is treated by septic tank or latrine. For the sewerage served population by municipality, see Table 3.3.

(2) Inventory of Major Sewerage Systems

The existing inventories of the 13 major sewerage systems in two (2) cities and 11 towns were prepared through the interviews with each sewerage management organization. These are summarized below.

(a) Predeal Town

The sewerage networks of separate type have been developed since 1923 and they cover 85% of the town population at present. Total length of the main sewers (300-500 mm) reaches 5.0 km of which 75% was already rehabilitated. Rehabilitation of the remaining 25% is scheduled within 1998. The tertiary sewer pipes are also under rehabilitation.

The sewerage system receives the wastewater of 1,110 households and others. No factory wastewater is discharged into it.

The treatment plant originally constructed in 1956 was extended and modernized to meet the requirement in 2015. The new plant was completed in September 1997. The wastewater is treated through mechanical and biological processes. The design capacity is 90.0 l/s.

(b) Azuga Town

The sewer networks of combined type serve 85% of the town population. The main sewer with a diameter of 300-500 mm is 7.6 km long in total. The sewerage system receives the wastewater of 1,600 households, one (1) large non-metallic (cement) factory with pre-treatment and others.

However, the sewerage system is provided with no treatment plant.

(c) Busteni Town

The sewer networks of combined type serve 60% of the town population. The main sewer of 100-1,000 mm diameter is 17.0 km long. They are old. They were constructed during 1911 to 1956. The sewerage system receives the wastewater of 2,200 households, one (1) large hotel with pre-treatment and others.

The sewerage system has no treatment plant.

(d) Sinaia Town

The sewer networks of combined type serve 80% of the town population. Their construction started in 1917 and therefore, part of them are old. The main sewer of 150-400 mm diameter is 37.2 km long. The sewerage system receives the wastewater of 3,430 households, six (6) major industrial establishments (2 factories, 3 hotels and 1 education facility) mostly with pre-treatment and others.

The treatment plant with a design capacity of 109.0 l/s was constructed in 1980. The wastewater is treated through mechanical and biological processes.

The treatment plant cannot always collect all wastewater in the served area due to frequent pumping troubles in the sewer networks. Some wastewater is directly discharged into the Prahova River at the time of pumping troubles. The treatment efficiency is at a low level due to its old treatment system and lack of capacity.

(e) Breaza Town

The sewer networks of combined type cover 47% of the town population. They are comparatively new. They have been developed since 1970. The main sewer (diameter: 500 mm) is 4.0 km long in total. The sewerage system collects the wastewater of 3,000 households, two (2) major industrial establishments (1 factory with pre-treatment and 1 public facility without pre-treatment) and others.

A new treatment plant was constructed in October 1997 and the old one was abandoned except the primary sedimentation tank. The new plant with a capacity of 76.0 l/s is designed to meet the requirements for the year 2015. The wastewater is treated through mechanical and biological processes.

(f) Cimpina City

The sewer networks of separate type cover 64% of the town population. They have been installed since 1945. The main sewer with a diameter of 150-800 mm is 40.0 km long in total. The sewerage system receives the wastewater of 10,500 households, 15 major industrial establishments (11 factories, 1 hotel, 1 trading company, 1 educational facility and 1 social/health facility) with mostly pre-treatment and others.

The treatment plant constructed in 1975 treats the wastewater through mechanical and biological processes. It is old and overloaded. The design capacity of the plant is 150.0 l/s, while the actual average flow rate during 1995-1997 is estimated to be approximately 235 l/s.

(g) Baicoi Town

The sewer networks of separate type cover only 24% of the town population. They were constructed during 1961 to 1966. The main sewer length with a diameter of 250-400 mm reaches 10.0 km. The sewerage system receives the wastewater of 1,210 households, six (6) major industrial establishments (4 factories and 2 social/health facilities) with pre-treatment and others.

The treatment plant was installed in 1967 and it treats the wastewater through mechanical and biological processes. It is old and overloaded. The design capacity is 26.0 l/s, while the actual average flow rate during 1995-1997 is estimated to be approximately 50 l/s. Its operation is often suspended due to technical troubles.

(h) Plopeni Town

The sewer networks of separate type serve 79% of the town population. They were installed during 1960 to 1980. The main sewer with a diameter of 300-500 mm extends 13.9 km. The sewerage system receives the wastewater of 4,750 households, one (1) large machinery factory with pre-treatment and others.

The treatment plant consisting of mechanical and biological processes was constructed in 1964 and improved in 1976. The design capacity of the plant is 190.0 l/s. The plant does not function well since it is old.

(i) Slanic Town

The sewer networks of separate type serve 33% of the town population. The main sewer with a diameter of 300 mm extends 4.0 km. The sewerage system receives the wastewater of 800 households and others. No wastewater of major industrial establishments is discharged into it.

The treatment plant was constructed during 1981-1982. It treats the wastewater through mechanical and biological processes. The design capacity is 27.0 l/s.

(j) Valenii de Munte Town

The sewer networks of separate type serve only 23% of the town population. They were constructed during 1963-1980. The main sewer with a diameter of 500 mm extends 8.3 km. The sewerage system receives the wastewater of 1,100 households, two (2) major industrial establishments with pre-treatment and others.

The treatment plant was installed in 1978 and improved in 1987. It treats the wastewater through mechanical and biological processes. The design capacity of the plant is 106.0 l/s and this nominal capacity is large enough compared to the actual average inflow rate (30.3 l/s) during 1995-1997. However, the plant does not function well because of frequent pump and engine troubles.

(k) Boldesti Scaieni Town

The sewer networks of combined type cover 32% of the town population. They were constructed during 1973-1993. The main sewer with a diameter of 200-500 mm extends 10.5 km. The sewerage system receives the wastewater of 1,070 households, four (4) major factories (two with pre-treatment, two with no pre-treatment) and others.

The treatment plant with a design capacity of 40.0 l/s was installed during 1990-1993. The wastewater is treated through mechanical and biological processes. However, it is overloaded due to the unexpected increase of industrial wastewater. The wastewater inflow rate to the plant varies much, resulting in difficulty of plant operation.

(l) Urlati Town

The sewer networks of combined type cover 42% of the town population. They were constructed during 1950-1960 and in 1980. The main sewer with a diameter of 250-600 mm extends 7.0 km. The sewerage system receives the wastewater of 1,700 households, two (2) major factories with pre-treatment and others.

The treatment plant with a design capacity of 32.0 l/s was installed during 1990-1992. The wastewater is treated through mechanical and biological processes. Treatment efficiency of the plant is not good. The aerator has troubles often.

(m) Ploiesti City

The sewer networks of combined type serve 87% of the town population. They have been installed since 1906. The main sewer with a diameter of 200-3,000 mm extends 276.3 km. The sewerage system receives the wastewater of 88,000 households, 42 major industrial establishments (39 factories, 1 recreational facility, 1 educational facility and 1 public facility) mostly with pre-treatment and others.

The treatment plant was constructed during 1969-1971. The wastewater is treated through only mechanical process. The design capacity of the plant is 1,200 l/s. On the other hand, the actual average inflow rate during 1995-1997 is estimated to be 1,522 l/s. Hence, treatment efficiency of the plant is at a low level.

Inventory of the existing sewerage system of the above 13 cities/towns is summarized in Table 3.3. For location of the sewer networks and layout of the treatment plants, see Appendix D, Fig. D.3.2 and Fig. D.3.3, respectively. For details of the wastewater discharge of major industrial establishments to sewerage system, see also Appendix D, Table D.1.2.

(3) Average Pollution Load Effluent from Sewerage System during 1995-1997

The wastewater from the sewerage systems is discharged into the respective neighboring rivers. Romanian Waters has periodically observed the effluent quantity and quality from the sewerage systems. In this study, BOD, SS and Oil are discussed as the representative water quality parameters of sewerage effluent. The average effluent quantity and quality during the recent three (3) years of 1995-1997 are shown in Table 3.4, compared with the existing permitted and national new standards.

The Romanian Government published the new national standards that are constant throughout the country in November 1997. Until then, the effluent quality had been permitted for the wastewater discharge individually. However, the existing permission will be effective for the time being until the existing license expires. Thereafter, the national new standards will be applied for all the wastewater effluents.

BOD, SS and Oil concentrations exceed the national standards in almost all the sewerage systems. The sewerage effluent quality of Ploiesti City is considered the worst in the integrated index of BOD, SS and Oil. The effluent quality of Predeal and Breaza sewerage was much improved after completion of the new treatment plants. The new plants of Predeal and Breaza were completed in September 1997 and in October 1997 respectively.

The total average pollution load effluent from the sewerage system in the Basin during 1995-1997 is roughly estimated to be 9.0 ton/day in BOD, 24.1 ton/day in SS and 1.9 ton/day in Oil Products.

The Ploiesti sewerage is the largest domestic wastewater pollutant source in the Basin. It discharges 72% in BOD , 69% in SS and 83% in Oil of the total pollution load effluent of the sewerage systems in the Basin. The sewerage pollution load effluent by area is summarized below.

Municipality	BOD		SS		Oil Product	
	(kg/day)	(%)	(kg/day)	(%)	(kg/day)	(%)
Ploiesti	6,485	72.1	1,6534	68.7	1,588	83.1
Campina	572	6.4	2,672	11.1	153	8.0
Prahova Valley	1,166	12.9	2,062	8.6	106	5.5
Others	776	8.6	2,787	11.6	65	3.4
Total	8,999	100.0	2,4055	100.0	1,912	100.0

Note : Prahova Valley includes Predeal, Azuga, Busteni, Sinaia and Breaza.

The pollution load effluent of each sewerage system is shown in Table 3.4.0

(4) Existing Baseline Sewerage Pollution Load Effluent

The sewerage discharge in the Basin consists of major industrial wastewater discharge, gross domestic wastewater discharge (including net domestic, small industries, shops/restaurants, offices, public facilities, etc.) and groundwater infiltration (including groundwater, rainfall, snow melt, etc.). The sewerage discharge data in King II Database of Romanian Waters present only a total value of the above three (3) components.

For projection of the future sewerage discharge, the existing discharge of these three (3) components should be estimated separately. This separation is also necessary for estimation of the existing and future sewerage influent quality.

On the other hand, the new treatment plants of Predeal and Breaza were completed in September 1997 and October 1997, respectively. The effluent quality of these sewerage systems was much improved.

Therefore, the existing baseline sewerage pollution load is estimated as follows.

(a) Existing Sewerage Discharge

(i) Major Industrial Discharge

The discharge data of each major industrial establishment are available in King II Database. The average total discharge of industrial establishments to each sewerage system during 1995-1997 is used as the existing major industrial discharge to each sewerage system.

(ii) Per Capita Gross Domestic Discharge

The gross domestic discharge of each sewerage system is estimated by multiplying served population by per capita gross domestic discharge. The per capita gross domestic discharge is estimated based on the per capita gross domestic water consumption of King II Database.

The average per capita gross domestic water consumption of the related municipalities is assumed as follows.

Ploiesti and Cimpina Cities : 370 l/c/d
11 Towns : 280 l/c/d
Floresti and Maneciu Communes : 180 l/c/d

(iii) Groundwater Infiltration

Groundwater infiltration is usually considerably large, especially when sewer pipeline is old and damaged. The sewer networks of Ploiesti City is very old. Those in the other municipalities are comparatively new except Busteni and Sinaia. The sewer pipelines of Busteni and Sinaia are not considered to be much prone to groundwater infiltration due to their topographic advantages. On the other hand, the sewer pipelines of Ploiesti may be much affected by groundwater infiltration since the City is located in a low-lying area.

Hence, per capita groundwater infiltration of the above municipalities are classified into two (2) groups: Ploiesti and other city/towns.

The groundwater infiltration is estimated by deducting the above-mentioned per capita gross domestic wastewater discharge (280 l/c/d or 370 l/c/d) from the per capita gross domestic wastewater discharge calculated based on the King II data (Ploiesti: 532 l/c/d, average of other city/towns: 406 l/c/d, see Appendix D,Table D.2.2) as shown below.

Ploiesti City : 532 – 370 = 162 l/c/d ≈ 160 l/c/d
Other City/Towns : 406 – 305 = 101 l/c/d ≈ 100 l/c/d

In this study, the groundwater infiltration of Floresti and Maneciu communes is also assumed to be 100 l/c/d.

The existing baseline sewerage discharge (average daily discharge) of each city, town and commune is determined from the above discussions. The above calculation method of the existing baseline sewerage discharge is summarized below.

Sewerage Discharge	Ploiest City	Cimpina City	11 Towns	2 Communes
Major Industrial Discharge	King II data	King II data	King II data	King II data
Gross Domestic Discharge	370 l/c/d x served pop.	370 l/c/d x served pop.	280 l/c/d x served pop.	180 l/c/d x served pop.
Groundwater Infiltration	160 l/c/d x served pop.	100 l/c/d x served pop.	100 l/c/d x served pop.	100 l/c/d x served pop.

Note: pop. : population

The calculated results of each sewerage system are shown in Table 3.5.

(b) Existing Sewerage Influent Quality

(i) Major Industrial Wastewater

The above mentioned major industrial wastewater is discharged to the sewerage system mostly after pre-treatment. The wastewater quality data discharged to the sewerage system of each industrial establishment are available in King II Database. Hence, the existing major industrial wastewater quality to sewerage system is determined based on the average wastewater quality data of each industrial establishment during 1995-1997.

The existing average quality (BOD) of major industrial wastewater to each sewerage system is shown in Table 3.5.

For the average wastewater quality during 1995-1997 by each industrial establishment, see Appendix D, Table D.1.2.

(ii) Gross Domestic Wastewater

Human pollutant load generation is usually estimated to be 40-50 g/c/d (g/person/day) in BOD. It varies a little according to the level of living standards. On the other hand, the average net domestic wastewater discharge in each sewerage system is estimated to be 260 l/c/d for two (2) cities and 210 l/c/d for the other towns (see Appendix D, Table D.2.1). Hence, BOD concentration of the net domestic wastewater of all the sewerage systems is assumed to be a constant at 200 mg/l.

The existing gross domestic wastewater quality of each sewerage system is determined at 200 mg/l in BOD by assuming that the wastewater quality of small industries, offices, shops/restaurants, public, etc., is the same as the quality of net domestic wastewater.

(iii) Groundwater Infiltration

It only dilutes the major industrial and gross domestic wastewater. It is assumed to generate no pollution load.

The average sewerage influent quality of each sewerage system widely varies depending on the major industrial influent quality. It is in the range of 75 mg/l of Ploperi to 156 mg/l of Urlati in BOD. The existing baseline sewerage influent BOD concentration and load of each municipality are shown in Table 3.5.

(c) Existing Sewerage Effluent Quality

The average actual effluent quality during 1995-1997 shown in Table 3.3 is used as the existing baseline sewerage effluent quality (BOD) of each sewerage system except Predeal and Breaza. For Predeal and Breaza, the average effluent quality data after completion of their new plants is applied. The existing baseline sewerage effluent quality of each sewerage system is shown in Table 3.5.

The existing baseline pollution load effluent (BOD) of each sewerage system is also estimated as the product of the above existing baseline effluent quality and existing baseline sewerage discharge. The existing baseline sewerage pollution load by area is summarized below.

Area	BOD Load	
	(kg/day)	(%)
Ploiesti	6,466	73.4
Campina	521	5.9
Prahova Valley	1,108	12.6
Others	714	8.1
Total	8,808	100.0

Note : Prahova Valley includes Predeal, Azuga, Busteni, Sinaia and Breaza.

The existing baseline discharge, effluent quality (BOD) and effluent BOD load of each sewerage system are shown in Table 3.5.

3.3.2 Industrial Wastewater

(1) Pollutant Sources

In 1997, there were 164 pollutant sources in the Basin discharging their wastewater through 189 effluent channels; namely 13 to river without treatment, 73 to river with treatment, 82 domestic sewerage system, 7 to industrial sewerage system and 14 to underground.

The domestic sewerage systems to which 82 effluent channels connected are Azuga, Busteni, Sinaia, Breaza, Cimpina, Baicoi, Plopeni, Valenii de Munte, Boldesti Scaieni, Urlati, Ploiesti and Floresti.

There are two (2) industrial systems both situated in Ploiesti and Berceni area. One is the S.C. Astra Romana S.A. System which receives wastewater from five (5) factories and discharges it into Dimbu River. The other is Ubemar System which receives wastewater from two (2) factories and discharges it into the Ploiesti domestic sewerage system.

Location of the above effluent channels is distributed over 33 municipalities. Number of effluent channels by area is summarized below.

Area	Nos. of Effluent Channel				
	River	Domestic Sewer	Industry Sewer	Under-ground	Total
Ploiesti City & Surroundings*	34	40	7	6	87
CimpinaCity	9	15	-	-	24
Prahova Valley	15	10	-	1	26
Other Area	28	17	-	7	52
Total	86	82	7	14	189

Note: 1) Ploiesti Surroundings include Aricesti Rahtivani, Barcanesti, Berceni, Blejoi, Brazi, Bucov, Paulesti, Targsoru Vechi communes.
2) Prahova Valley includes the upstream area of Cimpina City

For number of the effluent channels by municipality and by receiving body, see Appendix E, Table E.1.1.

The above wastewater is discharged from 30 industrial activities (categories). Out of 189 effluent channels, 98 effluents concentrate in seven (7) industrial categories and the remaining 91 effluents are grouped into 23 categories as shown below.

Industrial Category	Nos. of Effluent
Machinery/Equipment	20
Petroleum Refinery	16
Public Administration/Defense	16
Food/Beverage	15
Construction Material	11
Land Transport	10
Health/Social Work	10
Other Industries	91
Total	189

(2) Existing Wastewater Discharge

The total average annual wastewater quantity of 189 effluent channels during 1995-1997 is estimated at 76,722 x 10^3/year based on the King II data of Romanian Waters. Out of this total volume, the wastewater discharge of seven (7) factories to the industrial sewerage of 5,595 x 10^3/year is duplicated. Hence, the real total wastewater quantity comes to 71,127 x 10^3/year. It is broken down by receiving body and by area as follows.

Area / Receiving Body	Wastewater Vol.(10^3m^3/yr)				
	River	Domestic Sewer	Industrial Sewer	Under-ground	Total
Ploiesti City & Surroundings*	42,488	5,314	(5,595)	74	47,876
Cimpina City	3,160	2,244	-	-	5,404
Prahova Valley	4,884	1,842	-	7	6,733
Other Area	7,737	2,476	-	901	11,114
Total	58,269	11,876	(5,595)	982	71,127

Note: 1) Ploiesti Surroundings include Aricesti Rahtivani, Barcanesti, Berceni, Blejoi, Brazi, Bucov, Paulesti, Targsoru Vechi communes.

2) Prahova Valley includes the upstream area of Cimpina City

3) ( ) : duplicated wastewater quantity

For the wastewater quantity of each pollutant effluent (189 effluent channels), see Appendix E, Table E.1.3. Industrial category, location and wastewater receiving body of each pollutant effluent are also presented in this table.

(3) Observed Wastewater Quality

Romanian Waters has observed the wastewater quality of 72 factories with 75 effluent channels. The average wastewater quality of BOD, Oil and toxic substances (CN, phenol, Cd) during 1995-1997 are described below.

(a) BOD was observed in 75 effluent channels. The observed pollutant effluents cover 76% of the total pollutant effluents (excluding effluents discharged to underground) in terms of wastewater discharge quantity. Further, the observation covered most part of the pollutant sources discharging a high BOD.

(b) Oil was observed in 47 effluent channels with a significant Oil concentration. The observation also covered most part of the pollutant sources with a significant Oil concentration.

(c) On the other hand, observation of toxic substances was made for the limited pollutant effluents that have a possibility of discharging toxic substances. CN, phenol and Cd were observed in 14, 10 and 10 effluents, respectively. The industrial activities in which the toxic substances are identified are machinery/equipment, construction (materials), metal products fabrication, wood, petroleum refinery, tanning/dressing leather, food/beverage and electrical machinery.

The observed quality values are summarized below.

Parameter	Nos. of observed effluent	Max (mg/l)	Min. (mg/l)	Ave.(mg/l)
BOD	75	972	3.5	63.4
Oil	47	53.1	0.0	8.9
CN	14	0.359	0.000	0.038
Phenol	10	0.459	0.000	0.223
Cd	10	0.118	0.000	0.018

For the above water quality by each pollutant effluent, see Appendix E, Table E.1.4, Table E.1.7, Table E.1.9, Table 1.10 and Table E.1.11.

(4) Estimated Existing Pollution Load

BOD and Oil are considered as the most important water quality parameters for the industrial wastewater pollution control planning of the Basin. The existing BOD and Oil loads are estimated as follows.

(a) Total BOD Load

BOD data are limited to the above mentioned 75 effluent channels and no data are available for the remaining 114 effluent channels.

The average BOD concentration of 98 effluent channels excluding fish farming (two pollutants discharged to river) and pollutants discharged to underground (14) were roughly estimated based on the data of 75 effluent channels considering industrial activity and treatment conditions. In this study, BOD productions of fish farming and pollutants discharged to underground are neglected since their effects on the river water is small. Further, the BOD productions of the pollutants discharged to the industrial sewerage are duplicated.

The existing total BOD load effluent from the industrial establishments of the Basin is estimated to be 15,187 kg/d (average during 1995-1997) of which 2,157 kg/d to the industrial sewerage is duplicated. The real BOD effluent is 13,030 kg/d. The estimated existing BOD load effluent by area and by receiving body is summarized below.

(unit: BOD kg/d)

Receiving Body	River	Domestic Sewerage	Industrial Sewerage	Total
Ploiesti &Surroundings	8,908	1,269	(2,157)	10,177 (12,334)
Cimpina City	537	774	-	1,311
Prahova Valley	268	430	-	698
Other Area	629	215	-	844
Total	10,342	2,688	(2,157)	13,030 (15,187)

Note: 1) Ploiesti Surroundings include Aricesti Rahtivani, Barcanesti, Berceni, Blejoi, Brazi, Bucov, Paulesti, Targsoru Vechi communes.
2) Prahova Valley includes the upstream area of Cimpina City
3) ( ) : duplicated BOD load

The existing BOD load effluent is broken down by municipality and by receiving body as shown in Table 3.6. For the BOD load of each effluent, see Appendix E, Table E.1.12.

These BOD loads are discharged from the pollutant sources of 29 industrial categories. The largest category is petroleum refinery followed by food/beverage and livestock farm in this order as shown below.

(unit: BOD : kg/d)

Receiving Body	River	Domestic Sewerage.	Industrial Sewerage	Total
Petroleum Refinery	7,872	5	(2,121)	7,877 (9,998)
Food/Beverage	79	1,147	-	1,226
Livestock Farm	1,104	-	-	1,104
Others	1,287	1,536	(37)	2,823 (2,860)
Total	10,342	2,688	(2,158)	13,030 (15,188)

Note: ( ) : duplicated BOD load

The existing BOD load effluent is broken down by industrial category and by receiving body as shown in Table 3.7.

(b) Total Oil Load

Oil data are available for 47 effluent channels of 44 industrial establishments. These data are considered to cover almost all the Oil pollution load generated in the Basin since significant Oil pollutant sources are limited to several industrial categories. In this study, the total Oil pollution load is estimated by using the available data of 47 effluent channels.

The existing Oil load is mostly (83%) discharged from oil refinery industry. The existing Oil load effluent by industrial activity and receiving body is summarized as below. Regionally, 94% of the total oil load concentrates in the Ploiesti City and its surroundings.

(unit: Oil : kg/d)

Receiving Body	River	Domestic Sewerage.	Total
Petroleum Refinery	2,346	0.0	2,346
Electricity/Gas/Water Supply	325	-	325
Others	75	78	153
Total	2,746	78	2,824

Out of the total Oil load (2,824 kg/d), 2,261 kg/d or 80% is discharged from three (3) petroleum refineries of S.C. Petro Brazi S.A. (806 kg/d), S.C. Astra Romana S.A. (581 kg/d) and S.C. Petrotel SA PL. (874 kg/d).

For Oil effluents by each industrial establishment, see Appendix E, Table E.1.13.

(c) BOD Load Discharged to River

In this study, BOD is adopted as the typical parameter for the simulation of river water quality. BOD load discharged to domestic sewerage is included in the sewerage BOD effluent discussed in the previous section. BOD load to industrial sewerage is finally discharged to river or domestic sewerage. Hence, only BOD load discharged to river is used for the simulation of river water quality.

Number of the effluent channels to river (excluding 2 fish farming) is 84 of which 73 effluent channels are provided with treatment, while 11 effluent channels have no treatment plants. Number of effluent channels, wastewater discharge and BOD load effluent are summarized below.

	Nos. of Channel	Discharge (l/s)	Ave. BOD (mg/l)	BOD Load (kg/d)
Without Treatment	11	16.7	19	27
With Treatment	73	1,831.0	65	10,313
Total/Average	84	1,847.7	65	10,340

Out of the above total BOD load (10,340 kg/d), 7,331 kg/d or 71% is discharged from three (3) petroleum refineries of S.C. Petro Brazi S.A. (4,008 kg/d), S.C. Astra Romana S.A. (1,947 kg/d) and S.C. Petrotel SA PL. (1,376 kg/d).

The wastewater discharge, BOD concentration and BOD load to river by each effluent channel are shown in Table 3.8.

(5) Existing Baseline Pollution Load to River

The existing baseline effluent is defined as the average effluent during 1995-1997 excluding the wastewater of S.C. Romfosfochim SA. since S.C. Romfosfochim SA. was closed in August 1997. Then, the total existing baseline discharged to river comes to 1,793.7 l/s (excluding 53.9 l/s of S.C. Romfosfochim SA). Similarly, the total existing baseline BOD load effluent to river is 10,062 kg/l (excluding 280 kg/d of S.C. Romfosfochim SA). The existing baseline BOD load effluent to river by area is summarized below.

Area	Existing	
	BOD Load (kg/d)	(%)
Ploiesti City & Surroundings	8,908	88.5
Cimpina City	537	5.3
Prahova Valley	268	2.7
Other Area	349 (629)	3.5
Total	10,062 (10,342)	100.0

Note: 1) Ploiesti Surroundings include Aricesti Rahtivani, Barcanesti, Berceni, Blejoi, Brazi, Bucov, Paulesti, Targsoru Vechi communes.
2) Prahova Valley includes the upstream area of Cimpina City
3) ( ) includes Romfosfochim Factory.

(6) Inventory of Representative Factories

Inventory survey of the representative 20 factories was conducted to establish the existing condition of factory wastewater treatment in the Basin. Twenty (20) factories were selected based on the following criteria so that they may well represent the treatment condition of the entire factory wastewater in the Basin.

(i) They should cover a large portion of industrial pollution load in BOD.

(ii) They should cover a wide field of industrial activities.

The selected 20 factories are listed below.

Code	Factory	Industrial Category	BOD Load (kg/d)	Receiving Body
4143	INCAF. Ploiesti	Food/Beverage	338	Industrial S.
4311	Coca Cola Ploiesti	Food/Beverage	184	Domestic S.
4006	Bere Azuga	Food/Beverage	42	River W/T
4007	Postav Azuga	Textile	52	River W/T
4318	Prahoveana Ploiesti	Leather	9	Domestic S.
4102	S.C. Cahiro S.A.	Paper	32	River W/T
4014	Hartia Busteni	Paper	123	River W/T
4051	S.C. Petrobrazi S.A.	Petroleum Refinery	4,008	River W/T
4148	S.C. Petrotel SAPL.	Petroleum Refinery	1,376	River W/T
4158	S.C. Astra Romana S.A.	Petroleum Refinery	1,947	River W/T
4035	S.C. Steaua Romana S.A.	Petroleum Refinery	337	River W/T
4137	S.C. Vega S.A.	Petroleum Refinery	504	Industrial S.
4124	S.C. Dero Lever Ploiesti	Chemical Products	104	Domestic S.
4138	Progresul Ploiesti	Rubber/Plastic	3	River W/T
4146	Feroemail Ploiesti	Metal Products Fabrication	41	Domestic S.
4559	Neptun Campina	Machinery/Equipment	48	Domestic S.
4554	Electroutilaj	Electrical Machinery	546	Domestic S.
4150	Matizol	Construction (Material)	33	River W/T
4575	I.R.A. Campina	Land Transport	49	Domestic S.
4010	Spitalul Azuga	Health and Social Work	12	River W/T
	Total		9,788	

Note: W/T: with treatment, Domestic S.: domestic sewerage, Industrial S.: industrial sewerage

(a) INCAF. Ploiesti

This is a meat/processed meat production factory of which stocks are mostly shared by the state. The factory with 175 employees recorded a turnover of 22,836 million lei in 1996.

The wastewater of 4.38 l/s is discharged into the domestic sewerage system of Ploiesti City after pre-treatment of mechanical process. The wastewater quality much exceeds the national standards and even the existing permitted limits. (Note: The Romanian Government published the new national standards that are constant throughout the country in November 1997. Until then, the effluent quality had been permitted for the wastewater discharge individually. However, the existing permission will be effective for the time being until the existing license expires. Thereafter, the national new standards will be applied for all the wastewater effluents.)

(b) Coca Cola Ploiesti

This is a private beverage production factory established in 1995. The factory with 285 employees recorded a turnover of 489,000 million lei in 1997.

It discharges wastewater of 6.98 l/s into the domestic sewerage system of Ploiesti City after chemical and biological pre-treatment. The treatment plant functions well.

(c) Bere Azuga

This is a beer production factory established in 1870 of which stocks are mostly shared by the state. The factory with 480 employees recorded a turnover of 23,000 million lei in 1997.

It discharges wastewater of 4.76 l/s into the Prahova River after mechanical and biological treatment. The aeration tank is not well operated, hence, the wastewater quality exceeds both the national standards and existing permitted limits.

(d) Postav Azuga

This is a textile-manufacturing factory established in 1886. Approximately 70% of the stocks are shared by the state. The factory with 278 employees recorded a sales amount of 9,477 million lei in 1996.

The wastewater of 6.37 l/s is discharged into the Prahova River after mechanical, chemical and biological treatment. The wastewater quality exceeds both the national standards and existing permitted limits due to the lack of chemicals input into the plant and insufficient aeration.

(e) Prahoveana Ploiesti

This is a private leather-processing factory. The factory with 130 employees recorded a turnover of 3,280 million lei in 1996.

It discharges wastewater of 0.70 l/s into the domestic sewerage system of Ploiesti City after a simple pre-treatment. The wastewater quality much exceeds both the national standards and existing permitted limits in Oil.

(f) S.C. Cahiro S.A.

This is a paper and paper products manufacturing factory owned by the state. The factory with 650 employees recorded a turnover of 21,000 million lei in 1997.

The wastewater of 12.08 l/s is discharged into the Teleajen River after mechanical, chemical and biological treatment. The wastewater quality exceeds both national standards and existing permitted limits due to the lack of chemicals input into the plant and insufficient aeration.

(g) Hartia Busteni

This is a paper and paper products manufacturing factory of which ownership is a combined type of state and private. The factory with 691 employees recorded a turnover of 45,143 million lei in 1996.

The wastewater of 67.99 l/s is discharged into the Prahova River after mechanical and chemical treatment. The treatment plant is properly operated.

(h) S.C. Petro Brazi S.A.

This is a petroleum-refining factory under the control of the state petroleum corporation (SNP). The factory employed 5,365 staff/workers and recorded a turnover of 1,569,898 million lei in 1996.

The wastewater of 427.89 l/s is discharged into the Prahova River after mechanical, chemical and biological treatment. The wastewater quality much exceeds both the national standards and existing permitted limits, especially in Oil since the capacity of the existing plant is not fully employed.

(i) S.C. Petrotel S.A. Ploiesti

This is a private petroleum-refining factory established in 1904. The factory employs 2,600 staff/workers at present.

The wastewater is disposed by two (2) systems. Part of the wastewater (227.01 l/s) is discharged into the Teleajen River after treatment by the plant with mechanical, chemical and biological processes installed inside the factory (ECBAR treatment plant). The remaining wastewater is discharged into the treatment plant of S.C. Astra Romana S.A. through an industrial sewer after pre-treatment of mechanical and chemical processes.

The wastewater quality of the ECBAR treatment plant much exceeds both the national standards and existing permitted limits, especially in Oil due to the overloading of the plant.

(j) S.C. Astra Romana S.A.

This is a private petroleum-refining factory established in 1880. The factory with 1,861 employees recorded a turnover of 820,000 million lei in 1996.

The wastewater of 266.36 l/s is discharged into the Dimbu River after treatment of mechanical, chemical and biological processes. The wastewater quality exceeds both national standards and existing permitted limits due to the lack of chemicals input into the plant and insufficient aeration.

(k) S.C. Steaua Romana S.A.

This is a petroleum-refining factory of which ownership is a combined type of state and private. It was established in 1897. The factory with 895 employees recorded a turnover of 300,000 million lei in 1997.

The wastewater of 64.28 l/s is discharged into the Doftana River after treatment of mechanical and chemical processes. The wastewater quality exceeds both the national standards and existing permitted limits due to the lack of biological treatment process.

(l) S.C. Vega S.A.

This is a petroleum-refining factory of which ownership is a combined type of state and private. It was established in 1904. The factory with 347 employees recorded a turnover of 387,000 million lei in 1997.

The wastewater of 26.45 l/s is discharged into the treatment plant of S.C. Astra Romana S.A. after pre-treatment through an industrial sewer. The pre-treatment plant is properly operated.

(m) S.C. Dero Lever Ploiesti

This is a private manufacturing factory of chemical products. The wastewater of 9.01 l/s is discharged into the Ploiesti domestic sewerage after pre-treatment of mechanical and chemical processes. The pre-treatment plant is properly operated.

(n) Progresul Ploiesti

This is a private manufacturing factory of chemical products with 618 employees. It recorded a turnover of 19,042 million lei in 1996.

The wastewater of 8.63 l/s is discharged into the Dimbu River after mechanical treatment. The treatment plant is properly operated.

(o) Feroemail Ploiesti

This is a state owned factory of metal fabrication with 880 employees. It recorded a total sales amount of 20,156 million lei in 1996.

The wastewater of 8.05 l/s is discharged into the Cimpina domestic sewerage after pre-treatment of mechanical process.

(p) Neptun Campina

This is a manufacturing factory of mechanical equipment of which ownership is a combined type of state and private. The factory with 1,411 employees recorded a turnover of 45,609 million lei in 1996.

The wastewater of 14.27 l/s is discharged into the Cimpina domestic sewerage after pre-treatment of mechanical process.

(q) Electroutilaj

This is a manufacturing factory of electrical equipment of which stocks are mostly shared by the state. The factory with 2,000 employees recorded a sales amount of 62,000 million lei in 1997.

The wastewater of 6.31 l/s is discharged into the Cimpina domestic sewerage after pre-treatment of chemical process. The wastewater quality much exceeds the both national standards and existing permitted limits due to the lack of chemicals input into the plant and pollutants of pig breeding. (Note: The factory breeds pigs for self-consumption.).

(r) Matizol

This is a private manufacturing factory of construction materials established in 1939. The factory employs 1,530 staff and workers.

The wastewater of 8.97 l/s is discharged into the Teleajen River after mechanical and biological treatment.

(s) I.R.A. Campina

This is a private factory of automobile repairing established in 1947. The factory employs 1,280 staff and workers at present.

The wastewater of 7.52 l/s is discharged into the Cimpina domestic sewerage after pre-treatment of mechanical process. The plant is properly operated.

(t) Spitalul Azuga

This is a private hospital established in 1947 with a capacity of 190 patients. The hospital employs 126 staff at present.

The wastewater of 1.14 l/s is discharged into the Prahova River after treatment of Inhoff Tank. The wastewater exceeds both the national standards and existing permitted limits due to improper operation of the tank.

The wastewater quality of the above representative factories is shown in Table 3.9.

(7) Inventory of Representative Livestock Farms

Most of the livestock in the Basin are raised by individual farmers and are distributed over the entire river basin. In this study, their pollution loads are dealt as non-point sources. On the other hand, the existing major livestock farms to be dealt as point sources are only five (5). The inventories of the representative two (2) major livestock farms are summarized below.

Livestock Farm Name	Comporsa Stancesti	S.C. Agros Scaieni
Location	Stncesti	Boldesti Scaieni
Livestock Kind	Pig	Pig/Cattle
Nos. Livestock		5,460
Receiving Water	Prahova	Teleajen
Ave. Q (l/s)	5.33	0.86
Ave. BOD (mg/l)	1,249	285
Av. SS (mg/l)	1,978	428
Ave. BOD Load (kg/d)	575	21
Ave. SS Load (kg/d)	911	32
Treatment	W/T	W/T (M+B)

Note: (1) W/T: with treatment, (2) M: mechanical process, B: biological process

3.4 Existing River Water Quality and Aquatic Life

3.4.1 River Water Quality at Principal Location

(1) General

Romanian Waters has periodically observed the water quality of the Prahova Main River and its tributaries at 14 points since 1953. The river system and periodical observation points are shown in Fig. 3.3 along with location of the major wastewater effluents and water intakes.

The water quality of the Prahova River was analyzed and assessed based on the available data during the recent three (3) years from 1995 to 1997. The existing river water quality is summarized in the following sections.

(2) Organic Water Pollution

(a) Prahova Main River

The river water in the upper reaches of Sinaia is comparatively clean although the river receives the wastewater of several small sewerages and factories.

The water pollution gradually increases while the river runs downward due to the additional domestic and industrial wastewater effluents of Sinaia Town, Comarnic Town, Breaza Town and Cimpina City. The river water in the middle reaches is turbid in blue/gray color. This is considered due to erosion of the exposed clay minerals in the riverbanks and mountain slopes between Sinaia and Cimpina.

In the downstream reaches, three (3) major factories discharge a large quantity of wastewater with a high BOD and Oil concentration to the Prahova Main River southwest of Ploiesti City. The river water quality becomes worse.

The existing average organic pollution of the Prahova Main River at the monitoring points is summarized below.

Code No.	River Name	Location Name	River Distance(km)	River Reach	BOD (mg/l)	COD (mg/l)	SS (mg/l)
180	Main	Predeal	5.0	Upper	3.84	2.09	76
195	Main	Amonte Sinaia	15.0	Upper	4.34	2.41	89
200	Main	Cornu	53.0	Middle	6.21	3.42	169
217	Main	Nedelea	73.0	Middle	6.23	3.50	138
220	Main	Tinosu	105.0	Lower	18.02	11.00	324
190	Azuga	Azuga	21.0	Upper Tributary	3.32	1.84	67
205	Doftana	Amonte Traisteni	1.0	Upper Tributary	3.37	1.83	73

Note: River distance is measured from riverhead.

(b) Teleajen River

The river water is clean in the upstream reaches of Maneciu Dam. The water quality in the middle reaches deteriorates gradually towards Ploiesti City area mainly due to the domestic wastewater effluents.

The river water in the lower reaches is much affected by the effluents of domestic and industrial wastewater from Ploiesti City and its surrounding areas. In particular, the water quality suddenly becomes worse after the confluence of the Dimbu River.

Further, the river water is turbid in blue/gray color in the middle reaches due to erosion of the exposed clay minerals in the riverbanks and mountain slopes.

The existing average organic pollution of the Teleajen River at the monitoring points is summarized below.

Code No.	River Name	Location Name	River Distance (km)	River Reach	BOD (mg/l)	COD (mg/l)	SS (mg/l)
230	Teleajen	Cheia	10.0	Upper	3.69	2.02	65
240	Teleajen	Gura Vitioarei	58.0	Middle	6.08	3.38	201
260	Teleajen	Moara Domneasca	110.0	Lower	22.22	13.81	335
250	Dimbu	Goga	37.0	Lower Tributary	34.70	22.64	305

Note: River distance is measured from riverhead.

(c) Cricovul Sarat River

Concentration of the organic materials in the river water is high over the entire river stretches because of the small flow rate of the river. The water pollution is high even in the upper reaches. The river water quality in the downstream is further polluted due to the wastewater effluents from Urlati Town.

Moreover, the river water is highly turbid in yellow/brown color due to soil erosion of the riverbanks and watersheds.

The existing average organic pollution of the Cricovul Sarat River at the monitoring points is summarized below.

Code No.	River Name	Location Name	River Distance (km)	River Reach	BOD (mg/l)	COD (mg/l)	SS (mg/l)
275	Cricovul Sarat	Sangeru	10.0	Upper	15.15	9.21	307
280	Cricovul Sarat	Ciorani	88.0	Lower	17.62	10.64	328

Note: River distance is measured from riverhead.

(3) Toxic Pollution

Available data of the toxic water pollution is limited. However, the following toxic pollution has been identified in the Basin.

Code No.	River Name	Location Name	CN (mg/l)	Phenol (mg/l)	Oil (mg/l)	Cd (mg/l)
180	Prahova Main	Predeal	-	-	-	-
195	Prahova Main	amonte Sinaia	0.01	0.00	0.00	0.00
200	Prahova Main	Cornu	0.01	0.01	0.09	0.00
217	Prahova Main	Nedelea	0.01	0.02	0.61	0.00
220	Prahova Main	Tinosu	0.03	0.09	6.03	0.00
190	Azuga	Azuga	-	-	-	-
205	Doftana	amonte Traisteni	-	-	0.00	-
230	Teleajen	Cheia	-	-	0.00	-
240	Teleajen	Gura Vitioarei	0.01	0.01	0.02	0.00
260	Teleajen	Moara Domneasca	0.04	0.05	6.27	-
250	Dimbu	Goga	0.01	0.12	15.08	0.01
275	Cricovul Sarat	Sangeru	-	0.05	1.04	-
280	Cricovul Sarat	Ciorani	0.03	0.04	3.25	0.00

As shown in the above table, toxic materials with high concentration, especially Oil are observed at the downstream of Prahova Main River (monitoring station: 220), at Dimbu River (monitoring station: 250) and at the downstream of Teleajen River (monitoring station: 260). The industrial wastewater effluents in Ploiesti City and its surrounding areas mainly cause his water pollution.

(4) Pollution Load Balance in River

The average daily organic pollution load (BOD) at each monitoring station of the River is calculated as shown below.

No.	River Name	Location Name	Ave. Flow Rate (m^3/s)	Ave. BOD Content (mg/l)	Ave. BOD Load (ton/day)
180	Prahova Main	Predeal	1.61	3.8	0.53
195	Prahova Main	amonte Sinaia	2.16	4.3	0.81
200	Prahova Main	Cornu	8.96	6.2	4.81
217	Prahova Main	Nedelea	8.33	6.2	4.48
220	Prahova Main	Tinosu	10.98	18.0	17.10
190	Azuga	Azuga	1.21	3.3	0.35
205	Doftana	amonte Traisteni	4.16	3.4	1.21
230	Teleajen	Cheina	0.80	3.7	0.26
240	Teleajen	Gura Vtioarei	3.80	6.1	2.00
260	Teleajen	Moara Domneasca	8.68	22.2	16.66
250	Dimbu	Goga	2.58	34.7	7.74
275	Cricovul Sarat	Sangeru	0.25	15.6	0.34
280	Cricovul Sarat	Ciorani	0.99	17.6	1.51

The BOD load in the Prahova Main River much increases between Nedelea (No. 217) and Tinosu (220) from 4.48 ton/day to 17.10 ton/day. This BOD increase is attributable to the wastewater effluents of the factories located between both monitoring stations.

The Dimbu River receives a large quantity of BOD load (7.74 ton/day) from the sewerage and factories in Ploiesti City. It shares 46% of the total BOD load (16.66 ton/day) of the Teleajen River.

On the other hand, the BOD load in the Cricovul Sarat River is as small as 1.51 ton/day even in the downstream reaches although the river water quality shows a high BOD concentration. This high concentration is due to the small flow rate of the river.

(5) Comparison of Existing River Water Quality with National Standards

The national standards (STAS 4706/1988) classify river water quality into three (3) categories by water use. Applicable water uses by category in the standards are summarized below. For details, see Appendix C, Chapter I 1.6.

Category	Quality (mg/l)			Scope of Water Use
	BOD	Oil	CN	
I	5	0.1	0.01	• Centralized potable water supply • central water supply for food industry requiring potable water quality • others
II	7	0.1	0.01	• water supply for industrial technological processes • others
III	12	0.1	0.01	• water supply for irrigation • water supply for cooling system • others

The average water quality (BOD, Oil and CN) of the River at each monitoring station is classified by the standard water quality category as follows.

Code No.	River Name	Location Name	BOD	Oil	CN
180	Prahova Main	Predeal	I	I	I
195	Prahova Main	Amonte Sinaia	I	I	I
200	Prahova Main	Cornu	II	I	I
217	Prahova Main	Nedelea	II	D	I
220	Prahova Main	Tinosu	D	D	D
190	Azuga	Azuga	I	I	I
205	Doftana	Amonte Traisteni	I	I	I
230	Teleajen	Cheia	I	I	I
240	Teleajen	Gura Vitioarei	II	I	I
260	Teleajen	Moara Domneasca	D	D	D
250	Dambu	Goga	D	D	I
275	Cricovul Sarat	Sangeru	D	D	I
280	Cricovul Sarat	Ciorani	D	D	D

Note: D means out of standard category.

The water quality parameters (BOD, Oil and CN) of the River exceeds the Category III in the entire downstream reaches due to the domestic and industrial wastewater effluents from the Ploiesti City and its surrounding areas.

The above assessment is for the annual average river water quality. The assessment for the river water quality during dry season is more severe.

3.4.2 Aquatic Life in the River

(1) General

A rapid industrialization started in the middle of 1960's in most of the cities and towns along the Ialomita and Prahova rivers except Ploiesti City. Ploiesti City had already been developed as the center of petroleum industry since the middle of 19th century. This industrial development contaminated the river water quality, resulting in ousting various fish species which had lived in the 1960's from the two (2) rivers.

(2) Fish Species Lived in 1960's

In the beginning of 1960's, Dr. P. Banarascu identified 28 fish species living in the entire Ialomita and Prahova rivers. These species lived in different river sections from the spring to the river mouth respectively. The fish species lived in each river section are summarized as follows.

(a) Ialomita River

(i) Upper Reaches (Spring -- Pucioasa Lake; mountain area)

Salmo truta fario (trout), *Noemacheilus barbatulus* (loach), *Phoxinus phoxinus* (minnow), *Cotus gobio gobio* (miller's thumb), *Gobio uranoscopus frici*

(ii) Middle Reaches (Pucioasa Lake – Confluence with Prahova River)

Noemacheilus barbatulus (loach), *Phoxinus phoxinus* (minnow), *Alburnoides bipunctatus bipunctatus*, *Gobio gobio obtusirostris*, *Gobio uranoscopus frici*, *Barbus meridionalis*, *Leuciscus cephalus*, *Rhodeus sericeus amarus* (rhodeus), *Barbus barbus* (barbel), *Leucispus delineatus* (fish fry), *Alburnus alburnus* (bleak), *Silurus glanis* (sheat fish), *Carassius carassius* (crucian)

(iii) Lower Reaches (Confluence with Prahova River – Tandarei)

Rhodeus sericeus amarus (rhodeus), *Barbus barbus* (barbel), *Leucispus delineatus* (fish fry), *Pelecus culturatus*, *Silurus glanis* (sheat fish), *Esox lucius* (pike), *Carassius carassius* (crucian)

(iv) Around River Mouth

Gobio albibipinnatus, *Leuciscus idus* (cisco), *Barbus barbus* (barbel), *Cobitis taenia*, *Aspius aspius* (rapacious carp), *Leucispus delineatus* (fish fry), *Abramis brama* (bream), *Pelecus culturatus*, *Cyprinus carpio*, *Bilcca bjoerkna* (Romanian freshwater fish), *Carassius auratus gibelio* (crucian carp), *Rutilus rutilus* (roach), *Esox lucius* (pike), *Acerina schraetser*, *Misgurnus fossilis* (loach; eel)

Note: For location of Pucioasa and Tandarei, see Appendix C Fig. C.5.1.

(b) Prahova River

(i) Upper Prahova Valley (upstream of Azuga)

Salmo truta fario (trout),

(ii) Middle and Lower Prahova Valley (Busteni – Cimpina)

Phoxinus phoxinus (minnow), *Barbus meridionalis*

(iii) Middle and Lower Reaches (Cimpina – Confluence with Ialomita River)

- none -

(3) Existing Fish Species

(a) Ialomita River

The number of fish species in the Ialomita River has considerably decreased since the 1960's due to the water pollution. Especially, species that are less resistant to water pollution completely disappeared from the lower reaches. However, fish fries have been reported recently in the lower reaches because the current economic depression has decreased the industrial wastewater discharge into the river.

(b) Prahova River

In the Prahova valley, the same species that lived in the 1960's can still be seen, while no fish specie has been identified in the middle and lower reaches.

(4) Recovery of Fish Species

The fish species that lived in the 1960's are expected to go back to the rivers in the future when the existing river water pollution is cleaned up.

3.5 Analysis of River Water Pollution Mechanism

3.5.1 Supplementary Water Quality Observation

(1) General

Simultaneous water quality observation of river water, and sewerage, factory and livestock farm wastewater effluents is necessary to analyze the existing water pollution mechanism of the River.

The JICA Study Team conducted simultaneous water quality observations, with the cooperation of Romanian Waters, two (2) times between the middle of February and early March to analyze the pollution mechanism in the winter season. Sampling and laboratory analysis were carried out two (2) times for each of the following 64 locations.

The first observation was from February 9 to 13, 1998 and the second was from March 2 to 6, 1998. The laboratory analysis was made at the laboratory of Romanian Waters, Prahova Office.

River	River	Sewerage (effluent)	Factory (effluent)	Livestock (effluent)	Total
Prahova Main	13	7	10	2	32
Teleajen	8	7	12	1	28
Curicovul Sarat	3	1	0	0	4
Total	24	15	22	3	64

Note: Teleajen River includes Dimbu River.

Further, the Study Team conducted simultaneous water quality observations, with the cooperation of Romanian Waters, once between the middle of July and early August to analyze the pollution mechanism in the summer season. Sampling and laboratory analysis were carried out once for the following 105 locations. The third observation was done between July 20 and August 3, 1998. The laboratory analysis was made also at the laboratory of Romanian Waters, Prahova Office.

River	River	Sewerage		Factory		Livestock		Total
		Influent	Effluent	Influent	Effluent	Influent	Effluent	
Prahova Main	13	4	7	8	15	2	2	51
Teleajen	8	8	8	7	16	1	1	49
Cricovul Sarat	3	1	1	0	0	0	0	5
Total	24	13	16	15	31	3	3	105

Note: Teleajen River includes Dimbu River.

For details of the sampling locations, see Fig. 3.3.

(2) Observation

(a) First Observation

The first observation included the following water quality parameters:

Discharge, Water Temperature, Color, Odor, pH, Electric Conductivity, Turbidity, NH_4^+, NO_3^-, NO_2^-, Phenol, PO_4^{3-}, Dissolved O_2, BOD, COD-Mn, SS

(b) Second Observation

The second observation included the following water quality parameters:

Discharge, Water Temperature, Color, Odor, pH, Electric Conductivity, Turbidity, NH_4^+, NO_3^-, NO_2^-, Phenol, PO_4^{3-}, Dissolved O_2, Petroleum, BOD, COD-Mn, SS, Cadmium(Cd), Cyanide(CN), Cr^{6+}, Cr^{3+}, Copper(Cu), Anionic Detergents, Hg, Ni^{2+}, Lead(Pb), Zinc(Zn)

(c) Third Observation

The third observation included the following water quality parameters:

Discharge, Water Temperature, Color, Odor, pH, Electric Conductivity, Turbidity, NH_4^+, NO_3^-, NO_2^-, Phenol, PO_4^{3-}, Dissolved O_2, Petroleum, BOD, COD-Mn, SS, Cadmium(Cd), Cyanide(CN), Cr^{6+}, Cr^{3+}, Copper(Cu), Anionic Detergents, Hg, Ni^{2+}, Lead(Pb), Zinc(Zn), Organic Chloride

For observation results, see Appendix C, Table C.2.3 to Table C.2.5.

3.5.2 Construction of Water Quality Simulation Model

(1) General

The pollutant sources in the Basin are classified into point sources and non-point sources. The point sources consist of the wastewater of sewerage, factories and major livestock farms. The non-point sources include household wastewater not covered by a sewerage system, individual livestock wastewater and wastewater from lands (farmland, forest and built-up area).

The point and non-point pollution loads generated from each pollutant source run off on lands or through small channels/ditches to the tributaries. Thereafter, they run off through the tributaries to enter the main river. Finally, they flow down the main river.

In the first runoff stage, the pollution load is decreased by infiltration to the ground and natural purification effects. The runoff coefficient (R_1) is generally constant for each land use category. In the second runoff stage, the pollution load is reduced by the purification effect of tributaries. The runoff coefficient (R_2) varies according to the tributary length. In this study, pollution load effluent is defined as the pollution load runoff to the main river; namely, pollution load effluent is calculated by multiplying the runoff coefficients by the generated pollution load as follows:

Pollution Load Effluent = Generated Pollution Load x R_1 x R_2

For location of the tributaries and main rivers, see Fig. 3.1.

Furthermore, BOD in pollution load runoff and river water quality is simulated in this study because BOD is the most representative water quality parameter of the Basin.

(2) Modeling of the Basin

The river water quality of the Basin is simulated at 23 principal river stations. The stations are selected in consideration of the existing river water use and data availability. Corresponding to the 23 stations, the Basin is also divided into 23 sub-basins.

The 23 water quality evaluation points and sub-divided basins are shown in Fig. 3.1. The schematic diagram for the simulation model is shown in Fig.3.4.

(3) Pollution Load Generation and Effluent

(a) Point Pollutant Sources

The existing generated pollution loads of sewerage and industrial wastewater are estimated in Chapter III, Subsections 3.3.1 and 3.3.2. They are directly discharged into the main river except a very few sources.

(i) Non-point Pollution Sources

(i) Household

The household pollution load generation is estimated as the product of population and unit load. The unit load is assumed in consideration of the difference of living standards of two (2) cities and other municipalities as follows: 42.0 g/person/day for city and 33.6 g/person/day for town/commune.

In this estimation, it is assumed that all gray water is generated, however, black water generation is reduced by 50% due to the effect of septic tank/latrine.

The runoff coefficient R_1 is assumed to be 0.6 for city/town and 0.2 for commune.

The runoff coefficient R_2 is calculated as a function of the tributary length from the pollutant source to the main river. The reduction rate is 1.0% per km.

(ii) Livestock

The livestock pollution load generation is estimated as the product of number of livestock and unit load. The unit load is assumed at 640 g/head/day for cattle and 200 g/head/day for pig.

The runoff coefficient R_1 is assumed to be 0.1 for both animals. The runoff coefficient R_2 is estimated as a function of the tributary length from the pollutant source to the main river. The reduction rate is 1.0% per km.

(iii) Land

The land pollution load generation is estimated as the product of land area and unit load. The unit load is assumed to be 7.5 g/ha/day for forest area, 85.8 g/ha/day for farmland and 670 g/ha/day for built-up area.

The runoff coefficient R_1 is assumed at 0.2 for forest area, 0.2 for farmland and 0.6 for built-up area. The runoff coefficient R_2 is estimated as a function of the tributary length from the pollutant source to the main river. The reduction rate is 1.0% per km.

The existing total pollution load generation of the Basin is estimated at 107.7 ton/day. Breakdown by major sub-basin and by pollutant source are shown below.

(unit: kg/day)

Source	Prahova Main	Dimbu	Teleajen	Cricovul Sarat	Total	(%)
Point (sewerage)	1,790	6,760	405	44	8,999	8.4
Point (industry)*	6,235	2,056	2,049	1	10,342	9.6
Sub-total	8,025	8,816	2,455	45	19,341	18.0
Non-point (household)	5,242	2,071	5,211	2,210	14,735	13.7
Non-point (livestock)	26,750	3,395	18,324	7,958	56,426	52.4
Non-point (land)	8,023	1,807	4,829	2,453	17,112	15.9
Sub-total	40,016	72,72	28,364	12,621	88,273	82.0
Total	48,041	16,088	30,819	12,666	107,614	100.0

*: including factories, major livestock farms and other industrial activities

The existing total pollution load effluent to the main river is estimated to be 33.4 ton/day. Breakdown by major sub-basin and by pollutant source are shown below.

(unit: kg/day)

Source	Prahova Main	Dimbu	Teleajen	Cricovul Sarat	Total	(%)
Point (sewerage)	1,790	6,760	404	44	8,998	27.0
Point (industry)*	6,212	2,056	2,035	1	10,313	30.9
Sub-total	8,002	8,816	2,439	45	19,302	57.9
Non-point (household)	1,565	1,002	1,409	502	4,477	13.4
Non-point (livestock)	2,496	338	1,752	761	5,347	16.1
Non-point (land)	1,864	676	1,144	498	4,180	12.6
Su-total	8,685	2,015	4,304	1,761	13,965	42.1
Total	13,927	10,831	6,743	1,806	33,306	100.0

*: including factories, major livestock farms and other industrial activities

For details of the pollution load generation and effluent to the main river, see Appendix C, Table C.3.1 to Table C.3.4.

(4) Simulation of River Water Quality

The above-estimated pollution load effluents are used as input data to simulate the existing river water quality at 23 stations of the main rivers. The Streeter Helps Equation is applied for the simulation of BOD water quality of the main rivers. BOD concentration is calculated by the following equation.

$$L_L = \left(L_u - \frac{L_a}{2.31k_r} \right) \bullet 10^{-k_r t} + \frac{L_a}{2.31k_r}$$

$$D_L = \frac{k_1}{k_2 - k_r} \left(L_u - \frac{L_a}{2.31k_r} \right) \bullet \left(10^{-k_r t} - 10^{-k_2 t} \right) + \frac{k_1}{2.31k_2} \bullet \left(\frac{L_a}{k_r} + \frac{D_B}{k_1} \right) \bullet \left(1 - 10^{-k_2 t} \right) + D_u 10^{-k_2 t}$$

L : Biochemical demand of carbonaceous oxygen (mg/ℓ)
D : Dissolved oxygen deficit (mg/ℓ)
Subscript u : Upper reach point L : Lower reach point
kr : BOD removal rate (= $k1 + k2$) (ℓ/day)
$k1$: Removal rate of BOD with consumption of DO (ℓ/day)
$k2$: Re-aeration rate
$k3$: Removal rate of BOD without consumption of DO
La : BOD added from riverbed (mg/ℓ/day)
D_B : DO supply or consumption except re-aeration
t : traveling time (day)

In the above equations, the constants of BOD removal rate are assumed referring to the analyses in Japan. BOD added from riverbed is considered negligible, judging from the existing riverbed conditions of the Prahova River.

Calibration of the simulation model was done for the observed river water quality and discharge during the dry season of September to November in the recent three (3) years (1995-1997), as shown in Fig. 3.5.

As shown in Fig. 3.5, the simulated water quality is considered to be in comparatively well agreement with the observed one.

3.5.3 Standard River Flow Rate for Water Quality Assessment

(1) General

River flow rate fluctuates throughout the year and, accordingly, river water quality also always varies depending on river flow rate. Hence, it is necessary to determine a proper standard river flow rate for the assessment of river water quality. If the standard river flow rate is determined too low, dilution effects of the river water is under-estimated. As a result, the water pollution control cost required to attain the target river water quality will be over-estimated, although the river water quality with a high reliability can be secured.

The standard river flow rate of the Prahova River is determined in due consideration of the rate to assure target river water quality, river water use categories, improved river water quality by wastewater treatment and required wastewater treatment cost.

(2) Target River Water Quality

The target river water quality of the Basin is determined based on the national river water quality standards mentioned in Subsection 3.4.1.

All the domestic water and most of the industrial water in the Basin are extracted from the upper reaches of the River or underground where the water quality has no problem. In the middle and downstream reaches, the river water is used only for the industrial water of S.C. Petrobrazi S.A. (partly) and F.E. Ploiesti, and agriculture. This industrial water is extracted for the use of cooling and manufacturing process from the Nedelea Intake in the middle reaches of the Prahova Main River. It is not affected by the major pollutant sources of the Ploiesti area. The water use in all the other river sections is only for agricultural purpose.

Therefore, the target river water quality in the middle and lower reaches of the Prahova River falls in Category II at Nedelea Intake site and Category III in all the other river sections. The permissible BOD concentration is 7 mg/l at Nedelea Intake and 12 mg/l in all the other river sections. The target river water quality may not need to have a high safety factor as a whole.

(3) Application of Government Decision (NTPA-001)

The wastewater quality standards in Romania were published in November 1997 by the Government Decision (NTPA-001). The quality of all wastewater discharging to river must be below 20 mg/l in BOD. Further, NTPA–001 stipulates that the standard flow rate is the yearly minimum monthly mean discharge with a 95% probability.

The standard flow rates defined by NTPA-001 at the principal stations in the Basin are shown in the following table. The future river water quality (BOD) in 2015 when all the sewerage and industrial wastewater are treated up to 20 mg/l is also shown in the same table, compared with the target quality.

Station	Location	Standard Flow Rate (m^3/s)	Future Quality (mg/l)	Target Quality (mg/l)
Prahova	Prahova Main Downstream	3.32	21	12
Moara	Teleajen Downstream	2.79	34	12
Ciorani	Cricovul Sarat Downstream	0.11	73	12
Adincata	Upstream of Ialomita Junction	7.38	25	12

However, this standard flow rate is so small that practically it cannot be applied for the Basin. All the sewerage and industrial wastewater must be treated up to 5 mg/l in BOD by applying a high-level treatment process in order to attain the target river water quality in 2015. The total required investment and the annual O&M costs are estimated as follows, comparing with the normal treatment costs required to treat up to 20 mg/l in BOD.

Item	High Level Treatment (BOD 5 mg/l)	Normal Level Treatment (BOD 20 mg/l)
Investment Cost (US$ million)		
Sewerage	64,866	46,661
Industrial Wastewater	69,875	49,761
Total	134,741	96,422
Annual O&M Cost (US$ thousand/year)		
Sewerage	14,475	2,641
Industrial Wastewater	28,991	14,463
Total	43,466	17,104

Note: Sewerage includes the development and O&M costs of sewer networks

For details, see Appendix D, Chapter II, Section 2.4 and Appendix E, Chapter IV, Section 4.4.

In this study, a more practical standard river flow rate is proposed as described below.

(4) Assurance Rate of Target River Wate r Quality

River flow regime is generally evaluated by river flow rate - frequency curve. The average flow regime (daily flow rate - frequency curve) during the recent 20 years at the principal stations of the Prahova River are shown below.

(unit : m^3/s)

River	Station	20% (73 days)	50% (183 days)	60% (219 days)	70% (256 days)	75% (274 days)	80% (292 days)	90% (329 days)	95% (347 days)	100% (365 days)
Prahova Main	Prahova	14.56	7.28	6.33	5.76	5.42	5.19	4.80	4.26	3.63
Teleajen	Moara	11.34	6.93	6.30	5.65	5.38	5.17	4.81	4.52	3.97
Cricovul Sarat	Ciorani	1.50	0.85	0.72	0.62	0.56	0.52	0.43	0.35	0.21
Prahova River	Adincata	31.27	18.46	16.30	14.81	14.31	13.68	12.70	11.67	10.15

The flow rate of 95% (347 days flow rate) in the above table is much different from the standard flow rate defined in NTPA-001 (yearly minimum monthly mean discharge with a 95% probability), as shown below.

River	Station	Standard Flow Rate in NTPA-001	95 % Flow Rate in Above Table
Prahova Main	Prahova	3.32	4.26
Teleajen	Moara	2.79	4.52
Cricovul Sarat	Ciorani	0.11	0.35
Prahova River	Adincata	7.38	11.67

If a flow rate of 75% (274 days flow rate) is assumed as the standard flow rate, the river flow rate will be above 5.42 m^3/s at Prahova St., 5.38 m^3/s at Moara St., 0.56 m^3/s at Ciorani St. and 14.31 m^3/s at Adincata St. during 274 days per year on average and is below them during 91 days. On the other hand, the river water quality will be below the standards during 274 days and above the standards during 91 days.

If the assurance rate of target river water quality is defined as 100% during 274 days and decreases in inverse proportion to river flow rate during 91 days, the yearly average assurance rates of target river water quality at the principal stations are estimated as follows.

(unit : %)

Station	50 % Flow Rate			75 % Flow Rate			95 % Flow Rate		
	183 days	182 days	Yearly	274 days	91 days	Yearly	347 days	18 days	Yearly
Prahova	100	73.4	84.6	100	86.6	96.2	100	92.1	99.6
Moara	100	77.4	87.3	100	89.2	97.1	100	93.5	99.7
Ciorani	100	59.5	74.6	100	71.4	90.9	100	75.6	98.4
Adincata	100	76.2	86.5	100	87.9	96.6	100	92.9	99.6
Average	100	71.6	83.3	100	83.8	95.2	100	88.5	99.3

Similarly, the assurance rates of target river water quality in the cases of standard river flow rates of 50% (183 days flow rate) and 95% (347 days flow rate) are calculated also as shown in the above table.

(5) Improved River Water Quality by Wastewater Treatment

The future river water quality (BOD) at the principal stations of the River is roughly estimated as shown in the following table on the assumption that all the sewerage systems and factories will discharge wastewater in BOD 20 mg/l.

(unit : BOD mg/l)

Station	Location	50 % Flow	75 % Flow	95 % Flow	Target
Prahova	Prahova Main Downstream	10	13	14	12
Moara	Teleajen Downstream	12	16	16	12
Ciorani	Cricovul Sarat Downstream	10	13	17	12
Adincata	Upstream of Ialomita Junction	10	12	14	12

(6) Conclusion

The standard flow rate stipulated in NTPA-001 has a too high safety factor and it is difficult to attain the target river water quality (BOD : 12 mg/l) in the Basin. Adoption of the standard flow rate of NTPA-001 is considered impractical. Hence, a new standard is proposed in this study.

As shown in the table in Section (4), adoption of the standard flow rate of 95% also secures a too high assurance rate of the target river water quality. Generally, the standard flow rate of 50% or 75% is reasonably applicable.

In this study, the standard flow rate of 50% is applied for the Basin considering that:

(a) The water use in the middle and lower reaches of the Basin is mostly for agricultural purpose and a higher assurance rate is considered unnecessary.

(b) It is impractical to force a higher-level wastewater treatment than the normal level (BOD 20 mg/l) to the municipalities and industrial establishments under the existing water use situation of the Basin.

3.5.4 Simulation of Existing Baseline River Water Quality

The existing baseline river water quality of the River is simulated for the proposed standard river flow rate (mean daily flow rate of 50% or 183 days flow rate of average flow regime).

For this simulation, the existing pollution load effluents used in the calibration of the simulation model are employed as input data except domestic sewerage and one (1) factory effluent. The existing baseline pollution load effluents of sewerage are estimated in Chapter III, Subsection 3.3.1 and these data are applied for this simulation. The wastewater effluent of S.C. Romfosfochim SA is excluded from the existing baseline pollution load effluents of factory since it was closed in August 1997.

The total existing baseline pollution load generation of the Basin is estimated at 107.1 ton/day. Breakdown by major sub-basin and by pollutant source is shown below.

(unit: kg/day)

Source	Prahova Main	Dimbu	Teleajen	Cricovul Sarat	Total	(%)
Point (sewerage)	1,700	6,649	410	50	8,808	8.2
Point (industry)*	6,235	2,056	1,769	1	10,062	9.4
Sub-total	7,935	8,705	2,179	51	18,870	17.6
Non-point (household)	5,242	2,071	5,211	2,210	14,735	13.7
Non-point (livestock)	26,750	3,395	18,324	7,958	56,426	52.7
Non-point (land)	8,023	1,807	4,829	2,453	17,112	16.0
Sub-total	4,0016	7,273	28,364	12,621	88,273	82.4
Total	47,951	15,978	30,543	12,672	107,143	100.0

*: including factories, major livestock farms and other industrial activities

The total existing baseline pollution load effluent to the main river is estimated to be 32.8 ton /day. Breakdown by major sub-basin and by pollutant source is shown below.

(unit: kg/day)

Source	Prahova Main	Dimbu	Teleajen	Cricovul Sarat	Total	(%)
Point (sewerage)	1,700	6,649	408	50	8,806	26.8
Point (industry)*	6,212	2,056	1,763	1	10,032	30.6
Sub-total	7,912	8,705	2,170	51	18,838	57.4
Non-point (household)	1,565	1,002	1,409	502	4,477	13.6
Non-point (livestock)	2,496	338	1,752	761	5,347	16.3
Non-point (land)	1,864	676	1,144	498	4,180	12.7
Subtotal	5,925	2,015	4,304	1,760	14,005	42.6
Total	13,837	10,720	6,474	1,811	32,843	100.0

*: including factories, major livestock farms and other industrial activities

The simulated river water quality at principal stations is summarized below along with the proposed standard river flow rate.

Code No.	Station Name	Location of Station	Existing Standard Flow Rate (m^3/s)	Existing Baseline BOD (mg/l)
200	Cimpina	Exit of Prahova Valley	5.26	4.3
217	Nedelea	Upstream of Nedelea Weir	7.11	7.4
220	Prahova	Prahova Main Downstream	7.28	15.2
260	Moara	Teleajen Downstream	6.93	18.2
280	Ciorani	Cricovul Sarat Downstream	0.85	11.0
H	Adincata	Upstream of Ialomita Junction	18.46	14.2

Longitudinal profiles of the existing baseline river water quality in the respective rivers are shown in Fig. 3.6.

3.6 Accidental River Water Pollution

The Basin is frequently affected by accidental water pollution. Accidental water pollution has occurred 18 times since 1989. These accidental records are summarized in Table 3.10. The accident location in the past is shown in Fig. 3.7. For details, see Appendix F, Chapter III.

The accidental water pollution in the Basin can be roughly classified into two (2) types. One is leakage and spill of hazardous substances in Ploiesti City and its surrounding areas. The other is leakage of diesel oil from the pipeline running along the Prahova-Doftana River from Ploiesti City to Brasov City.

The former one has happened 10 times. The accidents were caused by pump/valve damage, spillover of the wastewater treatment plant due to heavy rainfall and others. However, the river water contamination was not serious because necessary countermeasures were taken immediately after the accidents and there is no river water use in the downstream.

The latter one has occurred eight (8) times in the upstream of the Paltinu dam or between the Paltinu dam and Voila water supply purification plant in the Doftana River, affecting the water supply to the beneficial municipalities. The accidents were all caused by leakage of diesel oil from the corroded holes of the pipeline.

Among the above accidents, the most serious ones are those in 1995 and 1996. The water supply was suspended during March 7 to May 24, 1995 and December 27, 1995 to July 31, 1996. The affected municipalities and population by these water supply suspensions are shown below. For location of the affected municipality, see Fig. 3.7.

Municipality Name	Affected Population	Remarks
Cimpina City	41,000	
Breaza Town	19,000	
Cornu Commune	4,000	
Banesti Commune	5,700	
Telega Commune	3,000	
Floresti Commune	5,500	
Moreni Town	14,500	Dimbovita County
Baicoi Town	14,000	
Ploiesti City	125,300	
Town	232,000	