JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MUNICIPALITY OF MARIBOR
MINISTRY OF ENVIRONMENTAL AND PHYSICAL PLANNING
REPUBLIC OF SLOVENIA

THE STUDY FOR THE SANITATION OF THE DRAVA RIVER BY WASTE WATER PRETREATMENT AND WATER CONSERVATION IN INDUSTRY IN THE CITY OF MARIBOR, REPUBLIC OF SLOVENIA

FINAL REPORT (MAIN REPORT)

MARCH 1997

WATER RE-USE PROMOTION CENTER JAPAN

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PREFACE

In response to a request from the Government of the Republic of Slovenia, the Government of Japan decided to conduct the Study for the Sanitation of the Drava River by Waste Water Pretreatment and Water Conservation in Industry in the City of Maribor, Republic of Slovenia)

JICA sent a study team, led by Mr. Totaro GOTO of WATER RE-USE PROMOTION CENTER to the Republic of Slovenia five times from March 1996 to March 1997.

The team held discussions with the officials concerned of the Government of the Republic of Slovenia, and conducted related field surveys. After returning to Japan, the team conducted further studies and compiled the final results in this report.

I hope this report will contribute to the promotion of the plan and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Slovenia for their close cooperation throughout the study.

March 1997

Kimio Fujita
President
Japan International Cooperation Agency

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PART 1

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Part I Outline

I . Objectives of Study

I. Objectives of Study

The objectives of the Study are the preparation of plans for standard waste water treatment systems and water conservation systems to improve waste water treatment and to promote water conservation in the main industrial sectors in Maribor and the recommendation of measures to be taken by the competent authority in Slovenia with a view to promoting the dissemination of these systems.

Ⅱ. Outline of Study Region

II. Outline of Study Region

To effectively fulfill the purposes of this study, it is of course essential to become familiar with the outline of our study subjects, the country of Slovenia and the city of Maribor. Accordingly, we focused the study on the country and city levels, on (1) the state of the natural conditions and social economy, (2) the state of pollution of the waters of the Drava River valley, and (3) the state of the supply and demand of water.

An understanding of the natural conditions is requisite for the design of treatment plants, and an awareness of the conditions of the social economy is needed to accurately depict the background conditions which require investigation and to prevent errors in judgment midway through the survey. Maribor City, the subject of this survey, is the largest of all the industrial cities related to the Drava River in Slovenia, and it is believed to be the largest source of pollutants discharged into the Drava River. Thus, we next investigated the state of pollution of the Drava River valley to clarify the levels of environmental pollution originating from Maribor City. Finally, we investigated the supply and demand of water, especially industrial water, and clearly defined the reasons for the need for pretreatment of industrial wastewater and conservation of industrial water (whether it was merely an environmental problem or involved also problems of water shortage). We used these data as the reference material for establishing the basic plan for our survey.

1. Natural and Socioeconomic Conditions

1. 1 General [1]

The Republic of Slovenia is a young country in Central Europe whose independence was declared in 1991. The republic is located to the south of the Alps, and borders Italy, Austria, Hungary and Croatia. It has an area of 20,256 km^2 with a population of about two million.

Slovenia's climate is quite diverse. The narrow coastal regions enjoy the sub-Mediterranean climate with relatively hot and dry summers and mild winters.
The average temperatures in Portoroz, 4.5℃ in January, and 23.3℃ in July (1,038mm of precipitation), are significantly higher than the temperaturs in Postojna,

a mere 60 km away (0.0℃ in January, 17.5℃ in July, 1,602 mm of precipitation) or Ljubljana, the capital, 120 km away, (-1.6℃ in January, 19.6℃ in July, 1,400 mm of precipitation).

Northward from the Dinaric range, the climate becomes alpine with fresh summers and cold winters. Precipitation increases to 1,500 mm and reaches more than 3,000 mm in the Julian Alps. Towards the east, the climate slowly changes to the Pannonian type,i.e.,a continental climate with cold winters and warm summers (in Murska Sobota, the average temperature is -2.7℃ in January, 19.4℃ in July and 800-1,200 mm of precipitation).

The geological location enables a quick and easy access to the European market. Therefore, Slovenia was traditionally oriented towards exports to the developed market economies even before the breakdown of the former Yugoslavia. Currently, around 75% of the total export goes to Western Europe.

Slovenia embarked on a path of transformation to a market economy and integration into the European economy with its independence in 1991. Through EU membership, it aims at :

1) faster economic growth, bridging the gap with the developed countries of Western Europe
2) a more competitive Slovene economy
3) permanent sustenance of economic growth from the ecological and ethnic standpoints.

A report by the Bank of Slovenia says that Slovenia's per capita GDP reached 9,348 U.S. dollars in 1995. Thus, Slovenia can be regarded as a rather advanced country in Europe.

1 .2 Socioeconomic condition of Slovenia (1)

The essential factors of economic development are human resources, capital, technology and entrepreneurship. It is a basic policy that the role of the state is to give a positive impact on the development of all the four factors.

1) Human resources

In the early 1990s, the birth rate of the Slovene population was far below the level which assures simple reproduction. The average family has only one or two children. Life expectancy is 69.5 years for men and 77.4 years for women. It seems that the reduction of the population is a long-term tendency in Slovenia. The decreased birth rate and small probability of an immediate improvement forecast a reduction and even a lack of available labor force at the beginning of the 21st century.

Education as an asset is measured by the population's average number of schooling years and training of the labor force. In 1991, the average Slovene had completed 10.1 years of schooling. Slovenia can provide primary, secondary and university education.

2) Capital and investment

Slovenia's business fixed capital is outdated and depreciated. The structure is inadequate and the market value is very low. This is a consequence of low investment activity in the last decade. The share of investment in GDP has been only 15 to 17%. The stronger investment activity in the next decade aims at restructuring capacities and at technological up-grading of capital assets.

According to the data of the Bank of Slovenia, at the end of 1993 there were 1,044 enterprises with a more than 10% share of foreign equity capital. The total direct foreign investment in 1993 amounted to US$123 million, or around of 1% of the GDP. The foreign investment will be welcomed but not unconditionally. Capital flow as a result of foreign investment is important, but Slovenia expects that foreign investment will provide technology, access to foreign markets, management, and integration in the international economy. Slovenia thinks that foreign direct investments are possible and understandable only if Slovene enterprises also increase their investments abroad.

3) Technical development

In the 1980's, Slovenia invested over 1.3% of its GDP in research and development. At the beginning of the 1990's, the situation in Slovene manufacturing worsened substantially. Only 6% of enterprises have R&D sectors and invest in production innovation.

After the establishment of the Slovene patent office in 1992, the number of registered patents doubled in 1993 (30 are domestic and 458 are foreign patents).

The technological balance of payment reflects the international trade of technology. Slovenia has a deficit in balance.

4) Development of domestic entrepreneurship

Entrepreneurship is of vital importance to industrial development because it introduces innovations in the production processes. Entrepreneurship can be defined as the process in which individuals and groups discover business opportunities. A seed capital and a venture capital are needed to support domestic entrepreneurs. In a small country like Slovenia, such capital is available only in limited amounts. Slovenia will stimulate the development of entrepreneurship in two ways:

(a) by creating a favorable environment for fast growing enterprises-high quality education, communications, and housing
(b) by supporting programs for the development of entrepreneurship and provision of information about business opportunities.

1.3 City of Maribor [2]

Maribor is the second largest city in Slovenia, with a population of 152,326 in 1994. The city has 357 km^2 of land area, and an elevation of 265m above sea level. The Drava divides the city into the north part—an old town, and the south part—a newly developed area.

The climate of the city is shown in Table 1-1.

Table 1-1 Climate of Maribor (1984-994)

	January	April	July	October	Year
Temperature					
Average (°C)	-0.1	10.2	20.5	10.2	10.2
Average maximal (°C)	4.2	15.6	26.3	15.6	15.3
Average minimal (°C)	-3.6	5.4	15.2	6.4	5.8
Absolute maximal (°C)	16.6	26.7	34.2	25.9	36.6
Absolute minimal (°C)	-21.0	-5.1	6.3	-4.0	-21.0
Air humidity(%)	78.1	66.1	67.4	79.3	73.1
Daylight hours (Hrs)	82.0	159.9	270.9	130.0	1900.5
Precipitation (mm)	47.2	83.6	105.2	107.5	1071.3

As shown in the table, the climate is rather mild with somewhat cold weather in winter. Therefore, we need antifreezing measures in building a wastewater treatment plant. Some parts of the plant should be kept inside the main building.

The population distribution by age is given in Table 1-2, indicating that the largest share is between 40 and 49 years of age. The poulation is showing a tendency towards decrease, with a falling from the maximum of 157,078 in 1988 to 152,326 in 1994.

Table 1-2 Population Distribution by Age as of December 31, 1994

Age	Total	%	Male	%	Female	%
0-9	14,358	9.4	7,351	10.1	7,007	8.8
10-19	29,020	13.1	10,276	14.1	9,744	12.3
20-29	21,831	14.3	11,005	15.1	10,826	13.6
30-39	23,628	15.5	11,578	15.9	12,050	15.2
40-49	24,180	15.9	11,993	16.5	12,187	15.3
50-59	20,086	13.2	9,923	13.6	10,163	12.8
60-69	16,414	10.8	6,937	9.5	9,477	11.9
70-79	8,064	5.3	2,693	3.7	5,371	6.8
80-89	3,439	2.3	1,010	1.4	2,429	3.1
90 and more	306	0.2	70	0.1	236	0.3
Total	52,326	100	72,836	100	79,490	100

Table 1-3 Structure of Employment

Activity	Employees in 1984	%	Employees in 1994	%	Index 1994/1984
TOTAL ECONOMIC SECTOR	**72,512**	**85.1**	**41,116**	**74.2**	**56.7**
Industry	35,080	41.2	18,927	34.2	54.0
Agriculture, fish farming	740	0.9	418	0.8	56.5
Forestry	342	0.4	68	0.1	19.9
Water commercial	0	0.0	58	0.1	0.0
Construction	10,383	12.0	4,602	8.3	44.3
Transport, communications	4,609	5.4	2,982	5.4	64.7
Trade	8,865	10.4	6,035	10.9	68.1
Catering, tourism	2,181	2.6	1,153	2.1	52.9
Craft, services	4,080	4.8	2,185	3.9	53.6
Residential, public utility services	1,429	1.7	1,103	2.0	77.2
Financial, technical, business services	4,803	5.6	3,585	6.5	74.6
TOTAL PUBLIC SECTOR	**12,699**	**14.9**	**14,301**	**25.8**	**112.6**
Education, science and culture	4,553	5.3	5,085	9.2	111.7
Health care, social protection	5,818	6.8	6,076	11.0	104.4
Others	2,328	2.7	3,140	5.7	134.9
TOTAL	**85,211**	**100.0**	**55,417**	**100.0**	**65.0**

Table 1-3 shows the structure of employment in 1984 and in 1994. As a whole, the total public sector increased from 14.9% to 25.8% during the decade. In the total economic sector, industry occupied the largest share with a decreasing trend, but the large shares were held by trade and business services, the latter of which increased from 5.6% to 6.5% between 1984 and 1994. In the total public sector, there was a high increase in all parts. It seems that the manufacturing industry will continue to play an important role in the employment in future, and that the structure of employment will change from a secondary industry to a tertiary industry at Maribor in the long run. The competitiveness of the existing industry is reflected by numbers in Table 1-4. No absolute figures are shown in this table, however, the ratio of import of each industry from and to all the other industries is indicative of general competitiveness, since it is unthinkable that import and export of all industries are too imbalanced. As a matter of fact, the following trend was observed in the 20 factories which were surveyed by our team.

Table 1-4 Export and Import by Activity in 1994

Activity	Export(%)	Import(%)
Electric power industry	0.0	0.0
Production of petroleum products	0.7	0.7
Manufacture of basic iron and steel	0.7	5.8
Manufacture of basic non-ferrous metals	0.3	2.7
Smelting, alloying and refining of non-ferrous metals	2.5	1.7
Extraction of non-ferrous minerals	0.0	0.2
Manufacture of non-ferrous minerals	3.2	3.6
Metalworking production	8.3	7.0
Machine building industry	13.8	11.1
Production of means of transport	14.8	7.2
Prod. of electrical machines and devices	9.2	11.4
Production of alkali chemical products	1.4	8.0
Processing of chemical products	8.1	10.2
Sand and stone quarrying	0.1	0.4
Production of construction material	0.3	0.7
Production of timber and boards	0.5	0.3
Production of finished wooden products	7.0	0.4
Production and processing of paper	0.1	1.8
Production of yarn, textile and knitted fabrics	9.6	3.8
Production of finished textile products	12.2	5.0
Manufacturing of leather footwear, other leather products	0.2	0.8
Rubber processing	0.1	0.6
Food industry	3.4	4.2
Beverage production	0.5	0.5
Manufacture of animal feeds	0.0	0.5
Printing activities	0.9	0.4
Collection and processing of industrial wastes	1.1	0.3
Manufacture of miscellaneous products	0.1	1.8
INDUSTRY	99.1	91.1
AGRICULTURE	0.7	3.7
FORESTRY	0.2	0.1
FINANCIAL, TECHNICAL, BUSINESS SERVICES	0.0	0.0
OTHERS	0.0	0.0
TOTAL	100.0	100.0

The city imports basic iron, steel and non-ferrous metals, and exports metal products, machinery, non-ferrous metal products, transport equipment, etc. The city imports basic chemicals, and exports yarn, textiles, knitted fabrics, and finished textile products. In processing of chemical products, the balance of exports and imports is almost equivalent, at 8.1% (exports) to 10.2% (import). Finished wooden products are another competitive field. Naturally agriculture is not in good balance in a large city like Maribor. In short, Maribor is an industrialized city which buys basic materials outside, and processes them, and sells them outside, and which is shifting from secondary to tertiary industries.

2. The Status Quo of Pollution in the Drava Region [3]

Groundwater and water springs are the nation's major natural resources and must be protected against pollution and excess use. A number of measures are being taken to curb the excessive or improper use of the natural resources. The basis for these measures are the data on the water condition and quality. Slovenia is a relatively rich country as far as the abundance of water is concerned, but the protection of water should be raised to a level where the preparation of drinking water calls only for filtering and disinfection. The republic's program to monitoring the quality of water sources, gradually expanded since 1987, is based on the guidelines of the EU for the quality of drinking water.

The Ministry of Environmental and Physical Planning entrusts the task of monitoring the water quality to the Hydrometeorological Institute of the Republic of Slovenia. Flowing and groundwater springs, lakes, and the sea are being monitored.

2.1 Ground Water and Water Springs

The Dravsko Polje continued to show contamination with pesticides and nitrates at all sampling points. Brunsvik was again the particular place where concentrations of pesticides in the groundwater were the highest. At the seven sampling points, pesticide concentrations exceeded the values laid down by the EU guidelines (0.50 μ g/l).

Intensive farming was reflected in the strong pollution of groundwater by nitrates. The limit values were exceeded at some sampling points, and nitrate concentrations above 60 mg NO_3/l were measured at four out of eleven sampling points and were above 50 mg NO_3/l (standard for the drinking water) at one of the sampling points for drinking water. However, increasing nitrates concentrations has slowed compared to the previous years.

Over the entire area of the Dravsko Polje, there were increased contents of potassium and zinc, whereas in the proximity of Maribor there was the presence of industrial pollutants - chlorinated organic solvents (the Tezno sampling points). The groundwater in Kamnica, which hydrologically does not pertain to the Dravsko Polje, was of very good quality.

The information given on the quality of groundwater and water springs in the previous years is also valid for 1994. The groundwater in Slovenia is particularly threatened by agriculture, since entire areas are polluted with nitrates and pesticides, including Dravsko Polje. The water quality of water springs analyzed in 1994 was good. However, the analyses of sediment in the seven samples of 1993 showed that pollution from the hinterlands was present and that water quality may suffer abrupt deteriorations due to heavy metals, PCB, and polycyclic aromatic hydrocarbons.

2.2 Surface Water

Monitoring of the surface water quality was performed under the monitoring programs for flowing water in conformance with the methodology recommended by international organizations. The most important criteria applied in determining the sampling frequency and necessary extent of analyses were the possible influences of surface water on groundwater and major springs, both of which are used for water supply.

The Slovene regulations for estimating the quality of surface water were still under preparation and two obsolete and lacking Yugoslavian regulations were still in force in 1994.

The regulation classifies flowing water into the following four quality classes with regard to its potential utilization.

1st class : waters which in their natural state or following disinfection may be used as drinking water, in the food-processing industry, and in breeding high class fish species (Salmonidae);

2nd class : waters which in their natural state may be used for bathing, water sports, breeding other species of fish (Ciprinidae), or which following normal treatment (coagulation, filtration and disinfection), may be used as drinking water or in the food-processing industry;

3rd class : water which may be used in irrigation, or following normal treatment, in industries other than the food-processing industry;

4th class : waters which must be given an adequate treatment before it is used for any purpose.

Evaluations of the water quality for individual samples as well as the total estimate for individual sampling points, determined on the basis of the analyses performed in 1994, have been compiled. According to the evaluations, the quality of water at most of the Drava sampling points is between the 2nd and 3rd classes.

The water quality was evaluated by the results of physico-chemical analyses including analyses of metals and organic compounds, bacteriological, and saprogenic analyses. Table 2-1 shows the mean and maximum values of representative pollution parameters for the sampling points along the Drava .

The Drava is a transboundary river, flowing through industrial regions of Austria, Slovenia, and Croatia. Its natural characteristics have been changed by the construction of a chain of hydroelectric power plants.

Table 2-1 Sampling Points with Maximum and Mean Pollutants

Sampling Point	BOD mgO_2/L		COD mgO_2/L		NH_4 mg/L		NO_3 mg/L		Phenol μ g/L		Mineral Oil μ g/L	
	Max.	Mean	Max.	Mean	Max.	Mean	Max.	Mean	Max.	Mean	Max.	Mean
Dravograd			14.8	7.6								
Brenzo			10.4	6.1								
Maribor otok			10.6	5.9								
Duplek			10.1	7.1			16.0	9.9				
Duplek/Kanal												
Ptuj			14.5	8.1	1.28	0.48						
Borl			17.8	11.9	2.44	1.23						
Ormoz					1.36	0.40						

A comparison of final evaluation for the quality of surface water since 1989 shows that the Drava has improved to a small extent. The highest COD value at all sampling points on the Drava was measured in August. The highest COD in 1994 was observed in Dravograd, Borl, and Ptuj. The BOD_5's in the upper stream were low in comparison with the COD. The pollution of the Drava downstream from Mariborski Otok rose gradually along the course of the river to reach its highest value in Borl(downstream of Maribor) where both COD as well as BOD_5 were high. This proves the presence of large amounts of easily decomposable organic matter. This was due both to the pollution and to the reduced discharge in the old river-bed of the Drava due to redirection of water into the power plant channel. Oxygen supersaturation was measured in the Duplek-Ormoz section at almost all sampling points, and an excessive growth of algae due to

the inflow of nutrients in the wastewater from Maribor was found.
A similar condition was observed for nitrogen compounds, the contents of which were increased downstream of Maribor reaching their highest values in Borl. The presence of both total phenols and mineral oils was constant along the course of the river. The maximum value of the phenol content was measured in the Mariborski Otok in Feburary 1994 (0.011 mg/l). The highest contents of mineral oils were measured at the Mariborski Otok (0.013mg/l) and at Dravograd in Feburary,1994.

The Drava is not heavily polluted with phenol, aromatic compounds, PCB or pesticides. Moderately high contents of these pollutants were measured only rarely. In 1994, the analyzed polycyclic aromatic hydrocarbons (PAH) in the Drava were close to the bottom detection limit for the applied method. PAH concentrations in the last three years have seen their sharpest fall in Ormoz in particular, where in 1994, they remained below the detection level. It is likewise important to stress the reduction of concentrations of highly toxic PAH which had been detected in Ormoz as late as 1990.

The bacteriological picture of the Drava deteriorated sharply downstream from Maribor below the inflow of the excessively polluted Strazunsk Kanal. Bacteriological pollutions were observed in all of the Drava River with the highest levels found in the Duplek. Bacteria of fecal origin were constantly present at all sampling points. The Strazunsk Kanal carried the wastewater of the greater part of Maribor, and was classified as an excessively polluted water course, that is, as a water course of the 4th quality class.

Chemical, sapogenic and bacteriological analyses of 1994 samples showed the quality of individual sampling points or sections of the water courses. Generally the trend of the reduction of the pollution of surface water courses in Slovenia continues. Gradually diminishing levels of metal pollutants and organic compounds were also determined in some rivers. The observed improvement may be partly attributed to the reduction of the wastewater due to the decrease in the industrial production, and partly to the implementation of rehabilitation measures. However, there are still some sections of the water courses classified in the worst, that is, the 4th quality class. Also, inadequate quality of water for drinking found in five water courses whose water infiltrates the ground, including the Drava-Mariborski Otok.

3. Water Supply and Use Conditions

3.1 State Level [4]

Slovenia is a land of forests. More than half of its territory is wooded, a ratio of which is well above the European average (33%). There are also many pastures, meadows, and fields. Many branch rivers of the Danube flow among them. Annual precipitation ranges from 800 to 1,600 mm, and provides agriculture with fresh water.

The republic abounds in natural water. The recent sources of public water supply are given in Table 3-1.The two major sources are underground water and springs.

Table 3-1 Water Sources of Public Water Supply
(Annual Supply in 1,000 m^3 Unit)

Source	1980	1985	1990	1991	1992
Underground waters	98,948	121,199	132,207	131,684	135,303
Springs	97,890	114,330	125,064	18,184	116,035
Surface waters	7,022	9,162	4,873	6,803	7,959
Total	203,861	244,691	262,144	256,671	259,297

The use of water in public water supply is also shown in Table 3-2.

Table 3-2 Water Supplied from Public Water Supply
(Annual Values in 1,000 m^3 Unit)

Use	1980	1985	1990	1991	1992
Household	60,065	75,655	86,217	85,378	80,326
Activities	99,927	83,002	78,834	76,686	66,016
Other water supply systems		8,568	16,304	15,420	6,266
Loss within waterworks network	71,486	77,466	79,789	79,187	106,689
Total	159,992	167,225	182,355	177,484	152,608

Table 3-3 indicates the water sources in the Slovenian manufacturing industries. As shown in the table, there are three major water sources for the industries, i.e., underground water, surface water,and water works.

Table 3-3 Water Sources in Manufacturing

(Annual Values in 1,000 m^3 Unit)

Manufacture	Under-ground	Springs	Surface	Others	Water-works
Basic Iron & Steel	9,132		5,751	1,433	9,435
Smelting Refining of Non-ferrous Metals			26		6,472
Metal Products	185	98	1,101		4,306
Machinery & Equipment	57	178		1	1,094
Transport Equipment	131	1			2,535
Electrical Equipment	385	96	342		4,366
Basic Chemicals	4,320	31	4,323	559	785
Chemical Products	1,712	2	2,878		2,040
Sand & Stone Quarrying	557	626	160	205	1,425
Construction Materials	268	12	1,544		416
Furniture, Wooden Products	96	19	41		1,255
Pulp & Paper	5,761	3	20,837		3,977
Textiles	2,178	876	1,600		788
Textile Products	525	11	105		1,514
Leather & Fur	145	101	1,201		230
Rubber & Rubber Products	109		1,453		720
Food Products	1,492	547	577	500	6,100
Beverages	2,841	32			1,570
Recycling	42				1,316

However, springs sometimes supply a considerable amount of water, which shows water abundance in Slovenia. As far as our investigation is concerned, there is no sign that a water shortage would cause a bottleneck for the Slovenian manufacturing industries. The problem is the pollution of surface water; most rivers are already of the 2nd and 3rd quality class, sometimes 4th quality class (see Table 3-4).

Table 3-4 Quality of Main Surface Water in 1990-1993

Watercources	Sampling Point	Evaluation				
		1990	1991	1992	1993	1994
Mura	Cersak	3	3	(2)-3	2-3	2-3
	Petanjci	3	3	(2)-3	2-3	2-3
	Mota	3	3	(2)-3	2-3	2-3
Drava	Dravograd	2-(3)	2-3	2-3	2	2-(3)
	Brezno	2-3	2-3	2-3	2-(3)	2-(3)
	Mariborski otok	2-3	2-3	2-3	2-3	2-(3)
	Duplek	-	-	3	(2)-3	2-3
	Duplek kanal	-	-	-	(2)-3	-
	Ptuj	2-3	2-3	2-3	2-3	2-3
	Borl	-	-	3	3	(2)-3
	Ormoz	2-3	2-3	2-3	2-(3)	2-3
Sava	Otoce	2-3	2-(3)	2-(3)	2	2
	Struzevo	2-3	-	-	-	-
	Prebacevo	(2)-3	2-3	3-(4)	3	2-3
	HE Medvode	2-3	-	-	-	-
	Medno	3	3-4	2-3	2-3	2-3
	Sentjakob	2-3	3	2-3	2-(3)	2-3
	Dolsko	3-4	3-4	3	3	3
	Litija	3	3	2-3	3	3
	Hrastnik	3-4	3-(4)	3	3	3
	RadecenadSopoto	3-4	3-4	3	3	3
	Bostanj	3	3	3	3	2-3
	Krsko NEK	3-4	4	-	-	-
	Brezice	3-(4)	3-4	3	3	3
	Jesenice	3	3	3	(2)-3	(2)-3

Number in parenthesis means that the quality of water inclines to be the class in parenthesis, but with main stress on the values which are not in parenthesis.

3.2 Maribor Level (5)

The only sources for the Maribor water supply system is groundwater . Table 3-5 gives the figures from 1985-1994.

Table 3-5 Water Supply System of Maribor
(Annual Values in 1,000m^3 Unit)

Year	Pumping-up	Sale	Industry	House-hold	Loss
1985	18,426	13,768	7,291	6,576	4,190
1986	17,742	13,845	7,600	6,244	3,897
1987	18,907	14,675	6,282	8,393	4,231
1988	18,677	13,743	5,321	8,421	4,871
1989	18,632	14,491	5,894	8,597	3,736
1990	18,941	14,140	5,304	8,835	4,798
1991	18,339	13,070	4,422	8,648	5,267
1992	18,631	12,966	4,190	8,776	5,666
1993	19,473	13,394	4,257	9,137	6,080
1994	19,027	13,015	3,773	9,247	6,014

On the other hand, the household consumption per capita per day is obtained by use of population statistics from 1985 to 1994 and shown in Table 3-6. According to the data in the table, the consumption increases steadily regardless of socioeconomic conditions. This is a common trend in the world, and the basis of the gradual expansion of water supply system for household use. The mean increase rate from 1985 to 1994 is 4.83% in the case of Maribor.

Table 3-6 Water Consumption for Household Use
(liters/person, day)

Year	Population	Household Consumption
1985	155,634	116
1986	155,933	110
1987	156,703	147
1988	157,078	147
1989	156,200	151
1990	156,399	155
1991	156,438	151
1992	155,318	155
1993	152,506	164
1994	152,326	166

In the case of Japan, in 1965 when the Japanese economy was growing rapidly, the household water consumption was 169 liters/day per person and the increase rate was 4.7%(6). However, in 1975 or later, the increase rates were reduced to 1.2%,with the consumption reaching 335 liter/day in 1993.

If the increase rates of Maribor in the years from 1995 to 2000 are 4.8, 4.6, 4.4, 4.2, 4.0, and 3.8%, respectively the consumption each year could be calculated as follows:

1995	166.2 x 1.048=174.2
1996	174.2 x 1.046=182.2
1997	182.2 x 1.044=190.2
1998	190.2 x 1.042=198.2
1999	198.2 x 1.040=206.2
2000	206.2 x 1.038=214.0

In 2000, the water consumption could reach 214 litter/day per person. One estimate predicts annual consumption of 11 million cubic meters in 2000 [5]. If this is true, the population of Maribor will be 140,827. No one can foretell the size of the population in 2000, but the figures indicate that we should prepare an expansion of the water supply system even if the population decreases.

The demand of industrial water for the water supply system of Maribor decreased from 7,291,000m³ in 1985 to 3,213,000m³ in 1995. We presently do not have enough data to analyze the content of the decrease. However, the JICA Team investigated the usage of the Model and Secondary Beneficiary Factories. According to the investigation, cooling water occupies a considerable portion of industrial water. If the factories promote the recycling of the cooling water, the demand for industrial water will not increase in the future. In fact, the water supply demand did not increase in Japan even during the period of rapid economic growth because of the increase in the recovery rate of industrial water. However, a quantitative estimate of industrial water demand is impossible at present because little information on the future aspect of industry is available. Estimation will become possible if we can predict the product outputs and recovery rates of industrial water.

For the administrators' convenience, some data are given in Table 3-7 concerning how much fresh water is required for the main industries [1]. Since the recovery rates of Slovenia and Japan differ, the given data are unit consumption of fresh water before recovery.

Table 3-7 Unit Fresh Water Consumption in Main Industries in Japan [7]

(Unit:m^3/day/100 Million Yen of Output)

Industry	1975	1980	1985	1990	1993
Food	32.2	31.4	27.3	24.2	22.6
Drink			14.5	12.9	13.1
Textile & Dyeing	90.6	80.9	67.8	61.7	59.8
Pulp & Paper	323.4	310.5	260.2	216.6	218.7
Chemicals	409.6	339.7	247.2	210.4	208.1
Oil & Coal Products	46.8	55.9	64	88.9	88.6
Plastics			33.6	30.5	32.5
Rubber Products	50.8	47.7	39.7	35.6	39.1
Glass & Ceramics	61.1	49.6	56.3	52	52.8
Iron & Steel	226.9	236.3	245.7	235	263.6
Non-ferrous Metals	117.4	96.4	63	43.3	41.5
Metal Products	13	8	12.5	9.3	9.4
Common Machinery	12.1	11.1	8.3	6.6	6.7
Electrical Machinery	23.7	18.3	13.8	10.6	9.6
Transport Equipment	44.7	34.6	32.1	27.2	25.4
Precision Instruments	12.7	7.8	6.5	6.4	5.2
Other Products	29.2	29.1	8	5.5	5.1

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Ⅲ. Environmental Administration

III. Environmental Administration

- Organization for environmental administration of the Republic of Slovenia

The Ministry of Environment and Physical Planning (MEPP), which manages the administration of the environment of the Republic of Slovenia, has three vice-ministers, one of whom is in charge of the environment. The Ministry also has an Environmental Legislation Department which takes the lead in drawing up and deciding on basic policies and plans regarding the environment.

- Preparation of National Environmental Action Plan (NEAP)

The government is expected to finish preparing a National Environmental Action Plan at the beginning of 1997. Priorities will be assigned to Slovenia's environmental measures on the basis of this plan, and a large framework for technical assistance and investment programs will be decided.

- Environmental inspectorate system

As part of Slovenia's strategy for preparing to join the European Union, the country must strengthen its environmental monitoring and enforcement capabilities. An Integrated Environmental Inspectorate with nine regional centers was established within MEPP in accordance with the Government Restructuring Act of January 1996. However, due to financial restrictions, the situation with respect to personnel, equipment, and skills is still not satisfactory .

- Environment protection laws

Upgrading Slovenia's laws regarding the protection of the environment to a level approaching that of the European Union is an important issue for the country. The framework of Slovenia's environment protection is declared in its constitution of 1991 and its Environment Protection Act of 1993. Many related laws have been enacted in order to achieve the objectives of the 1993 Act.

- Water quality control

The effluent standards issued on June 12, 1996, specify the maximum permissible water quality values for effluent discharged into rivers, other public water areas, and the sewerage. The standard for the former is extremely strict, while that for the latter is quite loose.

- Financial measures

In 1993, the Eco-Fund was established as a financial institution to promote investment in environmental protection by providing loans at favorable interest rates. The funds are allotted from the national budget and are not directly connected to environmental related-income.

- Maribor City's environmental administration

Maribor City is protecting its groundwater as its main potable water source and is grappling with the task of preserving the environment of the Drava River by designating the control and improvement of the city's household effluent and industrial wastewater as a top priority issue.

1. National Organizations and Their Roles [1][2]

1.1 National Background

Slovenia is a relatively young country, having obtained its independence from the Federation of Yugoslavia as recently as 1991. Prior to the country's independence, decentralized government was strong, with considerable power vested in 65 Communes and local administrations. Similarly, the administration of environmental protection and management was widely decentralized during this period.

The strong local power and vested interests resulting from the government's decentralization gave rise to regional variation in the enforcement of environmental pollution regulations.

It was in this climate and culture that Slovenia emerged as a fledgling democracy and that the Ministry of Environment and Physical Planning of Slovenia (MEPP) was established as the key agency responsible for environmental protection and management.

1.2 Environmental Administrative Organization of the Republic of Slovenia

The organization of the Ministry of Environment and Physical Planning (MEPP), the ministry responsible for environmental protection and management of the environment of the Republic of Slovenia, is shown in Fig. 1.1. As shown in the Figure, of the three Secretaries, one is in charge of the environment. The core group that plans and decides environmental policies is the Environmental Legislation Department.

(1) National Environmental Action Plan (NEAP)

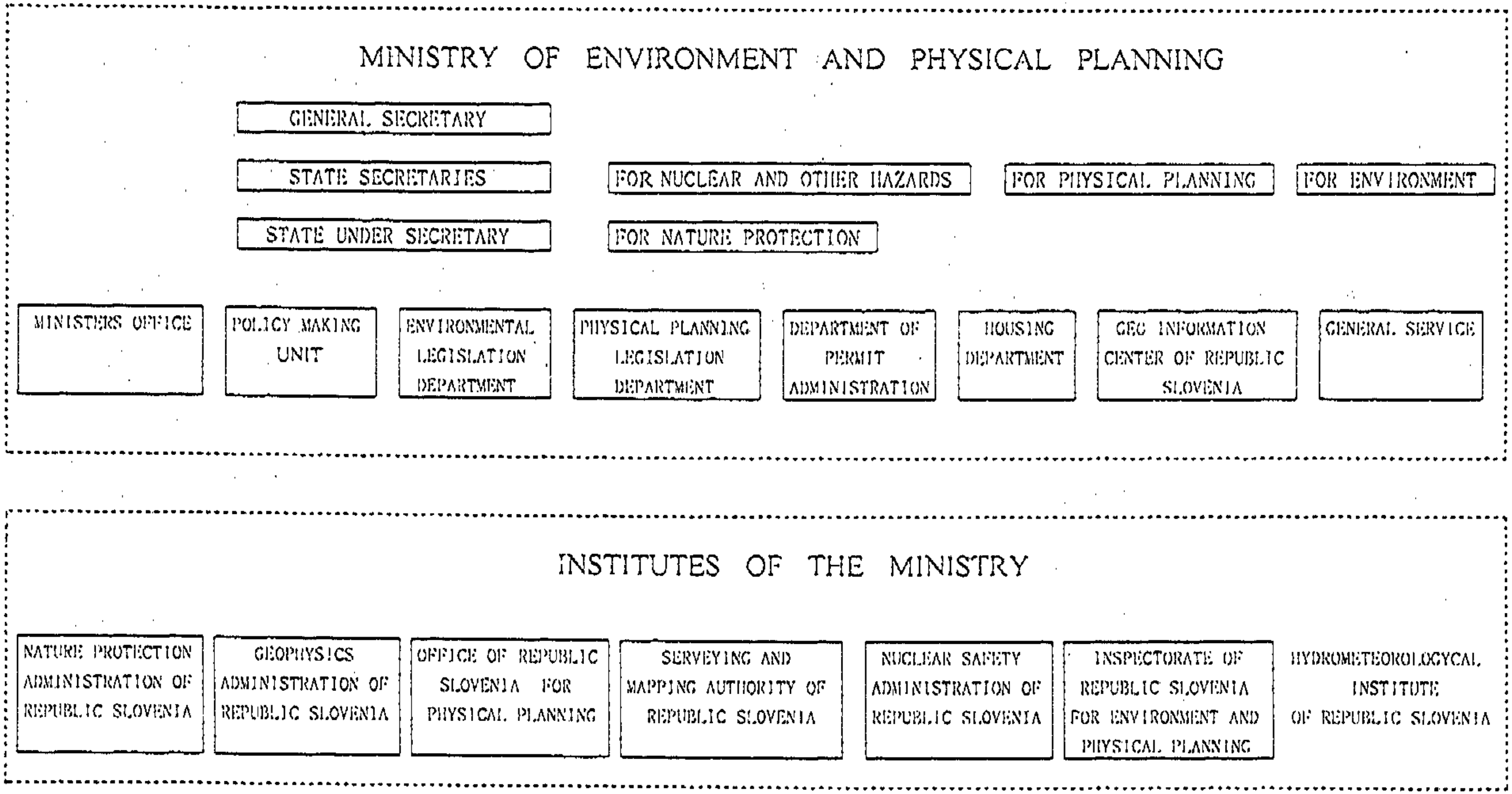
The National State of the Environment, a report updated by the government in 1995, is currently being used to provide baseline data for the preparation of the National Environmental Action Plan (NEAP). Slated for completion at the beginning of 1997, the NEAP will identify and prioritize issues and present outlines for technical assistance and solutions for investment programs.

(2) Environmental Inspectorate

To ensure that Slovenian environmental legislation complies with the EU legislation both in substance and form, the country's efforts to upgrade its environmental monitoring and enforcement capabilities must be administered in parallel with efforts to approximate its national environmental legislation to that of the EU.

Inspectorate is in particular need of institutional strengthening under the Pre-Accession Strategy. Up until 1994, the inspection functions were highly dispersed, with each municipality responsible for monitoring compliance under the guidance of four ministries, i.e., the MEPP (water), the Ministry of Health (air and waste), the Ministry of Agriculture (forestry), and the Ministry of Culture (protection of nature). This situation was altered by the Government Restructuring Act in January 1996, which established an Integrated Environmental Inspectorate within the MEPP with nine regional centers. Unfortunately, this new Inspectorate is considerably short of personnel, equipment, and skills. To cite an example, at the end of 1995, due to

Fig 1.1 Organization of Environment Administration in the Republic of Slovenia



financial constraints, only 40% of the 279 inspector positions deemed necessary for compulsory execution could be filled. In the short term, no substantial improvements of this situation are expected.

To strengthen the institutional structure of the Environmental Inspectorate and improve the effectiveness of its activities and inspectors, the NEAP is expected to implement programs geared towards the following:

- to streamline organizational structures and simplify operational procedures in order to improve the efficiency of allocation of decision-making responsibilities to the inspectors, etc.;
- to develop an integrated monitoring program which fully complies with national and EU requirements;
- to improve monitoring information links --improved data collection and transfer and processing of hardware and software;
- to provide training for the Inspectorate staff in best EU procedures and practices.

2. Laws Pertaining to Environmental Protection (1)(3)

The framework for environmental protection in Slovenia was provided by the 1991 Constitution and the 1993 Environmental Protection Act (EPA). The EPA is a framework act covering the principles of environmental protection and its implementation. In the future, however, the Act will have to be bolstered with enabling or subsidiary legislation before most of its requirements can be implemented. Significantly, the Act contains a summary of key economic instruments to be used as measures in support of environmental law enforcement, with the underlying basis founded on the 'polluter pays' principle. At present, the following laws, ordinances, decrees, and regulations pertaining to water quality have been enacted.

① Environmental-protection Law (OG 32/93,1/96)

② Ordinance on Projects Requiring Environmental Impact Assessment (OG 66/96)

③ Administration Law (OG 67/94)

④ Ministries Organization Law (OG 71/93)

⑤ Water Law (OG 38/81,29/86,15/91)

⑥ Decree on water pollution tax (OG 41/95,42/95,44/95)

⑦ Regulation of water refunds (OG 41/95,42/95)

⑧ Decree on determination of price per unit of water pollution for 1995 (OG 45/95)

⑨ Regulation of emissions of materials and heat in wastewater from sources of pollution (OG 35/96)

⑩ Regulation of emissions of materials in wastewater from sources of pollution in metal industries (OG 35/96)

⑪ Regulation of emissions of materials in wastewater from household wastewater treatment plants (OG 35/96)

⑫ Regulation of emissions of materials in wastewater from sources of pollution in the textile industry (OG 35/96)

⑬ Regulation of emissions of materials in wastewater from sources of pollution in the tanning and fur industries (OG 35/96)

⑭ Regulation of first measurements and monitoring of wastewater (OG 35/96)

⑮ Decree on the mode of operation for local water management service (OG 57/96)

OG: Official Gazette of the Republic of Slovenia

The composition and main items of the Environmental Protection Act are as follows.

① Chapter 1 Basic matters: Purpose, definitions, etc.

② Chapter 2 Preservation of natural environment

③ Chapter 3 Controls, control standards, types of control activities, Eco labeling in the field of environmental protection

④ Chapter 4 Environmental-protection measures

⑤ Chapter 5 Environmental-protection research and planning: Research and development carried out by the State, environmental programs that should be prepared, items that should be incorporated in programs,and programs of regional municipalities

⑥ Chapter 6 Activities and environmental restoration: Environmental effect evaluation, items of environmental effect evaluation, permits, participation of residents, environmental-restoration programs

⑦ Chapter 7 Environmental monitoring and environmental data system: Obligations of the State and regional municipalities

⑧ Chapter 8 Fiscal measures for environmental restoration: Compensation, surcharge, fiscal measures taken by the State, funds, organization and source of funds

⑨ Chapter 9 Conference on environmental protection

⑩ Chapter 10 Obligations of public bodies

⑪ Chapter 11 Cooperative organizations of economical bodies

⑫ Chapter 12 Penalties

⑬ Chapter 13 Interim measures

Recently, MEPP has commenced preparation of new subsidiary legislation. It has already updated the law regulating atmospheric emissions, and an integrated law on waste management is currently under preparation. The focus of waste management strategy and policy has shifted towards issues of technology and organization, i.e., minimization of waste vis-à-vis the previous approach, which focused on problems associated with locations for waste disposal. A particularly large number of new regulations have been enacted for the protection of nature, with an emphasis on preserving species and habitats, and participating in the European Ecological Network.

3. Industrial Emission Standards [1]

Standards for effluents were officially promulgated on June 12, 1996. The contents were studied for more than one year in Slovenia.

The emission standards are indications of the maximum permissible water quality values for discharges into rivers, other public water areas, and sewers. The former is very strict while the latter is lenient. First, there are general controls and these literally are standards. Unless otherwise specified, all items are applied. Other standards have been specified for the textile industry, nine kinds of metal treatment processes, and other specially designated businesses. In addition, there are many supplemental explanatory clauses. The emission standards are shown in Table 3.1.

Table 3.1 Emission Standards for Industrial Wastewater

	Item	Unit	River	Sewage
1	Temperature	℃	30	40
2	pH	–	6.5 ~ 9.0	6.5 ~ 9.5
3	SS	mg/ℓ	80	(a)
4	SV_{30}	mℓ/ℓ	0.5	10
5	SAK (Color)			
	436 nm	m^{-1}	7.0	
	525 nm	m^{-1}	5.0	(b)
	620 nm	m^{-1}	3.0	
6	Toxicity Test (SD)	mg/ℓ	.3	–
7	Biodegradation	%	–	(c)
8	B	mg/ℓ	1.0	10.0
9	Aℓ	mg/ℓ	3.0	(d)
10	As	mg/ℓ	0.1	0.1
11	Cu	mg/ℓ	0.5	0.5
12	Ba	mg/ℓ	5.0	5.0
13	Zn	mg/ℓ	2.0	2.0
14	Cd	mg/ℓ	0.1	0.1
15	Co	mg/ℓ	1.0	1.0
16	Sn	mg/ℓ	2.0	2.0
17	T-Cr	mg/ℓ	0.5	0.5
18	Cr^{6+}	mg/ℓ	0.1	0.1
19	Ni	mg/ℓ	0.5	0.5
20	Ag	mg/ℓ	0.1	0.1
21	Pb	mg/ℓ	0.5	0.5
22	Fe	mg/ℓ	2.0	(d)
23	Hg	mg/ℓ	0.01	0.01
24	$Cℓ_2$ (Free Chlorine)	mg/ℓ	0.2	0.5
25	$Cℓ_2$ (Total Available Chlorine)	mg/ℓ	0.5	1.0
26	$N-NH_3$	mg/ℓ	10	(e)
27	$N-NO_2$	mg/ℓ	1.0	10
28	$N-NO_3$	mg/ℓ	(f)	–
29	T-CN	mg/ℓ	0.5	10
30	Free CN	mg/ℓ	0.1	0.1
31	F	mg/ℓ	10	20
32	$Cℓ^-$	mg/ℓ	(g)	–
33	T-P	mg/ℓ	2.0 (1.0 (h))	–
34	SO_4	mg/ℓ	(i)	300
35	S	mg/ℓ	0.1	1.0
36	SO_3	mg/ℓ	1.0	10
37	TOC	mg/ℓ	30	–
38	COD_{cr}	mg/ℓ	120	–
39	BOD_5	mg/ℓ	25	–
40	Total Oil Content	mg/ℓ	20	100
41	THC	mg/ℓ	10	20
42	Aromatic Organochlorine	mg/ℓ	0.1	1.0
43	Adsorptive Organochlorine	mg/ℓ	0.5	0.5
44	Volatile Organochlorine	mg/ℓ	0.1	0.1
45	Water-soluble Organochlorine	mg/ℓ	(k)	(l)
46	Phenol	mg/ℓ	0.1	10
47	Surfactant	mg/ℓ	1.0	–

Note: (a) to (e) are notes for the application of the items and so have been omitted here.

4. Monitoring of Environment [1][2]

According to Article 67 of the Environmental Protection Act, environmental monitoring of the Republic of Slovenia can be largely divided into the following three categories.

① Monitoring of natural phenomena

② Monitoring of emissions (environmental pollution): Soil, water, atmosphere, flora and fauna

③ Monitoring of emissions (state of discharge): Substances discharged into soil, water and atmosphere

The monitoring assigned to the State is ① and ② above, while that assigned to the regional municipalities is ③ and, as needs be, ②. The Environmental Protection Act stipulates that the person at the discharge source is to monitor each individual source and, as occasion demands, the emission level due to discharge.

Incidentally, according to Slovenia's 1993 annual report on water quality, the Hydrometeorological Institute had monitored river water, underground water, and other public water areas a total of 3,857 times.

Monitoring of the water quality at source is being carried out from the past in accordance with EU guidelines. With regard to surface water, water quality in four grades has been used in the Hydrometeorological Institute's 1993 report.

5. Fiscal Measures [1]

(1) Eco-Fund

The current Eco-Fund was established in 1993 as a financial institution to promote investment in environmental protection by providing loans at favorable interest rates. The Fund reports directly to the government. Since its launch at the end of 1994, most of the focus has been in organizing its asset base, appointing special staff, and initiating various preliminary operations.

Compared with the old Environmental Protection Fund instituted in 1990, the Eco-Fund differs in several important respects, including both the sources and the uses of its funding.

Currently, the use of economic instruments in the environmental sector in Slovenia is restricted to two environmental charges introduced in 1976; i.e., an emission charge on wastewater and a user charge on drinking water. Rather than being earmarked for environmental purposes, the revenues generated from these environmental charges are collected into the state budget (MECU 6.4 in 1993). Although the Eco-Fund receives funds from the state budget, the funds are not tied in any way to these revenues.

Another relevant point is that the state budget, independent of the Eco-Fund, provides subsidies (albeit very small ones) to both the public and industrial sectors for investment in environmental equipment. The 'bottom line' is that the 'polluter pays' principle is not transparent in the operation of the current monetary cycle in the environmental sector. On a positive note, however, the Slovenian government representatives at the Sofia Conference (1995) stated that the 'polluter pays' principle will be implemented whenever possible, although they gave no time frame.

(2) Economical measures on water resources management

Two types of economic instruments are currently used in the field of water resource management.

A tax for water pollution (Official Gazette No.41/95), a charge on use of water (Official Gazette No.41/95), and changes of the decree in Official Gazette No.8/96.

To advance as much as possible the 'polluter pays' principle, the government adopted the decree on tax for water pollution load as an economic instrument for the protection of water quality and the environment.

The decree on tax for water pollution load categorizes wastewater as 'technological,' 'communal,' or 'atmospheric.' Persons liable to taxation are defined in accordance with the wastewater they discharge and divided into two groups, i.e., 'direct' and 'indirect' polluters, to determine the actual payment of the taxes. Revenue from direct polluters, those who discharge technological wastewater, goes directly into the state budget, while revenue from indirect polluters, those who discharge communal or atmospheric wastewater, is allocated indirectly to public enterprises which clean and process the wastewater, calculate the tax, and pay it into the state budget.

The decree on tax for water pollution load also offers material incentives to the polluters for prevention of water pollution at source by making it possible to finance investments in environmental protection (wastewater purifying plants, new technologies, etc.) with revenues from the water pollution load tax.

To facilitate the adaptation of the new decree by industries, the types of pollution load subject to taxation will be introduced progressively. Taxation will be imposed on COD (chemical oxygen demand) pollution load units from January 1, 1995, heavy metals from January 1, 1997, organic halogen compounds from January 1, 2000, and phosphorus and nitrogen from January 1, 2003.

Enterprises exceeding the standard levels of permitted emissions are subject to fines. Environmental inspectors can order polluters to take measures to reduce emissions and impose fines for failing to adequately execute the measures. The polluter pays taxes for volume of effluent regardless of quality. Taxes collected are also increasing proportionally as the degree of pollution by effluents progresses.

6. Environmental Administration Issues [11]

(1) Strengthening of system

At present, the Master Plan for Institutional Development for Environmental Protection, a report published in October 1996, is being used as a blueprint for developing organizational structures in the MEPP and Eco-Fund. However, in spite of the structural changes that are taking place, the MEPP, Environmental Inspectorate, and Eco-Fund need to be further strengthened with enhanced operational skills and procedures.

(2) Adjustment of legal system

The main objectives of Phase I will be to facilitate early compliance with the White Paper and approximate other cornerstone legislation such as that of the EU. The horizontal issues addressed will affect all sectoral topics, with an emphasis on the following:

- development of sectoral legislation and action/implementation plans for priorities identified in the NEAP regarding water, waste, and bio-diversity;
- development of inspection and enforcement mechanisms; and
- development of financial and economic instruments facilitating the future implementation of the NEAP and required investments. This will include the development of economic incentive and disincentive mechanisms (i.e., the 'polluter pays' principle) required to secure policy implementation and the financial mechanisms required to implement the strategy (for example, the Eco-Fund).

(3) Financing and economic measures

As the realization of NEAP objectives will require large-scale investments in the course of execution, heavy demands will be placed on limited financial resources. To support national budget allocations and ensure the sustainability of NEAP initiatives, it will therefore be imperative to develop effective financing schemes. At the fundamental level, these will include efforts to cooperate more fully with IFT's, the development of economic incentive and disincentive tools to stimulate private sector compliance (tax exemptions, fines, and penalties founded upon the 'polluter pays' principle), and the implementation of financial investment schemes to provide preferential loans to financially unviable projects which bear important environmental consequences. However, on the other hand, since these are accompanied by important obligations toward the environment, even closer cooperation with IFT will be required.

(4) Public participation

The successful implementation of the NEAP is heavily contingent on public and corporate participation and cooperation in planning and execution. As such, the NEAP will have to call together all the organizations involved and exert considerable sustained effort in promoting and explaining its objectives.

7. Environment Administration of Maribor City

(1) Regional background

Maribor City once supported highly developed textile, chemical, wood processing, metal, food processing, and automaking industries. Nevertheless, in spite of extremely intensive restructuring, even the city's larger enterprises (those employing over 3,000 people) have considerably stagnated and even disintegrated over the last ten years. As a result, 14,000 people are currently unemployed, and even among those who are employed, labor conditions are not good. Therefore there is limit to investment in environmental projects in environmental projects. On a positive note, however, the inhabitants of the city recognize the benefits of a higher-quality environment, and the very difficult economic and social situation is not precluding the strengthening of environmental initiatives.

Maribor City has set its environmental priorities on improving the management of its municipal and industrial wastewater in order to protect its groundwater, the main source of its potable water, and to keep the Drava River clean. These activities are implemented under three core projects:

- Extension and improvement of the sewerage system. Although the sewerage system is already about 70% complete, it remains unconnected at places, with more than 25% of its discharge released directly into the Drava River. As 75% of Maribor City is designated as a potable water protection area, this project is perhaps the city's most important.

- Industrial wastewater pretreatment technology and rational use of industrial water. The quantity and quality of industrial wastewater are to be regulated in accordance with the future approaches and technologies of the Central Wastewater Treatment Plant (WWTP).

- Construction and management of the WWTP.

- Improvement of the quality of the groundwater and water from the Drava River flowing from Slovenia towards Croatia through pretreatment of collected wastewater at the WWTP. Maribor is currently in the process of selecting a party to design, construct, and operate the WWTP in the future. At present, it has narrowed candidates down to three major consortia and a decision is expected to be made soon.

(2) Organization of environment administration in Maribor City

Maribor City's organization of environment administration is shown in Fig.7.1. The Vice Mayors in charge of the environment exercise control over the Environmental Protection Agency, Public Service Administration and City Inspection.

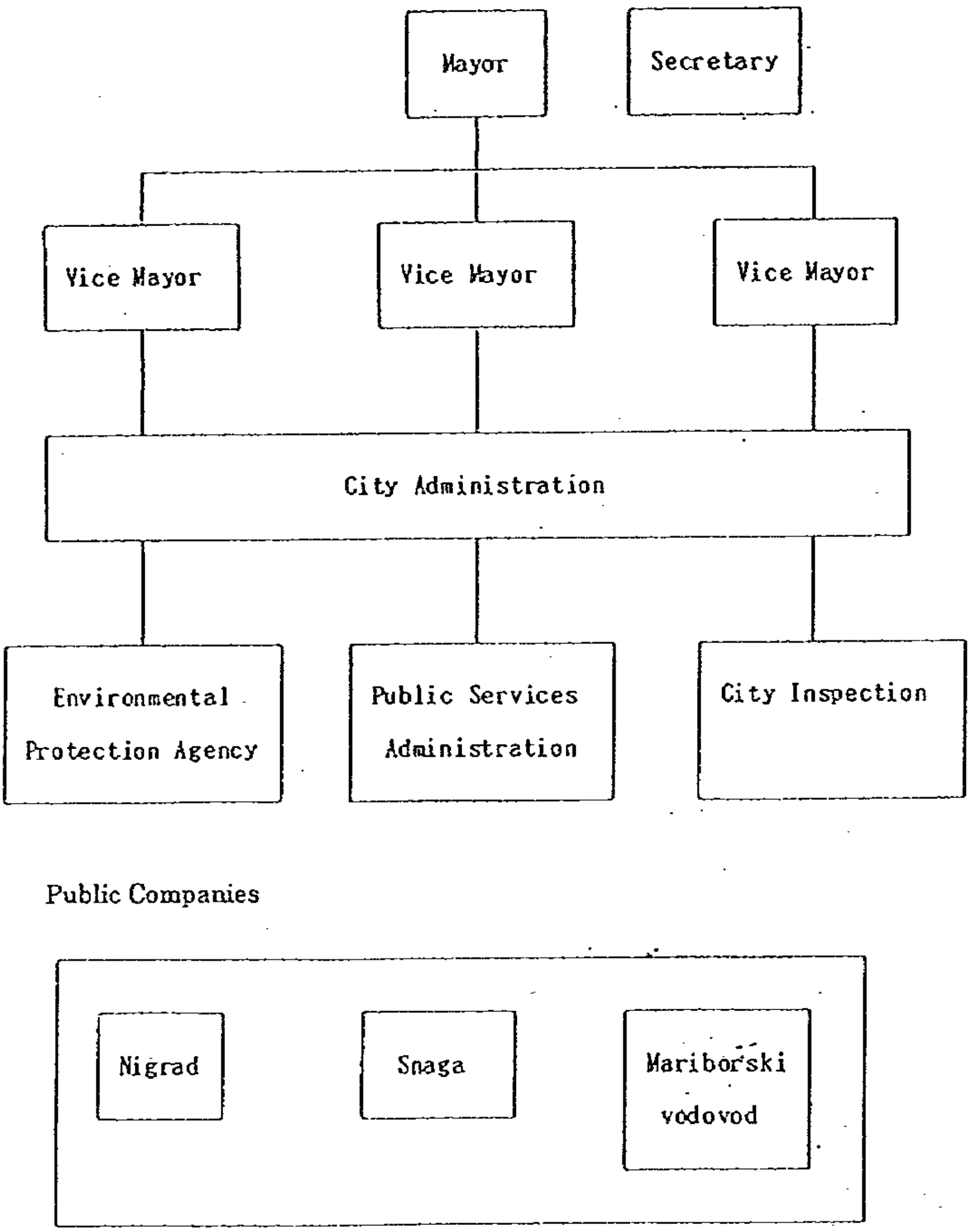
NIGRAD, Snaga, and Mariborski Vodovod, are also involved as related agencies.

The Environmental Protection Agency is the core department for administration of the environment. It plans and decides the basic policies pertaining to the environmental protection of Maribor City.

The Public Service Administration participates in the City's environmental administration while engaged in sewage, water supply, city waste, roads and other public services.

City Inspection carries out monitoring activities for the protection of the environment in accordance with Maribor City ordinances. NIGRAD is tackling environmental problems through the planning, designing and building of sewage-treatment facilities for processing household sewage and industrial effluent. Snaga is in charge of the disposition and recycling of city waste and the management of disposal plants. Mariborski Vodovod is building water supply facilities, securing sources of water supply, and controlling the quality of water.

Fig 7.1 Organization of Environment Administration in Maribor City



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Ⅳ.Results of Comprehensive Studies

IV. Results of Comprehensive Studies

This Chapter we will describe the results of our studies based on the outlines of our study subjects presented in the previous chapters. The study items are (1) treatment and pretreatment of industrial wastewater, (2) water conservation, and (3) the WWTP (Central Treatment Plant) project.

With regard to industrial wastewater treatment and pretreatment, Maribor City's entire industrial wastewater volume and the pollution load were estimated based on studies of the 20 main factories discharging more than 80% of the city's industrial wastewater. Next, on main seven plants that have been designated as model factories, a comparison was made of the merits and demerits, under the current effluent standards, of discharging their wastewater directly into the Drava River and discharging it into the WWTP. The results revealed that it would be economically advantageous for almost all the factories to discharge their wastewater into the WWTP.

It appears that consideration has been given to making the WWTP fully capable of treating present loads. However, based on future increase in loads, the rise of the polluter-pays principle, and other factors, it is conceivable that a fee structure based on pollutant loads or added restrictions to the effluent standards will be applied. Accordingly, studies were made of pretreatment for the purpose of reducing pollutant loads. Studies were made for each factory to determine how much reduction of pollutant load could be obtained using different process at different levels of investment. In addition, the results were summarized by industries -- textiles and dyeing, foods, chemicals, and machinery.

In water conservation, the first investigations focused on the costs to the factories for water consumption and wastewater, and what ratio those costs represented of the cost of the final shipped products. Next, for each factory, we clarified the water conservation method, the volume of water saved, the saved ratio and the cost. In addition, we summarized the volume of water saved by industries, pointed out their characteristics, and also estimated the volume that would be saved by each factory.

Note that in industrial wastewater treatment and pretreatment and in water conservation, we have totalized the data for each factory and show them by factory in Part II in order to observe the secrecy of the subject factories.

With respect to the WWTP, since Maribor City was in the process of evaluating the proposals of the bidding enterprises during the survey period, details were not revealed, and only an outline was given to. However, as a result of our pretreatment studies for reducing pollutants, it became clear that WWTP's wastewater treatment fee structure would be the most important factor for each factory in deciding whether or not it would pay for it to pretreat its wastewater. Therefore, we prepared simulation programs on what pretreatment would be carried out by which factory under what sort of fee structure . We then estimated the actions that would be taken by each factory to cope with various types of fee structures. As a result we were able to clarify factory's total investment amount and total pollution load amount. In addition, we introduced the basic concept behind sewer usage fee calculations in Japan and also the thinking with respect to the elimination of nitrogen and phosphorus.

Selection Reasons of Factories to be Surveyed

The factories investigated by our field surveys were selected for the following reasons.

The seven factories selected as the model factories (M Factory Group) consisted of one textile/dyeing factory, one furniture-making factory, one machine factory, and four food factories. Maribor City's main industries are textile/dyeing, food, and machines. Factories in these industries that use great amounts of water and have high wastewater pollution loads were selected.

From the food industry, four typical factories from the alcohol (beer and wine), meat, and dairy product businesses were selected. Therefore, it can be said that these seven factories are representative of the various industries of Maribor City.

The 13 factories comprising the secondary factories (S Factory Group) and tertiary factories (A Factory Group) consist of 4 textile/dyeing, 5 machine, 2 food, and 2 chemical plants. The criteria used for the selection of these factories are their wastewater pollution loads, which are the most severe in the city after those of the model factories. Four textile/dyeing factories are included because these consume large volumes of water and are part of one of Maribor City's typical industries.

Note that the tertiary factories are added partially in our surveys to further widen the range of factories selected. The tertiary factories are factories not included among the model or secondary factories which have large pollution loads or consume large volumes of water. Following is a breakdown of industries by selected factories.

Textile/dyeing	5 factories
Furniture making	1 factory
Machine manufacturing	6 factories
Food	6 factories
Chemical	2 factories
Total	20 factories

The names of the above 20 factories are listed in the table on the next page. In the table, both full name and abbreviations are shown and the abbreviations will be used hereafter.

Name of Selected Factories

No.	Industry	Full Name	Abbre-viation
M-1	Textile(Knitting)	SVILA TEKSTILNA TOVARNA, d.d.	SVILA
M-2	Furniture	MARLES HOLDING, d.d. MARLES POHISTVO, d.o.o.	MARLES
M-3	Machine & Metal Processing	LIVARNA Maribor ARMAL	ARMAL
M-4	Food(Brewery)	STAJERSKA PIVOVARNA, d.d.	PIVOVARNA
M-5	Food(Wine Cellar)	VINAG VINARSTVO-SADJARTVO	VINAG
M-6	Food(Slaughter House)	KOSAKI TOVARNA MESNIH IZDELKOV	KOSAKI
M-7	Food(Dairy Product)	MARIBORSKA MLEKARNA, d.o.o. MM MARIBORSKA MLEKARNA, d.o.o.	MLEKARNA
S-1	Textile	Tovarna Volnenih tkanin MERINKA, p.o. (TVT MERINKA)	MERINKA
S-2	ditto.	Tekstilna Tovarna TABOR, d.o.o.	TABOR
S-3	ditto.	Mariborska tekstilna tovarna Melje, d.d. (MTT MELJE), d.d. Tovarna tkanin MELJE, d.o.o.	MTT
S-4	ditto.	Tovarna sukancev in trakov TSP, p.o.	TSP
S-5	Machine & Metal Processing	METALNA, STROJE-GRADNJA, KONSTRUKCI-JE MONTAZA IN STORITVE, d.d.	METALNA
S-6	Food	MERKATOR-SLOSAD, d.d.	SLOSAD
S-7	ditto.	INTES MLIN TESTENINE	INTES
A-1	Machine & Metal Processing	TVT-Tovarna Vozil in toplotne tehnike-Boris Kidric-TIRNA VOZILA	TVT
A-2	ditto.	ELEKTROXOVINA-SVETILA	SVETILKE
A-3	ditto.	PRIMAT-Tovarna kovinske opreme	PRIMAT
A-4	ditto.	ELEKTROKOVINA Elektromotorji	ELKO
A-5	Chmical	HENKEL ZLATOROG	HENKEL
A-6	ditto.	SWATY Tovarna umetnih brusov	SWATY

1. Industrial Wastewater Treatment and Pretreatment

1.1 Industrial Wastewater Volume and Pollutant Load

1) Wastewater volume

(1) Industrial wastewater volume

The term industrial wastewater mentioned here means the wastewater that is discharged by factories producing various products. It does not include the wastewater that is discharged from enterprises that do not produce anything such as public utilities, communication businesses, wholesalers, retailers, restaurants, etc.

Estimation of the volume of discharge of industrial wastewater is extremely important when studying the treatment capacity of the WWTP. The JICA survey team took the following measures in order to obtain that figure.

① Totalized the water consumption of the 20 factories surveyed by the team, and estimated the volume of wastewater.

② Checked the data possessed by Maribor City and by its agencies.

As a result, based mainly on ① and partly supplemented by ②, the total volume of wastewater discharged by Maribor City was estimated to be about 14,600m^3/day. The following shows the course of events.

Of the Maribor City agencies, we believe that NIGRAD, a Public Sewage Corporation which receives industrial wastewater and collects a fee for it, is in possession of the most data.

The data were as follows.

① The base used by NIGRAD for collecting sewage fees is the volume of city water supplied. The volume of well water and river water being consumed is now under study. It will take some time before the data is put together.

② In this survey, a questionnaire was sent to each factory. Subsequently, NIGRADalso carried out a questionnaire survey of each factory in order to check the industrial wastewater volume.

③ Actual measurements of wastewater volume were conducted in a very small number of factories.

④ NIGRAD has not yet conducted checks of factories by verbal means or by factory visits.

Table 1.1.1 shows a comparison of the industrial water consumption as obtained by NIGRAD's questionnaire and the JICA study team's investigations.

Table 1.1.1 Comparison of Industrial Water Consumption

Consumption / Name of Co.	JICA TEAM STUDIED m³/D				NIGRAD STUDIED m³/D			
	CITY	WELL	RIVER	TOTAL	CITY	WELL	RIVER	TOTAL
M1 SVILA		1,587		1,587		1,516		1,516
M2 MARLES		298		298		284		284
M3 ARMAL	372			372	388			388
M4 PIVOVARNA		411		411		269		*269
M5 VINAG	71			71	11			11
M6 KOSAKI	365			365	400			400
M7 MLEKARNA	476			476	293			293
Sub-Total	1,284	2,296		3,580	1,092	2,069		3,161
S1 MERINKA	425	760		1,185	276	440		716
S2 TABOR	93	1,158		1,251				
S3 MTT	538	731	1,707	2,976	503	367	364	1,234
S4 TSP	36	29	278	343	39	26	224	289
S5 METALNA	212			212	190			190
S6 SLOSAD	20	15		35	21	16		37
S7 INTES	162			162	161			161
Sub-Total	1,486	2,693	1,985	6,164	1,190	849	588	2,627
A1 TVT	517		103	620	516		60	576
A2 SVETILKE	130			130	139			139
A3 PRIMAT	109			109	110			110
A4 ELKO	155			155	132			132
A5 HENKEL	339		312	651	805		650	#1,485
A6 SWATY	149			149	150			150
Sub-Total	1,399		415	1,814	1,852		740	2,592
Total 1	4,169	4,989	2,400	11,558	4,134	2,918	1,328	8,380
MPP Group & Others	Ca. 3,000			Ca. 3,000				
Total 2	7,169	4,989	2,400	14,558				

Note:(1)Original NIGRAD's data are presented as m³/Y. The values shown here are taken by assuming that operating days per year is 250.

(2)*, An actual datum measured in Feb.27-March 11,96.

(3)#, An actual datum in 1995

(4)A datum for MPP Group is based on the city water consumption.

As shown in this table, the results of investigations of the two parties are very much in agreement. For the following reasons, there are some factories in which the two figures do not agree.

① M-4 PIVOVARNA

NIGRAD's measurements on water consumption were made in the winter season when practically no beer was being produced. We believe that the annual average figure is closer to the figure obtained by JICA's study team.

② M-5 VINAG

There are two feedwater valves in this factory. However, NIGRAD's data shows only the raw water consumption of the valve with the smaller consumption.

③ S-3 MTT

NIGRAD's data show considerably less water consumption than that indicated the JICA study team's figures. The difference in consumption of well water is particularly large. The reason is not clear but it may be due to the difference in the times of survey (JICA's survey was done in June 1996 and NIGRAD's around September-October) or it may be due to a mistake on the part of the persons who filled out the questionnaire.

④ A-4 HENKEL-ZLATOROG

NIGRAD's data shows the water consumption for 1995. However, this factory stopped making soap in March 1996, so its water consumption was greatly reduced. The JICA study team's figures show the water consumption after the reduction.

In addition to a questionnaire survey, the JICA study team also conducted verbal surveys and field surveys by visiting the factories. Moreover, it showed the survey results to the factories and obtained their understanding. Therefore, the general consideration is that the JICA study team's figures are more reliable than NIGRAD's data. However, when NIGRAD's investigations progress further in the future, the reliability of it's data is expected to increase.

Considering these circumstances, the data on water consumption from the JICA study team's investigations are adopted at this time.

Of the factories on which checks of the water consumption could not be conducted by the JICA study team, the MPP Group (ex-TAM) is believing to be using a large amount of water. NIGRAD also only has data on the amount of city water supplied to this factory. Based on that figure, the water consumption is estimated to be about 3,000m^3/day.

Therefore, the water consumption for all factories is estimated to be about 14,600m^3/day, as shown at the end of Table 1.1.1.

The amount of industrial wastewater discharged is the amount consumed by the factories (water that becomes part of the products, evaporates, seeps into the ground, etc.) deducted from the water consumption. In Japan, standard runoff coefficients depending on purpose, individual surface characteristics, type of business, and other factors for the area are adopted based on experience. However, in this survey, we took the wastewater volume as the same as the water consumption volume.

However, there are daily and seasonal fluctuations in the volume of water consumed by factories. Therefore, some room should be made for this purpose in the WWTP's treatment capacity. We refer to this point in 2) below.

(2) Estimation of total volume of wastewater, household wastewater,

and industrial wastewater to flow into the WWTP

NIGRAD and the JICA study team checked the total volume of wastewater, household wastewater, and industrial wastewater to be discharged into the WWTP. As a result, it was agreed from the city water consumption data controlled by NIGRAD, that the volume of water consumed by small-scale users would be estimated as being equal to the volume of household wastewater.

Also, it was revealed that NIGRAD was still in the process of investigating the volume of industrial wastewater and did not yet have any reliable data on it. As a result of the two parties checking the results obtained by the present survey of the JICA study team, it was confirmed that, at the moment, JICA's survey results were the most detailed available.

The results checked by the two parties can be summarized is as follows.

Total wastewater to flow into the WWTP = 39,600 m^3/day

Household wastewater (25,000 x 0.9 - 0.95)= About 22,500 -23,750 m^3/day

Industrial wastewater (14,600 + 1,250 - 2,500)= About 17,100 - 15.850 m^3/day

Note that the designed value of the total volume of wastewater to flow into the WWTP indicated to us by Maribor City is 36,500 m^3/day. There is a difference of about 3,000 m^3 between this figure and ours shown above. The reasons for this difference are considered to be as follows.

In JICA's survey, wastewater that is at present being discharged into rivers and streams is included in the amount that would be discharged into the WWTP in the future. Also, actual measurements show that there are seasonal fluctuations in wastewater, so the volume of wastewater was calculated from the annual water consumption.

On the other hand, the designed value indicated by Maribor City of 36,500 m^3/day was estimated from actual measurements (at five places) taken over a short period (3 months) of some of the sewage wastewater. This method does not include the wastewater volume currently being discharged into rivers by factories. Also, since the actual measurements were not made over an entire year, we believe there is some error in the figure.

When designing the WWTP, we would recommend that, for the sake of safety, a figure of about 10% in excess be used.

Note that we believe the WWTP should be designed for a total wastewater volume estimated at 16,000 to 17,000 m^3/day. This is because the volume of small-scale factory users is not included in NIGRAD's small-scale user data, while the total wastewater volume (of 14,500 m^3/day) obtained through JICA's survey is estimated to cover 80 to 90% of the full amount.

Note: (1) Water supply source data is as follows:

Small-scale city water consumers	25,000 m^3/d (NIGRAD's data)
Large-scale city water consumers	7,200 m^3/d (JICA's data)
Ground water consumers (factories)	5,000 m^3/d (JICA's data)
River water consumers (factories)	2,400 m^3/d (JICA's data)
Total	39,600 m^3/d

(2) According to JICA's survey data, the total waste water volume of the 20 factories is 14,600 m3/d. Of this, 3,000 m3/d is the total waste water volume of 20 enterprises which make up MPP (formerly TAM).

2) Pollutant load

This survey covered a total of 20 factories (seven model factories, seven secondary factories, and six tertiary factories). The pollutant concentrations and pollutant loads for these twenty factories are shown in Table 1.1.2.

For the pollutant concentrations of the model factories, we took the actual measurements made during our second field survey or the designed values of the model wastewater-treatment systems. For the secondary and tertiary factories, we took the actual measurements made during our fourth field survey. For some factories which have more than one discharge outlet, we used values calculated from the flow rates. The pollutant loads were calculated by multiplying the wastewater volume by the pollutant concentration. The wastewater volumes are the same as those shown in Table 1.1.1.

The four textile factories have a large water volume. The total wastewater volume of the twenty factories is about 11,500m^3. This may be 80% or more than the total industrial wastewater volume. Also, it may be about 1/3 of the sewerage water volume initially estimated by the WWTP.

3) Comparison of water quality of sewerage water and factory wastewater

Data is available on water volume and quality at five main sewage discharge outlets measured in 1993. We calculated the pollutant load of these measurements in the same manner and compared the results with the total industrial wastewater of the 20 factories surveyed. The results are shown Table 1.1.3.

According to this Table, the water quality of the industrial wastewater and the overall sewage are practically the same. Moreover, the industrial wastewater shows lower figures than overall sewage for SS and P. In other words, it can be said that the overall pollutant load of the present industrial wastewater is about the same as the normal sewage for the WWTP.

However, some industrial wastewater have pollutant loads very much higher than general sewage or contain substances that are difficult to treat by sewage treatment. Close attention must be given to these factors.

Table 1.1.2 Wastewater Flow rate & Pollutant load of Each Factory

		Factory			Concentration of pollutants					Pollutant load				
		Name	Industry	Quantity	COD	BOD	SS	T-P	T-N	COD	BOD	SS	T-P	T-N
				m3/d	mg/L	mg/L	mg/L	mg/L	mg/L	kg/d	kg/d	kg/d	kg/d	kg/d
1	M-1	SVILA	Textile	1,587	500	300	40	10.0	50.0	794	476	63	15.9	79.4
2	M-2	MARLES	Furniture	298	141	60	36	1.5	12.0	42	18	11	0.4	3.6
3	M-3	ARMAL	Metal	372	20	8	0	0.0	0.0	7	3	0	0.0	0.0
4	M-4	PIVOVARNA	Food	411	890	260	76	6.0	12.0	366	107	31	2.5	4.9
5	M-5	VINAG	Food	71	750	510	90	17.0	0.0	53	36	6	1.2	0.0
6	M-6	KOSAKI	Food	365	1,500	1,000	1,000	40.0	200.0	548	365	365	14.6	73.0
7	M-7	MLEKARNA	Food	476	2,443	866	414	13.0	0.0	1163	412	197	6.2	0.0
8	S-1	MERINKA	Textile	1,185	650	150	40	3.0	30.0	770	178	47	3.6	35.6
9	S-2	TABOR	Textile	1,251	100	25	30	1.2	23.0	125	31	38	1.5	28.8
10	S-3	MTT	Textile	2,976	340	140	340	0.5	22.0	1012	417	1012	1.5	65.5
11	S-4	TSP	Textile	343	400	200	40	1.0	15.0	137	69	14	0.3	5.1
12	S-5	METALNA	Metal	212	146	62	32	2.0	30.0	31	13	7	0.4	6.4
13	S-6	SLOSAD	Food	35	4,300	1,400	500	5.0	50.0	151	49	18	0.2	1.8
14	S-7	INTES	Food	162	212	82	67	-	-	34	13	11	0.0	0.0
15	A-1	TVT	Metal	620	26	10	33	2.4	6.5	16	6	20	1.5	4.0
16	A-2	SVETILKE	Metal	130	70	5	30	11.0	18.3	9	1	4	1.4	2.4
17	A-3	PRIMAT	Metal	109	161	46	17	80.0	5.3	18	5	2	8.7	0.6
18	A-4	ELKO	Metal	155	47	5	18	2.1	32.0	7	1	3	0.3	5.0
19	A-5	HENKEL	Chemical	651	740	400	200	5.0	20.0	482	260	130	3.3	13.0
20	A-6	SWATY	Chemical	149	130	50	47	1.0	10.0	19	7	7	0.1	1.5
		Average			500	213	172	6	29					
		Total		11,558						5784	2467	1986	64	330

Note: The concentration of pollutants for SLOSAD(S-6) shows the seasonal maximum during two months per year.

Table 1.1.3 Comparison of Water Quality between Sewage Water and Effuluent from Factories

	Wastewater Sources		Quantity	Concentration of Pollutants					Pollutant Load				
				COD	BOD	SS	T-P	T-N	COD	BOD	SS	T-P	T-N
			m3/d	mg/L	mg/L	mg/L	mg/L	mg/L	kg/d	kg/d	kg/d	kg/d	kg/d
1	Sewer	Gorkega	1523	590	206	232	11	38	899	314	353	17	58
		Melje	8886	462	197	216	7	27	4105	1751	1919	62	240
		Studenci	1368	369	143	164	13	30	505	196	224	18	41
		Tabor	8452	635	266	296	11	47	5367	2248	2502	93	397
		Tenzo	9177	437	190	161	9	25	4010	1744	1477	83	229
		Total	29406						14886	6252	6476	272	966
		Average		506	213	220	9	33					
2	Factory	Total	11558						5784	2467	1986	64	330
		Average		500	213	172	6	29					

Note: (1) The data of Sewere water are from WASTEWATER TREATMENT PROJECT AND CONCESSION - REQUEST FOR PROPOSALS, Appendces, 27. September 1995.
(2) The data of Factory are from the JICA Survey Team. It is the total and avarage of the twenty factories s

4) COD_{Cr} and COD_{Mn}

The technical formation of wastewater treatment in Japan has been based on COD_{Mn}. Therefore, this point needs to be watched when referring to Japan's wastewater-treatment technology or achievements. For our fourth field survey, COD_{Cr} and COD_{Mn} were jointly measured.

Table 1.1.4 shows the results of analysis of industrial wastewater and Table 1.1.5 shows that of sewerage consisting mainly of household wastewater.

Table 1.1.4 COD_{Cr} and COD_{Mn} in the Industrial Wastewater

unit = mg/L

	Name	Sample	COD_{Cr}	COD_{Mn}	Cr/Mn	BOD	SS
M-1	SVILA	Print	270	240	1.1	90	70
M-2	MARLES	Total	33	19	1.7	20	< 30
M-5	VING	Final tank	13,900	6,800	2.0	3,100	3,900
M-6	KOSAKI	Slaughter	2,400	770	3.1	1,200	550
M-7	MLEKARNA	Total	16,600	2,900	5.7	1,100	6,600
S-1	MERINKA	Total	650	300	2.2	150	37
S-2	TABOR	Total	34	15	2.3	25	< 30
S-3	MTT	Total	340	120	2.8	140	340
		Textile dye	230	100	2.3		58
		Yarn dye	100	48	2.1		< 30
S-4	TSP	Total	360	190	1.9	100	32
S-5	METALNA	ECCE	19	15	1.3	< 5	80
		Palfinger	77	32	2.4	< 5	< 30
		Vanishing	1,800	750	2.4	300	85
S-6	SLOSAD	Tank 1	7,000	3,200	2.2	2,500	850
		Tank 2	1,600	630	2.5	250	80
A-1	TVT		16	10	1.6	< 5	55
A-2	SVETILKE	Tank	16	10	1.6	< 5	65
A-3	PRIMAT		380	200	1.9	230	180
A-4	ELKO		47	15	3.1	< 5	18
A-5	HENKEL	TPD	910	360	2.5	180	460
		outlet 4a	660	240	2.5	300	130
		outlet 5	2,400	810	3.0	1,400	310
A-6	SWATY	Total	130	32	4.1	50	47

Table 1.1.5 COD $_{Cr}$ and COD $_{Mn}$ in the Household Sewarage

Characterization of the sample			1 *	2 *	3 *	4 *
Type of the sample			spot	spot	spot	spot
Date of sampling			19.12.1996	19.12.1996	20.12.1996	20.12.1996
Parameter	expr.as	Unit				
Suspended solids		mg/l	150	240	140	230
Total nitrogen:	N	mg/l	33	69	122	88
- ammonium nitrogen	N	mg/l	27	48	72	44
- Kjeldahl nitrogen	N	mg/l	29	66	120	85
- nitrite nitrogen	N	mg/l	0.4	< 0.01	< 0.01	< 0.01
- nitrate nitrogen	N	mg/l	4.4	3.1	2.2	2.5
Total phosphorus	P	mg/l	1.2	6.6	7.0	5.0
COD_{Cr}	O_2	mg/l	280	720	900	780
COD_{Mn}	O_2	mg/l	80	150	150	190
BOD_5	O_2	mg/l	100	260	400	440

* 1 - Pohorska ulica - the area of "Rožna dolina"

2 - the corner of Ulica Pariške komune and Radvanjska cesta - the "Tabor" area

3 - the corner of Ulica Proleterskih brigad and Ljubljanska cesta - the "Tabor" area

4 - Ulica borca (at the end) - the "Brezje" area

When COD_{Cr}/COD_{Mn} or COD_{Cr}/BOD is large, it may mean that substances of poor biodegradability are contained in the waste water. When the COD removal rate is bad after start of operations of WWTP, it will probably be necessary to carry out studies about making it compulsory for factories, discharging waste water with large ratios of these substances, to install pretreatment facilities to reduce the pollution load.

1.2 Wastewater Treatment and Pretreatment

1.2.1 Design Conditions (Common for All Model Factories)

1) Treatment system

As the quality of raw water is designed based on the field analysis results, some of the numerical values may differ from those of the questionnaire which was distributed to each factory prior to the field analysis.

The quality of the treated waste water is designed to meet Slovenia's Emission Standards which the Study Team received on June 12th, 1996. Past experience and results in Japan were also used to determine the design treated waste water quality. However, industrial waste water requires different treatment levels depending on the product type and raw materials and secondary raw materials used. Consequently, the necessary tests to obtain design data before proceeding to the actual design stage of a waste water treatment system, are essential.

2) Treatment plant site

Waste water treatment plant construction is planned on an empty site and no special site constraints are assumed unless stated otherwise.

3) Plant installation conditions

In view of easy plant maintenance in winter, the plant will be installed inside a building which is heated for 3 months in winter. An outdoor minimum temperature of -20° C and snow cover of 1 m in winter are assumed.

4) Scope of estimation

The plant cost is estimated on the turn key basis. The following items are, however, excluded from the estimate.

a. Piping work outside the battery limit range
b. Power cabling work on the primary supply side
c. Substation
d. Piling and surplus soil removal
e. Spare parts

5) Utility costs

(1) Electricity : 15 SIT/kwh
(2) Water : 200 SIT/m^3
(3) Heating oil : 60 SIT/litre
(4) Chemicals
a. Urea H_2NCONH_2 100% : 52 SIT/kg
b. K_2HPO_4 100% : 394 SIT/kg
c. PAC 11% Al_2O_3 : 74.7 SIT/kg
d. $Al_2(SO_4)_3$ 18 H_2O : 39.15 SIT/kg
e. Ferric chloride 13% Fe : 64 SIT/kg
f. Polymer (nonion type) 100% : 990SIT/kg
g. Polymer (anion type) 100% : 990 SIT/kg
h. Polymer (cation type) 100% :2,000 SIT/kg
i. $NaHSO_3$ 32% : 113.6 SIT/kg
j. NaOCl 11% - 13% as Cl_2 : 54 SIT/kg
k. H_2SO_4 98% : 70.2 SIT/kg
l. HCl 30% : 22 SIT/kg
m. NaOH 100% : 83.2 SIT/kg
n. Na_2CO_3 100% : 40 SIT/kg
o. Granular activated carbon : 930 SIT/kg

6) Waste disposal cost

General waste : 1,423 SIT/m^3
Harmful waste: 49,683 SIT/m^3
(Disposed of at the waste disposal site located 10 km from Maribor.)

7) Control system

(1) pH control : automated
(2) Tank liquid level control : automated
(3) Sand filter : automated
(All other operations are conducted manually.)

8) Operation staff

When the waste water plant is in operation for 24 hours/day, 2 operators will supervise the operation for 8 hours each and no operator will be assigned to the over-night operation of 8 hours unless otherwise stated. A communication system to inform of any breakdown or accident during the unmanned night operation must be installed as a necessary condition for continuous operation.

9) Materials and symbols

The equipment symbols have the following meanings.

- FC : Cast iron
- FC13Cr : Cast iron (13 Cr)
- SUS : Stainless steel
- SS : Mild steel
- SS/EP : Mild steel inside epoxi-tar lining
- PVC : Polyvinyl chloride resin
- PE : Polyethylene
- VP : Vinyl pipe
- FC + RL : Cast iron inside rubber lining
- SGP : Steel gas pipe
- FRP : Fibre reinforced plastic
- RC : Reinforced concrete

10) Miscellaneous

(1) Voltage : 400 V
Frequency : 50 Hz

(2) Rainwater, domestic waste water are treated separately and, therefore, are not mixed with the industrial waste water treatment plant, unles it's specially mentioned.

1.2.2 Model System of Wastewater Treatment

On the seven model factories, detailed design and economic evaluations were made on the wastewater-treatment equipment for discharging directly into rivers based on the results of the second field survey.

The results are shown in Table 1.2.1. The Table shows the equipment cost, depreciation, interest, running cost, etc. Looking at the total treatment costs per water volume, all are higher than the estimated cost for discharge into sewers. Moreover, it can be seen that the costs are exceptionally higher in all but two factories.

The following can be cited as the main reasons for the high costs.

(1) The emission standard for discharging directly into rivers is very strict.

(2) The systems are small in scale so the cost per treated water volume becomes comparatively higher.

(3) As model systems, their performance was designed on the safe side.

1.2.3 Pretreatment to Satisfy the WWTP's Emission Standard

The items set as the emission standard for discharging into the WWTP are temperature, pH, immediate-settling SS, heavy metals, chlorine and chlorine compounds, cyanide, fluorine, sulfur and sulfur oxides, and oil content. All of these are substances that are injurious to the WWTP or substances that are difficult to treat by the WWTP. There are no standards for TOC, COD, BOD, and standard SS that can be treated by the WWTP.

The seven model factories already have pretreatment facilities for heavy metals or oil. However, the facilities of four factories are insufficient and require new installation. The details are comparatively simple and the cost is not high.

The cost per flow rate is shown at the lower part of Table 1.2.1. Note that the sewage fee given to us for this survey, 160 SIT/m^3, is not definite.

The figures in ( ) in 4, Total Treatment Cost, of Table 1.2.1, are figures for reference in case the interest becomes 1.0% due to financial aid or other policies. If the interest is reduced or exempt, there will be cases in which the wastewater-treatment cost will be on a par with the charge for discharge into sewers.

As a conclusion of the studies of the model factories, if the WWTP emission standards are applied with no change, it will be economically more advantageous for those factories to discharge into the WWTP than directly into rivers. The same holds true for the secondary and tertiary factories.

Table 1.2.1 Cost Comparison of Waste Water Treatment for Model Factories

	M-1 SVILA	M-2 MARLES	M-3 AKMAL	M-4 PIVOVARNA	M-5 VINAG	M-6 KOSAKI	M-7 MLEKARNA
1. Volume of waste water m³/d	1,500	304	150	720	90	400	474
2. Operation condition, d/y	252	239	256	216	251	250	365
3. Equipment cost SIT ①+②+③+④+⑤	506,050,000	92,779,000	243,317,000	189,573,000	81,214,000	296,076,000	148,120,000
①Equipments	176,142,000	35,781,000	124,966,000	49,549,000	27,969,000	122,625,000	60,133,000
②Equipment installation & Electrical works	83,743,000	20,383,000	56,725,000	23,119,000	15,394,000	46,224,000	32,774,000
③Civil engineering & Building works	227,113,000	30,000,000	48,125,000	109,750,000	33,125,000	111,390,000	48,125,000
④Trial run cost	3,150,000	1,890,000	1,463,000	3,555,000	1,238,000	3,150,000	2,475,000
⑤Design cost	5,625,000	4,725,000	7,988,000	3,600,000	3,488,000	5,062,000	4,613,000
4. Total treatment cost ⑥+⑦+⑧ 合計 SIT/m³	548(476)	237(180)	1,291(1,006)	223(168)	711(550)	565(432)	208(170)
⑥Depreciation	64	67	370	52	179	151	45
⑦Interest	80(8)	64(7)	317(32)	61(6)	179(18)	148(15)	43(5)
⑧Running Cost	404	106	604	110	353	266	120
5. WWTP Discharge rate ①+② SIT/m³	170	223	160	160	164	160	188
① Sewage System ② Pretreatment	160 10	160 63	160 -	160	160 4	160	160 28

Note : Values in ( ) show in case of 1.0 % interest.

1.2.4 Pretreatment for Reducing Pollutant Load

The planned WWTP capacity seems fully adequate to treat the present load. However, we believe consideration must be given to a load increase in the future and the growing of "those-who-benefit-should-pay" consciousness among users. For this, we think a fee system in accordance with the pollutant load or additional control of emission standards may be applied.

From the above viewpoint, we conducted wastewater analysis surveys, pretreatment tests and equipment design studies on pretreatment for reducing the main pollutant items, COD, BOD, dye waste of textile industry, and SS. These surveys, tests, and studies were conducted not only on the seven model factories, but also on the seven secondary factories and six tertiary factories.

As pretreatment facilities for reducing pollutant load, we studied coagulating sedimentation, coagulating pressure flotation, and other chemical treatment processes, and anaerobic, fixed bed, and other biological treatment processes suitable for high BOD loads.

For designing the pretreatment facilities, we did not establish target water qualities as the preconditions. Instead, we made it our main objective to accumulate and present information regarding what sort of water quality could be obtained, at what cost, and with what type of treatment, etc.

We describe "the pretreatment required for reducing the pollution load" of each factory of Part II and the details and results of the respective studies.

Table 1.2.2 summarizes the treatment processes, equipment costs, treatment costs, and the anticipated water quality after treatment of the pretreatment facilities studied for each factory. This Table gives information which will be useful for the WWTP when a fee system based on pollutant load or extra control of emission standards is studied.

Note that for harmful substances, pretreatment is imperative, and unique equipment and technology for satisfying the emission standard for each of these substances have now been standardized. Pretreatment facilities for treating harmful substances are already installed at the factories of Maribor City. Details on the difficulties of harmful substances and information about their elimination technology are given in Part III of this report.

Table 1.2.2 Examples of Applicable Pretreatment System for Each Factory

NO.	Factory		Quantity	Wastewater Quality			Pretreatment Equipment				Water Condition after Pretreatment			
	Name	Industry		COD	BOD	SS	Case	Process	Const. cost	Pretre. Cost	Quantity	COD	BOD	SS
			m3/d	mg/L	mg/L	mg/L			1000SIT	SIT/m3(1)	m3/d	mg/L	mg/L	mg/L
M-1	SVILA	Textile	1500	500	300	40	Case-1	Coa & Sedi	154.400	147	1.500	300	200	30
			1500	500	300	40	Case-2	Coa & Sedi	55.000	103	1.500	200	100	100
			1500	500	300	40	Case-3	Coa & Sedi	43.200	82	1.500	200	100	100
M-2	MARLES	Furniture	298	141	60	36	Case-1	Coa & Sedi	23.955	63	298	117	56	22
			298	141	60	36	Case-2	Case1+Aero	44.000	174	298	28	1	6
M-3	ARMAL	Metal	372	20	8	0	-	-	-	-	372	20	8	0
M-4	PIVOVARNA	Food	515	890	260	76	Case-1	Anaerobic	39.300	117	515	249	74	76
			515	890	260	76	Case-2	Aerobic	35.960	61	515	400	74	113
			515	890	260	76	Case-3	Aerobic	43.500	71	515	400	74	113
M-5	VINAG	Food	90	750	510	90	Case-1	Aerobic	24.630	226	90	220	100	172
M-6	KOSAKI	Food	400	1500	1000	1000	Case-1	Oil Sepa.	0	0	400	1.500	800	600
			400	1500	1000	1000	Case-2	Coa & Flo	50.000	140	400	800	400	30
			400	1500	1000	1000	Case-4	Case2+Aero	80.000	188	400	250	100	30
M-7	MLEKARNA	Food	476	2443	866	414	Case-1	Neutra.	13.605	28	476	2,443	866	414
			476	2443	866	414	Case-2	Coa & Flot	19.000	65	476	1,397	464	13
			476	2443	866	414	Case-3	Case2+Anae	40.000	158	476	446	141	38
			476	2443	866	414	Case-4	Case2+Aero	36.000	106	476	1.032	473	39
S-1	MERINKA	Textile	1200	650	150	37	Case-1	Coa & Sedi	143.800	152	1.200	350	80	30
S-2	TABOR	Textile	1200	100	25	30	Case-1	Coa & Sedi	50.000	265	400	100	25	30
			1200	100	25	30	Case-2	Coa & Sedi	18.000	55	400	100	25	30
S-3	MTT	Textile	3000	340	140	340	Case-1	Coa & Sedi	50.000	13	3.000	330	130	340
S-4	TSP	Textile	200	400	200	40	Case-1	Coa & Sedi	40.000	225	200	250	80	30
			200	400	200	40	Case-2	Coagulate	10.000	55	200	300	120	100
S-5	METALNA	Metal	222	146	62	32	Case-1	Coa & Sedi	24.000	95	222	128	59	30
S-6	SLOSAD	Food	35	4300	1400	500	Case-1	Anaerobic	12.000	140	35	2,150	700	250
S-7	INTES	Food	126	212	82	67	-	-	-	-	126	212	82	67
A-1	TVT	Metal	620	25.6	10.1	33.2	-	-	-	-	620	26	10	33
A-2	SVETILKE	Metal	130	70	5	30	-	-	-	-	130	70	5	30
A-3	PRIMAT	Metal	109	161	46	17	Case-1	Coa & Sedi	10.000	64	109	137	41	7
A-4	ELKO	Metal	155	47	5	18	-	-	-	-	155	47	5	18
A-5	HENKEL	Chemical	651	740	400	200	Case-1	Anaerobic	39.300	50	651	340	180	200
A-6	SWATY	Chemical	149	130	50	47	-	-	-	-	149	130	50	47

1.3 Pretreatment by Industries

We summarize herewith, by main industries of Maribor City, the results of studies on the state of their effluent and pretreatment. Our detailed studies for each factory are shown in the part II. As prescribed above, the results of our studies on pretreatment are shown in the Table 1.2.2.

1.3.1 Textile/Dyeing Industry

(1) Positioning of business category

There are only five textile companies with plants in Maribor City, but they are important because their effluent amounts to 20% of the total sewage.

Each of the five companies has its own characteristics, so it is difficult to make a sweeping statement. However, problems such as colored effluent and large fluctuation in drainage volumes and pollutant loads are common to all five.

(2) Likelihood of discharge into rivers

Since a strict emission standard has been set separately for the textile industry, the costs of wastewater treatment and equipment in this case rise far above the costs for plants discharging wastewater into sewage. As can be seen from Table 1.3.1, at present, two companies are discharging directly into rivers. S-2 Tabor is already more or less meeting the emission standards.

(3) Infringements of WWTP emission standards

In the emission standard for discharging into WWTP, there are controls on temperature, pH, heavy metals, oil content, sulfur content, and halogen. All of these concentrations in the wastewater of the five companies, except some of the pH levels which have to be monitored carefully, are well within the existing standards.

(4) Methods of reducing pollution load

Coloring of effluent is a form of pollution unique to the textile industry. The coloring fluctuates greatly depending on the time, but as a whole, absorbance of the strictest controlled value of 620nm is estimated to be 30 or less. This falls to 1/10 when it is diluted five times with other sewage and halved again by the WWTP. In other words, it will meet the emission standard. The measured value of color by absorbance, in the light range, is more or less proportionate to concentration. If coagulating sedimentation is adopted by WWTP, the color will be reduced to a much greater degree. Azoic dyes, which are frequently used in synthetic textiles, are known to be efficiently decomposed by anaerobic biological treatment. If the WWTP adopts the anaerobic biological treatment process, the problem of color will be alleviated even further. According to the above reasoning, pretreatment for the purpose of eliminating color at each factory will not be required.

However, in the future, there is a possibility that the WWTP may have to demand that textile factories which discharge colored wastewater carry out the necessary decoloring pretreatment so that the wastewater meets the emission standard for discharge into rivers. We list below the processes that are generally used for decoloring the wastewater of dyeing factories. ① Activated carbon adsorption: Decoloring by the biochemical adsorption property of activated carbon. ② Ozone treatment: Decoloring by the oxidative decomposition property of ozone. ③ Coagulating-sedimentation treatment: By mixing inorganic and organic flocculants, the coloring substances are coagulated into floc. ④ Fenton treatment: Decoloring by processes such as the oxidative decomposition of hydrogen peroxide in the presence of an iron catalyst.

Table 1.3.1 Wastewater of Textile Industries

	M-1	S-1	S-2	S-3	S-4	Emission Standard	
Company	SVILA	MERINKA	TABOR	MTT	TSP	Discharge to River	Discharge to Sewage
Material	Rayon	Wool	PET	PET	PET		
Quantity m³/d	1,587	1,200	1,250	3,000	343		
Discharge to	River	Sewage	River	Sewage	Sewage		
Sampling date	Jun.05,1996	Dec.10,1996	Dec.03,1996	Dec.16,1996	Dec.05,1996		
pH	7.8 - 10.0	8.2	7.9	11.3	8.8	6.5 - 9.0	6.5 - 9.5
SS mg/L	< 30	37	< 30	340	32	80	-
Color							
α (436nm) m^{-1}	42 / 14	37	2.6	17	31	7	
α (525nm)	33 / 15	30	1.9	14	30	5	
α (620nm)	25 / 18	25	1.5	13	27	3	
T-N mg/L	13.5 / 7.3	24	23	22	14		
T-P mg/L	0.3 / 8.7	3.1	1.3	0.5	0.7	1.0	-
COD_{Cr} mg/L	140	650	34	340	360	200	
COD_{Mn} mg/L		300	15	120	190		
BOD_5 mg/L	50	150	25	140	100	30	
T-Fat mg/L	5	30	30	12	19		
mineral oil						10	20

A good rate of removal of about 90% can be obtained from both ① activated carbon adsorption and ② ozone treatment. Efficiency is poor if there is COD and SS, so these processes are used as the final treatment after COD and SS are removed. Treatment costs depend on concentrations, but generally speaking, they are very high.

Since the controlled value is extremely strict when the color of wastewater is regulated in Japan, one of these two methods is used.

With ③ coagulating-sedimentation treatment, there are various cases that can occur depending on the properties of the wastewater. Sometimes good decoloring is achieved with just inorganic flocculants, and sometimes decoloring becomes effective by adding a dicyandiamide-based organic decoloring flocculant. In special cases, the flocculant cannot decolor because it does not form floc. Generally speaking, this process is frequently used in Japan for pretreatment of waste dyeing water as it can also remove BOD, COD, SS, and especially P, while removing the color.

④ Fenton treatment can decolor very well if the conditions are right. It is also effective for changing conspicuously bright colors into inconspicuous colors such gray or white. The reaction pH condition is on the acidic side of about 3.5. Therefore, the process is quite expensive because of the costs for the pH-adjusting acid, the neutralizing alkali, and the oxidizing agent, hydrogen peroxide. Also, unless coagulation is carried out, there is the problem of an overall increase in pollutants in spite of the successful decoloring of the wastewater.

5) Coagulation-treatment test

As mentioned before, the most usual and economical pretreatment process is the coagulating-sedimentation treatment. Moreover, this treatment becomes even more economical if only the thick wastewater after dyeing is treated. However if only the dye liquid is separated, there are times when the coagulant does not form floc. In most cases, pH neutralizing and decoloring is done when the dye liquid is mixed with the 1st washing water, and flocculation is more likely to take place at such times. Also, coagulating treatment may be difficult for wastewater which contains a lot of surface-active agent, so care is required.

Although the coloring must be decreased, one method which can be used when there is a margin in SS is to floc the color with the coagulating treatment and then discharge the water without any sedimentation separation. Since this method does not require the installation of a dehydrator, no cost or labor is involved. It is an especially convenient method that can be adopted when discharging wastewater into sewers.

In this survey, we carried out coagulating-sedimentation tests on the wastewater of five companies and additionally conducted a Fenton treatment jar tests on some samples. When actually designing pretreatment facilities in the future, further wastewater treatment tests should be carried out to fully check the conditions and effectiveness of the treatment.

1.3.2 Food Industry

We studied four kinds of food industry factories. The total water volume of the four factories comprises about 10% of the total for the 20 factories investigated in this survey. All of them have high pollutant loads, but those of BOD and COD are by far the highest, each taking up about 40% of the share on average. Following is a summary of the respective items by business category.

1) Beer brewery (M-4, STAJERSKA)

(1) Positioning of business category

This is the only brewery in Maribor City. It is said to have the second largest output in Slovenia, but the output is relatively small.

The ratio of its pollution load to that of the 20 factories is 3.6% by water volume, 6.3% by COD, and 4.3% by BOD. The main source of wastewater is the bottle-washing machinery. Because the equipment is old, the wastewater volume is large compared to the quantity of production.

(2) Likelihood of discharging into rivers

As emission standards for discharging into rivers are strict (especially for T-P, which is restricted to 2 mg/L), the treatment cost comes to 223 SIT/m^3. Since the factory is also located quite a distance from a river, the prohibitive cost of laying a pipeline makes it advantageous for the brewery to discharge into the WWTP at present, and the possibility of discharge into rivers remains slim.

(3) Infringements of WWTP emission standards

From the result of our survey, the water quality of the wastewater at the final stage is within the WWTP emission standards and there is no particular problem.

(4) Methods of reducing pollutant load

Generally, physico-chemical treatment (coagulating-sedimentation method) is mostly used for the pretreatment system for reducing pollutant load. Although this treatment will remove SS from this wastewater, it is not very effective in removing soluble organic pollutants. Therefore, we studied the use of the biological treatment method, formulating conceptual designs of three cases; i.e., Case 1 for separating thick wastewater and subjecting it to anaerobic treatment, Case 2 for aerobic treatment, and Case 3 for further aerobic treatment of the general drainage.

The result was that the treatment cost of Case 2 was the lowest at 61 SIT/m^3. This reduction was enabled by our selection of the biofilm-filter process, a process which removes high loads, for the aerobic treatment. Although the use of such a process increases electricity costs, it reduces equipment costs by a considerable margin. Another factor for the low treatment cost in Case 2 was the absence of any need for a heat source to heat the raw wastewater. The order by treatment cost was Case 2<Case 3<Case 1.

Also, the anaerobic treatment became the most expensive because the heat source cost for heating the raw wastewater took up a large share of the treatment costs (the anaerobic treatment method becomes advantageous when organic pollutant concentrations are high).

Note that the quantity of excess sludge that is created in the aerobic treatment tank is small. Therefore, in order to keep equipment costs as low as possible, it is better to discharge the sludge into the WWTP together with the treated wastewater than to install sludge-treatment facilities. However, the SS concentration in the treated wastewater will increase slightly due to the added amount untreated sludge.

2) Winery (M-5, VINAG)

(1) Positioning of business category

This is a winery located in the center of Maribor City. The squeezed juice is brought to the winery by tank trucks, stored in underground tanks and allowed to mature. The matured wine is then bottled and shipped out.

The scale of production is small and its ratio of pollution load to that of the 20 factories is only 0.6% by water volume, 0.9% by COD, and 1.5% by BOD.

(2) Likelihood of discharging into rivers

As with the brewery, the standards for discharging into rivers are strict (especially for T-P, which is restricted 2mg/L), so the treatment cost is a high 711 SIT/m^3. Major factors for this relatively high cost of treatment per unit volume are that the amount treated is small, and that the winery stays in operation on only a limited number of days per year (216 days/year).

Therefore, at present, it would be advantageous to discharge into the WWTP. Also, this factory is located in the heart of Maribor City, so it would be extremely difficult to lay a pipeline to a river. Thus, discharge into rivers is a virtual impossibility.

(3) Infringements of WWTP emission standards

Neutralizing facilities are already installed and the treated water quality is within WWTP emission standards, so there is no particular problem. The wastewater generated by the factory is separated into acid and alkaline wastewater and stored in separate tanks. Since there is a possibility of reducing, to a certain degree, the amount of the neutralizing agents being currently used if the two liquids are mixed and discharged, there is room for study on this point.

(4) Methods for Reducing Pollutant Load

With regard to pretreatment facilities for lowering the pollutant load by the physico-chemical treatment method (coagulating sedimentation), SS can be removed using the same method applied by the beer producer. However, as not much can be expected with regard to removal of soluble organic pollutants, we studied the biological treatment method.

There are two biological treatment methods; i.e., the aerobic and anaerobic methods. However, if the anaerobic method is selected, a heating source for heating this wastewater will be required since its organic pollutants concentration is low and only a small amount of bio-gas will be generated. Thus, in this case, the cost of treatment by the anaerobic method will become greater than that for treatment by the aerobic method.

Therefore, the low-cost biofilm-filter process is more suitable as the pretreatment system since, in spite of its increased electricity cost, it will remove high loads without causing bulking.

Note that the quantity of excess sludge created in the aerobic treatment tank is small. Therefore, in order to keep equipment costs as low as possible, it is better not to install sludge-treatment facilities, and to instead discharge the sludge into WWTP together with the treated wastewater. However, the SS concentration in the treated wastewater will increase slightly due to the added amount of untreated sludge.

3) Meat Producer (M-6, KOSAKI)

(1) Positioning of business category

This enterprise is the only slaughterhouse in the Maribor area. It produces fresh beef and pork. The plant is located very close to the Drava River. Since the factory works only in the daytime, the generation of its wastewater is concentrated during that time zone. Its pollution load is high, comprising 3.2% of the total by water volume, 9.5% of the total by COD, and 15% of the total by BOD.

(2) Likelihood of discharge into rivers

The factory is close to a river, so we believe the cost of installing a pipeline will be cheap. However, since the emission standards are strict, the cost of treatment becomes a high 565 SIT/m^3. Thus, discharge into the WWTP is far more advantageous.

(3) Infringements of WWTP emission standards

The existing oil-water separation equipment is functioning very well and the treated water quality is within the WWTP emission standards, so there is no particular problem.

(4) Methods of reducing pollutant load

As the pretreatment facility for reducing pollutant loads, we studied the coagulating-pressure-flotation method, and a physico-chemical treatment process. The reason for opting for this method instead of the coagulating-sedimentation method is that it is suitable for removing oil content which, by nature, has a tendency to float. The sludge separated by coagulating pressure flotation contains a large amount of oil. We compared the disposal of this sludge with and without dewatering it. The latter is naturally cheaper in equipment and running costs . However, there are some indefinite points in this method regarding how the sludge can be received without dewatering and what the cost will be.

When BOD and COD have to be reduced further, biological treatment is applied. Anaerobic biological treatment is frequently employed when the pollutant load is high, but it does not work so well when the oil content is high. Anaerobic biological treatment becomes advantageous after coagulating-pressure-flotation treatment has been carried out since the load is reduced. As the SS will have decreased, fixed-bed biological contact aeration treatment would be most suitable. As only a small quantity of excess sludge is created in the aerobic treatment tank, it is discharged as is without being separated.

The pollutant load is greatly reduced by the coagulating-pressure-flotation treatment, but the treatment cost is about the same as the standard sewage fee. Pretreatment for the purpose of reducing load will not become economically viable unless the progressive fee based on pollutant load becomes about twice the standard fee. In other words, unless there is a system of additional controls on the emission standard, it will be more economical to pay the sewage for as long as the additional fee is small.

4) Dairy products producer (M-7, MLEKARNA)

(1) Positioning of Business Category

MARIBORSKA MLEKARNA p.o is the only dairy products producer located in Maribor City. Of the 756m^3/day used by its factory, 280m^3/day is recycled for use as boiler water and refrigeration water. Thus, the net volume of water supplied is 476m³/day. The wastewater volume is the same as the supplied 476m³/day. Among the 20 factories, it comprises 4.1% of the total industrial water and 1.3% of overall sewage water.

The cause of pollution of the wastewater is loss due to washing of dairy products and the acid and alkaline washing agents. In manufacture of city milk and cream, there is CIP wastewater, and in manufacture of cheese, there is whey wastewater and loss of cheese. The latter manufacturing wastewater in particular has high concentrations of both COD and BOD. Also, the main cause of N and P in the wastewater is washing agents. The only way to lower the pollution load of wastewater in the production of cheese is to improve the shop work methods and discharging process so that loss of whey and cheese is kept to the minimum.

(2) Likelihood of discharging into rivers

The cost of treating wastewater with pretreatment equipment for neutralizing wastewater and discharging it into the WWTP (Case 1) is 205 SIT/m³. Since the cost of wastewater treatment with pretreatment equipment for discharging into rivers is 208 SIT/m³, if improvement of work methods to prevent the loss of cheese is successful, it will be cheaper to discharge into the WWTP. However, because the cost of treating wastewater with pretreatment equipment for reducing the pollution load is higher than the cost of pretreatment with equipment for discharging into rivers, there is the possibility that wastewater-treatment equipment for discharging into rivers will be installed.

The COD of wastewater from dairy product manufacturing can be reduced to a low level by biological treatment which runs on low load. For wastewater-treatment equipment for the purpose of discharging into rivers, we took into consideration the prevention of bulking and proposed the anaerobic/aerobic (AO) system. However, COD is still left in water that is treated biologically, of which 40 to 60% is humic acid-like substances which do not have biodegradation properties. Due to this, the recycling of treated water is said to be difficult for reasons of economy and safety rather than problems of technology.

(3) Infringements of WWTP emission standards

Water quality conditions that, depending on the discharge conditions of the wastewater, may possibly infringe on the WWTP emission standards are pH and oil content. However, if the loss of cheese can be prevented, oil content will no longer pose any potential problem, and the only concern will be the pH.

(4) Methods of reducing pollution load

We proposed as Case 2, pretreatment equipment for the coagulating pressure flotation method which removes oil content and SS as well as neutralizes wastewater. This was on the assumption that the effectiveness of preventing the loss of cheese would be low.

Furthermore, in order to reduce the BOD and COD pollution load due to organic materials, we proposed as Case 3, the addition of anaerobic biological treatment, and, as Case 4, the addition of biofilm-filtering treatment. The removal rate of the biofilm-filtering method is low but both the cost of its facilities and treatment are low.

1.3.3 Chemical Industry

(1) Positioning of business category

The chemical industry of Maribor City consists only of factories that use chemicals as raw materials. In the current survey, we studied two factories. One is a maker of household chemicals who prepares the chemicals and then puts them into containers. Effluent from the washing of the containers is produced when changing over from the manufacture of one product to another. The other factory is a maker of grindstones that uses binders and other chemical materials.

(2) Likelihood of discharging into rivers

Both are discharging into sewers. For these factories also, there is no likelihood of discharge into rivers in the future.

(3) Infringements of WWTP emission standards

The former factory has a high pollution load but at present it meets the WWTP emission standards. In the latter, the pollution load was low in all of its effluent but that produced from a grindstone material mixer. However, the effluent from the mixer amounts only to a few cubic meters a day, and even by itself, it satisfies the WWTP's emission standards.

(4) Methods of reducing pollutant load

In order to cope with the future sewage fee based on COD, BOD and other loads, we studied the following pretreatment systems for treatment of the high pollution loads at the former factory.

Recovery and reuse:	Closed system
Separation removal:	Concentrated separation
	Coagulating separation
Decomposition:	Chemical decomposition
	Ozone treatment
	Anaerobic treatment

① In the case of powdered detergent, a completely closed system is possible with just a little more effort. At present, city water is being replenished in a recycled water tank. However, by controlling the replenished water at a lower level than the present one, there is room, at the time of changing over, etc., for absorbing the 1 to 2m^3 of recycled water that is overflowing irregularly but constantly.

② As the wastewater volume is a large 180m^3/day, concentrated separation is difficult when producing cosmetics. However, in the case of the hair dye being planned, a wastewater volume as small as 1m^3/day can be realized using this method. This method is also effective for coping with oil content, which is essential. Unlike the case with powdered detergent, reuse of the concentrated content is believed to be difficult for hair dye products because of their delicate function and color. Normally, the content is evaporation-dried and incinerated or otherwise disposed of as solid waste. If there is ample heat, the concentrated liquid can be mixed with boiler fuel and burnt off.

③ Coagulation treatment of the wastewater is difficult in the case of cosmetics and hair dyes. A wide range of conditions was tested by jar tests, but the inorganic coagulants formed no floc at all.

④ Oxidative decomposition by the Fenton treatment showed a distinct change in color, but the measured values of absorbance and COD did not drop. Moreover, the method is not suitable because of problems such as high cost and the increase in overall pollutant load it causes.

⑤ As seen from the test results of the Fenton treatment, decomposition by ozone treatment is also difficult.

⑥ Anaerobic biological treatment is a method worth considering for wastewater treatment of cosmetics. If the treatment results are good, we believe it can also be applied to the wastewater treatment of hair dyes.

Based on the above study, for the pretreatment system, we planned the anaerobic biological treatment mainly for cosmetics wastewater. This has the aim of removing the extremely high COD, BOD and fat. The pH of the raw water is about neutral, and as there is no coarse SS, it is heated as is to about 35oC and treated in an anaerobic biological reaction tank. We made the reaction tank a fixed-bed type. To conserve the heat source for heating, the treated water and the wastewater were liquid-liquid heat exchanged, and heat that was insufficient was augmented by steam. The gas generated in the reaction tank can be recovered as a heat source for the boiler.

The treated water quality can be lowered to a COD of about 1/4 and BOD of about 1/5. The treatment cost comes to 117 SIT/m^3 for 300m^3 of cosmetics wastewater. If calculated to the total wastewater volume of 700m^3, inclusive of other wastewater, the cost comes to 50 SIT/m^3.

1.3.4 Machine & Metal Processors

The sources of wastewater of the machine and metal processors can be largely divided into the metal processing, surface treatment (including plating), and painting processes. Also, since MARLES POHISTVO, a company in the business of making wooden furniture, also has a painting process, we decided to include that business category in this section.

1) Positioning of business category

The primary six companies engaged in the machine and metal processing business in Maribor City are ARMAL (manufactures water faucets, flush toilet fixing outlets, castings for heating and cooling, etc.), METALNA Group (manufactures all types of hydroelectric power equipment other than turbines, construction and transportation equipment, and industrial machinery), TVT Group (manufactures and repairs rolling stock), ELEKTROKOVINA SVETILKE (manufactures lighting equipment, electric motors, and generators), PRIMAT (manufactures safes and steel furniture), and ELKO ELEKTROKOVINA (manufactures motors and pumps). There is an additional company, the TAM Group, which manufactures automobiles, but because it was impossible to visit and survey the factory and collect data, we will not refer to it here.

The machine and metal processing business as a whole consumes a total of 3,431m^3 of water a day, of which 1,789m^3/day is recycled. The total volume of wastewater generated, 1,598m^3/day, comprises 13.8% of the total industrial wastewater and 4.4% of overall sewage.

(1) ARMAL

Total water consumption is 492m^3/day, of which 120m^3/day is being recycled as washing water, so the net volume of water supplied to the factory is 372m^3/day. The wastewater volume is equal to the water consumption of 372m^3/day, accounting for 3.2% of total industrial wastewater and 1.0% of overall sewage.

(2) METALNA Group

Total water supplied and total water consumed are the same, at 212m^3/day. The wastewater volume is equal to the water consumption of 212m^3/day, accounting for 1.8% of total industrial wastewater and 0.6% of overall sewage.

(3) TVT Group

Of the 2,169m^3/day consumed, 1,549m^3/day is recycled as boiler water, washing water, and cooling water, so the net volume of water supplied to the factory is 620m^3/day. The wastewater volume is equal to the water consumption of 620m^3/day, but 16m^3/day of that volume is water leakage, so the actual volume is 600m^3/day, accounting for 5.4% of total industrial wastewater and 1.7% of overall sewage.

(4) ELEKTROKOVINA SVETILKE

Of the total 250m^3/day consumed, 120m^3/day is being recycled as cooling water, so the net volume of water supplied to the factory is 130m^3/day. The wastewater volume is equal to the water consumption of 130m^3/day, accounting for 1.1% of total industrial wastewater and 0.4% of overall sewage.

(5) PRIMAT

Total water consumption and water supplied are the same, at 109m^3/day. The wastewater volume is equal to the water consumption of 109m^3/day, accounting for 0.9% of total industrial wastewater and 0.3% of overall sewage.

(6) ELKO ELEKTROKOVINA

Total water consumption, water supplied, and wastewater volume are all the same, at 199m^3/day. However of this total wastewater volume, 44m^3/day is being treated at a joint wastewater-treatment plant and the balance of 155m^3/day is being discharged. Therefore, the wastewater volume accounts for 1.3% of total industrial wastewater and 0.4% of overall sewage.

(7) MARLES POHISTVO

MARLES POHISTVO is the only company in Maribor City which makes wooden furniture. Of the 519.7m^3/day of water consumed, 222m^3/day is being recycled as boiler water, so the net volume of water supplied to the factory is 297.7m^3/day. The wastewater volume is equal to the net volume of water supplied of 297.7m^3/day, accounting for 2.6% of total industrial wastewater and 0.8% of overall sewage.

2) Likelihood of discharging into rivers

The only company with the likelihood of discharging into rivers is the wooden furniture manufacturer, MARLES POHISTVO.

(1) ARMAL

The wastewater that must be treated is waste cutting oil, waste perchloroethylene (PEC), and plating wastewater. The waste cutting oil is recovered and disposed of as industrial waste by a contractor. The waste PEC is recovered, and, after its impurities are removed with solvent regeneration equipment, it is reused as PEC. The plating wastewater is treated in a wastewater-treatment plant. Therefore, there is no need to study the likelihood of discharge into rivers.

(2) METALNA Group

The wastewater that must be treated is waste cutting oil and the painting booth waste washing water. The waste cutting oil is recovered and is disposed of as industrial waste by a contractor. The painting booth waste washing water has a high COD concentration and contains organic compounds with anti-biodegradation properties, but the frequency of occurrence of the wastewater is extremely small. Due to this, the treatment of wastewater for the purpose of discharging into rivers would be mainly on domestic wastewater, thus making the installation of comprehensive wastewater-treatment facilities uneconomical. Therefore, there is no likelihood of the wastewater being discharged into rivers.

(3) TIV Group

There is no discharge of wastewater that would have to be treated prior to discharge into rivers. The plating wastewater is treated by treatment equipment and the car waste washing water is recycled. Therefore there is no need to study the likelihood of discharge into rivers.

(4) ELEKTROKOVINA SVETILKE

The wastewater that must be treated is being treated at a joint wastewater-treatment plant. Therefore, there is no need to study the likelihood of discharge into rivers.

(5) PRIMAT

The wastewater that must be treated for discharge into rivers is from the painting booth washing water and the pre-painting treatment. The pollution concentration of the pre-painting treatment wastewater is low. Also, by changing the painting method from the current booth water washing system to a dry powder coating system, wastewater will no longer be produced. Due to this, the treatment of wastewater for the purpose of discharge into rivers would be mainly on domestic wastewater, thus making the installation of comprehensive wastewater-treatment facilities uneconomical. Therefore, there is no likelihood of the wastewater being discharged into rivers.

(6) ELKO ELEKTROKOVINA

The wastewater that must be treated is being treated in a joint wastewater-treatment plant. Therefore, there is no need to study the likelihood of discharge into rivers.

(7) MARLES POHISTVO

The cost of treating wastewater with wastewater-treatment facilities for the purpose of discharge into rivers is cheaper than the cost of treating wastewater with pretreatment facilities for reducing the pollutant load. Thus, there is a good likelihood of the wastewater being discharged into rivers. The wastewater-treatment equipment for the discharge of wastewater into rivers will process the painting booth waste washing water and the gluing machine waste washing water with coagulating sedimentation. The treated water will then be mixed with domestic wastewater and treated by the contact aeration method. Subsequently, it will be subjected to further coagulating sedimentation treatment to remove P.

3) Infringements of WWTP emission standards

The water quality items of the total wastewater discharged that infringe on the WWTP's emission standards are the pH which results from the pre-painting treatment wastewater at PRIMAT, and the heavy metals and organic compounds which result from the painting booth waste washing water at METALNA, PRIMAT, and MARLES POHISTVO.

(1) ARMAL

Basically there are no water quality items in the overall wastewater that infringe on the WWTP's emission standards. However, heavy metals somewhat exceeding the standard are detected in the water treated by the plating wastewater treatment facilities. Some of the conceivable causes for this are ① inadequate pH adjustment, ② creation of complex chemicals due to mixed discharge of wastewater, and ③ outflow of SS containing hydroxides of heavy metals. Accordingly, appropriate countermeasures are ① reappraisal of the chemicals being used, ② change of operating conditions, ③ separate discharge or separate treatment of the wastewater, ④ use of appropriate high-molecular coagulants, ⑤ installation of a filtering tower, ⑥ installation of a chelate-resin tower, etc. It is hoped that the causes be determined and appropriate measures be taken to improve the treatment into more rational systems.

(2) METALNA group

The heavy metals and organic compounds contained in the wastewater, when painting booth waste washing water is discharged, infringe on the WWTP's emission standards.

(3) TVT group

Basically there are no water quality items in the overall wastewater that infringe on the WWTP's emission standards. However, heavy metals somewhat exceeding the standard are detected in the water treated by the plating wastewater treatment facilities. Some of the conceivable causes of this are ① inadequate pH adjustment, ② creation of complex chemicals due mixed discharge of wastewater, and ③ outflow of SS containing hydroxides of heavy metals. Accordingly, appropriate countermeasures are ① reappraisal of the chemicals being used, ② change of operating conditions, ③ separate discharge or separate treatment of the wastewater, ④ control of operations by means of equipment, ⑤ use of appropriate high-molecular coagulants, ⑥ improvement of reaction tank into a completely mixed type, ⑦ installation of a filtering tower, ⑧ installation of a chelate-resin tower, etc. It is hoped that causes be determined and appropriate measures be taken to improve the treatment into more rational systems.

(4) ELEKTROKOVINA SVETILKE

The water quality items that could possibly infringe on the WWTP's emission standards are the oil content and heavy metals resulting from the waste cutting oil, and the heavy metals and organic compounds resulting from the painting booth waste washing water. However, these wastewaters are being treated in a joint treatment plant, so there are no water quality items that infringe on the WWTP's emission standards.

(5) PRIMAT

The water quality item that could possibly infringe on the WWTP's emission standards is the pH resulting from the pre-painting treatment wastewater. At present, there are heavy metals and organic compounds that result from the painting booth waste washing water, but these problems will be eliminated by changing the painting process.

(6) ELKO ELEKTROKOVINA

The water quality items that could possibly infringe on the WWTP's emission standards are the oil content and heavy metals resulting from the waste cutting oil, the pH and heavy metals resulting from the alumite processing wastewater, and the heavy metals and organic compounds resulting from the painting booth waste washing water. However, these wastewaters are being treated in a joint treatment plant, so there are no water quality items that infringe on the WWTP's emission standards.

(7) MARLES POHISTVO

The water quality items that infringe on the WWTP's emission standards are the heavy metals and organic compounds resulting from the painting booth waste washing water.

4) Methods of Reducing Pollutant Load Both BOD and COD concentrations of the overall wastewater of the machine and metal processing industry are low so there is no need to install pretreatment facilities for reducing the pollutant load.

Note that at MARLES POHISTVO, the wooden furniture maker, there is painting booth and gluing machine waste washing waters which, although small in volume, have high concentrations of both BOD and COD. For this reason, we proposed pretreatment equipment that would treat these wastewaters by coagulating sedimentation, mix the treated water with domestic wastewater, and then treat it by the contact-aeration process.

2. Water Conservation

2.1 Expenses Required for Water and Sewage

Industries bear the following water and sewage expenses for their activities:

①	City Water rate	97.4 SIT/m^3
②	Sewage rate	58.8 SIT/m^3
③	Local tax on sewage	40.8 SIT/m^3
④	National tax on sewage	16.8 SIT/m^3

In addition to the above, there are expenses that are generated within the business such as the costs of power, maintenance of equipment, labor, etc., but we will not touch on these costs here.

The shipment prices of the products of 12 of the factories subjected to this survey were revealed. We calculated the costs of the water and sewage for these 12 factories and obtained their ratio to the shipment prices of the products. The results are shown in Table 2.1. The following can be seen from that Table.

① The average ratio to the shipment prices of the 12 factories is 0.98%, but there is a considerable variation depending on the type of business.

② The highest ratio was the textile industry, which came to 2.15%. This is because this industry consumes large volumes of water for its shipment price.

③ The lowest ratio was held by chemicals and furniture. The products of these factories are unique so there is no data that can be used for comparisons. However, even when compared to the non-water using industries, machine and metal processing, their ratios are considerably lower. So they may be called non-water using types of factories.

④ Machine and metal processing are typical non-water using industries, but the ratio to the shipment price was 0.82%. This is about 40% of the corresponding ratio in the textile industry, which consumes large volumes of water. This figure is very high when it is compared to that of Japan (about 20%).

⑤ The above ratios are much higher than the corresponding ratios for Japanese factories in the same types of businesses. In the textile industry, for example, the ratio is double, and in the machine and metal-processing industry, it is quadruple.

⑥ For one food factory we could not make clear comparisons with the same type of factory in Japan (brewery) because of lack of adequate data, but we estimate that it is more or less on the same level. At Japanese food and beverage factories, the ratio of use of costly city water is high, so the ratio of the charges for water used and wastewater against the shipment value is high compared to other businesses.

Table 2.1 Ratio of Water Use and Waste Water Discharge Cost to Production (1/3)

Unit of Water Volume : m^3 / day、 Unit Cost of Water : SIT / m^3

Industry	Machine & Metal Processing										
Name of Factory	M-3 ARMAL		A-1 TVT		A-2 SVETILKE		A-3 PRIMAT		A-4 ELKO		Sub-Total
Water Source	Water Volume	Unit Cost	Water Volume	Unit Cost	Water Volume	Unit Cost	Water Volume	Unit Cost	Water Volume	Unit Cost	Water Volume
City Water	372	213.5	517	213.5	130	213.5	109	213.5	155	213.5	1,283
Well Water											
River Water			103	116.1							103
Total	372		620	197.3	130		109		155		1,386
Waste Water is discharged to	Sewerage		Sewerage		Sewerage		Sewerage		Sewerage		
Total Water Cost 1,000 SIT / yea	19,856		30,584		6,939		5,818		8,273		71,470
Annual Production Million SIT / year	2,675		2,000		2,269		885		920		8,749
Cost / Production Ratio %	0.75		1.53		0.31		0.66		0.90		0.82

Table 2.1 Ratio of Water Use and Waste Water Discharge Cost to Production (2/3)

Unit of Water Volume; m^3 / day、 Unit Cost of Water: SIT / m^3

Industry	Food		Textile								
Name of Factory	M-4 PIVOVARNA		M-1 SVILA		S-2 TABOR		S-3 MTT		S-4 TSP		Sub-Total
Water Source	Water Volume	Unit Cost	Water Volume	Unit Cost	Water Volume	Unit Cost	Water Volume	Unit Cost	Water Volume	Unit Cost	Water Volume
City Water					93	154.7	538	213.5	36	213.5	667
Well Water	411	116.1	1,587	57.3	1,158	57.3	731	116.1	29	116.1	3,505
River Water							1,707	116.1	278	116.1	1,985
Total	411		1,587		1,251	64.5	2,976	133.7	343	126.3	6,157
Waste Water is discharged to	Sewerage		River		River		Sewerage		Sewerage		
Total Water Cost 1,000 SIT/yea	11,929		22,734		20,185		99,479		10,833		153,231
Annual Production Million SIT/year	1,900		2,404		941		3,200		597		7,142
Cost/Production Ratio %	0.63		0.95		2.15		3.11		1.82		2.15

Table 2.1 Ratio of Water Use and Waste Water Discharge Cost to Production (3/3)

Unit of Water Volume : m^3 / day、 Unit Cost of Water : SIT / m^3

Industry	Furniture & Chmical Industry					Total
Name of Factory	M-2 MARLES		A-5 HENKEL		Sub-Total	
Water Source	Water Volume	Unit Cost	Water Volume	Unit Cost	Water Volume	Water Volume
City Water			339	213.5	339	2,289
Well Water	298	57.3			298	4,214
River Water			312	116.1	312	2,400
Total	298		651	166.8	949	8,903
Waste Water is discharged to	Rive		Sewerage			
Total Water Cost 1,000 SIT/yea	4,269		27,150		31,419	268,049
Annual Production Million SIT/year	1,155		8,317		9,472	27,263
Cost/Production Ratio %	0.37		0.33		0.33	0.98

Note:

1. The Costs of Water Use and Waste Water Discharge here mean payment to the outside, and do not include the inside cost, e.g. power, maintenance, labor etc.
2. The costs are estimated on the assumption that necessary charge, tax etc. are paid.

The reasons for the high ratio to the shipment price are believed to be the limited scale of recovery/reuse activities, the low shipment price of the products, and the high unit prices of water and wastewater.

In the case of the textile industry, the water consumption per production quantity is about the same as Japan's, so the reasons are believed to lie in the shipment production price and the unit prices of water and wastewater.

Also in the case of machinery and metal processing, based on the size of the factories, water consumption cannot be said to be excessive. Therefore, the reasons are believed to be same as those of the textile industry. However, as not much recovery/reuse is being done, there is much room to lower the ratio by water conservation.

For reference, we show in Table 2.2 the average water and wastewater unit price by industries for the 20 factories that were studied.

Table 2.2 Average Cost of Water Use and Waste Water Discharge

Unit of Water Volume; m³/day.

Industry	Machine & Metal Processing	Food	Textile	Furniture & Chemical Industry	Total
No. of Factories	6	6	5	3	20
City Water	1,495	1,094	1,092	488	4,169
Well Water		426	4,265	298	4,989
River Water	103		1,985	312	2,400
Total	1,598	1,520	7,342	1,098	11,558
Total Water Cost 1,000 SIT/year	82,786	70,243	180,555	39,372	381,956
Average Water Cost SIT/m²	207.2	184.9	98.4	143.4	132.2

2.2 Results of Water Conservation on Individual Factories

The possibility of water conservation was studied respectively for the seven model factories, seven secondary factories, and the six tertiary factories (total of 20 factories). The results are shown Tables 2.3 to 2.5.

The quantities of water conserved shown in these Tables are volumes of water that are, in economic terms, fully capable of being conserved based on the present prices for water and wastewater.

The possible water-conservation ratio is 25.1% for the model factories, 14.7% for the secondary factories, and 30.3% for the tertiary factories. The differences in these ratios are due mainly to differences in type of business composition, as described below.

Among the conservation methods, the "installation of a water meter" is mentioned as a basic method for the study of rationalization. Therefore, the amount of water that can be conserved by that method is not listed.

The standard for judging the feasibility of conserving water is the cost of the water consumed and wastewater discharged shown in Table 2.1. This figure will naturally go up if the sewage rate goes up. The result will be that the feasibility of conserving water will widen and the volume of water that can be conserved will most likely increase. However, the costs required for conserving different types of water vary in the following ways.

① The cost of conserving water that practically never becomes dirty such as indirect cooling water, air conditioning water, etc., is very cheap.

② The cost of conserving water whose wastewater is dirty and whose quality has a direct effect on the quality of the product, for example, product-processing water, washing water, etc., is very high.

③ There is a considerable difference between the above two, and the feasibility of conserving water based on cost is clearly divisible into two groups.

From the results of our conservation studies, it became clear that, on the basis of current water and wastewater charges, most of the indirect cooling water and air conditioning mentioned in Group ① would be conservable.

As for conservation plans pertaining to group ②, factories M-1, S-3, and S-4 are looking into the reclamating the wastewater from the textile industry. Of these, M-1's plan, shown in Table 2.3, is considered to be implementable.

If, in the future, sewage rates go up, we believe that the feasibility of reclamating the wastewater of the other textile industry factories will improve considerably.

Even if sewage rates go up, the progress which can be expected in the reclamating of wastewater in industries other than the textile industry is limited since the water volumes are small, the water quality required is very strict (foodstuff, metal finishing process, etc.), the wastewater is very dirty (chemicals), etc.

Table 2.3 Possible Water Conservation for Model Factories

Unit of Water Volume: m³/day

Name of Factory	M-1 SVILA	M-2 MARLES	M-3 ARMAL	M-4 PIVOVARNA	M-5 VINAG	M-6 KOSAKI	M-7 MLEKARNA	Total
City Water			372		71	365	476	1,284
Well Water	1,587	298		411				2,296
River Wat.								
Total	1,587	298	372	411	71	365	476	3,580
Water Conservation Plan	1. Recycling of cooling water for oil cooler by a cooling tower 2. Saving of air conditioning water by flow regulator 3. Reclamation of dying waste water(500)	1. Installation of flow meter 2. Recycling of coolinng water by a cooling tower	Cascade use of PEC cooling water to cooling water of a casting plant	1. Installation of flow meter 2. Renewal of bottle washing machines to water saving type	Renewal of bottle washing machines to water saving type	No margin for water cnservation	Sufficient control of water use	
Cons. Vol.	593	43	71	120	20		50	897
Cons. Rate%	37.3	13.7	19.1	29.2	28.2		10.5	25.1
Remarks	Possibility of reclamation is fairly difficult.			Possible when the equipment is renewed	Possible when the equipment is renewed			

Table 2.4 Possible Water Conservation for Secondary Beneficiary Factories

Unit of Water Volume: m^3/day

Name of Factory	S-1 MERINKA	S-2 TABOR	S-3 MTT	S-4 TSP	S-5 METALNA	S-6 SLOSAD	S-7 INTES	Total
City Water	425	93	538	36	212	20	162	1,486
Well Water	760	1,158	731	29		15		2,693
River Wat.			1,707	278				1,985
Total	1,185	1,251	2,976	343	212	35	162	6,164
Water Conser-vation Plan	1. Sufficient control of washing water for dyeing 2. Sufficient control of domestic water 3. Prevention of water leak	1. Installation of flow meter to well water 2. Sufficient control of washing water for dyeing	1. Installation of flow meter to well water 2. Recycling of cool. water for compressor 3. Sufficient control of washing water for dyeing 4. Sufficient control of domestic water	No margin for water cnservation	Recycling of cooling water	1. Installation of flow meter to well water 2. No margin for water cnservation	No margin for water cnservation	
Cons. Vol.	182	188	458		80			908
Cons. Rate%	15.3	15.0	15.3		37.8			14.7
Remarks	Estimated Cons. Rate for dyeing water is 15%. for Domestic water is 20%	Average water Conservation rate estmated at 15%.	Estimated Cons. Rate for cooling water is 95%, deying is 15%, domes-tic is 20%		Estimated Conservation rate for cooling water is 80%			

Table 2.5 Possible Water Conservation for Teritiary Beneficiary Factories

Unit of Water Volume: m^3/day

Name of Factory	A-1 TVT	A-2 SVETILKE	A-3 PRIMAT	A-4 ELEKO	A-5 HENKEL	A-6 SWATY	Total
City Water	517	130	109	155	339	149	1,399
Well Water							
River Water	103				312		415
Total	620	130	109	155	651	149	1,814
Water Conservation Plan	1. Grasping of water usage of small-scale buisiness that use same water source. 2. Reduction of loss of city water	Install individual flow meter at all factories	Recycling use of cooling water for welders	1. Install individual flow meter at all factories 2. Recycling use of cooling water for casting 2. Recycling use of cooling water for molding machines	1. Installation of flow meter to river water 2. Recycling use of cooling water for compressors	Recycling use of cooling water for molding machines	
Cons. Volume	Ca. 100	0	Ca. 60	Ca. 100	Ca. 220	Ca. 70	Ca. 550
Cons. Rate%	16.1	0	55.0	64.5	33.7	47.0	30.3
Remarks	The small-scale business in the group are all indipendent enterprises.	At presentr, one flow meter is used for the whole group.		At presentr, one flow meter is used for the whole group.		As molding machines are scattered in different locations, complete recycling is very difficult.	