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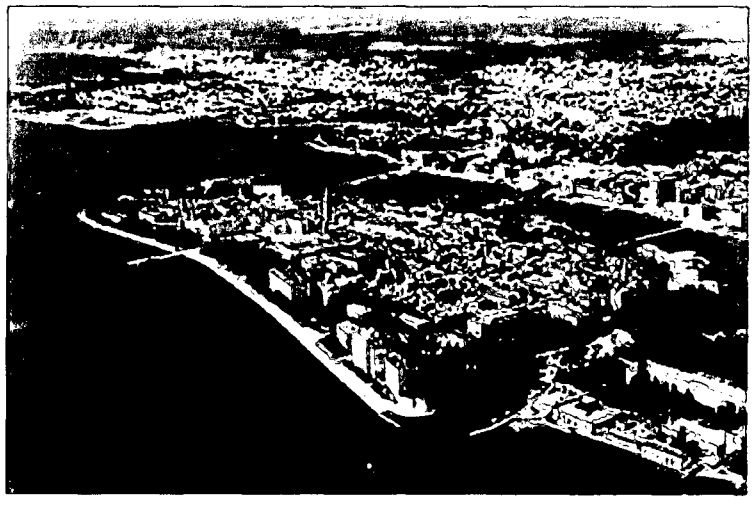
REPUBLIC OF CROATIA
MINISTRY OF ENVIRONMENTAL PROTECTION AND PHYSICAL PLANNING

22980

HOT SPOT AREA
INDUSTRIAL ZONE OF ZADAR, CROATIA



PRE-INVESTMENT STUDY

Zagreb, October 2003

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PRE-INVESTMENT STUDY IN A «HOT SPOT» AREA INDUSTRIAL ZONE OF ZADAR CROATIA

PRE-INVESTMENT STUDY

Y1-I10.00.01-G01.0

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Annex : # INTRODUCTION

I INTRODUCTION

In the context of the development of a Strategic Action Programme (SAP) for combating pollution in the Mediterranean, the activities for the identification of pollution hot spots was launched by UNEP/MAP in order to assess the main pollution sources in the Mediterranean basin. The first phase of the activity was completed in 1997, with a preliminary assessment of the current situation in each country gravitating towards the Mediterranean Sea.

A follow up project was launched in 1998, related to the implementation of SAP. Major components of the project cover the work on pollution hot spots and the preparation of pre-investment studies in selected hot spot, which will guide competent institutions to select the appropriate alternatives and to plan future investments for concrete projects.

In view of a long-lasting cooperation between ICS/UNIDO and UNEP/MAP, and the outcome of contacts and activities carried out in 2001, ICS/UNIDO has included the development of pre-investment studies in hot spot areas of the Mediterranean into its "Environmental Work Programme for 2001". The ICS/UNIDO presented the tender at the first session of the Inter – Agency Steering Committee.

Subsequently to kickoff meetings, ISC/UNIDO and UNEP/MAP gave their consent to the development of the pre-investment study in a hot spot area – industrial zone of Zadar, Croatia (hereinafter referred to as: Pre-Investment Study).

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Annex: OBJECTIVES AND TASKS OF THE PRE-INVESTMENT STUDY

II OBJECTIVES AND TASKS OF THE PRE-INVESTMENT STUDY

Pursuant to the bidding documents, the main tasks of the Pre-investment study in a "hot spot" area – industrial zone of Zadar, are the following:

- identification and classification of pollution sources within a hot spot area (industrial zone Gaženica near Zadar, in the area located between the Adriatic Highway and the sea coast), Annex 101,
- ranking of pollution sources for setting priorities for investment and amelioration,
- technical, environmental, organizational and financial description of amelioration options,
- specification of actions and projects to be formulated, implemented and financed in the subsequent phases.

The Study itself has to be developed, in terms of content and methodology, consistent with the guidelines and procedures defined in the document "Guidelines, methodology and content of a pre-investment study in a "hot spot" area" (UNEP 1998.). Pursuant to the mentioned document, this type of study consists of two parts:

1. Classification of pollution sources (total pollution load is identified and its impact on the environment assessed, the ranking of individual pollution sources is carried out),
2. Definition of amelioration measures (selection of solutions – amelioration measures, organization of their implementation and analysis of project costs and project funding methods).

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Annex : # CLASSIFICATION AND RANKING OF POLLUTION SOURCES

III CLASSIFICATION AND RANKING OF POLLUTION SOURCES

1. IDENTIFICATION OF TOTAL POLLUTION LOAD

1.1 Definition – Classification of Pollution Sources

There are several pollution sources within the studied «hot spot» area, the industrial zone of Zadar, that contribute with their effluents to the deterioration of the quality of the sea as the recipient water. (Annex 1). Effluents reach the seawater either directly (through coastal and/or submarine outfalls) or indirectly (via rivers, creeks etc. and percolating through soil).

The first step in the classification and ranking of pollution sources is to make a rapid qualitative inventory of all point sources within the «hot spot» area on the basis of existing data. In general, pollution sources are classified as municipal sources (settlements, tourist units) and industrial sources . Commercial activities, usually small scattered sources within an urban area, are not considered in the Study, nor is the pollution caused by agricultural activities.

In view of the fact that the «hot spot» - the industrial zone Gaženica in Zadar, houses no residential and tourist units, the conclusion can be reached that the main pollution sources within this particular area are industrial point sources.

Major waste streams relative to industrial point sources can, further on, be classified as follows:

- liquid,
- solid
- air emissions.

Please note that within the context of this Pre-investment Study major importance is given to liquid wastes (i.e. wastewater), and secondarily to solid wastes. Air emissions (in case of large amounts of particulate emissions) can only in special cases affect water quality.

1.2 Inventory of Pollution Sources

1.2.1 General

The inventory, i.e. the list of pollution sources located within the industrial zone (Zadar) has been developed on the basis of existing data collected from the following data sources:

- Hrvatske vode /Croatian Waters/ (issued water-use permits)
- Hrvatska gospodarska komora /Croatian Chamber of Commerce/ (list of industrial/commercial undertakings in the studied area)
- Telefonski imenik HT-a /Phone Book of HT/ (search per industry in the studied area)

The identified industrial/commercial undertakings, or pollution sources (Annex 2), were individually approached and presented with a questionnaire. The collected data were processed and the pollution sources initially grouped (classified) as follows:

a) Pollution sources with a water-use permit
   a.1) with available wastewater analyses
   a.2) without available wastewater analyses

b) Pollution sources without a water-use permit and available wastewater analyses.

Below, there is a list of individual identified pollution sources made pursuant to the above classification. The list is given in a tabular form (tables 1.2.1 through 1.2.3), specifying the name of industrial/commercial undertaking, business activities performed at a particular location and the number of employees. Finally, the recorded water consumption for the year 2002 is given and the estimate (made by industrial/commercial undertaking) on maximum possible water consumption in case of operation at full installed capacity.

Table 1.2.1: Pollution sources with water-use permits and available wastewater analyses

Company	Activity	No. of employees	Annual water consumption (m^3)
ADRIA d.d. Gaženička cesta 20	Fish catch, processing and cannery and fishing trade	262	82 598 (max) 85 000
ELKA d.d. Gaženička cesta 22	Manufacturing of insulated wires and cables	69	2 000 (max) 2 000
MARASKA d.d. Biogradska cesta bb	Production of alcoholic and non-alcoholic drinks	70	31 663 (max) 60 000
MARITUNA d.d. Gaženička cesta 6	Fish catch, processing and fishing trade	41	14 157 (max) 15 000
SOJARA d.d. Gaženička cesta bb	Soy processing	100	50 000 (max) 100 000
TANKERKOMERC d.d. Gaženička cesta 6	Terminal and trade in liquid goods	34	2 931 (max) 2 931
TURISTHOTEL d.d. Gaženička cesta bb	Laundering and ironing	30	30 929 (max) 45 000
TOTAL		606	214 278 (max) 309 931

Table 1.2.2: Pollution sources with water-use permits and without available wastewater analyses

Company	Activity	No. of employees	Annual water consumption (m^3)
LURA d.d. Gaženička cesta 8	Trade in milk, diary products and beverages	47	1 200 (max) 1 200
TOTAL		47	1 200 (max) 1 200

Table 1.2.3: Pollution sources without water-use permits

Company	Activity	No. of employees	Annual water consumption (m3)
ADEX d.o.o. Gaženička cesta bb	Manufacturing of Al and p.v.c. carpentry	38	60 (max) 60
BLOKETARA MATEŠIĆ Biogradska cesta 29	Manufacturing of concrete blocks and concrete products	2	70 (max) 70
DALMACIJAVINO Biogradska 58	Trade in beverages	18	140 (max) 140
DIMO d.d. Gaženička cesta bb	Manufacturing and trade in garments, wallpapers and car rugs	31	1 500 (max) 1 500
DRVOPROIZVOD Gaženica bb	Trade	2	10 (max) 10
FONTANELA d.o.o. Jadranska cesta 119	Textile manufacturing and trade	10	120 (max) 150
FOST d.o.o. Gaženička cesta bb	Manufacturing of self-adhesive bands and wraps/foils, printing, cutting and readying	18	350 (max) 400
INA d.d. Gaženička cesta bb	Loading and unloading ships with forklift trucks	17	200 (max) 200
KEPOL PLAST d.o.o. Gaženička bb	Storing various goods	20	754 (max) 1 000
KEPOL-TERMINAL d.o.o. Gaženička bb	Storing and reloading liquid cargoes	10	5 912 (max 8 000)
LUKA ZADAR d.o.o. Gaženička cesta 28	Reloading and storing cargo	135	7 400 (max) 7 400
TKV d.d. Gaženička cesta bb	Manufacturing of textile ropes and SISAL adhesives	43	Not measured (max) 500
TRAKA - ZAGREB d.o.o. Biogradska cesta bb	Trade	8	70 (max) 70
TOTAL		352	16 586 (max) 19 500

In addition to the already mentioned companies, the companies listed in Table 1.2.4 were also approached, but it has been established that those companies are either out of operation or in bankruptcy and, as such, presently do not contribute significantly to total pollution load of the studied area:

Table 1.2.4: Pollution sources that are out of operation or in bankruptcy

Company	Activity	No. of employees	Annual water consumption (m^3)
GRAMAT d.d.	In bankruptcy	-	-
POLIKEM d.d.	out of operation	-	-
TVORNICA DUHANA ZADAR d.d.	out of operation	-	-

In order to ascertain the significance of individual pollution sources, and especially those that have no available wastewater analyses, in continuation there is a calculation of specific water consumption per employee for an annual average of 250 days. Specific water consumption below approx. 150 l/person/day points out that the water is primarily used for employees' sanitary needs and for equipment cleaning. Specific water consumption has been calculated both for the water consumption recorded in the year 2002, and for the estimated maximum possible water consumption (tables 1.2.5 through 1.2.7).

Table 1.2.5: Specific water consumption of a pollution source with a water-use permit and available wastewater analyses

Company	No. of employees	Annual water consumption (m^3)	Specific water consumption (l/employ/day)
ADRIA d.d.	262	82 598 (max) 85 000	1261 1298
ELKA d.d.	69	2 000 (max) 2 000	116 116
MARASKA d.d.	70	31 663 (max) 60 000	1809 3429
MARITUNA d.d.	41	14 157 (max) 15 000	1381 1463
SOJARA d.d.	100	50 000 (max) 100 000	2000 4000
TANKERKOMERC d.d.	34	2 931 (max) 2 931	345 345
TURISTHOTEL d.d.	30	30 929 (max) 45 000	4124 6000
TOTAL	606	214 278 (max) 309 931	1414 2046

Table 1.2.6: Specific water consumption of a pollution source with a water-use permit and without available wastewater analyses

Company	No. of employees	Annual water consumption (m^3)	Specific water consumption (l/employ/day)
LURA d.d.	47	1 200 (max) 1 200	102 102
TOTAL	47	1 200 (max) 1 200	102 102

Table 1.2.7: Specific water consumption of a pollution source without a water-use permit

Company	No. of employees	Annual water consumption (m^3)	Specific water consumption (l/employ/day)
ADEX d.o.o.	38	60 (max) 60	6 6
BLOKETARA MATEŠIĆ	2	70 (max) 70	140 140
DALMACIJAVINO	18	140 (max) 140	31 31
DIMO d.d.	31	1 500 (max) 1 500	194 194
DRVOPROIZVOD	2	10 (max) 10	20 20
FONTANELA d.o.o.	10	120 (max) 150	48 60
FOST d.o.o.	18	350 (max) 400	78 89
INA d.d.	17	200 (max) 200	47 47
KEPOL PLAST d.o.o.	20	754 (max) 1 000	151 200
KEPOL-TERMINAL d.o.o.	10	5 912 (max 8 000)	2365 3200
LUKA ZADAR d.o.o.	135	7 400 (max) 7 400	219 219
TKV d.d.	43	Not measured (max) 500	- 47
TRAKA - ZAGREB d.o.o.	8	70 (max) 70	35 35
TOTAL	352	16 586 (max) 19 500	188 222

Please note that the questionnaire included the question on the use of water, and that all the pollution sources listed in tables 1.2.6 and 1.2.7 declared that they use water for employees' sanitary needs and for equipment cleaning, if required. The exception is the company KEPOL-TERMINAL d.o.o.

which uses large quantities of water for reservoir cooling (whereby the major part of water evaporates).

It is obvious that all the pollution sources that do not have available wastewater analyses belong into the category of consumers that use water for employees' sanitary needs and for equipment cleaning. Their contribution to the pollution can, tentatively, be expressed as the number of population equivalent (PE), in other words by the number of employees. The same applies to the company ELKA d.d. which has available wastewater analyses and to the company KEPOL-TERMINAL d.o.o. which, as already stated, uses large quantities of water for reservoir cooling (whereby the major part of water evaporates).

1.2.2 Existing wastewater treatment (purification) within the pollution source (at site)

Each pollution source was asked in the questionnaire whether the wastewaters are presently treated at site prior to their discharge into the recipient, or not. The questionnaire included an enquiry on the recipient itself. Tables 1.2.8 through 1.2.10 below give a survey of the existing situation regarding the treatment of wastewaters prior to their discharge into the recipient and the types of recipients.

Table 1.2.8: Treatment of wastewaters of a pollution source with a water-use permit and available wastewater analyses prior to its discharge into the recipient

Company	Type of treatment	Recipient
ADRIA d.d.	No treatment	the sea
ELKA d.d.	Sedimentation tank	the sea (via "Adria" company)
MARASKA d.d.	No treatment	the sea
MARITUNA d.d.	No treatment	the sea
SOJARA d.d.	Septic tanks Separators	the sea (outfall covered by dike)
TANKERKOMERC d.d.	API separator	the sea
TURISTHOTEL d.d.	Neutralization temperature lowering	the sea

Table 1.2.9: Treatment of wastewaters of a pollution source with a water-use permit and without available wastewater analyses prior to its discharge into the recipient

Company	Type of treatment	Recipient
LURA d.d.	No treatment	the sea (Maraska's pipeline)

Table 1.2.10: Treatment of wastewaters of a pollution source without a water-use permit prior to its discharge into the recipient

Company	Type of treatment	Recipient
ADEX d.o.o.	No treatment	Septic tank emptied by "Odvodnja" Zadar
BLOKETARA MATEŠIĆ	No treatment	Septic tank emptied by "Odvodnja" Zadar
DALMACIJAVINO	No treatment	Septic tank emptied by "Odvodnja" Zadar
DIMO d.d.	No treatment	The sea (Maraska's pipeline)
DRVOPROIZVOD	No treatment	Public sewage system
FONTANELA d.o.o.	No treatment	Septic tank emptied by "Odvodnja" Zadar
FOST d.o.o.	No treatment	(Kemoplast's pipeline)
INA d.d.	No treatment	The sea
KEPOL PLAST d.o.o.	No treatment	Septic tank emptied by "Odvodnja" Zadar
KEPOL-TERMINAL d.o.o.	No treatment	Septic tank emptied by "Odvodnja" Zadar
LUKA ZADAR d.o.o.	No treatment	Septic tank emptied by "Odvodnja" Zadar
TKV d.d.	No treatment	The sea
TRAKA - ZAGREB d.o.o.	No treatment	Public sewage system

1.2.3 Specific Pollution Load

The assessment of pollution per individual parameter is carried out on the basis of specific pollution loads (c_{mean}, c_{max}, c_{min}) that differ per individual pollution source. For pollution sources that have available wastewater analyses the data contained in such analyses are used as specific pollution loads. In principle, these are mean concentrations (the 2002 average) of a particular pollution parameter in tested samples. The mentioned data are shown in tables 1.2.12 through 1.2.18 attached below. In addition to standard indicators (BOD_5, COD, total SS, total N and total P) from available water analyses, the indicators that significantly exceed maximum permitted concentrations are also shown.

In case of pollution sources without available wastewater analyses, the pollution load of which can be expressed as the number of population equivalent (PE) i.e. the number of employees, the pollution load of, so called, typical equivalent inhabitant is used. Such load values are usually used for the dimensioning of treatment plants in the absence of actual measurements (table 1.2.11):

Table 1.2.11: Specific pollution load for 1 PE

Pollution indicator	Specific pollution load for 1 PE (g/PE/day)
BOD_5	60
COD	120
Total SS	70
Total N	11
Total P	2.5

Table 1.2.12: Specific pollution load for the company ADRIA d.d. (for the year 2002 n = 8 samples)

Pollution indicator	Unit of measure	C_{mean}	C_{min}	C_{max}
BOD_5	mgO_2/l	971.7	219.0	3024.0
COD	mgO_2/l	1508.1	221.2	5000.0
Total SS	mg/l	363.1	62.0	840.8
Total N	mg/l	31.8	8.4	60.3
Total P	mg/l	4.8	1.9	6.5
Total grease	mg/l	37.1	0.3	202.1
Phenols	mg/l	28.3	0.0	162.0

Table 1.2.13: Specific pollution load for the company ELKA d.d. (for the year 2002 n = 3 samples)

Pollution indicator	Unit of measure	C_{mean}	C_{min}	C_{max}
BOD_5	mgO_2/l	93.8	11.0	176.6
COD	mgO_2/l	145.2	50.0	240.4
Total SS	mg/l	41.4	-	-
Total N	mg/l	39.1	0.3	77.8
Total P	mg/l	2.1	0.1	4.2
Anion. det.	mg/l	5.6	1.3	10.0

Table 1.2.14: Specific pollution load for the company MARASKA d.d. (for the year 2002 n = 4 samples)

Pollution indicator	Unit of measure	C_{mean}	C_{min}	C_{max}
BOD_5	mgO_2/l	363.8	173.2	706.0
COD	mgO_2/l	472.0	182.7	784.0
Total SS	mg/l	37.9	16.6	66.2
Total N	mg/l	-	-	-
Total P	mg/l	0.4	0.0	0.1

Table 1.2.15: Specific pollution load for the company MARITUNA d.d. (for the year 2002 n = 1 sample)

Pollution indicator	Unit of measure	C_{mean}	C_{min}	C_{max}
BOD_5	mgO_2/l	57.8	-	-
COD	mgO_2/l	77.7	-	-
Total SS	mg/l	82.5	-	-
Total N	mg/l	0.8	-	-
Total P	mg/l	-	-	-

Table 1.2.16: Specific pollution load for the company SOJARA d.d. (for the year 2002 n = 8 samples)

Pollution indicator	Unit of measure	C_{mean}	C_{min}	C_{max}
BOD_5	mgO_2/l	46.3	5.7	145.3
COD	mgO_2/l	60.8	9.5	170.0
Total SS	mg/l	14.2	1.8	26.2
Total N	mg/l	1.9	0.2	4.6
Total P	mg/l	0.08	0.03	0.14

Table 1.2.17: Specific pollution load for the company TANKERKOMERC d.d. (for the year 2001 n = 8 samples)

Pollution indicator	Unit of measure	C_{mean}	C_{min}	C_{max}
BOD_5	mgO_2/l	25.0	0.9	60.8
COD	mgO_2/l	-	-	-
Total SS	mg/l	7.5	0.0	12.3
Total N	mg/l	-	-	-
Total P	mg/l	-	-	-
Anion. det.	mg/l	25.0	0.9	60.8
Arom. hydrocarbons.	mg/l	25.0	0.9	60.8

Table 1.2.18: Specific pollution load for the company TURISTHOTEL d.d. (for the year 2002 n = 4 samples)

Pollution indicator	Unit of measure	C_{mean}	C_{min}	C_{max}
BOD_5	mgO_2/l	81.5	7.0	159.2
COD	mgO_2/l	206.6	9.6	319.7
Total SS	mg/l	32.8	3.9	58.8
Total N	mg/l	-	-	-
Total P	mg/l	13.9	1.8	31.7
Anion. det.	mg/l	26.4	1.4	50.3

The estimate of annual pollution load can be made for each pollution source separately, on the basis of the above stated specific pollution loads identified for each pollution source and estimated maximum possible annual water consumption . Such an estimate is given in subparagraph 1.4 of this Chapter.

1.3 Review – examination of standards

The issue of indicator limit values and allowable concentrations of hazardous and other substances in process wastewaters prior to their discharge into a public sewage system or another recipient, and in the effluents that are being discharged after treatment from a public sewage system into natural recipients, has been regulated in the Republic of Croatia by the effective Rule Book on Limit Values for Indicators of Hazardous and Other Substances in Wastewater (Official Gazette 40/1999) and by the Rule Book on the Amendments to the Rule Book on Limit Values for Indicators of Hazardous and Other Substances in Wastewater (Official Gazette 6/2001). Indicator limit values and allowable concentrations of hazardous and other substances in the process wastewater that is being discharged into a natural recipient or a public sewage system have been regulated by Article 2 and Table 1 of the Rule Book and by Article 1 of the Amendment, depending on the category of natural recipient in which process wastewaters are being discharged.

Annex D-2 of the State Plan for Water Protection (Official Gazette 8/1999), Water Categorization, classifies the sea in the zone of influence of wastewater discharge from the mainland, and the area outside the circle around the diffuser of a (submarine) outfall within a 300 m radius, under II category water, with a remark that the abovementioned refers to the categorization of seawater to be elaborated by the State Directorate for Nature and Environmental Protection in cooperation with the Ministry of Maritime Affairs, Traffic and Communications and the State Water Directorate until 31 December 1999. Furthermore, it has been pointed out that the water categorization shall be published in the Official Gazette as an appendix to Annex D-2. However, the classification still hasn't been published in this respect.

On the other hand, on the basis of water-use permits issued by the Croatian Waters and the report on the testing of wastewater issued by the Institute of Public Health, it can be concluded that the recipient of discharged wastewaters – the sea – is considered a natural recipient of II class.

Therefore, table 1.3.1 below shows indicator limit values and allowable concentrations of hazardous and other substances in process wastewater discharged into a natural recipient of II class only for certain selected indicators. A comprehensive list can be found in the original Rule Book and its amendment. For the sake of comparison, limit values and allowable concentrations are presented that apply for the discharge of process wastewaters into a public sewage system.

Table 1.3.1: Indicator limit values and allowable concentrations of hazardous and other substances for the discharge of process wastewater into a natural recipient of II class and into a public sewage system

Indicator and substance	Indicator limit values and allowable concentrations of hazardous and other substances discharged into	
	Natural recipient of II class	Public sewage system
PH	6.5 – 8.0	5.0 – 9.5
Temperature (degrees C)	35	45
Solid substances	No	No
Total suspended substance (mg/l)	35	Should have no influence on public sewage system and wastewater treatment plants
BOD_5 (mgO_2/l)	25	250
COD (mgO_2/l)	125	700
Total phosphorus (mgP/l)	1	10.0
Total nitrogen (mgN/l)	21.0	-
Mineral oils (mg/l)	5.0	30.0
Total oil and grease (mg/l)	25	100
Detergents, anionic (mg/l)	1.0	10.0
Total phenols (mg/l)	0.1	-
Total ar. hydrocarbons (mg/l)	0.02	0.2

1.4 Classification of Pollution

1.4.1 Liquid sources of pollution

In continuation, there are data on total estimated annual pollution load for individual standard pollution indicators (BOD_5, COD, total SS, total N and total P) and for individual pollution sources. The estimates are based on data given in subparagraph 1.2. In addition to total estimated annual pollution load, excessive annual load is also presented, calculated as the difference between allowable concentrations for a certain indicator (from a water-use permit) and mean concentrations from wastewater analyses. Finally, for annual pollution load expressed by BOD_5 indicator, the estimated annual pollution load is also given, for the purpose of comparison, in the form of equivalent load by way of equivalent inhabitant. The mentioned data are shown in tables 1.4.1 through 1.4.5.

On the basis of the above standard pollution indicators and data contained in the existing wastewater analyzes, the conclusion can be reached that a certain number of pollution sources with their wastewaters introduce other, specific substances into the environment (the sea). Such substances are referred to as total grease, phenols, aromatic hydrocarbons and anionic detergents. Annual pollution loads per such indicator are shown in tables 1.4.6 through 1.4.9.

Table 1.4.1: Annual pollution load - BOD_5

Pollution source	Annual pollution load (kg BOD_5)	Equivalent load (PE)	Exceeding allowable annual load (kg BOD_5)
ADRIA d.d.	82 594.5	5506	80 469.5
ELKA d.d.	187.6	13	137.6
MARASKA d.d.	21 828.0	1455	20 328.0
MARITUNA d.d.	867.0	58	492.0
SOJARA d.d.	4 630.0	309	2130.0
TANKERKOMERC d.d.	75.0	5	0.0
TURISTHOTEL d.d.	3 667.5	245	2.542.5
OTHERS	8 738.1	583	-
TOTAL	122 587.7	8174	-

Table 1.4.2: Annual pollution load - COD

Pollution source	Annual pollution load (kg COD)	Exceeding allowable annual load (kg COD)
ADRIA d.d.	128 188.5	117 563.5
ELKA d.d.	290.4	40.4
MARASKA d.d.	28 320.0	20 820.0
MARITUNA d.d.	1 165.5	No
SOJARA d.d.	6 080	No
TANKERKOMERC d.d.	-	-
TURISTHOTEL d.d.	9 297.0	3 672.0
OTHERS	17 476.2	-
TOTAL	190 817.6	-

Table 1.4.3: Annual pollution load – total SS

Pollution source	Annual pollution load (kg SS)	Exceeding allowable annual load (kg SS)
ADRIA d.d.	30 863.5	27 888.5
ELKA d.d.	82.8	12.8
MARASKA d.d.	2 274.0	174.0
MARITUNA d.d.	1 237.5	712.5
SOJARA d.d.	1 420.0	No
TANKERKOMERC d.d.	22.5	No
TURISTHOTEL d.d.	1 476.0	No
OTHERS	10 194.5	-
TOTAL	47 570.8	-

Table 1.4.4: Annual pollution load - total N

Pollution source	Annual pollution load (kg N)	Exceeding allowable annual load (kg N)
ADRIA d.d.	2 703.0	918.0
ELKA d.d.	78.2	36.2
MARASKA d.d.	-	-
MARITUNA d.d.	12.0	No
SOJARA d.d.	190.0	No
TANKERKOMERC d.d.	-	-
TURISTHOTEL d.d.	-	-
OTHERS	1 602.0	-
TOTAL	4 585.2	-

Table 1.4.5: Annual pollution load – total P

Pollution source	Annual pollution load (kg P)	Exceeding allowable annual load (kg P)
ADRIA d.d.	408.0	323.0
ELKA d.d.	4.2	2.2
MARASKA d.d.	24.0	No
MARITUNA d.d.	-	-
SOJARA d.d.	8.0	No
TANKERKOMERC d.d.	-	-
TURISTHOTEL d.d.	625.5	1 096.5
OTHERS	364.1	-
TOTAL	1 433.8	-

Table 1.4.6: Annual pollution load – total grease

Pollution source	Annual pollution load (kg)	Exceeding allowable annual load (kg)
ADRIA d.d.	3 153.5	1 028.5
ELKA d.d.	30.0	No
MARASKA d.d.	120.0	No
MARITUNA d.d.	25.5	No
SOJARA d.d.	30.0	No
TOTAL	3 359.0	1 028.5

Table 1.4.7: Annual pollution load - phenols

Pollution source	Annual pollution load (kg)	Exceeding allowable annual load (kg)
ADRIA d.d.	2 405.5	2 397.0
SOJARA d.d.	0.1	No
TOTAL	2 405.6	-

Table 1.4.8: Annual pollution load – anionic detergents

Pollution source	Annual pollution load (kg)	Exceeding allowable annual load (kg)
ADRIJA d.d.	93.5	8.5
ELKA d.d.	11.2	9.2
MARASKA d.d.	6.0	No
MARITUNA d.d.	7.5	No
SOJARA d.d.	4.0	No
TANKERKOMERC d.d.	75.0	72.0
TURISTHOTEL d.d.	1 188.0	1 143.0
TOTAL	1 385.2	-

Table 1.4.9: Annual pollution load – aromatic hydrocarbons

Pollution source	Annual pollution load (kg)	Exceeding allowable annual load (kg)
TANKERKOMERC d.d.	73.3	73.24
TOTAL	73.3	73.24

1.4.2 Solid/firm sources of pollution

The survey carried out among pollution sources in the studied area suggests that solid waste does not significantly contribute to the pollution of the recipient – the sea. Depending on the type of solid waste, such waste is transported onto a communal waste disposal site by communal pick-up service or is transported for further treatment/recycling in licensed companies, which can be understood from the data contained in tables 1.4.10 through 1.4.12.

Table 1.4.10: Waste handling and disposal – pollution sources with water-use permits and available wastewater analyses

Company	Solid waste handling and disposal
ADRIA d.d.	Licensed organizations transport waste Al sheets; other wastes are transported in containers
ELKA d.d.	Waste Al wire is sold to licensed waste collectors; waste steel wire is transported to a communal waste disposal site; licensed collectors transport hazardous waste (oils) for incineration
MARASKA d.d.	Broken glass, PE foils and paper are used as secondary raw material; other solid wastes are transported as communal waste
MARITUNA d.d.	Delivered to collectors of non-hazardous process waste
SOJARA d.d.	No solid waste
TANKERKOMERC d.d.	No solid waste
TURISTHOTEL d.d.	No solid waste

Table 1.4.11: Waste handling and disposal – pollution sources with water-use permits and without available wastewater analyses

Company	Solid waste handling and disposal
LURA d.d.	No solid wastes

Table 1.4.12: Waste handling and disposal – pollution sources without water-use permits

Company	Solid waste handling and disposal
ADEX d.o.o.	Aluminum and p.v.c. scarp is sold for recycling purposes
BLOKETARA MATEŠIĆ	No solid waste
DALMACIJAVINO	No solid waste
DIMO d.d.	Utilizable waste is pressed and transported to "Regeneracija"; other wastes are transported as communal waste
DRVOPROIZVOD	No solid wastes
FONTANELA d.o.o.	Disposed as communal waste
FOST d.o.o.	Disposed as communal waste; discarded material scarp is recycled
INA d.d.	No solid waste
KEPOL PLAST d.o.o.	No solid waste
KEPOL-TERMINAL d.o.o.	Saturated active coal is transported to specialized waste incineration plants
LUKA ZADAR d.o.o.	No solid waste
TKV d.d.	Disposed as communal waste
TRAKA - ZAGREB d.o.o.	No solid waste

1.4.3 Air emissions

On the basis of the questionnaire filled by individual pollution sources it can be concluded that the contamination of water with particulates contained in flue gases or by air emissions in the studied area is not significant. Out of processed pollution sources, only the companies ADRIA d.d., ELKA d.d., SOJARA d.d., TANKERKOMERC d.d. and TURISTHOTEL d.d. confirmed that their industrial processes generate flue gases, mainly in boiler houses, for the purpose of room heating, preparation of hot water, steam, process steam and other. The emissions are either temporary (e.g. during winter months i.e. in the heating season) or continuous (for the heating of water utilized in the technological process). The measured concentrations of air pollutants meet the provisions of the effective Rule Book on Limit Values of Pollutant Emission into the Air from Stationary Sources (data recived from Zadarska County Public Health Institute).

2. ENVIRONMENTAL IMPACT ASSESSMENT

2.1 Climatic Characteristics

2.1.1 Air temperature

Mean annual air temperature in the studied area is 15.2°C. Mean temperature in July is 23.5°C, and in January 6.1°C. Absolute air temperature extremes are the following: maximum temperature is 36.1°C and minimum –6.4°C. All the above elements point out to standard maritime variations in air temperature.

2.1.2 Precipitation

Mean annual precipitation in the area of Zadar amounts 949 mm. On average, minimum precipitation occurs in July and maximum in December. Such annual variation of precipitation is characteristic for the areas under the influence of the sea (table 2.1.1). High annual variability of precipitation is due to maritime characteristics of the climate. The majority of annual precipitation quantities occur during the cold part of the year, while the warm part of the year is characterized by relatively low precipitation quantities and the summers are often dry.

Table 2.1.1 – Mean monthly precipitation in mm (MMP), maximum daily precipitation per month in mm (MDP) and mean number of precipitation days per month (MND) recorded at the Zadar weather station

ZADAR			
Month	**MMP**	**MDP**	**MND**
January	85	52	11
February	67	49	10
March	67	59	10
April	53	50	9
May	53	45	9
June	51	70	8
July	39	52	5
August	57	61	6
September	94	101	8
October	123	209	9
November	145	96	13
December	115	73	14

2.1.3 Air humidity

Mean annual variation of air humidity in the area of Zadar (table 2.1.2) is in inverse relationship with mean annual variation of air temperature, so that minimum values of air humidity were recorded in the warm part of the year (in July 68%). Mean annual relative humidity is approximately 72%.

Table 2.1.2 – Mean monthly air humidity (%) in Zadar

Month	Mean monthly air humidity (%)
January	72
February	70
March	73
April	73
May	74
June	72
July	68
August	69
September	75
October	74
November	73
December	72
Year	72

2.1.4 Wind

The characteristic winds in the area of Zadar are : bora (NNE, NE and ENE wind) and sirocco (ESE, SE and SSE wind) prevailing in the winter period, and maestral /landward breeze/ (NW wind) which is a prevalent wind in the summer period. Long lasting calms are also frequent during the summer. Figure 2.1.1 shows the wind rose for the City of Zadar. The number of days with force 6 winds or greater in Zadar is 17, and with force 8 winds or greater it is 1.

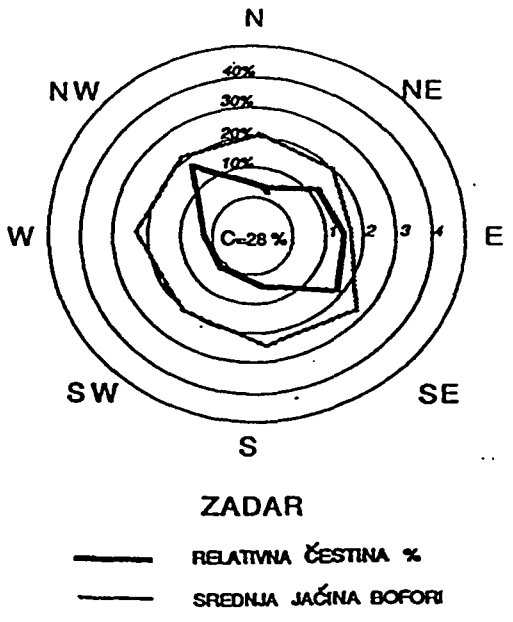


Figure 2.1.1 – Annual wind rose at the Zadar station

2.2 Geological and seismological data

Limestone rocks prevail in the area of Zadar, spreading in syncline layers from the seashore towards the area where karst valleys Pelegrinovo and Pudarica are situated. (Annex 100).

A 500-800 m wide littoral belt is made of well stratified light-colored Senonian limestone. In parallel with this belt, some 1000-2000 m far from the seashore, there is an 800-1000 m wide belt of less stratified Lower Eocene limestone. A narrow belt, 400-600 m wide, is spreading along watercourse beds comprising a zone of alluvial deposits. On either side of these layers there are impervious rocks made of Eocene flish (marl, limestone marls and sandstones).

Due to erosive and corrosive water activity throughout geological past, karst phenomena can be found here as well, e.g. caverns, caves, etc.

According to the seismological map, the area of Zadar is situated in an earthquake zone, for which the estimated maximum magnitude for a return period of 200 years is 7 (MCS scale), and for the period of 500 years 8 (MCS scale).

2.3 Hydrological and hydrogeological data

There is only one natural watercourse in the wider area of Zadar - a torrent stream Ričina, which is formed by the confluence of the Jaruga tributary and the "Ričina Tributary" (Annex 100).

The Jaruga flows through the central part of the Babin Dub field and at field's egress joins the «Ričina Tributary» flowing from the northwest. They continue to flow as the Ričina stream towards the southwest. The Ričina stream enters the sea at the industrial zone Gaženica in Zadar.

The Jaruga watershed occupies 5.3 km^2, and that of the "Ričina Tributary" 2.27 km^2. The immediate watershed of the Ričina occupies 1.98 km^2, so that the overall watershed of the Ričina stream occupies approximately 9.6 km^2.

In the lowest layers of the soil, the Eocene flish is covered by alluvial deposits. Such areas contain certain amounts of groundwater reserves. Groundwater is utilized through digged up wells the abundance of which is insignificant. Consequently, during droughty periods such wells largely dry out. In the immediate vicinity of the Jaruga mouth into the Ričina, there is the Batina well the minimum abundance of which is 1.0 l/s.

2.4 Bio-ecological data and data on landscape

The Mediterranean vegetation is prevalent in the area of Zadar. Larger areas covered by pine forests are located at city's outskirts. On steeper suburban hillsides, where the remnants of a more fertile (pedological) layer exist, the Mediterranean macchia has developed subsequent to the erosion process.

The industrial zone Gaženica belongs to a degraded ecosystem. The mentioned site hosts no specific biocenoses that have to be protected.

2.5 Data on protected natural and cultural heritage

In the industrial zone Gaženica there are no registered cultural or natural monuments, nor archeological sites. However, during the reconstruction and construction it is necessary to pay attention to possible tracks that signal that there are cultural monuments or archeological sites present at the location.

2.6 Oceanographic data

The Zadar Channel represents a typical enclosed channel spreading in the direction southeast – northwest. Its depth decreases from 50 m at the northwestern entrance to 25 m in the southwestern part (Figure 2.6.1). The channel is approximately 20 km long and 4-7 km wide. The shallower and narrower Pašman Channel continues along the southeastern side of the Zadar Channel. The shallowest part of the Pašman Channel, up to 8 m deep, represents the southeastern communication between the Zadar Channel and the broad sea. The Vir Sea is located along the northwestern side of the Zadar Channel, which is the widest and the deepest in this very part. The depth of the Vir Sea reaches up to 80 m. Therefore, water exchange between the two basins is very intensive. Between the islands of Pašman and Ugljan, i.e. at the southeastern entrance into the Zadar Channel, there is the Ždrelac Straits, approximately 50 m wide and up to 5 m deep. However, due to its small cross-section it has no significant impact on the oceanography of the Zadar Channel. Except for submarine wells that are sporadically present, there are no significant freshwater inflows into the Zadar Channel and the Pašman Channel from the mainland.

During the 90ties of the past century, oceanographic research of the Zadar Channel was carried out (Institute for Oceanography and Fishery Split, 1994), in the scope of which physical, chemical and biological properties of the sea were monitored at several measurement stations (Figure 2.6.2).

2.6.1 Sea dynamics

Sea currents

The determinants of sea currents are their velocity and direction and they represent one of the most significant dynamic properties of the sea. The knowledge of sea currents is of special importance from environmental viewpoint since, in case of contamination, sea currents directly convey pollution from one area to the other.

The results of measured sea currents suggest that the currents in the Zadar Channel are somewhat weaker than in similar channels along the Croatian coast of the Adriatic Sea. This is less favorable from environmental point of view. The average speed of sea currents over the Zadar Channel is 5 to 10 cm/s. Calculations have established that the water mass exchange period in the Zadar Channel is 3 to 5 months. The currents that are vertical to the seashore occur rather rarely and are of lower speeds.

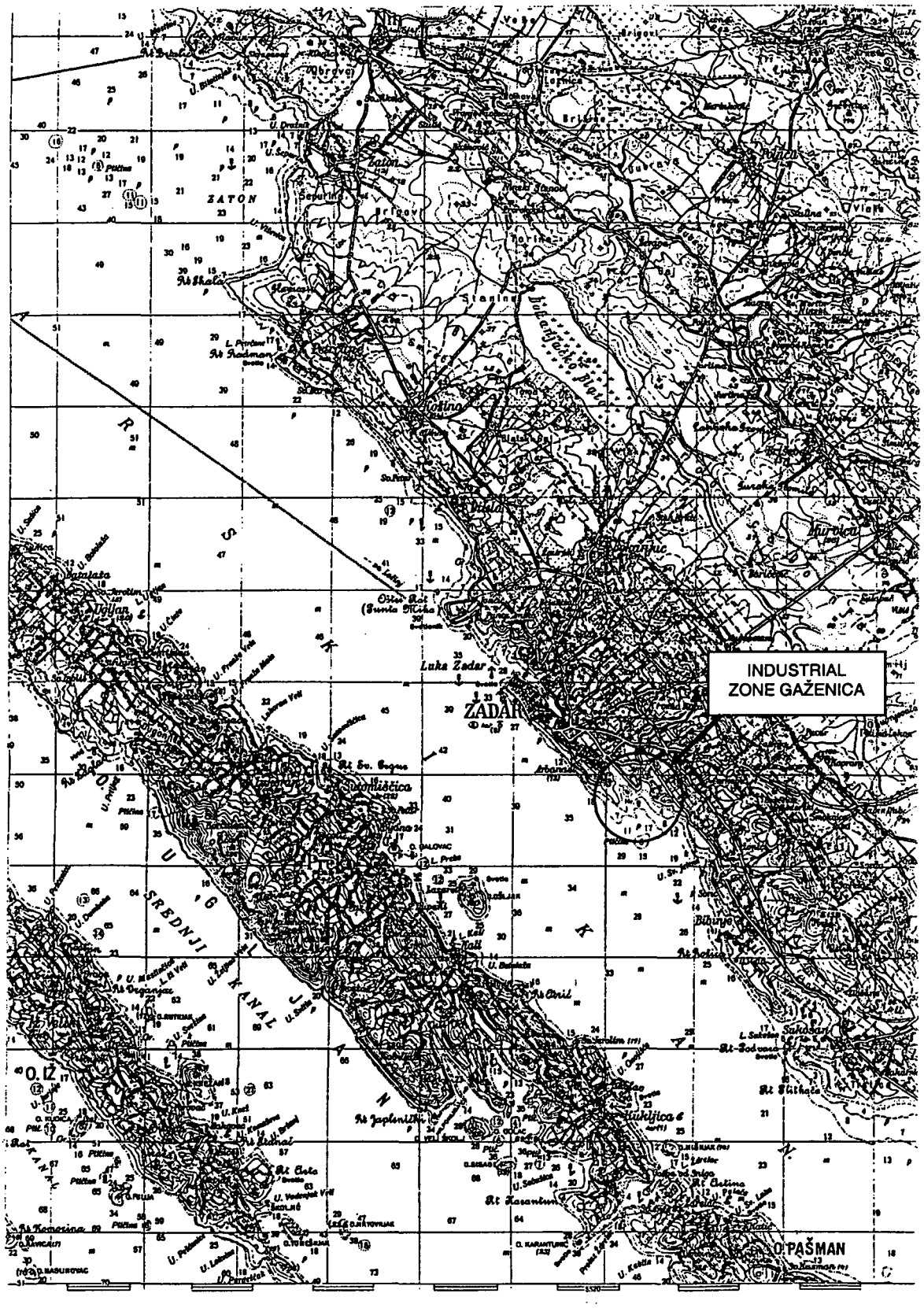
Long-term oscillations of the sea level

Sea level oscillations are caused by various forces, out of which the tidal force and mechanical force of the atmosphere (air pressure and wind) are of utmost importance. These are, so called, forced oscillations of the sea level. Free oscillations of the sea level also appear in response to sharp changes of wind and air pressure. Free oscillations are very frequent in enclosed and semi-enclosed basins, and so are they in the Zadar Channel where their period is about 2.2 hours and amplitude up to 30 cm. Total range of sea level oscillations is 136 cm.

Wind induced surface waves

From the oceanographic viewpoint, and especially from the viewpoint of surface wave generation, the maritime zone of the Zadar Channel is considered an enclosed marine area with limited wind generation.

Figure 2.6.1: Location of the industrial zone Gaženica- Zadar in the wider maritime zone of Zadar



2.6.2 Physical properties of the sea (sea temperature, salinity and density)

As regards basic physical properties of the sea (temperature, salinity and density of seawater), the Zadar Channel represents a typical enclosed channel.

Temperature

In late spring, due to intensive heating of the surface water layer and the transport of heat downwards to deeper layers, a thermocline appears in a 10 m deep layer. Additional heating during the summer shifts the thermocline to greater depths and at the end of summer it can deepen as far as over 30 meters below surface. However, synoptic-scale disturbances, even if their duration is several days only, can significantly increase water mixing, creating in September an isothermal water column, from the surface to the bottom, in the parts of the channel the depth of which does not exceed 30 meters. In deeper parts of the channel a strong thermocline appears in the bottom layer coupled with the halocline (increase of salinity from the surface to the bottom) which has an impact on the occurrence of the pycnocline (increased difference in the density of the surface layer and the bottom layer) at the depth of approximately 30 meters.

Clarity

The average clarity of the sea measured by a white Secchi disc in the central part of the Zadar Channel is approximately 10.0 m, significantly less than on the broad sea. The sea color pursuant to the Forelle's scale has the value from III to IV, which is characteristic for uncontaminated or insignificantly contaminated littorals.

Salinity

The measured salinity in the studied area (vertical mean 37.9 ‰) significantly differs from the values measured in the neighboring basins, such as the Srednji Kanal (vertical mean 37.9 ‰) and the broad sea (vertical mean 38.2 ‰).

2.6.3 Chemical properties of the sea (dissolved oxygen and nutrient salts)

Dissolved nutrient salts are inorganic compounds that participate in primary productivity cycles of the sea. Nitrogen and phosphorous are the principal nutrient salts. In the process of photosynthesis, the mentioned compounds implant into the organic matter of phytoplankton cells and enter into the food chain (phytoplankton reproduces if nutrient reserves are available). External sources of nutrient salts (outfalls of municipal or industrial effluents) can affect a significant change in the concentrations of nutrients in the sea and, consequently, the change in a biological cycle of phytoplankton. When phytoplankton die, they sink to the bottom and use the dissolved oxygen for decomposition. If there is a high level of organic matter, dissolved oxygen concentrations can significantly decrease or can be completely depleted and succeeded by hydrogen sulfide.

Dissolved oxygen

During the studied period, oxygen concentrations at all stations generally matched that of oversaturated solutions. Mean oxygen concentrations ranged from 99.8% to 120.9% O_2. High oxygen concentrations and oxygen saturation indicates that this is a well aerated and dynamic basin with rapid changes in the circulation of individual nutrient salts.

Nutrient salts

The test for nutrient concentrations was carried out in the Zadar Channel and the results were as follows:

- nitrate concentrations ranged from 0.0 to 3,75 m mol/m^3
- ammonia concentrations ranged from 0.10 to 2.98 m mol/m^3
- phosphate concentrations ranged from 0.012 to 0.162 m mol/m^3
- silicate concentrations ranged from 0.11 to 8.13 m mol/m^3

Nutrient concentrations are within expected limits for an Eastern Adriatic channel area, and the impacts from the mainland that can be detected are not significant. The restrictedness of the area disables more significant impact of broad sea waters on the studied area, and therefore specific conditions are created in channels.

Hazardous accumulation of nutrient salts coupled with decreased oxygen concentrations, which would point to the eutrophycation of the studied ecosystem, hasn't been recorded.

2.6.4 Biological properties of the sea

Bacteria

The analysis of bacteriological characteristics of the Zadar Channel encompasses the following parameters:
1) Heterotrophic bacteria, as the indicator of the trophic level of the basin,
2) Indicators of fecal pollution, as the parameters for the estimate of sanitary quality of the sea in the basin.

Heterotrophic bacteria

Heterotrophic bacteria play an important role in marine ecosystems thanks to their biochemical activities, i.e. their capability to use and break down the organic matter in its diluted form. Each change in the amount of dissolved organic matter in the sea has an impact on the number of bacteria, their metabolic activity and the composition of a microbial community. All the aforesaid indicates that heterotrophic bacteria can be a good indicator of eutrophycation of a certain area, either for the purpose of comparing different areas with each other or for sequential monitoring of the degree of eutrophycation.

The research into heterotrophic bacteria, as an indicator of eutrophycation level, has documented that the concentrations of heterotrophic bacteria in the studied area of the Zadar Channel were two times higher than the average identified for broad sea. The concentrations ranged from $2.51x10^6$ cells/ml to $3.28x10^6$ cells/ml (July) and from $1.04x10^6$ cells/ml to $1.85x10^6$ cells/ml. This fact leads to the conclusion that the studied area is richer in organic matter which causes the population of heterotrophic bacteria to grow at a higher rate. Since the research into the distribution of fecal pollution indicators has established a stronger influence of municipal wastewaters only within narrow city limits, such density of heterotrophic bacteria over the studied area can be interpreted by the fact that this is a rather shallow, channel-type area which is naturally richer in the organic matter .

Thus, in view of the identified concentrations of heterotrophic bacteria, the conclusion can be reached that the maritime zone of the Zadar Channel can be considered a moderately eutrophycated area.

Fecal pollution indicators

Major sources of bacteriological pollution of the sea are wastewaters of fecal origin that enter the seawater from various sources (households, hotels, beaches, industrial plants, etc.). Due to their

physical and chemical properties, wastewaters spread on the sea surface far beyond the site of original pollution source. For that reason, their proper disposal is crucial in order to protect recreational zones which, pursuant to the effective regulations, encompass the belt up to 300 m far from the seashore.

The research into fecal pollution gave the following results:

- Total coliform concentrations ranged from 8 TK/100 ml to 3200 TK/100 ml
- Fecal coliform concentrations ranged from 0 TK/100 ml to 245 TK/100 ml
- Fecal streptococcus concentrations ranged from 0 TK/100 ml to 88 TK/100 ml

On the basis of obtained results, the conclusion can be drawn that municipal wastewaters of the City of Zadar are the main source of fecal pollution in the studied area. The sanitary quality of the sea is deteriorated within narrow city limits, although municipal wastewaters can spread to greater distances under the influence of wind and sea currents.

Primary productivity (phytoplankton)

The research into oceanographic properties of the Zadar Channel included the research into the phytoplankton community, i.e. the primary productivity of the area. By determining the level of productivity at the first step of a trophic pyramid it is possible to anticipate the rate of growth of the biomass at all other trophic levels. At the same time, the structure of the phytoplankton community and the size and distribution of phytoplankton biomass (chlorophyll concentrations, cell-carbon amount) represent very good indicators of eutrophycation, i.e. wastewater loads in the studied area.

On the basis of research results it has been assessed that the area of the Zadar Channel is well aerated even during the summer period and is not prone to excess blooming. A bit higher rate of productivity has been recorded in late summer in the form of diatomeic blooming. However, the homogenous distribution of phytoplankton in the water column and a satisfactory diversity of organisms suggest that such an increase in productivity is of natural origin. It is necessary to note that the station located in the Gaženica area was an exception during the entire period of research, both in view of the biomass and structure of the phytoplankton community, which indicates that either the dynamics of the water mass is unfavorable in this area or that there is a continuous inflow of wastewaters from the mainland.

Benthic biocenoses

The objective of the research into the composition and distribution of benthic plant (phytobenthos) and animal organisms (zoobenthos) in benthic communities (biocenoses) was to determine the intensity and changes in the composition of habitats caused by deteriorated quality of seawater originating from sea pollution in the Zadar Channel.

Phytobenthos

The research into the composition of phytobenthos (plant) habitats has identified a total of 217 species of benthic algae (126 species belonging to the Rhodophyta genus, 50 to Chlorophyta and 41 to Phaeophyta genus), which represents a rather comprehensive inventory for the area of the Zadar Channel. Please note that the abundance of the benthic algae species is not equally distributed throughout the channel area. In deeper, movable seabeds the representation of species is modest, and at the seashore to the west of Zadar (Punta Mika) the habitats have significantly changed since the prevailing species belonging to the *Cystoseira* genus have almost completely disappeared and have been replaced by nitrophylus species of green, brown and red algae that prefer waters rich in organic matter. The research data point to the conclusion that the identified changes in the floristic structure of phytobenthic habitats stem from the sea pollution level, especially in the littoral part near Zadar. The data on the occurrence, spreading and great abundance of nitrophylus algae habitats substantiate this

conclusion. Nitrophylus algae are the indicators of increased eutrophycation of the sea, caused in particular by the wastewaters discharged from the city port. Certain nitrophylic species of the benthic algae are present particularly to the west of the city port of Zadar. The lack of abundant flora of benthic algae in greater depths of the Zadar Channel is due to certain abiotic factors (sedimentation of fine particles of sediments, currents) that enable the formation of silty sediments in greater depths which prevent the development of bottom-dwelling algae habitats, even the habitats of seagrass *Posidonia oceanica.* The habitats of *Cystoseira* species disappeared in certain shallow parts of the littoral part of the Zadar Channel due to wastewaters discharged from the city port of Zadar and from other smaller pollution sources situated at the seashore near Zadar. Out of total number of 4 species of seagrass that abide in the Adriatic Sea, the identified species are *Posidonia oceanica* and *Cymodocea nodosa.*

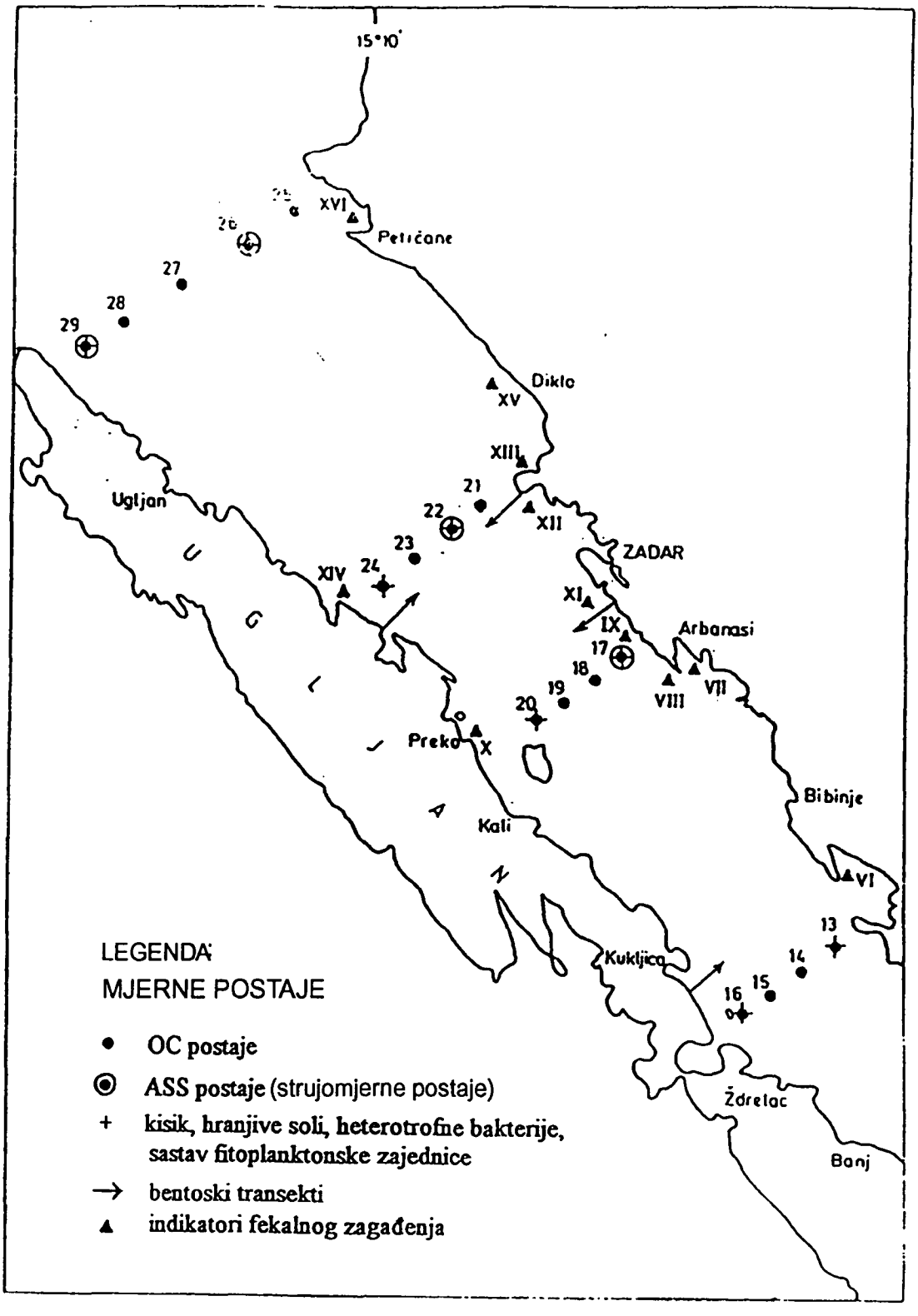
Zoobenthos

The results on the representation and distribution of animal species in the littoral bicenoses of the Zadar maritime zone point to a standard condition of biocenoses that develop in the coastal, channel-type and less exposed part of our seacoast.

The diversity of animal species in the entire researched area and the presence of all species that characterize a certain biocenosis of the littoral part of the coast suggest that this area has not experienced significant changes due to adverse anthropogenic impacts from the mainland, which is more pronounced at research sites away from the pollution source. In the area of the island of Ugljan the highest diversification of animal species has been recorded, although the movable bed is present there at a relatively small depth and there are less abundant plant and animal communities than at other researched locations.

The representation of individual species in terms of their number also substantiates the fact that the researched benthic biocenoses suffered no adverse changes in animal composition. At places where the impact of pollution is significant certain species disappear and the number of survived species noticeably grows, which did not occur in this area.

Figure 2.6.2 - Map of measuring stations (the summer of 1994)



2.7 Sociological and urban data

The industrial zone Gaženica presently houses ca 27 different companies that altogether employ approximately 1005 persons. Business activities of these companies include: food processing (fish, soft drinks, and soy), processing of semi-products (Al and p.v.c. carpentry, garments, insulated wires and cables, wraps/foils and bands, ropes), trade and storing and reloading of cargo.

The area in question is not connected to the existing sewage system of the City of Zadar. Wastewaters (effluents from the plants and stormwaters from asphalt surfaces within the zone) are mainly discharged unpurified into the sea.

2.8 Conclusion

In view of the data presented in previous chapters, the following conclusion can be drawn:

- pursuant to the Forelle's scale, the sea color has the value from III to IV, which is characteristic for uncontaminated or insignificantly contaminated littorals;
- high oxygen concentrations and oxygen saturation indicate that this is a well aerated and dynamic basin with rapid changes in the circulation of individual nutrient salts;
- municipal wastewaters of the City of Zadar are the main source of fecal pollution in the studied area and the sanitary quality of the sea is deteriorated within narrow city limits, although municipal wastewaters can spread to greater distances under the influence of wind and sea currents;
- in view of the identified concentrations of heterotrophic bacteria, the maritime zone of the Zadar Channel can be classified under moderately eutrophycated areas;
- the representation of individual animal species in terms of their number substantiates the fact that the researched benthic biocenoses suffered no adverse changes in animal composition. At places where the impact of pollution is significant, certain species disappear and the number of survived species noticeably grows, which did not occur in this area;
- the station located in the Gaženica area was an exception during the entire period of research, both in view of the biomass and the structure of the phytoplankton community, which indicates that either the dynamics of the water mass is unfavorable in this area or that there is a continuous inflow of wastewaters from the mainland.

3. RANKING OF POLLUTION SOURCES

In order to set the priorities in resolving the problems related to individual pollution point sources within the entire critical zone (industrial zone Gaženica), criteria should be defined on the basis of which the assessment of urgency in dealing with individual pollution point sources can be performed.

3.1 Basic criteria

Basic criteria for the evaluation of impact relate to the impact that a particular pollution point source has on public health, drinking water quality, recreation, aquatic life, beneficial uses of the sea and economy. The mentioned criteria and the evaluation thereof (the impacts are classified under one of six groups: no effect(1), slight effect (2), moderate effect (3), major effect (4), severe effect (5) and extreme effect) are described in Annex I to the UNEP's "Guidelines, methodology and content of a pre-investment study in a "hot spot" area".

According to the mentioned criteria and pursuant to the evaluation system anticipated in the UNEP's Guidelines, the impact of pollution point sources located in a "hot spot" area (industrial zone of Zadar) on the studied neighboring area (maritime zone and coastal area) have mainly been classified in two categories: slight impact or no impact, i.e. have been mainly assessed as (2) or (1). The result of overall assessment of individual point sources in view of their respective impact and in accordance with basic criteria is given in Table 3.3.1. below.

Table 3.3.1: Impact assessment for pollution point sources pursuant to basic UNEP criteria (criteria: A. Public Health, B. Drinking Water Quality, C. Recreation, D. Other Beneficial Uses, E. Aquatic Life, F. Economy and Welfare)

Company	Criteria						Total	
	A	B	C	D	E	F		
Adria	1	1	2	1	3	3	11	
Elka	1	1	2	1	2	2	9	
Maraska	1	1	2	1	3	2	10	
Marituna	1	1	2	1	3	2	10	
Sojara	1	1	2	1	2	3	10	
Tankerkomerc	1	1	2	1	2	2	9	
Turisthotel	1	1	2	1	3	2	10	
Lura	1	1	2	1	2	2	9	
Adex	1	1	1	1	2	2	8	
Bloketara Mardešić	1	1	1	1	2	2	8	
Dalmacijavino	1	1	1	1	2	2	8	
Dimo	1	1	2	1	2	2	9	
Drvoproizvod	1	1	1	1	2	2	8	
Fontanela	1	1	1	1	2	2	8	
Fost	1	1	2	1	2	2	9	
Ina	1	1	2	1	2	2	9	
Kepol plast	1	1	1	1	2	2	8	
Kepol-terminali	1	1	1	1	2	2	8	
Luka Zadar	1	1	2	1	2	3	10	
TKV	1	1	2	1	2	2	9	
Traka-Zagreb	1	1	1	1	2	2	8	

3.2 Specific criteria

Additional criteria that cannot be neglected by the decision making process on the ranking of pollution sources are the criteria relating to their specific impact on the environment and on socio-economic relations. Pursuant to UNEP's Guidelines, such criteria are, on the whole, less significant in this particular case for the following reasons:

a) Environmental impact criteria
- Protection of existing biocenoses – according to research work performed so far, the existing biocenoses in the studied area are not endangered
- Condition of the recipient – the maritime zone of the Zadar Channel can be classified into a natural, moderately eutrophicated area.

b) Socio-economic criteria
- Inadequate legislation – the legislative framework in the Republic of Croatia requires the problem of wastewaters to be resolved in conformity with the highest standards applied for the protection of recipient bodies of water,
- Pressure of local population for immediate actions – the industrial zone is located outside the settlement, so that the local community does not exercise pressure for immediate actions,
- On-going planned environmental investments – project documentation has been completed for the area of the City of Zadar which includes the reconstruction and extension of the existing sewage system and the construction of a central wastewater treatment plant with a possibility to accommodate the effluents from the industrial zone,
- Preparation of physical plans – physical plan has been developed for the studied area in which a comprehensive solution to municipal and industrial wastewater drainage has been envisaged.

Out of the specific criteria, only the criterion of limited resources to finance environmental projects bears significance in the ranking of pollution sources. However, due to overall economic state of all commercial undertakings in the industrial zone (poor financial position), this criterion is also unimportant for their ranking.

3.3 Final ranking of pollution sources

The above defined criteria for the evaluation of impact are not "sensitive" enough for the studied area so as to enable uniform and recognizable ranking of pollution sources, since they would result in the classification of pollution sources into four groups only (only one source falls into the first-priority group, 5 sources fall into the second-priority group, 7 sources fall into the third-priority group and 8 sources fall into the fourth-priority group). Consequently, criteria are being defined that are more adequate for the industrial zone of Zadar. The following criteria were proposed for the classification of polluters located within the industrial zone Gaženica, pursuant to the weighting principle.

- pollution sources with available wastewater analyses (on the basis of measured pollution values)

A. Annual pollution load expressed in BOD_5 indicator, presented in the form of equivalent load by way of equivalent inhabitant

1. up to 100
2. 100 to 500
3. 500 to 1000
4. 1000 to 2000
5. over 2000

B. Nutrients – total phosphorus, as the main eutrophicant

1. Wastewaters containing phosphorus (tracks)
2. Wastewaters with phosphorus content not exceeding 1 mgP/l
3. Wastewaters with phosphorus content ranging from 1 mgP/l to 2 mgP/l
4. Wastewaters with phosphorus content ranging from 2 mgP/l to 4 mgP/l
5. Wastewaters containing more than 4 mg/l of phosphorus

C. Oil and grease content

1. Wastewaters containing oil and grease (tracks)
2. Wastewaters with oil and grease content not exceeding 25 mg/l
3. Wastewaters with oil and grease content ranging from 25 mg/l to 30 mg/l
4. Wastewaters with oil and grease content ranging from 30 mg/l to 40 mg/l
5. Wastewaters containing more than 40 mg/l of oil and grease

D. Total suspended solids (SS)

1. Wastewaters containing SS (tracks)
2. Wastewaters with SS content not exceeding 20 mg/l
3. Wastewaters with SS content ranging from 20 mg/l to 30 mg/l
4. Wastewaters with SS content ranging from 30 mg/l to 50 mg/l
5. Wastewaters containing more than 50 mg/l of SS

E. Impact of pollution on recreation

1. No impact
2. Wastewaters represent potential risk to the environment
3. Wastewaters discharged at the distance of less than 3000 m

F. Investment

1. The construction of the facility does not require high financial investments
2. The construction of the facility requires medium-scale financial investments
3. The construction of the facility requires small financial investments
4. There is no need to construct the facility

G. Existing wastewater treatment facilities

1. Treatment of all wastewaters
2. Partial treatment, septic tanks

3. No wastewater treatment facility

H. Disposal of solid wastes generated in the production process

1. No solid wastes generated
2. Solid wastes generated and disposed by licensed organizations
3. Solid wastes generated and not disposed in a legally prescribed manner

I. Emissions into the air

1. No exhaust gases generated
2. Exhaust gases are generated, the concentration of pollutants is within permitted limits
3. Exhaust gases are generated, the concentration of pollutants exceeds permitted limits

- pollution sources without available wastewater analyses (based on data on specific pollution load per PE – Table 1.2.11, Annex III):

B. NUTRIENTS – TOTAL PHOSPHORUS, AS THE MAIN EUTROPHICANT

1. Wastewaters containing phosphorus (tracks)
2. Specific phosphorus pollution load below 0,15 gP/PE/day
3. Specific phosphorus pollution load ranges from 0,15 gP/PE/day to 0,30 gP/PE/day
4. Specific phosphorus pollution load ranges from 0,30 gP/PE/day to 0,6 gP/PE/day
5. Specific phosphorus pollution load exceeds 0,6 g/PE/day

D. TOTAL SUSPENDED SOLIDS (SS)

1. Wastewaters containing SS (tracks)
2. Specific SS pollution load below 3,0 g/PE/day
3. Specific SS pollution load ranges from 3,0 g/PE/day to 4,5 g/PE/day
4. Specific SS pollution load ranges from 4,5 g/PE/day to 7,5 g/PE/day
5. Specific SS pollution load exceeds 7,5 g/PE/day

The ranking of pollution sources was carried out pursuant to the above criteria (Table 3.3.2). Five pollution sources require priority wastewater treatment solutions: Adria, Marituna, Turisthotel, Luka Zadar and Kepol- Terminali.

Table 3.3.2 – Classification of polluters within the industrial zone Gaženica

Company	Criteria									Total	Range
	A	B	C	D	E	F	G	H	I		
Adria	5	5	4	5	2	1	3	2	2	29	1
Elka	1	3	2	4	2	3	2	2	2	21	7
Maraska	4	2	2	4	2	2	3	2	1	22	6
Marituna	5	5	4	5	2	1	3	2	1	28	2
Sojara	2	1	1	2	2	3	2	1	2	16	9
Tankerkomerc	2	3	2	2	2	3	2	1	2	19	8
Turisthotel	5	5	2	4	2	2	2	1	2	25	3
Lura	1	5	2	5	2	2	3	1	1	22	6
Adex	1	5	2	5	2	3	2	2	1	23	5
Bloketara Mardešić	1	5	2	5	2	3	2	1	1	22	6
Dalmacijavino	1	5	2	5	2	3	2	1	1	22	6
Dimo	1	5	2	5	2	2	3	2	1	23	6
Drvoproizvod	1	5	2	5	2	4	2	1	1	23	5
Fontanela	1	5	2	5	2	3	2	2	1	23	5
Fost	1	5	2	5	2	2	3	2	1	23	5
Ina	1	5	3	5	2	2	3	1	1	23	5
Kepol plast	1	5	3	5	2	3	2	1	1	23	5
Kepol-terminali	1	5	3	5	2	3	2	2	1	24	4
Luka Zadar	2	5	3	5	2	3	2	1	1	24	4
TKV	1	5	2	5	2	2	3	2	1	23	5
Traka-Zagreb	1	5	2	5	2	3	2	1	1	22	6

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Annex	:	AMELIORATION MEASURES

IV AMELIORATION MEASURES

1. SELECTION OF ALTERNATIVES

1.1 Systems for pollution control

1.1.1 Introduction

The chapter "Classification and Ranking of Pollution Sources" establishes that the industrial plants located in the industrial zone Gaženica pollute the environment by discharging their untreated wastewaters into the coastal sea. The discharge of solid waste (Table 1.4.10 – 1.4.12 Annex III) and exhaust gases – flues (Chapter 1.4.3 Annex III), does not have significant adverse impact on the environment. Therefore, further consideration on environmental improvement will be restricted to the measures that control wastewater discharge.

In general, there are two options of how to control waste discharge from industrial plants, namely:

- Waste reduction "at source", i.e. application of clean technologies, including recycling of wastes and/or water,
- "end-of-pipe" control, i.e. application of wastewater treatment plants and discharge of effluents into natural water bodies.

The application of clean technologies is one of the options related to the development of individual industrial plants and represents an optimum option in view of environmental protection.

This Study does not consider the above option since plant managers have to make that choice by themselves, depending on economic performances associated with each production process.

For that reason, present Study elaborates the second option, the implementation of which is based on the "polluter pays" principle.

Presently, wastewaters are discharged into the coastal sea of the Gaženica Bay which serves as an industrial and trading port.

In the immediate vicinity of the Bay there is an area earmarked for recreation purposes and water sports.

Though, the Gaženica Bay is a part of the coastal sea of the Zadar Channel with limited sea water mass and occasionally reduced hydrodynamic exchange. As already stated, there are still no legal provisions regarding sea water classification in the Republic of Croatia, and Water Protection Plans do not outline water categorization.

The present Study assumes that the sea in this area will be categorized as coastal sea of III class, which is acceptable in view of the existing use of the seawater in this Bay.

However, if the Water Framework Directive of the European Union be implemented in the future, the criteria "good ecological status" and "good chemical status of surface waters" will apply.

Therefore, the conditions for wastewater discharge into a natural recipient listed in table 1.3.1 Annex III will be used for the needs of this Study.

The application of the "end-of-pipe" control principle enables two options for treating wastewaters from the industrial zone Gaženica:

Option I: Anticipates the discharge of industrial effluents from individual plants into the Gaženica Bay,

Option II: Anticipates the collection of all industrial effluents within the industrial zone, their treatment in the central treatment plant of the City of Zadar and discharge via submarine outfall into the Zadar Channel.

1.1.2 Wastewater discharge options

Option I. –discharge of effluents into the Gaženica Bay

This option envisages that industrial plants treat their wastewaters in own wastewater treatment facilities and discharge effluents into the coastal sea mainly through the existing coastal outfalls.

Bearing in mind the intended use of the coastal sea in the Gaženica Bay, the utilization of long submarine outfalls is not feasible due to ship anchorages.

Discharged effluents have to meet the requirements listed in table 1.3.1 for the discharge of effluents into natural recipient bodies of water.

Wastewater treatment facilities of individual industrial plants are examined below.

"Adria" Facility

The "Adria" company is classified into food industry and its wastewaters resemble municipal wastewaters as regards basic properties. The size of the facility can be estimated pursuant to the "equivalent inhabitant".

In line with the chapter "Identification of total pollution load", the size of the "Adria" wastewater treatment facility would be 5500 PE, and input data are the following:

Hydraulic load

Q_{year} = 85000 m^3/year

Q_{day} = 340 m^3/d

Table 1.1.2.1.1. Daily waste load and percentage reduction for the "Adria" facility

Indicator	Load (kg/d)	Reduction (%)
BOD-5	330	97
COD	513	92
S.S.	123	90
N_{total}	11	34
P_{total}	1.6	79
Total grease	13	33
Total phenols	10	99

Biological treatment process can also be applied. One of the recommended solutions is the process with biological removal of phosphates by activated sludge with anaerobic, anoxic and aerobic purification stage (III level of purification).

The process with low-loaded activated sludge will be simultaneous with the process of sludge stabilization . Stabilized and filtered sludge can be disposed at a sanitary waste disposal site.

"Elka" Facility

The "Elka" company is classified into the electrical fittings industry.

In principle, wastewaters are not compatible with municipal wastewaters. However, the analyses of wastewater composition have shown that these waters can be purified in the same manner as municipal waters.

According to available data, the size of the "Elka" facility would be 13 PE.

Hydraulic load

Q_{year} = 2000 m^3/year

Q_{day} = 8 m^3/d

Table 1.1.2.1.2. Daily waste load and percentage reduction for the "Elka" Facility

Indicator	Load (kg/d)	Reduction (%)
BOD-5	0.75	73
COD	1.16	14
S.S.	0.33	15
N_{total}	0.31	46
P_{total}	0.02	52
Anion. det.	0.04	82

Considering the size of the facility and purification requirements, the most favorable option will be to purify wastewaters at the nearest (neighboring) wastewater treatment facility of similar characteristics. In this case, it is the "Adria" facility. If no agreement can be reached on shared costs, standard treatment facility with activated sludge process can be applied in this industrial plant.

The existing sedimentation tanks are insufficient for the required treatment performance.

"Maraska" Facility

The "Maraska" company is classified into food industry.

The size of the facility would be 1455 PE.

Hydraulic load

Q_{year} = 60000 m^3/year

Q_{day} = 240 m^3/d

Table 1.1.2.1.3. Daily waste load and percentage reduction for the "Maraska" facility

Indicator	Load (kg/d)	Reduction (%)
BOD-5	87	93
COD	113	74
S.S.	9	8
P_{total}	0.01	-

The implementation of biological process with low-loaded activated sludge (II level of purification) with simultaneous sludge stabilization is recommended.

"Marituna" Facility

The "Marituna" company is classified into food industry.

The size of the facility would be 58 PE.

Hydraulic load

Q_{year} = 15000 m^3/year

Q_{day} = 60 m^3/d

Table 1.1.2.1.4. Daily waste load and percentage reduction for the "Marituna" facility

Indicator	Load (kg/d)	Reduction (%)
BOD-5	3.5	57
COD	4.7	-
S.S.	5.0	58
N_{total}	0.05	-

Biological process with activated sludge can be applied. Due to rather small dimensions of the facility it would be beneficial to treat wastewaters in the facility shared with the neighboring company. To simplify the operation, the facility with simultaneous sludge stabilization is recommended.

"Sojara" Facility

The "Sojara" company is classified into food industry.

The size of the facility would be 309 PE.

Hydraulic load

Q_{year} = 100000 m^3/year

Q_{day} = 400 m^3/d

Table 1.1.2.1.5. Daily waste load and percentage reduction for the "Sojara" facility

Indicator	Load (kg/d)	Reduction (%)
BOD-5	18.5	46
COD	24.3	-
S.S.	5.7	-
N_{total}	0.8	-
P_{total}	0.03	-

Biological process can be applied. Since maximum waste concentrations exceed permitted limits, the II level of purification is required. Activated sludge process with simultaneous stabilization is recommended to make the operation simple and safe. The existing separator could be sufficient, but should be checked for performance.

"Tankerkomerc" Facility

The "Tankerkomerc" company is a trading company. Anionic detergents and aromatic hydrocarbons are distinct waste indicators.

Hydraulic load

$$Q_{year} = 2931 \text{ m}^3/\text{year}$$

$$Q_{day} = 12 \text{ m}^3/\text{d}$$

Table 1.1.2.1.6. Daily waste load and percentage reduction for the "Tankerkomerc" facility

Indicator	Load (kg/d)	Reduction (%)
BOD-5	0.3	-
S.S.	0.1	-
Anion. detergents	0.3	96
Aromat. hydrocarbons.	0.3	99.9

The existing API separators are insufficient. Additional purification is required. The application of activated sludge filter is recommended.

"Turisthotel" Facility

This company is a launderette and its wastewaters can be classified into wastewaters compatible with industrial effluents, i.e. can be purified together with municipal wastewaters.

The size of the facility would be 245 PE.

Hydraulic load

Q_{year} = 45000 m^3/year

Q_{day} = 180 m^3/d

Table 1.1.2.1.7. Daily waste load and percentage reduction for the "Turisthotel" facility

Indicator	Load (kg/d)	Reduction (%)
BOD-5	14.7	69
COD	37.2	39
S.S.	5.9	-
P_{total}	2.5	93
Anion. detergents	4.8	96

The neutralization tank has been constructed, but is insufficient. The facility for reducing organic load and phosphorus is required. Low-loaded biological process is recommended with phosphorus reduction and simultaneous sludge stabilization.

"Lura" Facility

The "Lura" company is engaged in the trade of milk, diary products and beverages. There are no available data on wastewater analyses. Wastewaters are sanitary waters of 47 employees and wastewaters produced by cleaning warehouses and equipment.

Hydraulic load

Q_{year} = 1200 m^3/year

Q_{day} = 4,8 m^3/d

The construction of a septic tank for sanitary wastewaters is recommended. For waters used for cleaning it is necessary to envisage a sedimentation tank of approximately 5 m^3/d.

"Adex" Facility

The "Adex" company manufactures aluminum and p.v.c. carpentry. There are no process wastewaters, only sanitary wastewaters of employees (38 employees).

The size of the facility would be 4 PE.

Hydraulic load

Q_{year} = 60 m^3/year

Q_{day} = 0.24 m^3/d

Estimating that the daily waste load of employees expressed in BOD-5 accounts for 1/10 of total daily load, daily waste load will be BOD-5 = 0,23 kg/O_2/d.

The construction of a septic tank is recommended.

"Bloketara Matešić" Facility

This industrial plant manufactures concrete blocks and concrete products. There are no process wastewaters, only sanitary wastewaters of 2 employees. The existing septic tank is sufficient to meet treatment needs.

"Dalmacijavino" Facility

The company is a trading company. There are no process wastewaters, only sanitary wastewaters of 18 employees. The existing septic tank is sufficient to meet treatment needs.

"Dimo" Facility

The "Dimo" company manufactures and sells garments, wall papers and car rugs. There are no data on the concentrations and composition of wastewaters. For the needs of this study, it has been assumed that the waste load expressed in BOD-5 will be 300 mg O_2/l.

Hydraulic load

Q_{year} = 1500 m^3/year

Q_{day} = 6 m^3/d

Waste load BOD-5 = 1,8 kg O_2/d

Size of the facility 30 PE

The application of a low-loaded activated sludge biological process has been anticipated, with simultaneous stabilization. It can be assumed that a neutralization tank should be envisaged prior to

biological process. Before reaching final decision, it should be checked whether hazardous substances exist, such as chromium and sulfides that will disturb the biological process

"Drvoproizvod" Facility

The "Drvoproizvod" company is a trading company without process wastewaters; there are only sanitary wastewaters of 2 employees.

The construction of a septic tank is recommended.

"Fontanela" Facility

The Fontanela company manufactures and sells garments. There are no available data on the composition and concentration of wastes.

It is assumed that the wastewater volumes are very low, since maximum daily water consumption is 0.6 m^3/d and the company has 10 employees.

The existing septic tank meets treatment needs.

"Fost" Facility

The "Fost" company manufactures self-adhesive bands and foils, and is engaged in printing, cutting and readying paper products.

There are no available data on wastewater.

Total daily hydraulic load is 1.6 m^3/d. Since the company has 18 employees, it can be assumed that it generates a very low volume of process wastewater.

The construction of a septic tank is recommended.

"INA" Facility

This subsidiary of the INA company is engaged in loading and unloading of ships by forklift trucks. There are no process wastewaters, only sanitary wastewaters. The company employs 17 persons.

Daily water consumption is 0.8 m^3/d.

The construction of a septic tank is recommended.

"Kepol-Plast" Facility

The "Kepol-Plast" company stores various goods. There are no process wastewaters. Wastewaters are sanitary waters of 20 employees.

Maximum daily water consumption is 4 m^3/d.

The existing septic tank meets treatment needs.

"Kepol-Terminal" Facility

This company is engaged in storing and reloading liquid cargoes. There are no process wastewaters. Wastewaters are sanitary waters of 10 employees and water used for cooling (the major part of which evaporates). Maximum daily water consumption has been estimated at 2 m^3/d.

The existing septic tank meets treatment needs for sanitary wastewaters.

"Luka Zadar" Facility

The company performs reloading and storing of cargo. There are no process wastewaters. Wastewaters are sanitary waters of 135 employees. Maximum daily water consumption is 29.6 m^3/d.

The existing septic tank is sufficient for sanitary wastewaters. For wastewaters produced by cleaning, sedimentation tanks of about 24 m^3/d should be envisaged.

"TKV" Facility

The "TKV" company manufactures textile ropes and Sisal adhesives. There are no process wastewaters, only sanitary wastewaters of 43 employees. Maximum daily water consumption is 2 m^3/d.

The construction of a septic tank is required.

"Traka" Facility

The "Traka" company is a trading company. There are no process wastewaters, only sanitary wastewaters of 8 employees. Maximum daily water consumption is 0.28 m^3/d.

The construction of a septic tank is required.

Option II. –Discharge into a common treatment plant of the City of Zadar

Prior to their discharge into the public sewage system, the composition of and waste concentrations in process wastewaters should be controlled.

It is necessary to limit the discharge of harmful and hazardous substances from production plants into the public sewage system in order to:

- protect the health of persons employed with the public sewage system,
- prevent undesirable impacts on the security and durability of buildings and apparatuses of the public sewage system,
- avoid adverse impacts on wastewater treatment procedures and sludge treatment procedures,
- preserve natural equilibrium of aquatic ecosystems and provide water for the intended use without restrictions,
- ensure that the processing and discharge of sludge is being performed in an environmentally acceptable and not harmful manner.

Limit values for indicators and permitted concentrations of hazardous and other substances in process wastewaters are defined in table 1 of the Rule Book on Limit Values for Indicators of Hazardous and Other Substances in Wastewaters (Official Gazette 40/99 and 6/01). The indicators, that are present in the wastewaters of the industrial zone Gaženica are listed in table 1.3.1, chapter , Classification of pollution sources.

Wastewaters produced in certain industrial plants have increased allowable concentrations of pollutants, namely:

- "Adria": BOD-5, COD, phenols,
- "Maraska": BOD-5, COD,
- "Tankerkomerc": anionic detergents, aromatic hydrocarbons
- "Turisthotel": anionic detergents, pH,
- "Lura": BOD-5, total grease
- "Dimo": BOD-5, pH.

Consequently, such industrial plants should construct wastewater treatment facilities to treat wastewaters prior to their discharge into a public sewage system.

However, Article 3 of the Rule Book on Limit Values for Indicators, allows that other limit concentrations be set for BOD-5, COD , total phosphorus and total nitrogen indicators, if the public sewage system comprises a wastewater treatment plant that can achieve the purification level consistent with the one prescribed by the Rule Book, even after the discharge of process wastewaters.

On the basis of above estimates, total daily load of (the existing) industrial plants at the Gaženica site will be:

- 385 kg O_2/d for BOD-5
- 596 kg O_2/d for COD
- 10 kg/d phenols
- 5 kg/d anionic detergents
- 0.3 kg/d aromatic hydrocarbons

- 1193 m^3/d wastewater

In view of the above load, mean wastewater concentrations within the industrial zone (after mixing in pipelines, pumping stations) will be:

BOD-5	323 mg O_2/l
COD	500 mg O_2/l
phenols	8.4 mg/l
anion. deter.	4.2 mg/l
arom. hydrocarb.	0.25 mg/l

The stated wastewater concentrations approximate the concentrations of communal wastewaters, i.e. they are within the values permitted for public sewage system.

The central treatment plant of the City of Zadar should be enlarged by 6416 population equivalent to serve the existing plants.

In any case, certain industrial plants should construct wastewater neutralization systems and systems for the reduction of total grease, in order to protect channel networks and provide for more favorable operating conditions of the sewage system.

1.2 Selection procedures

The compliance of a particular alternative with generally acceptable criteria should be assessed in order to enable decision makers to select an alternative. These criteria relate to environmental, hygienic, technical/economic requirements as well as local conditions. The criteria are categorized and classified according to the final objectives set by decision makers.

One way to select the most adequate alternative, which is applied in this Pre-investment Study, is the introduction of criteria which will be evaluated by way of "weighted classification".

A certain "weight" is applied to each category, expressing its importance in the evaluation process. The suitability of each alternative with each weighted criterion is expressed as numeric value i.e. score (i.e. 4 = very good, 3 = good, 2 = moderate, 1 = poor).

1.2.1 Assessment of impacts – consequences of alternatives

For each identified alternative, the significance of its impact on the environment, on public health and its socio-economic impact will be outlined below, i.e. respective impacts of the following options:

Option I (discharge of industrial effluents into the Gaženica Bay),
Option II (discharge of effluents into a common treatment plant of the City of Zadar).

Environmental impact

In principle, wastewater treatment facilities represent an efficient environmental protection and preservation measure. Such a statement will suggest that each treatment facility has positive impact on the environment. However, this statement is only partially true, since in certain cases treatment facilities can have adverse impact on the environment or a part thereof.

It can be established that Option II is more suitable than Option I as regards the discharge of effluents into the sea due to the application of a long submarine outfall (the application of long submarine outfalls is not feasible under Option I). By the application of long submarine outfalls it is possible to use distant and deeper parts of the Zadar Channel as effluent recipients. Furthermore, long submarine outfalls provide for the seawater quality in the littoral belt. If the performance of the wastewater treatment facility is poor or in case of accidental operational failure or some other disruption, the discharge of less effectively treated effluents through a submarine outfall into that part of the sea where more favorable oceanographic conditions exist, especially continuous circulation of seawater, will not cause long lasting and significant adverse impacts on the environment, i.e. sea quality and biota.

The processing and removal of sludge and other wastes from the facility and their disposal often cause adverse environmental impacts. Under Option I, waste removal is facing greater difficulties (since the waste is being removed from several sites) than under Option II, especially during summer months, so that comprehensive hygienic measures should be envisaged (cleaning of containers, vehicles, etc.).

Other impacts associated with the operation of industrial plants chiefly reflect as odors, insects and noise.

Odors occur at facility's inlet pumping stations, grits, sludge compressors, sludge filters, but can occur in other parts of the facility as well, depending on facility's maintenance and operation. The basic principle of preventing odors is to keep the entire system clean and have "fresh wastewaters". Under such conditions, protective measures include the covering up of facility's components and, in more sensitive cases, even the entire facility, and the purification of air prior to its release into the atmosphere.

Insects breeding (flies, mosquitoes) in wastewater treatment facilities is always linked with the cleanness, and sometimes depends on the technological solution. The covering up of certain components of the facility, e.g. grits, microfilters, decreases the possibility of insects breeding.

In wastewater treatment facilities machines produce noise, especially air compressors (in the activated sludge process). Presuming that all machines that can originate noise will be located in enclosed areas and adequate protective measures applied, this undesirable environmental impact can be eliminated in all proposed alternatives.

Conclusion can be reached that, in view of other impacts attributable to the operation of wastewater treatment facility, Option II is more adequate than Option I since all the required measures (regular maintenance, covering up of facility's components, and other) can be implemented in a more comprehensive manner in a central wastewater treatment plant than in several smaller ones.

In general, it is anticipated that sludge and other wastes generated during the operation of a wastewater treatment facility will be ultimately disposed on a sanitary waste disposal site (depot). Final solid waste disposal site should selected in advance and all measures and procedures for its sanitary disposal should be implemented.

Public health risks

Wastewaters contain a vast number of microorganisms that can cause human diseases. In addition to enteric diseases, wastewaters spread other invectious diseases, such as hepatitis, meningitis, tuberculosis and others. Although the intended use of the coastal sea at Gaženica site is an industrial and trading port, it should be noted that tourism is highly developed in the wider area of the City of Zadar and the occurrence of epidemics caused by wastewaters could have serious and long-lasting consequences for the entire economy.

It should be emphasized that the standard level I and level II wastewater purification processes are insufficient, without disinfection process, to reduce the number of microorganism and bring them down to the levels permitted for bathing seawater. Therefore, the more adequate solution is to discharge effluents through long submarine outfalls (Option II) since the wastewater dilution and dispersion process and dying of microorganisms when they float on the surface up the sea belt earmarked for bathing are sufficient to maintain littoral seawater quality at the levels set for bathing and water sports.

As far as it is presently known, in the coastal sea of Zadar aquacultural activities have been envisaged, especially not shell farming. The highest threat to human health from wastewater discharge represent those aquatic organisms that are being eaten raw (shells). Therefore, health related standards for the waters used for shell farming are far stricter than those for bathing seawater.

The reuse of effluents is not always safe for human health, especially if adequate safety measures and procedures are not obeyed. The period of survival of microorganisms in soil or in plants depends on local conditions, and especially on solar radiation, temperature, humidity, pH value and predator organisms. Epidemiological research suggests that the highest risk in the reuse of untreated wastewaters for irrigation purposes lies in nematodes and bacteria.

If the alternative which includes the reuse of treated wastewater for irrigation purposes is implemented, additional procedures related to the disinfection of wastewater should by all means be envisaged. On top of disinfection, additional protective measures are also required, especially local population has to be informed about all health protection measures.

Socio-economic impacts

It should be emphasized that, as regards construction costs, the situation is more complex since under Option II which envisages the discharge of industrial effluents into a common treatment facility of the City of Zadar, it is necessary to construct a central treatment facility. The construction costs associated with such a facility are higher than the construction costs of individual industrial wastewater treatment facilities, envisaged under Option I. On the other hand, specific construction costs (i.e. construction costs expressed as equivalent inhabitant) are still lower under Option II than under Option I. In order to protect and preserve the Zadar maritime zone, the construction of a central treatment facility is certainly required (rated capacity of which will be 10 times higher than the sum of individual capacities of small industrial treatment facilities). Therefore, as regards construction costs the precedence should nevertheless be given to Option II i.e. to the construction of a central or common wastewater treatment facility.

Option II should also have precedence over Option I as regards operation and maintenance costs that are cumulatively lower for a central facility than operation and maintenance costs of a number of separate wastewater treatment facilities.

A very important aspect is the size and location of the land required for the construction of a wastewater treatment facility. It can be assumed that under Option I there will be local difficulties in finding and providing land of required size to construct the facility within a particular industrial plant site. The conditions are more favorable for Option II. New, effective general urban development plan of the City of Zadar envisages the construction of a central treatment facility and the location i.e. land for such facility has already been procured.

The aforementioned fact is important for the estimate of public acceptance. General urban development plan of the City of Zadar, prior to its adoption and coming into force, has been subject to public debate, and Option II can be considered more acceptable to the public. On the other hand, certain public opposition to the implementation of Option I can be expected in view of the fact that effluents are discharged by coastal outfalls into the Gaženica Bay, and due to fears for operational safety of several smaller treatment facilities.

1.2.2 Definition of criteria

In line with the preceding chapter which analyses the consequences of alternatives, i.e. the assessment of environmental impact, public health risks and socio-economic impacts, the following criteria are proposed:

- environmental criteria
- health/hygienic
- sociological/economic

Furthermore, factors are defined for each criterion:

a) Environmental criterion:
   1. impacts on seawater quality
   2. impacts on air quality
   3. impacts on soil quality
   4. conservation of landscape

b) Health/hygienic criterion:
   5. uses of the sea for bathing, recreation, fishing
   6. general state of the public health i.e. risk of infections

c) Sociological/economic criterion:
   7. construction costs
   8. operation and maintenance costs
   9. size and location of the required land
   10. public acceptance

The selection of the best alternative will be carried out by way of "weighted classification" according to the expression:

$$C = \sum_{i=1}^{n} W_i \cdot S$$

where:

i = number of the considered criterion,
n = total number of criteria,
W_i = weight of criterion "i",
S = suitability of criterion "i" for the given alternative.

The proposed "weights" are only a suggestion, and the procedure can be repeated in a way that the decision maker selects a different weighting scheme.

The following "weights" were applied to individual factors for further analysis (table 1.2.2-1). Every weighted criterion is expressed as numeric value (i.e. 4 = very good, 3 = good, 2 = moderate, 1 = poor) which has to be multiplied by the criterion´s weighted value (table 1.2.2-2)

Table 1.2.2-1: "Weights" applied to individual factors

Factor – measure	Weight (W_i)
a) Environmental protection	
1. impact on seawater quality	10
2. impact on air quality	8
3. impact on soil quality	7
4. conservation of landscape	10
Total	35
b) health-hygienic	-
5. uses of the sea for bathing, recreation, fishing	15
6. general state of public health i.e. risk of infections	25
Total	35
c) Sociological/economic	-
7. construction costs	6
8. operation and maintenance costs	9
9. size and location of the required land	7
10. public acceptance	8
Total	30
Cumulative	100

Table 1.2.2-2 below shows a preliminary classification, i.e. assessment of considered alternatives.

Table 1.2.2-2: Assessment of considered alternatives

Factor	Option I	Option II
1.	10 × 2 = 20	10 × 3 = 30
2.	8 × 2 = 16	8 × 3 = 24
3.	7 × 2 = 14	7 × 2 = 14
4.	10 × 3 = 30	10 × 3 = 30
5.	15 × 2 = 30	15 × 3 = 45
6.	25 × 2 = 50	25 × 3 = 75
7.	6 × 3 = 18	6 × 2 = 12
8.	9 × 2 = 18	9 × 3 = 27
9.	7 × 2 = 14	7 × 3 = 21
10.	8 × 2 = 16	8 × 3 = 24
Total:	226	302

The evaluation leads to the conclusion that the precedence should be given to Option II, i.e. the solution with a common treatment facility, for the above reasons.

In addition to the aforementioned criteria and their weighted share in the "convenience" of each option, another specific criterion is present according to which options are being compared – conditions for future system implementation and its operation control. Since Option II has the advantage over other options under this criterion, too (smaller permitting requirements and requirements relating to ensuring conditions for system operation control), it can be considered that, under this methodology, Option II has been selected as far more adequate option for the management of Gaženica industrial wastewaters.

2. PROJECT OVERVIEW

2.1 Technical Conditions for Environmental Protection

2.1.1 Design requirements

In finding solution to the treatment of wastewaters of the industrial zone Zadar and discharge of treated wastewaters into the Zadar Channel as the recipient, the following has to be identified:

- pollutant loading,
- wastewater standard,
- recipient standard.

2.1.1.1 Pollutant Loading

Total daily amount of pollutants from the industrial zone Zadar has been estimated in Chapter III, sub-paragraph 1.2.

Pursuant to the mentioned analyses, total daily loading stemming from the industrial plants located in the Gaženica zone, considering the present state, is as follows:

Table 2.1.1 Daily pollutant loading

Indicator	Quantity kg/d
BOD-5 (20°C) kg O_2/d	385
COD-Cr kg O_2/d	596
Phenols kg/d	10
Anion. detergents kg/d	5
Arom. hydrocarbons kg/d	0.3

Daily wastewater quantity discharged from the studied zone, considering the present state, is 1,193 m^3/day (estimated wastewater quantities are somewhat higher than the quantities currently discharged), and the mean wastewater concentration upon mixing in pipelines and pumping stations will be the following:

Table 2.1.2 Mean pollutant concentration in industrial wastewaters

Indicator	Concentration
BOD-5 (20°C) mg O_2/l	323
COD - Cr mg O_2/l	500
Phenols mg/l	8.4
Anion. detergents mg/l	4.2
Arom. hydrocarbons mg/l	0.25

Industrial wastewaters will be collected by a separate sewage sub-system and discharged into public sewage system of the City of Zadar.

2.1.1.2 Wastewater standards

Wastewater standards in the Republic of Croatia are regulated by the Water Act (Official Gazette 107/95) and the Rule Book on Limit Values for Indicators of Hazardous and Other Substances in Wastewaters (Official Gazette 40/99, 6/01) (hereinafter referred to as the Rule Book). The Rule Book sets limit values for indicators of hazardous and other substances in case of wastewater discharge into a natural recipient and in case of wastewater discharge into the public sewage system. Indicator values for the discharge of hazardous and other substances into natural recipients are consistent with the EU Council's Directive relating to the purification of municipal wastewaters (91/271/EEC).

In case of discharge of industrial wastewaters into the public sewage system, the wastewater standard is set in accordance with wastewater limit values, as shown in Table 2.1.3 below.

Table 2.1.3: Indicator limit values for pollutants and other substances in industrial wastewaters

Indicator		Limit values
PH		5.0-9.5
Temperature (degree C)		45
Total suspended solids		Should not affect the sewage system and wastewater treatment facility
BOD-5 (20°C)	mg O_2/l)	250
COD - Cr	mg O_2/l	700
Total phenols	mg/l	10.0
Anion detergents	mg/l	10.0
Total arom. hydrocarbons	mg/l	0.2

Article 3 of the Rule Book regulates that only exceptionally different limit values can be set as BOD-5 and COD indicator limit values (as well as for other indicators that do not relate to the studied wastewaters discharged from the industrial zone Gaženica) if the common facility achieves the degree of wastewater treatment consistent with the Rule Book. Such different limit values are defined in the water-management permit.

After the treatment of industrial wastewaters in the central wastewater treatment facility of the City of Zadar, treated wastewaters will be discharged into the Zadar Channel via submarine outfall.

Based on the oceanographic research into the Zadar Channel, and in accordance with the Environmental Impact Study for the Wastewater Treatment Facility "Centar" - Zadar (developed by the School of Civil Engineering, University of Zagreb, March 2000), the Zadar Channel has been classified under "less sensitive areas".

In line with the Rule Book, and considering limit values set for the discharge of treated wastewaters from the facility «Centar» - Zadar through a submarine outfall into the "less sensitive area" of the Zadar Channel, the following treatment stages have been envisaged in this facility:

Table 2.1.4 Wastewater treatment stages in the facility Centar - Zadar

Development period	Treatment stage
up to 50,000 PE	primary (I)
beyond 50,000 PE	primary (I) + secondary (II)

Under Article 2 of the Rule Book, the allowable indicator limit values for pollutants and the minimum permissible reduction in input loading for this facility are as follows::

Table 2.1.5: Allowable indicator values for pollutants and minimum loading reduction

Treatment stage	Indicator	Limit value	Minimum reduction in input loading (%)
I.	Total suspended solids	150 mg/l	50
II.	Total suspended solids	35 mg/l	90
	Biochemical oxygen demand BOD-5 (20°C)	25 mg O_2/l	70-90
	Chemical oxygen demand COD - Cr	125 mg O_2/l	75
III.	Total phosphorus	2 mg P/l (10,000-100,000 PE) 1 mg P/l (over 100,000 PE)	80
	Total nitrogen (organic N+NH_3-N+NO_2-N+NO_3-N)	15 mg N/l (10,000-100,000 PE) 10 mg N/l (over 100,000 PE)	70-80

2.1.1.3 Recipient standards

Recipient standards that relate to all surface waters, groundwater and the sea, have been set by the Regulation on Water Classification (Official Gazette 77/98) (hereinafter referred to as the Regulation). For the coastal sea, this standard refers only to its protection against pollution from land- and island-based sources.

The Regulation on Water Classification classifies all bodies of water into five water classes pursuant to selected indicators. The indicators used for water classification in the Regulation are divided in two groups:

a) the first group consists of compulsory indicators for the assessment of general ecological function of waters: physical and chemical (A) indicators, oxygen regime (B) indicators, nutrients (C) indicators, microbiological (D) and biological indicators (E);

b) the second group is composed of indicators that are examined in accordance with special water protection programs: metals (F), organic compounds (G) and radioactivity (H).

Under the State Plan for Water Protection (Official Gazette 8/99), the sea in the zone affected by the discharge of wastewaters from the mainland is classified under water class II, in the area beyond the outfall's diffuser cycle of 300 m in radius. Within the cycle surrounding the diffuser of 300 m in radius, the sea can fall under water class III.

Allowable limit values for compulsory indicators are presented for water classes II and III that can be used as the coastal sea affected by pollution from mainland- and island-based sources.

Table 2.1.6 Allowable indicator limit values for individual water types

Indicator groups	Indicator	II class	III class
Physico-chemical A	PH	6.,5-6.3 8.5-9.0	6.3-6.0 9.0-9.3
	Alkalinity mg $CaCO_3$/l	200-100	100-20
	Electrical conductivity µS/cm	500-700	700-1000
Oxygen regime B	Dissolved oxygen mg O_2/l	7-6	6-4
	Oxygen saturation % epilimnium hipolimnium	 70-90 100-120 70-50	 50-70 120-130 50-30
	COD-Mn mg O_2/l	4-8	8-15
	BOD-5 mg O_2/l	2-4	4-8
Nutrients C	Ammonia mg N/l	0.10-0.25	0.25-0.60
	Nitrites mg N/l	0.01-0.03	0.03-0.10
	Nitrates mg N/l	0.5-1.5	1.5-4.0
	Total nitrogen mg N/l	1.0-3.0	3.0-10.0
	Total phosphorus mg P/l	0.01-0.025	0.025-0.06
Microbiological D	coliform bacteria UK/l	$5x10^2$-$5x10^3$	$5x10^3$-10^5
	fecal coliforms FK/l	$2x10^2$-10^3	10^3-10^4
	aerobic bacteria BK/ml	10^3-10^4	10^4-10^5
Biological E	P-B saprobity index	1.8-2.3	2.3-2.7
	Biotic index	8-9	6-7
	Trophic degree	mezotrophic	moderately eutrophicated

Table 2.1.7 shows allowable indicator limit values examined under special programs.

The Regulation on Hazardous Substances in Waters (Official Gazette 78/98) regulates recipient standard in view of substances that are detrimental for water environment and have been identified pursuant to toxicity, solubility and bioaccumulation criteria. Hazardous substances are classified in two groups. Maximum allowable concentrations of individual hazardous substances are set for mainland waters and the sea (Tables 2.1.6 and 2.1.7).

Table 2.1.7 Allowable limit values for indicators of individual water types

Indicators groups	Indicator	II. class	III. class
Metals F	Copper µgCu/l	2–10	10-15
	Zinc µgZn/l	50–80	80–100
	Cadmium µgCd/l	0.1–0.5	0.5-2.0
	Chromium µgCr/l	1-6	6-15
	Nickel µgNi/l	15-30	30-50
	Lead µgPb/l	0.1-2.0	2.0-5.0
	Mercury µgHg/l	0.005-0.02	0.02-0.10
Organic compouds G	Mineral oils mg/l	0.02-0.05	0.05-0.10
	Total phenols mg/l	0.001-0.005	0.005-0.01
	PCB µg/l	0.01-0.02	0.02-0.04
	Lindan µg/l	0.01-0.02	0.02-0.10
	DDT µg/l	0.001-0.005	0.005-0.01
Radioactivity H	Total β radioactivity mBq/l	200-500	500-1000

Out of hazardous substances classified under group b. limit values for the concentrations of total phenols in the sea are presented. amounting to:

Table 2.1.8 Allowable limit values for hazardous substances in the sea

Indicator	Sea 1	Sea 2
Total phenols (mg/l)	0.001-0.005	0.005-0.025

Sea 1 means the coastal sea

Sea 2 means the sea affected by pollution from mainland- and island-based sources at wastewater discharge locations (approx. 100 m from the diffuser) and at the estuaries of watercourses and channels (at the mixture point)

The Regulation on Beach Water Quality Standards is also mentioned as recipient standard (Official Gazette 33/96).

Although it hasn't been specifically stated in the Regulation on Beach Water Quality Standards. water quality requirements usually consider a 200-300 m wide sea belt spreading along the beach. depending on local circumstances.

Allowable limit values for individual indicators prescribed by this Regulation (table 2.1.9) are the following:

Table 2.1.9 Beach water quality requirements

Indicator	Limit value
Visible color	natural
Clarity (meters)	minimum 2
Visible floating waste matter	without
Visible mineral greases	no visible greasy cover on water surface
Suspended waste matter	no
Turbidity (degrees of silicate scale)	20
PH	8.1 ± 0.3
Dissolved oxygen. % saturation	70-120
Ammonia mg N/l	0.1
Total coliform bacteria in 100 ml	500 (in 80% of samples) 1000 (in 20% of samples)
Fecal coliform bacteria in 100 ml	100 (in 80% of samples) 200 (in 20% of samples)
Fecal streptococcus in 100 ml	100 (in 80% of samples) 200 (in 20% of samples)
Enetroviruses. infective units / 10 l	0
Salmonellae. isolated / l water	0

The above recipient standards are applied in the dimensioning. especially in determining the length of submarine outfalls and diffusers. and are used for the control of operating efficiency of the wastewater treatment facility and discharge.

2.1.2 Site selection

The site on which the central wastewater treatment facility of the City of Zadar will be located has already been identified in the prepared project documentation (Conceptual Design prepared in 1999) and in the General Urban Development Plan of the City of Zadar. The Environmental Impact Study for the Wastewater Treatment Facility of the City of Zadar has also been developed for this particular location.

2.1.3 Environmental Impact Assessment

2.1.3.1 Description of the Development

At present. industrial wastewaters from the industrial zone Gaženica are discharged into the coastal sea with minimum treatment or without being pretreated at all.

This project considers two options for the collection. treatment and discharge of industrial wastewaters. namely:

-Option I: Wastewater collection and treatment in the facilities of distinct industrial plants. and separate discharge of purified wastewaters into the coastal sea by coastal outfalls;

-Option II: Collection of all wastewaters by a common sewage system. wastewater pumping to the central treatment facility of the City of Zadar. wastewater treatment and discharge of treated wastewaters by a submarine outfall into the Zadar Channel.

The two options were examined and compared. and the Option II was selected as the better solution.

2.1.3.2 Overview of potential environmental impacts

2.1.3.2.1 Adverse environmental impacts

Considering their origin. composition and concentrations. untreated wastewaters have adverse impact on the environment. including public health. However. adverse environmental impacts and adverse impacts on public health can occur even if wastewaters are treated. if the construction and/or maintenance and operation of the public sewage system is not carried out in accordance with the principles of environmental protection and protection of public health.

Potential adverse impacts of a public sewage system (including wastewater treatment facilities) on the environment and public health can ensue :

- during the construction of a public sewage system.
- during the utilization of a public sewage system.
- due to incidents and interruptions in sewage system operation.
- when a public sewage system is not being used any more .

In continuation. only those impacts that can develop in the Gaženica subsystem under the proposed Option II are mentioned that directly relate to finding solution to the problems related to industrial wastewaters.

Impacts during construction

Many of the machines used during the construction produce noise. The construction process increases the contents of dust particles in the air and causes atmospheric pollution. During the transportation of dug-up material it can scatter on traffic routes and during wet weather mud can occur on roadways. Soil contamination occurs during the disposal of excess dug-up material on inadequate disposal sites. During the construction of individual structures. the existing adjacent structures can be damaged (e.g. due to the blasting of rocks). as well as the existing utility installations. including household connections.

Impacts during utilization

During the utilization of a public sewage system there are potential adverse impacts on canal network. on treatment facilities and submarine outfalls. The wastewater treatment facility and submarine outfall are common buildings used for municipal and industrial wastewaters. Adverse environmental impacts and adequate protection measures have been considered in the Environmental Impact Study for the Wastewater Treatment Facility "Centar" - Zadar (School of Civil Engineering. 2000). Here. only adverse impacts relating to the Gaženica subsystems are cited (impacts on canals and pumping stations).

Under regular operation. the following adverse impacts can occur:

- Foul odors and air pollution can occur in pumping stations due to longer residence time of wastewater and waste decomposition.

- Wastewater seepage and pollution of groundwater or seawater can occur at the connections of canal parts and/or at the connection of canals and manholes and/or pumping station reservoirs.

- Noise can occur in pumping stations. degrading working and living conditions in its environs. mainly in case of temporary operation of diesel generating sets in case of interruptions in electricity supply from the electricity supply system.

- If hazardous and harmful substances are discharged from generating plants into the public sewage system. the corrosion of concrete and metal can take place in public sewage system structures. which will have an impact on the security and lifetime of such structures.

- Furthermore. harmful and explosive gas mixtures can develop. threatening the health of workers and the security of the system. Substances can be produced the composition and concentrations of which could have an adverse impact on wastewater treatment processes. sludge treatment and discharge and on the biota in the recipient of treated and discharged wastewaters.

Impact in case of incidents and interrupted operation

During the operation and maintenance of a public sewage system temporary. unforeseeable and accidental incidents can happen. Such incidents can be caused by:

- force major.
- interrupted operation.

"Force Major" means an earthquake of greater magnitude than the calculated one. war destructions and other intentional damage to buildings and equipment. Operation can be interrupted due to equipment faults (pumping stations). power failure. inadequate system maintenance (obstruction of canals and pumps). including the discharge of wastewater of unpermitted contents and concentrations from a certain plant (explosions. fire).

Post-utilization impacts

Public sewage systems are structures planned for permanent use. so that post-utilization impacts are. in general. not estimated.

2.1.3.2.2 Positive environmental impacts

Public sewage systems that collect. convey. treat and discharge wastewaters into the environment are. under the Water Act (Official Gazette 107/95) considered one of requisite measures for water conservation and protection of water quality in the Republic of Croatia. In addition to environmental protection. public sewage systems contribute to the protection of public health. preventing the occurrence and spreading of potential diseases by untreated wastewaters. The collected wastewaters are treated in wastewater treatment facilities up to the level at which such waters can be harmlessly discharged into natural recipients.

The following positive impacts can be achieved by the construction of a public sewage system in the industrial zone Gaženica:

- Improvement of general health of workers in the industrial zone. This implies not only the prevention of possible contagious diseases. but also overall feeling of comfort (due to the elimination of foul odors) that has influence on health condition in general.

- Improved biodiversity in the sea. which is the recipient of wastewaters. Wastewater treatment and controlled discharge of treated wastewaters through the submarine outfall. will prevent the decrease in the number of those marine organisms that are adversely impacted by untreated industrial wastewaters and either leave their natural habitats or die. Excessive growth of those organisms that favor the changed conditions of habitats will also be prevented.

- Improved scenery in the wider area. since untreated wastewaters discharged through coastal outfalls cause inauspicious manifestation of the coastal sea (turbidity. greasy spots. floating substances....) in the surroundings of the outfall. as well as in the wider area due to the influence of sea currents and pollution spreading.

2.1.3.3 Proposed measures for the mitigation and abatement of adverse impacts

Adverse environmental impacts and adverse impacts on public health should be avoided or offset to an acceptable level. Protection measures are based on legal. administrative. technical and technological conditions. The implementation of measures is envisaged during the construction of a public sewage system and during its operation and maintenance.

In continuation. only those measures are mentioned with regard to the sewage network and pumping stations that directly relate to finding solution to the problems of Gaženica industrial wastewaters. Protection measures for the wastewater treatment facility and submarine outfall have already been identified in the Environmental Impact Study for the Wastewater Treatment and Discharge Facility of the City of Zadar (School of Civil Engineering. 2000).

Protection measures during construction

- The contractor has the obligation to develop the project for the protection against noise from the construction site.
- The contractor has the obligation to undertake measures that prevent. or reduce dust and atmospheric pollution .
- It is prohibited to overfill vehicles with dug-up material and to dispose the excess of dug-up material on "illegal" disposal sites.
- The contractor has the obligation to protect the existing structures and installations against damage. In case of damage or breaks. the contractor has the obligation to repair the damage done in the shortest time possible and in accordance with the instructions given by the supervisory body.

Measures during operation

Pumping stations have to be constructed as fully enclosed structures for the protection against foul odors. Pumping station has to be dimensioned for minimum retention of wastewater in the pumping reservoir. Considering minimum inflow during nighttime and the threat from the development of foul odors in the deareating pipe of the pumping station. activated coal filter should be envisaged. All other openings have to be efficiently sealed.

- Connections of canals. manholes and reservoirs have to be watertight so as to protect the groundwater and the sea. Adequate calculation and construction methods have to be applied to prevent ruptures. taking into account adverse impacts of earthquakes. Prior to commissioning. water tightness of the canal network has to be checked by pressure tests.

- All the machinery that produces noise of higher magnitudes than permitted. has to be placed in fully enclosed buildings to provide for noise prevention. The project has to test noise levels and examine if additional protective materials have to be built in.

- Water-management permit for the existing production plants in the area of the public sewage system in the industrial zone Gaženica has to define the composition and concentrations of wastewaters that are allowed to be discharged into public sewage canals. and the degree of pre-treatment. if required.

- For new plants that will be built in the future. the discharge of process wastewaters into the public sewage system has to be defined by water-management conditions and approved by water-management permit.

Measures in case of incidents or interrupted operation

- Stand-by pumps have to be envisaged for all pumping stations with automatic switching on.
- Energy supply of pumping station has to be enabled from at least two independent power sources.
- Mobile pumps driven by a diesel generating sets have to be permanently in good operating condition and will be used in case that the operation of a certain pumping station is completely interrupted.
- To extinguish fire on electric installations. fire extinguishers have to be envisaged as a firefighting measure at appropriate locations.
- As protection against corroding activity of exhaust gases and steams. all metal parts in pumping stations have to be made of corrosion-resistant metals. or protected against corrosion.

2.2 Project Planning

2.2.1 Wastewater treatment

Industrial wastewaters from the Gaženica zone will be pre-treated in a common central wastewater treatment facility of the City of Zadar prior to their discharge into a natural recipient.

"Clean technology" methods have not been applied in the existing industrial plants. All wastewaters are discharged and thereupon treated at the "end-of-pipe". In the future. during the reconstruction of the existing plants and/or construction of new ones. "clean technology" should be applied in order to achieve the safest pollution control "at-source". In some of the plants. where justified. wastewater recycling will lessen the consumption of raw materials and decrease environmental pollution at the same time.

For the time being. it has been envisaged that the sewage network will collect wastewaters and pumping stations will pump wastewaters to the central municipal treatment facility.

The location of the central wastewater treatment facility "Centar" is along the Ričina stream. near the city cemetery (Annex 100).

All municipal wastewaters will be treated in the "Centar" facility together with industrial wastewaters of the Gaženica zone. Data on hydraulic load and daily pollutant quantities have been taken from the Conceptual Design of the Centar – Zadar Sewage System Wastewater Treatment Facility (Hidroprojekt-ING. 1999).

The construction of central municipal wastewater treatment facility has been envisaged in two development phases (periods):

- I period 100.000 PE
- II period 200.000 PE

Hydraulic load of the wastewater treatment facility. pursuant to the Conceptual design of the Public Sewage System (Hidroprojekt-ING. 1999) is the following:

Table 2.2.1 Hydraulic load of the facility

Inflow	I period	II period
Mean daily (m^3/d)	27.500	55.212
Relevant hourly. dry (m^3/h)	1.500	3.070
Relevant hourly. wet (m^3/h)	3.000	5.875

Pollution load has been estimated with relation to the number of population equivalent (PE).

Table 2.2.2 Daily pollution load

Indicator	I period	II period
BOD-5 (kg/d)	6.000	12.000
COD (kg/d)	12.000	24.000
Dispersed solids (kg/d)	7.000	14.000
Total nitrogen (kg/d)	1.100	2.200
Total phosphorus(kg/d)	250	500

The above values of hydraulic load and pollution load include the load stemming from the industrial zone. which was estimated at somewhat higher values in the Conceptual Design than it is the case today. i.e. it was determined on the basis of questionnaire presented to the commercial undertakings located presently on site.

Consistent with the State Plan for Water Protection (Official Gazette 8/99). secondary wastewater treatment has been envisaged in this wastewater treatment facility.

If the requirements get more stringent in the future. planned surface area required for the facility in the II period accommodates the possibility of facility's upgrade by installing equipment for tertiary treatment.

The quality of discharged wastewater has to meet the requirements stated in Table 2.1.5 of this Study.

The Conceptual Design envisaged the wastewater treatment facility with activated sludge process (biological process) and anaerobic sludge stabilization (in accordance with the treatment flow diagram given in Figure 2.1). The following structures have been planned for construction in the "Centar" wastewater treatment facility for wastewater treatment activities and processes (Annex 102):

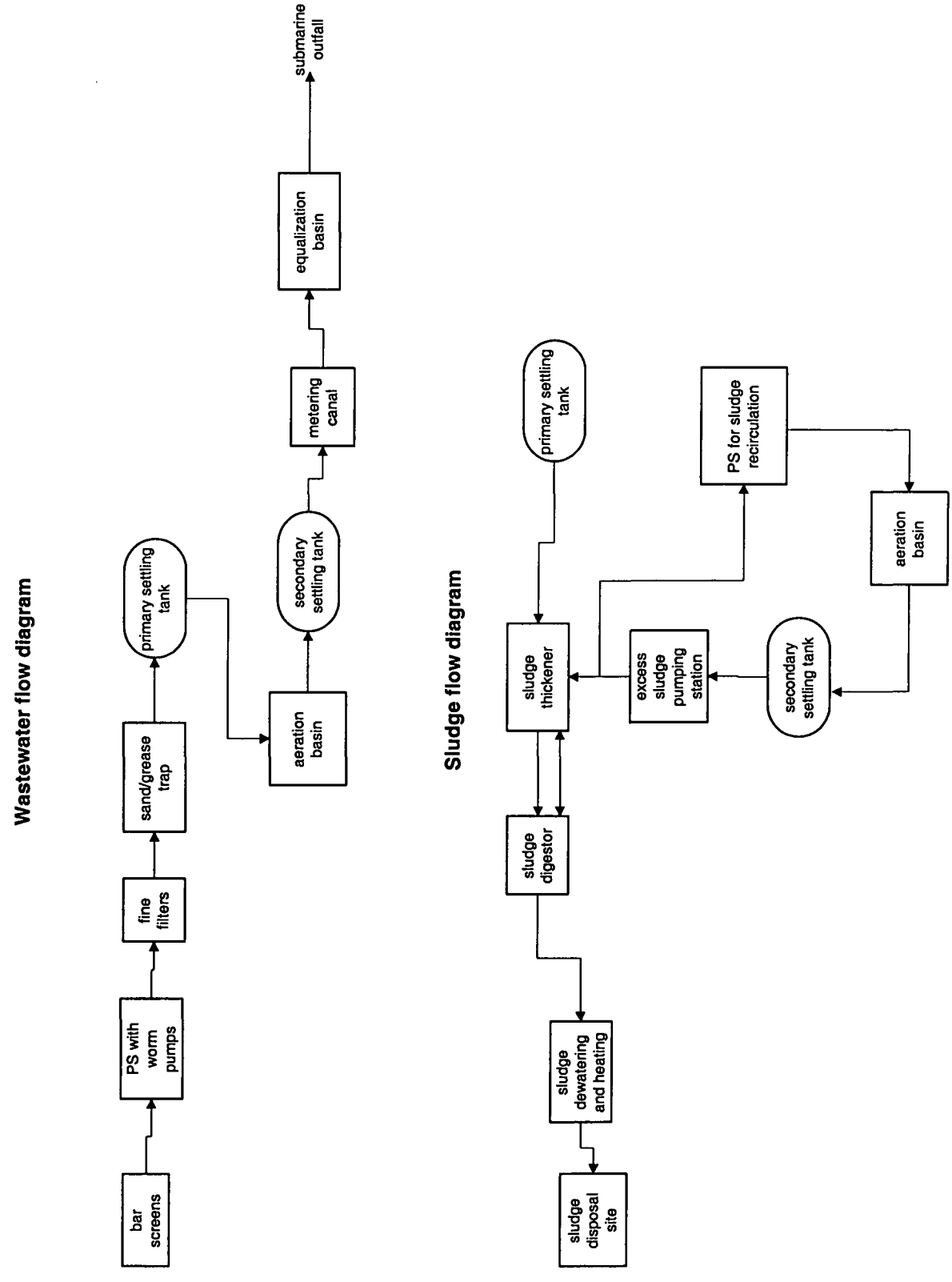
- mechanical bar screens (spaced up to 30 mm apart)
- mechanical filter (filter opening 3 mm)
- sand/oil filters (residence time in wet conditions 7 min)
- preliminary clarifier (hydraulic load 35 $m^3/m^2/h$)
- aeration basin (sludge load 0.25 kg BOD-5/kg ST/day)
- secondary clarifier (residence time of 3.0 hours)
- sludge thickener (thickening time 3 days)
- anaerobic digestor (residence time of 27 days)
- sludge dewatering (dry substance concentration 25%).

For the purpose of environmental protection it has been envisaged that some activities and processes will be carried out in fully enclosed buildings with forced aeration and flue gas scrubbing. Other processes will be carried out in open tanks/basins.

The construction of the following enclosed structures has been envisaged:

- water and sludge pumping stations
- bar screens and filters
- sludge thickeners
- digestors
- sludge filters
- areas with bar screens for waste retention. sand and oil filtration area and dewatered sludge retention area.

Figure 2.1: Treatment flow diagram for the wastewater treatment facility "Centar" -Zadar (wastewater flow and sludge flow)



2.2.2 Discharge of treated wastewater

Treated wastewater will be discharged from the wastewater treatment plant into the Zadar Channel by a long submarine outfall. Based on oceanographic research into the Zadar Channel. basic data are given below on the recipient of treated wastewaters of Zadar (Zore-Armando et al.. 1977; Zvonarić T. et al.. 1994).

The Zadar Channel is a typical enclosed channel spreading in the direction southeast-northwest. The channel is approximately 20 km long and 4-7 km wide. The sea depth in its northwestern part is 50 m and in the southeastern part 25 m. Seawater volume in the Zadar Channel is 5.4 km^3.

The mean speed of sea currents in the entire Zadar Channel is 5 to 10 cm/s. On the basis of measured currents. the calculated water mass exchange time in the Zadar Channel is 3 to 5 months. The estimate based on salinity values has resulted in water mass exchange time of 7.2 months. and the mean value resulting from both methods is 6.4 months. i.e. two water mass exchanges per year.

The research into nutrient salts concentrations in the Zadar Channel to date suggest that nitrate. ammonia. phosphate and silica concentrations are rather low. Concentrations of nutrient salts are significantly lower than in the majority of other seas and oceans. However. due to the encloseness of the area and limited water exchange with broad sea. there are some specific circumstances regarding the increase in nutrient salt concentrations over time.

The research into benthos communities confirms that wastewater discharge resulted in adverse impacts at certain locations.

The submarine outfall spreads from Punta Bailo towards the center of the channel. The submarine part is 2000 m long. and the pipeline diameter is 1200 mm. The diffuser length is 352. Diffuser opening diameter is 15 cm. The depth of the sea at the location of the diffuser is 34.0 m. At diffuser's end wastewater will be mixed with relatively clean seawater. and the concentration of pollutants will be decreased in the mixture of wastewater and seawater due to the diffusion and decomposition of organic matter. The concentrations of pollutants after treatment and discharge through the submarine outfall are presented. as calculated in the Environmental Impact Study mentioned before (School of Civil Engineering. 2000).

Table 2.2.3 Pollutant concentrations in the coastal sea

Indicator	Concentrations				
	Ahead of facility	After treatment	At 300m distance	At 950m distance	Allowable
BOD-5 mg O_2/l	217	21.7	2.73	2.02	2-4
COD mg O_2/l	434	86.8	5.64	4.12	4-8
S. S. mg/l	253	25.3	2.04	0.036	0
n. c. / 100 ml	10^8	10^7	-	361	500

Allowable concentrations of BOD-5 and COD indicators are set in accordance with the Regulation on Water Classification. and allowable concentrations of S.S. (suspended solids) and n.c. (number of coliforms) are set in accordance with the Regulation on Beach Water Quality Standards.

The conclusion can be made that no undesirable changes in the coastal sea of the Zadar Channel are to be expected if the envisaged wastewater treatment stage is applied for treating wastewaters of Zadar and if treated wastewaters are discharged via a submarine outfall equipped with diffuser.

2.2.3 Sludge treatment and disposal

Sludge treatment processes have been considered as per the option of final sludge disposal. In the selection of sludge process. basic treatment objectives have been assumed. i.e. to reduce sludge volume and dispose it safely without adverse environmental impact.

As regards final disposal of sludge. the following possibilities exist:

- sludge disposal on a separate sludge disposal site.
- sludge disposal on sanitary waste disposal site together with solid wastes.
- reuse of sludge in agriculture and/or forestry.

The reuse of waste mater in agriculture and/or forestry is the best method of final sludge disposal. since the circulation of nutrients is maintained in the geochemical cycle. Certain conditions have to be met in order to dispose sludge in such fashion. First of all. agricultural and/or forest land on which sludge can be reused. has to be located adjacent to the wastewater treatment facility. In other words. such land has to be of adequate pedological characteristics and appropriate cultures have to be cultivated on it. Further on. it is important that the users are willing to use sludge for such purposes. which implies that the "market" exists for the reuse of sludge or sludge-based compost. Finally. it should be mentioned that there are limitations to the reuse of sludge. among others in karst areas and coastal areas. which has been affirmed in the Rule Book on the Protection of Agricultural Land against Pollution by Harmful Substances (Official Gazette 15/92).

In view of the above. it has been proposed to dispose the treated sludge on a sanitary waste disposal site until the conditions are defined for its reuse. which among other things implies that the composition and concentrations of individual substances contained in the sludge have to be identified.

Prior to its disposal on the disposal site. the sludge has to undergo a stabilization process.

The following possibilities have been considered in the Conceptual Design:

- aerobic stabilization
- anaerobic stabilization
- chemical stabilization
- thermal stabilization.

When selecting the stabilization with biological process for the facility sized over 100.000 PE. anaerobic stabilization has advantage since such process generates more energy than the aerobic stabilization process. which only consumes energy for the disintegration of organic matter.

Sludge volume can be reduced by way of

- natural percolation and evaporation.
- mechanical process.
- thermal process.

To apply natural percolation and evaporation in the facility of this size large surface area would be required which does not exist at the location. Also. at the site where the facility will be constructed. in view of its spatial disposition. sludge drying fields cannot be applied due to aesthetic reasons (scenery) and the fact that this is an urban area.

The second possibility of sludge treatment is the solution with composting. The implementation of composting depends on the final disposal of sludge and possible reuse of sludge. One of the methods to further reduce sludge volume is its composting at disposal sites.

The composting has not been envisaged at facility's location. and potential implementation of this process will depend on future circumstances and will be performed at the final disposal site.

The Conceptual Design of the facility proposes anaerobic sludge stabilization using biogas for digestor heating and sludge dewatering by pressure filters.

Solid substances that are separated in filters and on bar screens have to be disposed off in an adequate manner. The quantity of solid substances separated on bar screens depends on wastewater composition and differ as per population habits. i.e. what type and quantity of waste are the inhabitants throwing into the sewer (paper. paper/plastic bags. rags. cotton wool. fruit and vegetable peels. etc.).

Mechanical bar screens remove minor solids that have passed through the bars and a part of dispersed matter. depending on the size of holes in the mechanical filter.

In accordance with the Rule Book on Waste Types (Official Gazette 27/1996). the waste from the bar screens and filters can be disposed on the sanitary waste disposal site. Prior to its disposal. such waste will be filtered and stored away in plastic bags to prevent its adverse impact on the environment.

Sand filter removes inorganic particles (sand. gravel) that can damage or interrupt the operation of process equipment in the facility.

Sand quantities collected in sand filters depend on the wastewater and stormwater drainage method and on the conditions in the catchment area of the public sewage system.

The Zadar facility envisages sand washing. i.e. the separation of organic pollutants.

In accordance with the Rule Book on Waste Types. the waste from the sand filter will be disposed on the sanitary waste disposal site after treatment (washing). The sand from the sand filter can be used as material for daily coverage of waste layers.

In the aerated sand-grease filters concurrent separation of greases (oils and greases) will take place. The amount of greases separated in grease filters depends on the method of natural or induced floatation. In case of induced floatation. the amount of grease further depends on the size of air bubbles and on whether the air was previously dissolved in water under pressure or not. However. for municipal wastewaters it can be assumed that approximately 25 percent of total grease can be removed by induced floatation. The amount of grease that occurs in the facility depends on local circumstances. too.

In accordance with the Rule Book on Limit Values for Indicators of Hazardous and Other Substances in Wastewater (Official Gazette 40/99). the concentration of grease in process wastewater discharged into a public sewage system cannot exceed 100 mg/l.

In line with the Rule Book on Waste Types. greases from the grease filter can be treated either biologically or thermally.

In case that the incineration plant is constructed within the facility for treatment and final disposal of solid substances in Zadar. greases from the facility will be incinerated in enclosed tanks. If the solid waste incineration plant is not built. greases from the facility can be biologically treated in-plant. In such case. greases will be discharged into the sludge digestor for anaerobic decomposition of organic matter.

2.3 System design. assembly and operation

The selected option for industrial wastewaters of Gaženica consists of the construction of common sewage network with pumping stations that convey wastewater to the municipal wastewater treatment and discharge facility. Since the solution and operating mode of the Zadar wastewater treatment facility has been shown in the Conceptual Design of the "Centar" – Zadar Sewage System Wastewater Treatment Facility (Hidroprojekt-ING. 1999). and in the Conceptual Design of the

Submarine Outfall (Hidroprojekt-ING. 1999). and since the City of Zadar has authority over this part of the system. in continuation we present the solution to and the operating mode of the part of the system connected with the sewage network and pumping stations for the collection of industrial wastewaters of Gaženica and their conveyance to the wastewater treatment facility "Centar"- Zadar.

2.3.1 Sewage network and pumping stations

Sewage collectors are key structures in the sewage system and account for the majority of structures in the sewage network both in physical and financial terms. To ensure that the gravity canals meet their purpose. the following has to be specified:

- piping material. which is cost-effective in terms of installation and required operational characteristics.
- minimum profile that guarantees optimum operational and hydraulic characteristics as regards discharge and maintenance.
- minimum and maximum permitted heads that ensure proper and permanent functioning of the system.
- calculation procedure. selection of the most favorable dimensioning methods.

The Conceptual Design prepared in 1999 proposed the utilization of asbestos concrete pipes for the construction of circular gravity canals.

All gravity canals are laid mainly beneath communication roads in accordance with effective technical standards. The exact position of collectors in the cross-section will be defined in detailed project design documentation.

In the distribution system envisaged for the industrial zone Gaženica. minimum profile of sanitary and industrial wastewater canals is Ø 250 mm. and of stormwater canals Ø 300 mm.

The Conceptual Design prepared in 1999 envisaged the application of asbestos concrete and PVC pipes for pressure pipelines of individual pumping stations.

Inspection manholes that enable the access to canals for sewage system maintenance purposes have to be constructed in the canal network. Furthermore. inspection manholes enable proper technical connection of canals. their routing. change of head and profile. The Conceptual Design of 1999 anticipated reinforced concrete inspection manholes of square cross-section and floor dimensions that vary depending on pipe profile. canal routing. height of cascades and the number of connections. The possibility has been envisaged in the detailed project design for asbestos concrete assembly manholes. if estimates show that this is. economically and technically. more favorable solution (especially along the coastline).

Pumping stations were designed with envisaged centrifugal submerged pumps ("wet" installation). Final selection of pump type will be carried out upon the elaboration of detailed project design. in accordance with the conditions that will be in effect at the time.

Geotechnical investigations should be performed at the location of each planned pumping stations on the basis of which the grounding solution will be given and the solution to the protection against construction pit implosion and water inflow.

All pumping stations have been envisaged as an ensemble of two structurally connected structures: the pumping basin as the central structure and the sluice hole. The automatic operation of all pumping stations has been envisaged with a stand-by power supply provided from steady generating set located in the above-ground building. which also accommodates transformer station. control room and toilet facilities.

2.3.2 Equipment

Major equipment to be installed in the planned sewage system structures is the following:

- piping material for gravity canals and pressure canals. and
- pumps.

2.3.3 Operation - maintenance

Sewage system operation means functional and constructional maintenance of all sewage system structures. In principle. supervision. cleaning and maintenance of municipal sewage system is carried out by a separate utility that employs personnel qualified for carrying out such activities.

Commonly. wastewater canals and pipelines have to be occasionally cleaned. The frequency of regular cleaning depends on the condition of the pipeline system. In general. endeavors should be made to clean all canal routes at least once a year. The most economical way of cleaning is rinsing. either by temporary hold back of wastewater or by intake of external water.

Furthermore. all the sewage system structures are subject to wear and tear. resulting in and specific damage (mechanical abrasion. external corrosion. internal corrosion. cracks. deformations. etc.). Different procedures can be applied to repair the damage (complete pipeline replacement. partial or complete lining. "relining" procedure. etc.).

3 PROJECT IMPLEMENTATION

Reliable operation of the Gaženica industrial wastewater treatment system depends on the overall organizational structure in its environment. Administrative. legal and financial organization required for project implementation should be planned and formulated on time in order to avoid delays and bottlenecks during the phase of implementation of the selected project and problems during its operation.

3.1 Institutional Framework for Project Implementation

3.1.1 Institutions responsible for project implementation

The following institutions participate in the implementation of the project selected for the treatment of industrial wastewaters of Gaženica:

a) operating unit (organization) in charge of construction and system management
b) state inspectorate in charge of quality control of the coastal sea in the hot spot area.
c) state institutions responsible for water and coastal sea protection policy.

3.1.1.1 Operating unit for system management

The City of Zadar has founded the company "Odvodnja d.o.o." seated in Zadar. The company was registered to provide services of wastewater drainage and treatment. Pursuant to the Municipal Services Act (Official Gazette 26/03). the company can manage overall construction and take upon itself the management of the system as a whole. including the sewage network and pumping stations located in the industrial zone Gaženica. wastewater treatment plant "Centar" – Zadar. and the submarine outfall.

3.1.1.2 State institutions and inspectorates

3.1.1.2.1 State institutions responsible for water protection policy and coastal sea protection policy

The authority over water management in the Republic of Croatia has been delegated to the State Water Directorate responsible to the Government of the Republic of Croatia. The organizational structure of the State Water Directorate includes Water Management Department and Division for Legal Affairs. Analysis and Standardization. Finances and Planning. General Affairs. Administrative and IT Affairs.

Water Management Department consists of the following divisions:

- Division for Water Management and
- Division for Inspection Supervision.

Division for Water Management carries out administrative and legal activities connected with direct enforcement of regulations in the water management field relating to the use of water and protection against detrimental effects of water and water protection. and performs information system activities. The Division organizationally encompasses:

- Section for the Use of Waters and Water Estate and Protection Against Detrimental Effects of Water and
- Section for Water Protection.

Section for Water Protection carries out administrative. legal and professional activities relating to the protection of inland surface waters and groundwater against contamination and pollution. protection

of the sea against pollution from inland-based sources. water management planning within water protection. monitoring of surface water and groundwater quality. planning and adjustment of development and construction activities related to public sewage systems and wastewater treatment systems. This Section also monitors the production and trade in chemical substances that can enter waters after their respective use. resolves issues connected with principal water management laboratory and other accredited laboratories for wastewater quality testing. carries out activities related to international cooperation concerning the mentioned issues and activities related to water-management documents. It participates in the development of regulations in the field of water protection. monitors conditions in the field of water protection and proposes measures for condition improvement. executes administrative control over Croatian Waters and controls the legality of its operations with relation to the authority delegated Croatian Waters. The Section cooperates with other state administration bodies and Croatian Waters. international organizations and institutions. It also executes administrative control over legal persons with public authority. and carries out other activities for other organizational units of the State Administration.

The activities related to water management at the level of the state are entrusted to Croatian Waters. in the scope defined by plans and consistent with financial resources earmarked for such purposes by the Water Management Financing Act.

3.1.1.2.2 State institutions responsible for control

The Division for Inspection Supervision has been organized within the State Water Directorate. This Division carries out inspection supervision over the enforcement of the law and corresponding regulations relating to water management. general law and individual acts relating to water management. the use of water and water estate. water protection. regulation of water courses and other water bodies and protection against detrimental effects of waters. The Division oversees the implementation of international obligations. activities on and condition of transboundary and national water systems and of the coastal sea. It supervises the preparation and implementation of the State Plan for Water Protection. the compliance with water-management documents and concession agreements. carries out supervision and control over the work of state administration bodies in counties and the City of Zagreb that carry out water inspection activities. coordinates the work of county water-management inspectorates and water-management inspectorate of the City of Zagreb. carries out administrative and legal activities. gives professional opinions and explanations regarding the enforcement of regulations in the field of water-management inspection supervision. keeps stipulated records. prepares reports on inspections. proposes annual operating plans and annual activity reports.

County water-management inspectorates supervise the enforcement of Water Act provisions and other regulations based thereon and the decisions reached by county assemblies or the City Assembly of the City of Zagreb. They implement the measures in the field of water management in cases that do not fall under the authority of the State Water Inspectorate. County water inspectors are employed with County Offices of the State Administration.

Water-management inspectorates carry out the following activities:

1. Urgent inspection supervision in cases of emergency water pollution and filing charges.
2. Undertake actions aimed at:

- gravel and sand excavation control.
- control over flood prevention structures.
- control and sampling of discharged waters at the locations that represent major polluters in terms of quality and quantity of discharged water.
- control the collection of catchment area water-use fees in local self-government units.
- control over the operation of municipal utility companies .

3. State Water Management Inspectorate carries out other activities. as follows:

   - executes supervision. provides professional aid and additional training to county water inspectors. Each year. a joint meeting of all water management inspectors is organized at which the work in the preceding period is analyzed. several professional topics elaborated and guidelines for further work set.

   - develops annual plans and reports on its own work and integrates data delivered by all county water management inspectors.

   - organizes thematic and coordination meetings of water management inspectors.

   - cooperates with other divisions of State Water Directorate. especially during the elaboration of draft bylaws and gives expert opinion in resolving second-stage complaints on court judgments.

   - cooperates with other inspectorates. especially those for environmental protection and mining.

Other state officials authorized by the Director can perform the activities of water management inspection. The State Water Management Inspectorate can directly carry out the activities that come within the competence of county water management inspectorates at the expense of the respective county if it rules that the provisions of this Act or other related regulations passed on the basis of the Act cannot be otherwise enforced. and the water management inspectorate authorized to carry out such activities failed to effect inspection supervision within stipulated time or did not complete the procedure in due time.

3.1.2 Legal basis for project implementation

3.1.2.1 Legislative framework

The identification of legal status of water bodies is very important for water management and use and for acquiring water rights. Paragraph 1 of Article 52 of the Constitution of the Republic of Croatia states that the sea. seashore and islands. water bodies. air space. mineral wealth and other natural resources enjoy. under the Constitution. special protection of the Republic of Croatia. and cannot be owned by anyone due to their natural properties.

Planning documents for water management are Water Management Master Plan of Croatia and water management master plans or plans of catchment areas (the preparation of which is currently underway). These planning documents set development guidelines. plans. measures and works required for securing necessary water quantities of required quality and usability and measures for rational water management and protection against detrimental effects of waters. and are based on the existing status regarding water quantities. distribution. quality and intended use of waters and the existing degree of completeness of the water system. demand estimates and possibilities of ensuring special purpose funds for the financing of such requirements.

Water protection is carried out on the basis of the following laws. regulations and international treaties:

Laws:

1. Water Act (Official Gazette 107/95)
2. Water Management Financing Act (Official Gazette 107/95. 19/96 and 88/98)

Regulations:

1. Decision on National Water Inventory (Official Gazette 20/96)
2. Rule Book on the Issuance of Water Management Acts (Official Gazette 28/96).

3. Rule Book on Conditions to be Met by Accredited Laboratories (Official Gazette 78/97 and 92/97)
4. Rule Book on Special Conditions to be Met by Legal Persons Carrying Out Wastewater Discharge Activities (Official Gazette 93/96. 53/97 and 102/97)
5. Decision on Water Protection Fee (Official Gazette 58/00)
6. Rule Book on the Calculation and Payment of Water Protection Fee (Official Gazette 62/00)
7. Regulation on Water Classification (Official Gazette 77/98)
8. Regulation on Hazardous Substances in Water (Official Gazette 78/98)
9. State Plan for Water Protection (Official Gazette 8/99)
10. Rule Book on Limit Values for Indicators of Hazardous and Other Substances in Wastewaters (Official Gazette 40/99. 6/01 and 14/01)
11. List of Accredited Laboratories (list of accredited scientific laboratories. accredited principal water management laboratory and accredited reference laboratory) (Official Gazette 107/00)
12. Instructions on Keeping Records on the Frequency of Discharge of Hazardous and Harmful Substances into Waters. Quantity and Composition of Such Substances and Method of Submitting Such Data to Public Water Management Companies (Official Gazette 9/90). in connection with Article 215 of the Water Act.

International obligations and standards:

1. Law on the Amendments to the Convention for the Protection of the Mediterranean Sea Against Pollution and Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft
   Official Gazette – International Treaties 17/98
2. Protocol on the Exploitation of Sea-Bed and its Sub-Soil
   Adopted: Madrid 1994
   The Republic of Croatia is the signatory to the Protocol. Madrid 1994
3. Convention for the Protection of the Mediterranean Sea Against Pollution
   The Republic of Croatia became the party to the Convention on the basis of the notification on succession
   (*Barcelona Convention*)
   Official Gazette – International Treaties 12/93.
4. Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft (Dumping protocol)
   The Republic of Croatia became the party to the Protocol on the basis of the notification on succession.
   Official Gazette – International Treaties 12/93
5. Protocol Concerning Cooperation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency (Emergency Protocol)
   The Republic of Croatia became the party to the Protocol on the basis of the notification on succession.
   Official Gazette – International Treaties 12/93
6. Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-Based Sources (LBS Protocol)
   The Republic of Croatia became the party to the Protocol on the basis of the notification on succession.
   Official Gazette – International Treaties 12/93
7. Protocol Concerning Mediterranean Specially Protected Areas (SPA Protocol)
   The Republic of Croatia became the party to the Protocol on the basis of the notification on succession
   Official Gazette – International Treaties 12/93

3.1.2.2 Organizational Structure

3.1.2.2.1 General

The provisions of the Water Act relate to all surface waters and groundwater. including estuaries of rivers that inflow into the sea and channels connected with the sea. mineral and thermal waters and sea waters with relation to their protection against pollution from land-based sources. The Act regulates legal status of waters and water estate. methods and conditions for water management (water use. water protection. regulation of water courses and other water bodies and protection against detrimental effects of waters). method of organizing and carrying out water management activities. basic conditions for carrying out water management activities. competencies and responsibilities of state administration bodies and other state bodies. local self-government and administrative units and other legal entities. and other issues of importance for water management.

Water protection is carried out in accordance with the State Plan for Water Protection and county plans for water protection and the plan for water protection of the City of Zagreb. Water Protection Plans in particular set out : required investigation and water quality testing activities. water protection measures. including measures in case of accidental and sudden water pollution. plans for the construction of wastewater drainage and treatment structures in settlements. required financial resources. sources and methods of financing. persons responsible for the implementation of plan. their competencies and responsibilities.

Progressive implementation of regulations is ensured by the issuance of water-management permits for wastewater discharge and the accessory act – permit order. Water-management permit defines wastewater quality to be achieved by each undertaking carrying out commercial activity of wastewater discharge. and permit order commands what actions and investments should be taken within certain period of time to achieve wastewater discharge consistent with water management permit.

State Plan for Water Protection (hereinafter referred to as the Plan) has been adopted for the protection of waters and protection of the sea against pollution from land- and island-based sources and comprises: required investigation work and water quality testing. water classification. construction plan for wastewater treatment plants and structures. sources and methods for Plan financing and list of physical and legal persons responsible for the implementation of the Plan. their competencies and responsibilities. County plan for water protection has to be adjusted to the provisions of this Plan.

The objective of the Plan is to carry out water management in accordance with the principle of integrated water system and of sustainable development. The Plan is based on the precautionary principle that implies planning and taking required measures with relation to water protection even if there are no solid evidences that water quality has changed. The Plan is implemented under the principle «use of best available technologies» and «polluter pays» principle. The principle of providing continuous information on water quality and the principle of exchanging information with neighboring countries are very important for public information and for implementing required water protection measures.

3.1.2.2.2 State Plan for Water Protection

State Plan for Water Protection provides basic components for the implementation of national policy in the field of water protection and protection of coastal sea of the Republic of Croatia. The selected solution for the treatment of wastewaters from the industrial zone Gaženica fits well into the Plan. The implementation components are given below:

Required investigation work and water quality testing:

a) surface waters. groundwater and the sea

1. Investigation work and water quality testing are carried out in order to determine the type of water and assess its quality and causes of quality change. and identify and implement required water protection measures.
2. Water and sea testing and investigation work are carried out on the basis of adopted programs that mandatory have to define the amount of financial resources required for implementation and sources of financing.
3. Water quality testing programs for transboundary waters. which are the subject of the agreements on water management relations entered into between the Republic of Croatia and neighboring countries.

Water quality testing programs for national waters (national testing program). inner sea waters and the territorial sea affected by pollution from land-based sources and the program for monitoring their land-based pollution sources (Protocol Concerning the Protection of the Mediterranean Sea Against Pollution from Land-Based Activities. Convention Concerning the Protection of the Mediterranean Sea Against Pollution. hereinafter referred to as LBS – Program) are developed and implemented by Croatian Waters. subject to the consent given by the State Water Directorate and opinion given by State Directorate for Nature and Environmental Protection in connection with the LBS-Program.

County plans for water protection define water quality testing programs for local waters. Test results are submitted to Croatian Waters and published together with the report on test results for national waters. Croatian Waters have the obligation to prepare and publish annual report on the results of all water and sea quality tests conducted. Every five years. Croatian Waters have to publish the assessment on water quality change. State Water Directorate submits report on water quality condition to the National Water Committee. the Government of the Republic of Croatia and Croatian State Parliament every five years.

b) wastewaters

Physical and legal persons that discharge process wastewaters directly into the sea and legal persons that carry out the activity of public drainage of wastewaters that are also discharged directly into the sea have the obligation to perform water quality testing in accordance with the LBS – Program for water quality testing. as defined in the water-management permit. Test results are submitted to Croatian Waters. which have the obligation to prepare annual report and submit it to the State Water Directorate.

c) other tests and water investigation work

The programs for special tests and water quality investigations are implemented in accordance with special programs defined by the State Water Directorate upon the proposal of Croatian Waters. Only accredited laboratories. listed in the Rule Book on Accredited Laboratories (Official Gazette 78/97) can carry out water quality investigation and testing programs.

Water Classification

Water classification identifies the planned water type and is achieved through the preparation of master plans for water management and through the implementation of water protection measures from the State Plan for Water Protection. Water classification categorizes water courses. parts of watercourses and other water bodies. and parts of the sea affected by pollution from land-based sources. into groups for which water class is defined. Water has to meet the prescribed conditions for a certain type of water. based on the standards set in the Regulation on Water Classification (Official Gazette 77/98).

Water protection measures

Water protection measures encompass the following: objectives of measures. administrative measures. water conservation measures. measures for the abatement and mitigation of water pollution. implementation measures and implementation schedule.

a) Objectives of water protection measures are the following:

1. To preserve still clean surface waters and groundwater. In water classification such waters have been assigned the first water class.
2. To end the tendency of water quality deterioration. This is achieved by the elaboration of medium-term and long-term measures.
3. To rehabilitate and eliminate pollution sources. first of all at the existing and planned sources of potable water and at other locations where the water is used for the purposes for which class II or class III water should be ensured (industry. agriculture. fishery. recreation. etc.).
4. The priority task for the short-term is to systematically control water pollution sources and potential accidental pollution and to implement prevention measures for the abatement of accidental pollution is.

b) Administrative measures for water protection are the following:

1. Water management master plans for water bodies and catchment areas that comprise among others: estimates on watercourse loading possibilities. total planned loading by wastewater discharge. identification of relevant recipient flow rates for the reception of discharge. solutions to decrease recipient loading.
2. Amendments to issued water-management permits for wastewater discharge by way of permit orders and their adjustment to required water protection measures and objectives.
3. Systematic monitoring of regulations in the field of water protection and their adjustment to measures identified for the purpose of water protection.
4. Development of water protection cadastre and its adjustment to the environmental information system and preparation of other technical documents required for the implementation of water protection measures.
5. Public information on water quality condition and on the efficiency of applied measures.

c) Water conservation measures are the following:

1. Ban on the construction in the areas where the quality of source waters and groundwater that are used or are planned to be used for public water supply is endangered.
2. Ban or restriction of construction in specially protected areas and valuable water ecosystems that are proclaimed natural parks. national parks. etc.
3. Restrictions on construction and carrying out activities on small watercourses or karst areas where the discharge of wastewater can have adverse impact on water quality despite the application of necessary water protection measures.
4. Ban on the discharge of hazardous substances. in accordance with the Regulation on Hazardous Substances in Waters. and priority removal of prescribed hazardous substances.
5. Limitation on the discharge of hazardous substances. in accordance with the Regulation on Hazardous Substances in Waters.
6. Increase of recipient capacity by the construction of required water management structures.

d) Measures for the abatement and mitigation of water pollution are the following:

1. Planning. reconstruction and construction of public sewage system.
2. Planning. reconstruction and construction of public sewage wastewater treatment facility.
3. Reduction of wastewater loading from various technological processes and adjustment of wastewater composition to allowable limit values for hazardous and other substances that are discharged into public sewage system or into natural recipient.
4. Replacement of existing technologies with more advanced. cleaner technologies. in technological processes that produce hazardous and other substances which contaminate water.

5. Implementation of measures to mitigate water pollution from agrotechnical substances.
6. Arrangement of erosion areas and prevention of runoffs by the construction of water regulation structures. reforestation. adequate soil cultivation. and adequate use of agrotechnical substances in the cultivation of plants.
7. Construction and equipping of disposal sites for all types of wastes so as to meet technical and technological conditions. especially those set in the Rule Book on Waste Management Conditions and the Regulation on Hazardous Waste Management Conditions.
8. Rehabilitation of the existing unarranged waste disposal sites. first of all at places where there is a threat from contamination of groundwater and surface waters used as potable waters.
9. Removal of land-based sources that pollute the sea and limit its use for certain purposes (shell breeding. fish farming. recreation. etc.).

e) Implementation measures

In order to implement water protection measures. the Implementation Plan is prepared consisting of:

1. List of water and sea polluting factors. assessment of water condition and setting priorities in the implementation of necessary measures.
2. Analysis of possibilities for the use of advanced technologies in certain technological processes.
3. Identification of necessary water and sea protection measures and required financial resources for their implementation. and assessment of revenues from investments into the implementation of envisaged measures.
4. Time schedule for the implementation of identified measures.
5. Persons responsible for the realization of the Implementation Plan.

f) Implementation schedule

The Implementation Plan is developed for:

- short-term (by the year 2005).
- medium-term (by the year 2010) and
- long-term (by the year 2025).

<u>Construction plan for wastewater treatment structures and facilities</u>

a) Structures – public sewage systems

1 It is recommended to complete the construction of public sewage systems that discharge wastewaters into waterways ("less sensitive areas") as follows:
   - by the year 2005. for the facilities greater than 15.000 PE.
   - by the year 2010. for the facilities between 2.000 and 15.000 PE and
   - by the year 2005. for the facilities that discharge wastewaters into "sensitive areas" and are greater than 10.000 PE.

2 It is prohibited to discharge wastewater into "very sensitive areas". Exceptionally. and under special conditions. wastewater discharge into "very sensitive areas" can be permitted. The proposal of such areas will be developed by Croatian Waters in cooperation with the Ministry of Spatial Planning. Construction and Housing and State Directorate for Nature Protection by 31 December 1999. and will be adopted by the Director of the State Water Directorate and published in the "Official Gazette".

3 County plan for water protection envisages the construction of a public sewage system. appoints legal person responsible for plan execution and plans the provision of required financial resources for its implementation.

b) Wastewater treatment facilities

1. The construction of wastewater treatment facilities can start if the construction of at least 70% of the entire public sewage system has been completed:
2. It is recommended to complete the construction of the "second stage" of the wastewater treatment facility from which wastewaters will be discharged into waterways ("less sensitive areas") as follows:
   - by the year 2010. for the facilities greater than 15.000 PE.
   - by the year 2025. for the facilities between 2.000 and 15.000 PE and
   - by the year 2005. for the facilities that discharge wastewaters into "sensitive areas" and are greater than 10.000 PE.
3. It is recommended to complete the construction of the "first stage" of the wastewater treatment facility from which wastewaters are discharged into the sea via an adequate submarine outfall as follows:
   - by the year 2010. for the facilities greater than 15.000 PE.
   - by the year 2025. for the facilities between 2.000 and 15.000 PE and
   - by the year 2005. for the facilities that discharge wastewaters that underwent the "secondary treatment" stage. and are greater than 2.000 PE.
4. The list of wastewater treatment facilities greater than 50.000 PE. the construction of which is considered a priority. is given in the Plan.
5. County plan for water protection envisages the construction of the wastewater treatment facility. appoints legal person responsible for construction plan implementation and plans the provision of required financial resources for construction plan implementation.

<u>Sources and methods of financing the Plan</u>

Financial resources for Plan implementation are provided from the following sources:

- water protection fee. out of which water protection is financed in accordance with the Water Management Financing Act ("Official Gazette" 107/95 and 88/98).
- prices of utility services in accordance with the Municipal Services Act ("Official Gazette". 36/95. 70/97 and 26/03.).
- state budget of the Republic of Croatia.
- loans. foreign and local.
- foreign and local grants.
- cash penalties for polluters and
- rescheduling foreign debts for the purpose of implementing water protection program.

Physical and legal persons responsible for the implementation of the Plan. their competences and responsibilities

The responsibility for the implementation of this Plan rests with:

- State Water Directorate.
- Croatian Waters.
- Physical and legal persons that pollute or can pollute waters by carrying out their respective business activities.
- persons carrying out municipal utility services.

1) State Water Directorate is in charge of:

- inspection supervision and administrative control over the implementation of this Plan and over the compliance of each county water protection plan with this Plan.
- coordination of implementation of international obligations encompassed by this Plan.
- carrying out required water and sea quality investigations based on international obligations. specific water and sea investigations regarding quality change resulting from the impact of wastewaters and other inland waters.
- implementation of water protection measures financed from the state budget of the Republic of Croatia.
- giving necessary instructions that are significant for the implementation of this Plan
- preparation of reports on Plan implementation to be submitted to the Government of the Republic of Croatia.

2) Croatian Waters are responsible for:

- elaboration of water protection measures and development of implementation measures for water protection.
- development of financial plans.
- development of operational plans in case of accidental water pollution.
- collection and processing of data obtained by water quality tests and submission of reports on water quality condition to the State Water Directorate at least once a year. or as required.
- giving proposals for amendments to water quality testing program.
- systematic monitoring of efficiency of measures envisaged in the Plan and submission of report to the State Water Directorate at least once a year with proposals for amendments to measures.
- ensuring permanent expert supervision over water protection structures. and reporting on operational irregularities to the State Water Inspectorate.

3) Physical and legal persons that pollute or can pollute waters by carrying out their respective activities have the obligation to:

- develop the plan of implementation measures. elaborating measures identified in this Plan and financial plan for their implementation.
- develop operational plan for the implementation of measures in case of accidental pollution

- develop training programs for operation and process managers. to promote water management.
- elaborate investment project for the transition to advanced production technologies.

4) Persons carrying out wastewater drainage and treatment activities have the obligation to:

- develop a plan of implementation measures and operative plan in accordance with this Plan.
- elaborate public sewage system development plans in accordance with the Decision on Wastewater Discharge.
- carry out systematic control over all users that discharge wastewater into the public sewage system and file complaints to water inspectorate if the wastewater discharge does not comply with the water-management permit or Decision on Wastewater Discharge.
- carry out systematic control over wastewater quality prior to its discharge from the public sewage system into the natural recipient and take care that wastewater quality complies with the conditions from the water-management permit.

5) The following persons are responsible for the implementation of this Plan:

- Director of the State Water Directorate.
- General Manager of Croatian Waters. or the person appointed in the Implementation and Operative Plan within this Plan.
- Manager. legal person or persons cited in the Implementation Plan and Operative Plan within this Plan.
- Physical person that independently carries out the activity has the obligation to develop the Implementation Plan and Operative Plan in accordance with this Plan .

3.2 Assignments related to project implementation

The wastewater treatment facility of the City of Zadar to which wastewaters from the industrial zone Gaženica will be conveyed belongs. in accordance with the State Plan for Water Protection. to the group of facilities greater than 50.000 PE (with II treatment stage) the construction of which is considered a priority.

The mentioned Plan recommends the following:

- to construct the public sewage system by the year 2005
- to complete the "first stage" of the wastewater treatment facility by the year 2010. from which wastewaters will be discharged into the sea via an adequate submarine outfall.

However. the start of the construction of the wastewater treatment facility "Centar" – Zadar. in accordance with the "Project for the Protection Against Pollution in the Coastal Area" - Program. Part I (Croatian Waters. 2002). has been envisaged in the year 2004. Till that time. the sewage network connected with the facility has to be completed. By the year 2004. all project documentation has to be prepared. property and legal relations resolved and necessary permits for the construction of the facility obtained (location and building permits). This part of project preparation is currently underway. and Croatian Waters and the City of Zadar carry out the work. The Program envisages the following methods of financing for the facility:

- 50% from loans.
- 5% financial resources provided by Croatian Waters from water protection fees.
- 21% financial resources provided by local self-government unit (the City of Zadar).
- 24% state budget.

Since the costs of construction of the overall selected solution for industrial wastewaters at Gaženica (which includes the construction of the sewage network and pumping stations in the industrial zone. the construction of the facility itself and the construction of the submarine outfall) are very high (ca HRK 203.625.000.0). and the deadlines for the completion very short (construction period is 5 years). it is assumed that the financing of the project will be ensured through loans.

In such case. the main project contractor for the entire system. including the facility. would be Croatian Waters as a state-owned organization experienced in similar developments. Croatian Waters would be the first borrower. would be responsible and have authority over the organization. implementation and monitoring of the realization of the entire program and would be the main partner in the negotiations with international financial institutions responsible for development projects (the World Bank. European Investment Bank. European Bank for Rehabilitation and Development. etc.). on behalf of the Government of the Republic of Croatia. Debt servicing will be also effected through Croatian Waters. and the resources for debt servicing will be raised from:

- water protection fees that finance water protection.
- price of utility services.

The commencement of such project is a part of regular activities carried out by Croatian Waters in terms of planning. and water management. Croatian Waters will play the role of project implementation coordinator with an aid of its water management department for the region of Dalmatia. which will be responsible for project management and monitoring of project implementation. With relation to the status of the existing utility sector. direct construction will be executed within municipal utility company. i.e. company "Odvodnja" which has to prepare and equip itself in commercial. professional and organizational terms to take over the investment activities. Direct control over the implementation will be assigned to the State Water Directorate and representatives of local self-government (City of Zadar).

Upon the completion of the project. the governance over the system will be transferred to the company "Odvodnja". Zadar. Upon the completion of the overall system. the company will assume the following tasks:

- supervision. cleaning. maintenance and repair of the sewage system in the industrial zone Gaženica.
- operation. supervision. cleaning. maintenance. repair and replacement of worn out parts of equipment in pumping stations of the sewage system in the industrial zone Gaženica.
- operation. supervision. cleaning. maintenance. repair and replacement of worn out parts of equipment in the wastewater treatment facility "Centar"- Zadar.
- disposal of sludge and other waste matters produced in the wastewater treatment process and maintenance of the entire system.
- supervision. cleaning. maintenance and repair of submarine outfall .
- monitoring and metering water quantities and quality at system users and at system's outlet entering the recipient.
- financial management of the system.

In order to perform the above tasks. 20 new educated employees have to be employed with the company "Odvodnja" (up to 2 employees with high education. up to 16 highly skilled workers and up to 3 unskilled attendants). the labor costs of which will be included in the maintenance costs of the entire system.

The companies will have to observe the following laws. codes and regulations during their operation:

- Water Act. Official Gazette 107/95.
- State Plan for Water Protection. Official Gazette 8/99.
- Regulation on Recommended and Limit Values for Air Quality. Official Gazette 101/96.
- Regulation on Water Classification. Official Gazette 77/98.
- Regulation on Beach Water Quality Standards. Official Gazette 33/96.
- Regulation on Hazardous Substances in Waters. Official Gazette 78/98.
- Rule Book on Maximum Allowable Noise Levels in the Surroundings where People Work and Live. Official Gazette 37/90.
- Rule Book on the Protection of Agricultural Land Against Pollution. Official Gazette 15/92.
- Rule Book on Waste Types. Official Gazette 27/96.
- Rule Book on Waste Management. Official Gazette 123/97.
- Rule Book on Limit Values for Indicators of Hazardous and Other Substances in Wastewaters. Official Gazette 40/99. Official Gazette 6/01.

During facility's operation. Croatian Waters carry out the control of system operation (its efficiency. implementation of prescribed measures). carry out control measurements of recipient water quality and collect and process all relevant data on water protection condition regarding this system and forward such information in the form of report to the State Water Directorate.

4 PROJECT FINANCING

4.1 Capital Costs and Operating and Maintenance Costs

4.1.1 General

The above analysis shows that the solution to the improvement of coastal sea condition in the industrial zone of Zadar (Gaženica) will be realized through the collection of wastewaters (both industrial wastewaters and sanitary wastewaters) from throughout the observed area and the conveyance of such wastewaters to the site where central wastewater treatment facility of the city of Zadar will located (the "Centar" facility). For that reason. investment funds should be provided for the construction of wastewater sewage system in the industrial zone Gaženica. consisting mainly of pipelines (gravity canals and pressure pipelines) and appertaining structures (inspection manholes. pumping stations. etc.). Since the collected wastewaters will be treated in the common wastewater treatment facility. the participation in the financing of facility's construction and operation is also required.

In general. the sewage system. being a part of urban infrastructure. represents an important and long lasting system that should retain its functionality over several generations. The construction and operation of a sewage system requires significant investments. both for its construction and for annual operation and maintenance.

The sewage system itself (more precisely. main canals) in the industrial zone of Zadar (Gaženica) has been designed in project documentation titled: Conceptual Design of the Wastewater Sewage System "Centar" – Zadar; volumes 1 through 7 ("HIDROPROJEKT-ING Zagreb. 1999). Pursuant to the data presented in the mentioned project documentation. current completion level of the sewage system in the studied area is low and has been integrated as such in project design. The construction of the entire sewage distribution system has been envisaged. Out of main structures in the wastewater sewage system two pumping stations are foreseen. PS "Gaženica I" and PS "Gaženica II". Canal routes in this area have been mainly designed beneath the planned communication routes (built-in) . in accordance with the General Urban Development Plan of the City of Zadar.

Pumping station "Gaženica II" conveys wastewaters of this catchment area via pressure pipeline to the collector of the catchment area served by pumping station "Gaženica I". Pumping station "Gaženica I" conveys all wastewaters from the industrial zone via pressure pipeline into an elevated manhole located within the treatment facility. and wastewaters are thereupon conveyed by gravity to the treatment facility.

Please note that stormwaters from the studied area are mainly discharged into the Gaženica Bay. Six main stormwater canals have been planned for construction. The majority of canals have been routed vertically to contour lines and built in the planned communication routes. in accordance with the routes from the General Urban Development Plan. The canals convey water directly into the sea.

4.1.2 Sewage System

The investments in the sewage system and its structures consists of the following components:

- Construction costs for civil works
- Procurement costs for technical equipment (mechanical and electrical)
- Other costs and project design costs.

Generally. accurate data on investment cannot be given for the construction of a sewage system since numerous local factors and historical factors affect such investments. At local level. the following factors have major influence on the investment amount:

- geo-mechanical conditions.
- groundwater existence and levels.
- aggravated conditions resulting from e.g. traffic. existing supply lines or vicinity of buildings and other structures.
- construction method.

At the time of investment. the costs will be also significantly influenced by

- type and requirements regarding communication (traffic) area.
- effective implementation requirements and requirements regarding technical equipment.
- general state of economy.
- conjuncture in civil engineering.
- subsistence of local civil engineering companies .

4.1.2.1 Canal Network

The insight in the above-mentioned Conceptual Design led to the conclusion that the construction of gravity canal mains of the following profiles and appertaining lengths has been envisaged:

- Ø 250 mm. L = 6900 m
- Ø 300 mm. L = 440 m
- Ø 350 mm. L = 340 m
- Ø 400 mm. L = 1250 m
- Ø 500 mm. L = 1390 m
- Ø 600 mm. L = 80 m

The construction costs for the mentioned pipelines were estimated at approx. HRK 14.400..000 in the Conceptual Design.

4.1.2.2 Structures

The above Conceptual Design foresees the construction of the following separate structures with the appertaining cost estimate:

- Pumping station "Gaženica I" with appertaining pressure pipeline
  (Q_c = 388 l/s; H_{man} = 23.5 m; V = 62 m^3; operating regime 3 + 1; N = 100 kW; pressure pipeline Ø 450 mm; L = 680 m) HRK 3.180.000

- Pumping station "Gaženica II" with appertaining pressure pipeline.
  (Q_c = 244 l/s; H_{man} = 16.6 m; V = 39 m^3; operating regime 3 + 1; N = 40 kW; pressure pipeline Ø 400 mm; L = 400 m) HRK 3.680.000

4.1.2.3 Operating Costs

Operating costs of a sewage system consist of the following components:

- Personnel costs
- Material expenditures (e.g.. energy. replacement parts. ancillary media and lubricants)
- Maintenance costs. etc.

The amount of individual costs differs from place to place. The costs mainly depend on the type of drainage. length of canal network. applied piping materials and cross-sections. required wastewater-pumping. organization of activities. etc.

No investigation has been carried out in Croatia regarding operating costs of a sewage system. It is common practice to estimate such costs at 0.5 to 1.5% of construction costs.

Under the assumption that operating costs account for approx. 1.0% of construction costs. estimated annual operating costs will be HRK 212.600.

4.1.3 Wastewater Treatment Facility

The costs relating to the construction and operation of the wastewater treatment facility have been taken from the Environmental Impact Study and Conceptual Design of the Wastewater Sewage System "Centar" – Zadar.

4.1.3.1 Costs of system for the final construction phase (200.000 PE)

Construction costs (the price includes submarine outfall):

- construction costs.....177.800.000.0 HRK
- consulting (11%).....19.558.000.0 HRK
- legal and administrative services (1.5%).....2.667.000.0 HRK
- land acquisition costs.....3.600.000.0 HRK

- Total:.....203.625.000.0 HRK

Operating costs:

- personnel.....2.400.000.0 HRK/year
- energy.....5.488.000.0 HRK/year
- chemicals.....16.000.0 HRK/year
- sludge disposal.....112.000.0 HRK/year

- Total.....8.016.000.0 HRK/year

Maintenance costs:

- investment maintenance of structures.....1.731.000.0 HRK/year
- equipment maintenance.....1.560.000.0 HRK/year
- operating supplies.....3.556.000.0 HRK/year

- Total.....6.847.000.0 HRK/year

4.1.3.2 Costs of system for the construction phase I (100.000 PE)

Construction costs
(Approximately 65% of the envisaged funds have to be earmarked for the construction phase I of the facility since already in the first phase of construction the land has to be purchased. infrastructure connection made. pre-treatment system constructed as well as administrative buildings and appertaining structures).

- construction costs.....177.800.000.0 HRK
- consulting (11%).....19.558.000.0 HRK
- legal and administrative services (1.5%).....2.667.000.0 HRK
- land acquisition costs.....3.600.000.0 HRK

- Total:.....203.625.000.0 HRK x 0.65 = 132.356.250.0 HRK

Operating costs:

- personnel.....2.400.000.0 HRK/year
- energy.....3.303.024.0 HRK/year

- chemicals.....8.000.0 HRK/year
- sludge disposal.....56.000.0 HRK/year

- Total.....5.767.024.0 HRK/year

Maintenance costs:
- investment maintenance of structures.....1.211.700.0 HRK/year
- equipment maintenance..... 1.092.000.0 HRK/year
- operating supplies.....2.489.200.0 HRK/year

- Total.....4.792.900.0 HRK/year

Since the industrial zone at the moment participates with 6500 PE in total wastewater pollution. which accounts for 3.25% of total capacity. industrial plants located in the Gaženica zone have to participate in the construction of the wastewater treatment facility with 6.617.813 HRK.

4.1.4 Recapitulation

Construction costs

structures	total (HRK)	for industrial wastewaters (HRK)
sewage system and PS	21.260.000.0	690.950.0
treatment facility and submarine outfall	203.625.000.0	6.617.813.0

Operation and maintenance costs

sewage system and PS	212.600.0	6.910.0
treatment facility and submarine outfall	14.863.000.0	483.048.0

4.2 Cost-benefit analysis

The cost-benefit analysis of infrastructure activities and environmental protection activities determines their overall social justification. This means that the analysis considers not only direct costs and benefits of the activities (construction costs. operation and maintenance costs. and marketable benefits to its users) but also all other costs associated with their realization:

- costs associated with the loss of natural and scenic values and benefits from improved condition (impact on plant and animal species. impact on natural resources. impact on scenic beauty).

- Costs associated with the elimination of impacts on local population and benefits improved condition (impact on public health. impact on property value. impact on economy).

- costs associated with different measures to control and abate adverse impacts (including monitoring costs).

All other benefits and costs usually cannot be immediately valued in market terms . and their respective value is defined by market simulation methods (indirect and direct methods).

In order to examine such other benefits and costs in a proper way. the sphere within which all measurable impacts of the activities are expected has to be determined together with the analysis period within which inter-generational impacts could be perceived.

In resolving the issue of industrial wastewaters from the Gaženica zone it is. however. very hard to define other benefits and costs of the Development for two basic reasons:

- present impact of the industrial zone on wider natural environment and local population. in relation to which future impact of the Development can be defined and evaluated. is not pronounced and is insignificant.

- data obtained by targeted environmental and sociological research are missing. Such data are required so as to define the value of other benefits and costs.

In other words. the impact of the existing status hasn't been determined by measurements in a wider coastal area adjacent to Gaženica. both with respect to appertaining plant and animal communities and anthropogenic use of this area. Furthermore. the impact of the Development itself (selected design for industrial zone's wastewater treatment) on the maritime zone. which in sociological and environmental terms results only in benefits (improvement of sea quality in the narrow coastal zone. improvement of air quality in the industrial zone due to reduction of foul odors) can hardly be evaluated since the industrial zone is distant from the residential area and from areas used for water sports and recreation.

Finally. the only measurable values regarding other costs and benefits are the following:
- monitoring costs and economic benefits. Since monitoring costs are included in capital and operating costs.
- economic benefits (benefits from the reduction in future fees for discharge of wastewaters produced during production processes that would otherwise be significantly higher)
- benefits to local population (benefits from mitigation and abatement of temporary foul odors. which at present decrease the value of local residential area)

Since monitoring costs have already been included in the investment and operation costs. only the benefits for economic undertakings in the industrial zone have to be estimated as well as benefits arising from the increase in the value of local property.

Economic benefits

The fee is calculated in accordance with the Rule Book on the Calculation and Payment of Water Protection Fee (Official Gazette 62/00) for total BOD_5 quantity and average loading. and 2.5 HRK/m^3 is subtracted from that fee (the anticipated fee for wastewater discharge to the facility). The resulting amount represents annual average benefit.

Under the assumption that the fee for wastewater discharge will be calculated pursuant to the method presented in the Rule Book on the Calculation and Payment of Water Protection Fee (Official Gazette 62/00) as of the year 2005. which takes into account both the quantities and level of wastewater pollution. for the majority of companies located in the industrial zone Gaženica it would be significantly more favorable to discharge wastewaters through the wastewater treatment facility than to discharge such waters directly into the recipient.

For commercial undertakings in the industrial zone Gaženica that have water use permits. pursuant to the above mentioned Rule Book and the Decision on the Water Protection Fee (Official Gazette 58/00). in case of maintaining the existing method of wastewater discharge the fees will be considerably higher (Tankerkomerc 100.72 HRK/m^3. Adria 31.68 HRK/m^3. Maraska 9.50 HRK/m^3. Turisthoteli 6.49 HRK/m^3. Elka 3.97 HRK/m^3).

Benefits from increased property value

It is assumed that temporary impacts of foul odors from the Gaženica zone mainly affect local population along the seashore to the northwest. in the radius of approximately 1500 m. The area affected approximates 200 ha and is completely urbanized. Conservative assumption can be made that the value of property and real estate in this area will increase by approx. 10% per m^2. and that the property will change hands at least once during the studied period throughout the territory. Thus. wider community's revenue from the capital transfer tax will account for 5% of all purchases and sales. Assuming an average land price of 400 HRK/m^2. and average price of 4000 HRK/m^2 for real estates (which. according to estimates. occupy 1/10 of total land surface). total increase in property value can be determined. which is equally allocated to years under study for calculation purposes.

Calculation elements are the following:
50-year period
discount rate for infrastructure developments is 2%

Table 4.2.1 Overview of input values for the calculation of social justification of the entire project

Year	Land sale benefits (HRK)	Facility benefits (HRK)	Economic benefits (HRK)	Construction cost (HRK)	Maintenance and operation costs (HRK))	Total costs (HRK)	Benefits (HRKn)
1				109,912,544		109,912,544	0
2				109,912,544		109,912,544	0
3				109,912,544		109,912,544	0
4	1,872,340	20,075,000	3,116,158		15,535,600	15,535,600	25,063,498
5	1,872,340	22,082,500	3,116,158		15,535,600	15,535,600	27,070,998
6	1,872,340	24,090,000	3,116,158		15,535,600	15,535,600	29,078,498
7	1,872,340	26,097,500	3,116,158		15,535,600	15,535,600	31,085,998
8	1,872,340	28,105,000	3,116,158		15,535,600	15,535,600	33,093,498
9	1,872,340	30,112,500	3,116,158		15,535,600	15,535,600	35,100,998
10	1,872,340	32,120,000	3,116,158		15,535,600	15,535,600	37,108,498
11	1,872,340	34,127,500	3,116,158		15,535,600	15,535,600	39,115,998
12	1,872,340	36,135,000	3,116,158		15,535,600	15,535,600	41,123,498
13	1,872,340	38,142,500	3,116,158		15,535,600	15,535,600	43,130,998

Year	Land sale benefits (HRK)	Facility benefits (HRK)	Economic benefits (HRK)	Construction cost (HRK)	Maintenance and operation costs (HRK))	Total costs (HRK)	Benefits (HRKn)
14	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
15	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
16	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
17	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
18	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
19	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
20	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
21	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
22	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
23	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
24	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
25	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
26	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
27	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
28	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
29	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
30	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
31	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
32	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
33	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
34	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
35	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
36	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
37	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
38	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
39	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
40	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
41	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
42	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
43	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
44	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
45	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
46	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
47	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
48	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
49	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
50	1,872,340	40,150,000	3,116,158		15,535,600	15,535,600	45,138,498
					npv	760,356,661	1,192,007,407

Total benefits arising from the construction of the facility amount to 431,650,746.0 HRK.

The results show that the overall solution is socially justified since it results in other indirect benefits to wider community in a long run. through the increase in property value and value of real estates and future cost reduction for commercial undertakings located in the Gaženica zone.

4.3 Financing

4.3.1 Investment Costs

Under Croatian legislation as well as in practice. several methods of financing can be applied for the construction and development of wastewater treatment systems. Since available sources of financing (water protection fee collected by Croatian Waters and a part of funds from water use fee collected by utility organizations which is earmarked for the financing of such systems) are not sufficient to fund intensive construction of the facility and of the system as a whole. debt financing should be ensured. Since this is an infrastructure investment. it is assumed that the project will not be able to meet the requirements for commercial loans and that favorable funding terms will be looked for in the infrastructure/financial/development loan market (lower interest rate. longer debt repayment period. disbursement adjusted to planned construction period. etc.). Investment funds can be granted by international financing institutions (the World Bank. European Investment Bank. EBRD) or by a national bank.

Average loan "terms and conditions" for infrastructure and environmental projects in the Republic of Croatia set by international financial institutions are the following

- repayment period of 15 years. 5 years grace period plus 10 years debt servicing.
- interest rate ca LIBOR + 0.5 % (about 5%).
- origination fee 0.75 % of total loan.
- capitalized interest ca 5 %.

In view of the above terms and conditions for debt financing. the required price of wastewater treatment per m^3 of wastewater has been calculated. on condition that this price covers all appertaining costs of system financing and operation but that no income is realized.

Different options for system implementation are considered below. for different user charging conditions and different completion levels of the wastewater treatment facility. as follows:

Option 1

Assumptions:
- the facility is constructed right away for full capacity of 200.000 PE
- inflow to the facility for full capacity is 55.215.0 m^3/day
- construction period for the facility and the appertaining discharge system is ca 5 years. and during that time there are no charges.

The resulting wastewater price is **2.38 HRK/m^3** (Table 4.3.1).

Option 2

Assumptions:
- the facility is constructed right away for full capacity of 200.000 PE
- inflow to the facility progressively grows from 26.207.5 m^3/day to full capacity of 55.215.0 m^3/day
- construction period for the facility and the appertaining discharge system is ca 5 years. and during that time there are no charges.

The resulting wastewater price is **3.36 HRK/m^3** (Table 4.3.2).

Option 3

Assumptions:
- in the first step. the facility is constructed for the capacity of 100.000 PE
- inflow to the facility is 26.207.5 m^3/day

- construction period for the facility and the appertaining discharge system is ca 5 years. and during that time there are no charges.

The resulting wastewater price is **3.32 HRK/m^3** (Table 4.3.3).

Option 4

Assumptions:
- in the first stage the facility is constructed for the capacity of 100.000 PE . and 10 years thereupon the II stage of construction starts resulting in the capacity of 200.000 PE
- inflow to the facility gradually grows from 26.207.5 m^3/day to full capacity of 55.215.0 m^3/day
- the construction period for the I phase of the facility and the appertaining drainage system is ca 5 years
- the charges are collected as of the fourth year (constructed sewage system and mechanical part of the facility).

The resulting wastewater price is **2.40 HRK/m^3** (Table 4.3.4).

Table 4.3.1 – Calculation of wastewater unit price for Option 1

wastewater price **2.38 HRK/m^3**

Year	Construction costs (HRK)	Debt servicing (HRK)	Maintenance and operation costs		Total costs (HRK)	Benefits (HRK)
			pipelines and pump.stations (HRK)	Facility (HRK)		
1	44,977,000.0					
2	44,977,000.0					
3	44,977,000.0					
4	44,977,000.0					
5	44,977,000.0					
6		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	48,049,363.1
7		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	48,049,363.1
8		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	48,049,363.1
9		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	48,049,363.1
10		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	48,049,363.1
11		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	48,049,363.1
12		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	48,049,363.1
13		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	48,049,363.1
14		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	48,049,363.1
15		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	48,049,363.1
				NPV	371,024,445.57	371,024,445.57

Table 4.3.2 – Calculation of wastewater unit price for Option 2

wastewater price **3.36 HRK/m^3**

Year	Inflow (m3/year)	Construction costs (HRK)	Debt servicing (HRK)	Maintenance and operation costs		Total costs (HRK)	Benefits (HRK)
				pipelines and p.stations (HRK)	Facility (HRK)		
1		44,977,000.0					
2		44,977,000.0					
3		44,977,000.0					
4		44,977,000.0					
5		44,977,000.0					
6	10,076,737.5		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	33,888,676.2
7	11,084,411.3		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	37,277,543.8
8	12,092,085.0		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	40,666,411.4
9	13,099,758.8		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	44,055,279.1
10	14,107,432.5		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	47,444,146.7
11	15,115,106.3		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	50,833,014.3
12	16,122,780.0		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	54,221,881.9
13	17,130,453.8		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	57,610,749.5
14	18,138,127.5		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	60,999,617.2
15	20,153,475.0		32,973,763.1	212,600.0	14,863,000.0	48,049,363.1	67,777,352.4
					NPV	371,024,445.6	371,024,445.6

Table 4.3.3 – Calculation of wastewater unit price for Option 3

wastewater price **3.32 HRK/m^3**

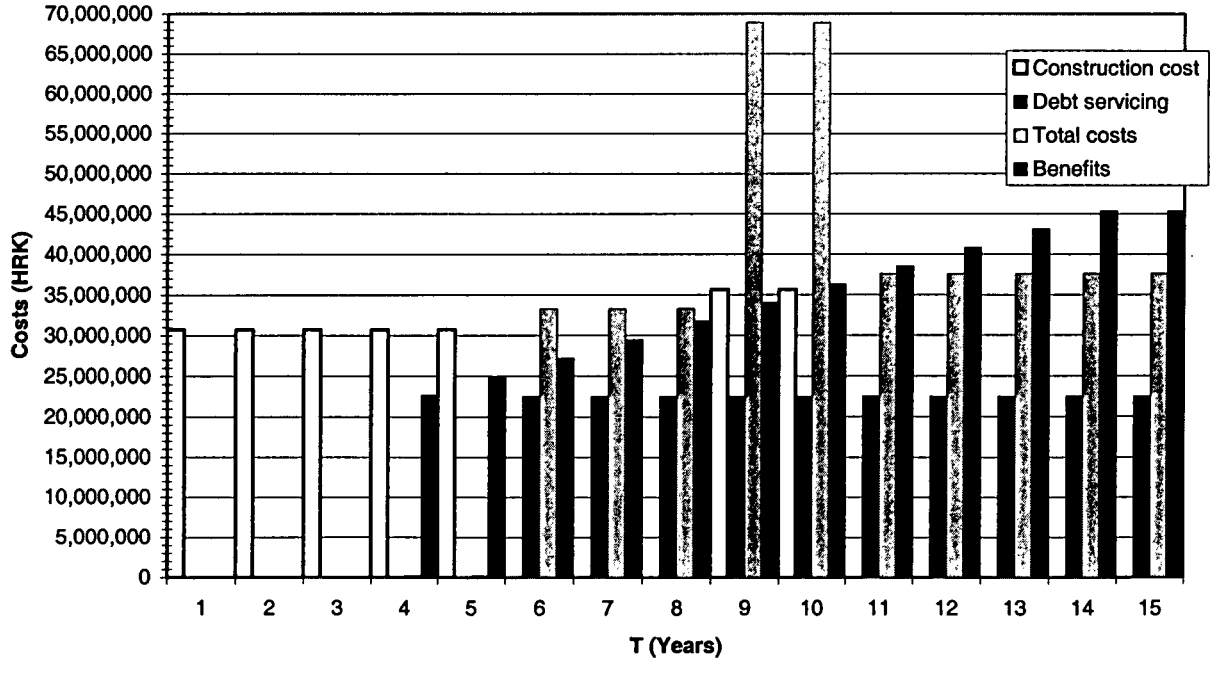
Year	Construction costs (HRK))	Capitalized interest	Debt servicing (HRK)	Maintenance and operation costs		Total costs (HRK)	Benefits (HRK)
				pipelines and p.stations (HRK)	Facility (HRK)		
1	30,723,250.0	1,536,162.5					
2	30,723,250.0	3,072,325.0					
3	30,723,250.0	4,608,487.5					
4	30,723,250.0	6,144,650.0					
5	30,723,250.0	7,680,812.5					
6			22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	33,296,506.7
7			22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	33,296,506.7
8			22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	33,296,506.7
9			22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	33,296,506.7
10			22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	33,296,506.7
11			22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	33,296,506.7
12			22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	33,296,506.7
13			22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	33,296,506.7
14			22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	33,296,506.7
15			22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	33,296,506.7
					NPV	257,106,798.5	257,106,798.5

Table 4.3.4 – Calculation of wastewater unit price for Option 4

wastewater price **2.4 HRK/m^3**

Year	Inflow (m3/year)	Construction costs (HRK)	Debt servicing (HRK)	Maintenance and operation costs		Total costs (HRK)	Benefits (HRK)
				pipelines and p.stations (HRK)	Facility (HRK)		
1		30,723,250.0					
2		30,723,250.0					
3		30,723,250.0					
4	10,037,500.0	30,723,250.0		212,600.0		212,600.0	23,910,460.8
5	10,754,464.3	30,723,250.0		212,600.0		212,600.0	25,618,350.8
6	11,471,428.6		22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	27,326,240.9
7	12,188,392.9		22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	29,034,130.9
8	12,905,357.1		22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	30,742,021.0
9	13,622,321.4		22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	32,449,911.1
10	14,339,285.7		22,523,982.7	212,600.0	10,559,924.0	33,296,506.7	34,157,801.1
11	15,056,250.0	35,634,375.0	22,523,982.7	212,600.0	14,863,000.0	73,233,957.7	35,865,691.2
12	16,310,937.5	35,634,375.0	22,523,982.7	212,600.0	14,863,000.0	73,233,957.7	38,854,498.8
13	17,565,625.0		22,523,982.7	212,600.0	14,863,000.0	37,599,582.7	41,843,306.4
14	18,820,312.5		22,523,982.7	212,600.0	14,863,000.0	37,599,582.7	44,832,114.0
15	20,075,000.0		22,523,982.7	212,600.0	14,863,000,0	37,599,582.7	47,820,921.6
					NPV	293,927,780.4	293,927,780.4

Chart 4.3.1 – Graphic illustration of investment costs for Option 4



4.3.2 Revenues

Recurring costs of the treatment facility (operation and maintenance) should be covered through customer charges under the "polluter pays" principle.

In the initial years of system operation when debt servicing is included into recurring costs. it is obvious that. in order to cover total system implementation and operation costs. unit price of wastewater treatment is significant. even in case when the most favorable and realistic option for the realization of the Development is selected (Option 4).

To avoid possible problems resulting from sudden increase of costs of this utility service. especially problems with local population connected to the sewage system. a gradual increase in unit price of wastewater discharge and treatment over a longer period of time should be considered. as well as the possibility of "bridging" the difference between revenues and system costs by some kind of co-financing of facility's operation or debt financing granted by local community to the company "Odvodnja" – Zadar or Croatian Waters budget.

4.3.3 Conclusion

Under the assumption that the fee for wastewater discharge will be calculated pursuant to the method presented in the Rule Book on the Calculation and Payment of Water Protection Fee (Official Gazette 62/00) as of the year 2005. which takes into account both the quantities and level of wastewater pollution. for the majority of companies located in the industrial zone Gaženica it would be significantly more favorable to discharge wastewaters through the wastewater treatment facility than to discharge such waters directly into the recipient.

For commercial undertakings in the industrial zone Gaženica that have water use permits. pursuant to the above mentioned Rule Book and the Decision on the Water Protection Fee (Official Gazette 58/00). in case of maintaining the existing method of wastewater discharge the fees will be considerably higher (Tankerkomerc 100.72 HRK/m^3. Adria 31.68 HRK/m^3. Maraska 9.50 HRK/m^3. Turisthoteli 6.49 HRK/m^3. Elka 3.97 HRK/m^3).

Pursuant to the same Rule Book. if the same commercial undertakings discharge their wastewaters through the wastewater treatment facility. the fees would fall with the coefficient of 0.2 which is. added to the fixed fee of 2.4 HRK/m^3 for facility's operation. a much more favorable solution for all the companies located in the Gaženica zone (except for Sojara). Other companies that do not have a water use permit. and Sojara. should be connected to the system under most favorable conditions applicable to households.

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-

Investor : Ministry of Environmental Protection and Physical Planning

Document type : Study

Project : Pre-investment Study in a Hot Spot Area – Industrial Zone of Zadar. Croatia

Annex: GRAPHIC ENCLOSURES

maps available at UNIDO HQs with the copy already received.