Caspian Environment Programme, Phase 2

Industrial Survey & Urban Wastewater

Assessment of Pollution Loads in I.R. Iran

December 2001

List of Acronyms

CEP	Caspian Environment Programme
CCPC	Caspian Centre for Pollution Control
DoE	Department of Environment
WHO	World Health Organisation
PAHO	Pan-American Health Organisation
USSR	United Soviet Socialistic Republics
WWTP	Waste Water Treatment Plant
IPC	Integrated Pollution and Control
HC	Hydrocarbons
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DO	Diesel Oil
PCB	Polychlorinated biphenyl
TSS	Total Suspended Solids
SS	Suspended Solids
TDS	Total Dissolve Solids
TOC	Total Organic Carbon
PAH	Pesticides

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Chapter 1. Introduction

The present report, titled: **"Industrial Survey & Urban Wastewater – Assessment of Pollution Loads"**, was prepared by Mrs Anthi Charalambous, during her stay at the Caspian Centre for Pollution Control (CCPC) and her visit to the Caspian Provinces of I.R. Iran. The preparation of this report was only possible with the significant assistance of the Iranian individuals listed in Appendix 1. The support of each during the data collection phase is acknowledged. The report is based on information from site visits, interviews, literature, questionnaires completed by official local consultants and the author's own experiences.

This study identifies the major industries (point sources) located in the Iranian Caspian coastal area. The Industrial Survey focuses on the discharge of wastewater into water bodies by such industries, data collection and its limitations, the identification of the industrial sectors represented on the Iranian side, the delineation of discharge patterns, pollution load estimation, and the identification of Hot Spot areas. The Urban Wastewater Survey focuses on the identification of cities located in the coastal area of I.R. Iran which utilise central sewage systems and discharge wastewater into water bodies. Furthermore the document encompasses the load inventory and the pollution minimisation scenario based on the requirements of the Council Directive 91/271/EEC.

Three provinces are located in northern I.R. Iran, the Guilan, the Mazadaran and the Golestan. Formed just recently, Golestan used to be under Mazadaran administration. Covering an area of 14,811 km^2 Guilan's total population is approximately 2.6 million and its capital is Rasht. The combined population of Mazadaran and Golestan is approximately 46.456 million, covering an area of 46,456 km^2. The Mazadaran capital is Sari and that of Golestan is Gorgan. The respective Departments of Environment (DoE) are located in these capital cities. The Guilan and Mazadaran provinces are more industrialised than the Golestan.

A variety of industrial sectors are represented throughout the Iranian side of the Caspian region, the most prominent of these being dairy, refreshment manufacturing, fruit and vegetable processing, fish processing, textile manufacturing and mining industries. The petroleum refineries, petrochemical and chemical industries and the oil & gas exploitation operations are without representation. The oil and gas exploitation and exploration sector is neither present in the on or off shore Caspian Iranian sites, but as announced in this summer's newspapers a new project is underway to erect a floating rig with drilling capabilities of up to 1km depth The Iranian government is financially heavily committed to this project with a view to tapping the oil potential of its part of the Caspian Sea. It is estimated that the country's finances will boom upon oil exploitation with reservoirs estimated to reach between 6 and 9 billion barrels of oil.

Guilan's capital Rasht is the most important city in the region. Its main port is Bandar-e Anzali, at the mouth of the Anzali wetland. The largest river is the Sefid, stretching from the Sefid Dam, on the boarder with Zanjan province, to the Caspian Sea. Located some 7 m below sea level and 15 km inland of the Anzali wetland, Rasht, the largest city in the Caspian provinces, has a population of approximately 450,000 and is the region's primary

industrial centre. The remaining major cities in the Guilan province are the Anzali port, Gorabzarmikh, Lahidjan, Roudsar, Amlash and Talesh. Sari, the Mazandaran capital, is much smaller than Rasht and less developed with a population of approximately 215,000. Other major cities in the Mazandaran province are RamSar, Tonekabon, Chalus, NohShahr, Nour, Babolsar, Ghaem-Shahr, Neka, Babol, Mahmounabad and Amol. Most of the cities are located near the coastline. Eastern Mazadaran is located in the Golestan province. The northern part of the province is largely inhospitable steppe. The Turkmen desert occupies the strip south of the Atrak River forming the border with Turkmenistan. The Golestan province has only recently been established and its capital Gorgan has a population of 195,000. Other major cities in the Golestan province are Gonbad, Bandartorkaman, Aliabad and AghGhala. The majority of these cities are not coastal.

The predominant practice in all the Caspian provinces is to discharge untreated domestic wastewater directly to either rivers or the Caspian Sea. Almost all the large cities utilise central sewage systems. There is only one municipal wastewater treatment plant in the vicinity of the Iranian coastal area, and this is operated by the Tchouka pulp & paper industry for the needs of its employees. The total absence of wastewater treatment plants contributes to the high pollution loads generated from human activity reaching surface waters and causing, in many cases, severe degradation. These sensitive recipients are, all too often, protected nature zones such as the Anzali and Miankaleh wetlands.

Chapter 2. Approach and Methodology

2.1. Approach

The adopted approach for the present study was to prepare an overview of the industrial pollution sources on the Iranian side that are found to be discharging significant pollution loads into the Caspian Sea. This involved both the determination of discharge patterns and the identification of liquid effluent discharge practices. The latter was based on existing data available at CCPC in Baku coupled to new data collected during the author's visit to I.R. Iran. A further prerequisite was the preparation of a load inventory from all major cities found discharging wastewater to surface waters. Finally the approach involved the outlining of priorities regarding overall pollution minimisation.

The following criteria were used to identify industries relevant to this study:

- amount of wastewater discharged to water bodies
- size of industrial enterprise.
- expected load (BOD, COD, TSS, N, P)
- presence of heavy metals and other harmful substances

In some cases poor data availability and questionable reliability hindered the assessment of the actual pollution loads. Flow measurements are rarely made and in many cases unavailable. Several laboratories face reagent and equipment availability problems. The pollution parameters, usually measured under existing monitoring programmes, often fail to satisfy the data needs of western-standard integrated environmental management. Some pollution parameters are determined in the vicinity of I.R. Iran, although in many cases data on total nitrogen and phosphorus is absent. Moreover, data on phenols, oil and grease, heavy metals and organic compounds are not determined.

2.2. Methodology

2.2.1. Industrial Survey

All the available reports and literature having been reviewed, an industrial survey of the industries in the study area was conducted. Local consultants undertook surveys of industries located in the Caspian provinces of I.R. Iran. Data and information on effluent discharges together with production data was collected, and industries were selected for visiting.

In order to achieve the objectives of this project, a data collection scheme was established. A preliminary industrial questionnaire was prepared with a view to collecting data from all the main industries located in the Caspian provinces of I.R. Iran. It included questions designed to enable the identification of industry, product types, production capacity, discharge points, wastewater flows, atmospheric emissions, solid wastes and energy consumption. The data collected enabled classification of all the main industries

located in the Caspian region by type (sector). All the preliminary questionnaires are now available at the CCPC office in Baku.

Additionally, a detailed industrial questionnaire was prepared. This questionnaire includes more specific detailed questions relating to process description, raw and auxiliary materials and products, production equipment, water and energy consumption, wastewater characteristics and treatment practices, air emissions and their control and monitoring, solid waste generation, planned pollution abatement, clean technology measures, and economic and financial aspects of production. The detailed industrial questionnaire was specifically prepared for distribution to the major industrial complexes in the Caspian provinces of I.R. Iran found either discharging industrial wastewater directly to the Caspian Sea or into rivers flowing into it. All the detailed questionnaires collected are now available at the CCPC office in Baku.

After the initial survey and evaluation of the acquired data, major industries were selected for visiting. Completion of the survey dictated visits to all the Caspian provinces of I.R.Iran. Additional industries were identified through discussions with national experts and officials of the respective local Environmental Departments.

The total number of preliminary questionnaires collected, detailed questionnaires distributed and detailed questionnaires returned, together with the number of site visits carried out are presented in the following Table 2-1.

Table 2-1: Methodology data

Province	Preliminary questionnaires	Detailed questionnaires completed	Data on effluent quality	Site visits
Guilan	68 (out of 134)	40 (out of 134)	108 (out of 134)	4 (out of 134)
Mazadaran	19 (out of 81)	10 (out of 81)	23 (out of 81)	2 (out of 81)
Golestan	7[1] (out of 7)	0 (out of 7)	7 (out of 7)	1 (out of 7)
Total	***94 (out of 222)***	***50 (out of 222)***	***138 (out of 222)***	***7 (out of 222)***

Following the collection and analysis of the preliminary questionnaire, all the industries were classified by Sector (type) according to the Pollution Prevention Handbook, World Bank 1998 [1]. The Environmental Categorisation of Industries, modified to suit the requirement of the study, is presented in the following Table 2-2. This table also presents the pollution parameters released by each sector and identifies pollutants determined in the environmental laboratories of the Caspian provinces of I.R. Iran.

[1] *Until October 2001 only 7 industries were identified in Golestan Province*

Table 2-2: Environmental categorisation of industries, Pollutants released by sector and pollutants Not determined in I.R. Iran

Industrial Sector	Liquid Effluents Pollutants	Pollutants which are NOT determined in I.R. Iran
Aluminium Manufacturing	pH, TSS, F, Al, COD, Hydrocarbons (HC), Temperature	F, Al, Hydrocarbons (HC)
Base Metal & Iron Ore Mining	pH, TSS, COD, Cyanide, Oil & Grease, Metals	Cyanide, Oil & Grease, Metals
Breweries	pH, TSS, BOD5, COD, Oil & Grease, NH4, Phosphorus	All pollutants are determined
Cement Manufacturing	pH, TDS, SS, Sulphate, Potassium	All pollutants are determined
Coal mining and production	pH, TSS, Oil & Grease	Oil & Grease
Dairy Industry	BOD5, COD, TSS, TDS, Phosphorus, Nitrogen, Oil & Grease, coliform bacteria	Oil & Grease
Dye Manufacturing	pH, COD, BOD5, TSS, Oil & Grease, Phenol, Cr, Cu, Zn, AOX	Oil & Grease, Phenol, Cr, Cu, Zn
Electronics Manufacturing	pH, TSS, Oil & Grease, Heavy Metals, P, CN, F	Oil & Grease, Heavy Metals, CN, F
Fish Processing	BOD5, TSS, Oil & Grease, Ammonia, Chlorine residual	BOD, TSS, Oil & Grease, Ammonia, Chlorine residual
Fruit & Vegetable Processing	pH, BOD5, COD, TSS, Oil & Grease, N, P	Oil & Grease
Glass Manufacturing	pH, TSS, COD, Oil & Grease, Heavy Metals, F	Oil & Grease, Heavy Metals, F
Iron & Steel manufacturing	pH, TSS, Oil & Grease, COD, Phenol, CN, Metals	Oil & Grease, Phenol, CN, Metals
Meat Processing & Rendering	pH, BOD5, COD, TSS, Oil & Grease, N, P, Coliform bacteria	Oil & Grease
Mini Steel Mills	pH, TSS, Oil & Grease, Heavy Metals	Oil & Grease, Heavy Metals
Pesticide Formulation	pH, TSS, COD, Oil & Grease, Heavy Metals, Organochlorines, Nitro-organics, Phenoxy compounds, Active ingredients	Oil & Grease, Heavy Metals, Organochlorines, Nitro-organics, Phenoxy compounds, Active ingredients
Pesticide Manufacturing	pH, TSS, COD, Oil & Grease, Heavy Metals, Phenol, Active ingredients	Oil & Grease, Heavy Metals, Phenol, Active ingredients

Industrial Sector	Liquid Effluents Pollutants	Pollutants which are NOT determined in I.R. Iran
Petrochemical Industries	pH, TSS, COD, Oil & Grease, Heavy Metals, Phenol, Sulphide, N, benzene	Oil & Grease, Heavy Metals, Phenol, benzene
Pharmaceutical Industries	pH, BOD5, COD, AOX, SS, Oil & Grease, Phenol, Heavy Metals	AOX, Oil & Grease, Phenol, Heavy Metals
Pulp and paper mills	pH, COD, N, P, Sulphite, AOX	AOX
Sugar manufacturing	pH, BOD5, COD, TSS, Oil & Grease, NH4, P	All pollutants are determined
Tanning and Leather Finishing	pH, BOD5, COD, TSS, Oil & Grease, Cr, Nitrogen, Phosphorous, Coliforms	Oil & Grease, Cr, Nitrogen
Textile Industry	pH, BOD5, COD, TSS, Oil & Grease, Heavy Metals, Sulphide, Coliforms	Oil & Grease, Heavy Metals
Thermal Power Plants	pH, TSS, Oil & Grease, Heavy Metals	Oil & Grease, Heavy Metals
Vegetable Oil Processing	pH, BOD5, COD, TSS, Oil & Grease, Total Nitrogen	Oil & Grease
Wood & wood products	pH, TSS, COD, Oil & Grease, Phenol, Heavy Metals, F, PAHs, Dioxins/Furans, Pesticides	Oil & Grease, Phenol, Heavy Metals, F, PAHs, Dioxins/Furans, Pesticides

2.2.2. Pollution load estimation from industrial activities

Pollution load estimation was primarily based on the official data provided by the DoE in the Caspian provinces. Due to information gaps identified later in this paragraph, it was decided that the estimation of undetermined pollutants would be achieved using the "Decision Support System for Integrated Pollution Control". This is software developed by the World Bank in collaboration with WHO/PAHO and is based on emission factors [2]. It should be noted that this is a tool for the rapid assessment of the pollution situation in a specific geographic location. Data on production and type of products is necessary to run this software, as well as data regarding reduction measures undertaken by industries. Reduction measures typically represent end-of-pipe technologies.

2.3. Urban Wastewater

In order for load estimation from human activity in the coastal area of I.R. Iran to be possible, information was requested from local experts regarding major coastal cities utilising central sewage systems: their populations, distances from the sea and specific discharge points. A comprehensive load inventory could not be achieved during the CEP phase I [3] because of lack of data at that time. The data collected through local expert reports combined with the author's visit to the Caspian provinces of I.R. Iran enabled the said estimation of pollution loads.

2.4. Limitations and Information Gaps

This section provides a concise review of the data collection scheme established and outlines the data limitations and information gaps that hindered the comprehensive identification of all industries and related patterns of discharge. Furthermore, it highlights the shortcomings encountered during the estimation of pollution loads.

Data collection

With the purpose of examining industrial activity in the Caspian Coastal Area of I.R. Iran the following data, being all that was available at CCPC, was reviewed:

- Data received last year during phase I, where the pollutant concentrations were provided regarding certain industries of the Guilan Region and which are available at the CCPC database.
- Detailed questionnaires, received earlier this year from certain industries in the Guilan and Mazadaran Regions.
- The Iranian report titled: "Industrial Pollutant Sources of the Southern Caspian Sea, winter 2001".

- Data given on a diskette during the CCPC Team Leader's visit to Teheran this spring.
- Data from Table 1 delivered this year.
- Data obtained from the author's visit to I.R. Iran.
- N.B. It was decided that hotels and hospitals would not be taken into account.

Data limitations regarding the survey and discharge pattern

- Only seven of the industries in the Golestan Province were identified.
- Only 94 (of 222 industries) preliminary questionnaires were available.
- Only 50 (of 222 industries) detailed questionnaires were available.
- The poor information collected through the detailed questionnaires.
- The limited number of site visits performed.
- Due to time restrictions neither the environmental performance assessment nor environmental management techniques of the companies could be identified. Only the wastewater management techniques of each were addressed.

Data limitations regarding the pollution load estimations

- Dissimilar pollutant concentrations were reported, for the same industry, from different data sources.
- A limited number of types of pollutants were measured.
- The pollutants measured in the liquid effluents were not always those relevant to specific sectors of industry. Table 2 gives the pollutants that are not determined by sector in the vicinity of the Caspian provinces of I.R. Iran .
- Data on effluent characteristics was limited and provided for only 138 industries (out of 222 total).
    - Data on nitrogen and phosphorus was limited.
    - Data on phenols, oil and grease, heavy metals and organic compounds is not determined. The method for E. coli determination is according to the waste & wastewater standard methods but the equipment used is outdated and in many cases incapable of providing reliable results.
- Lack of systematic monitoring/sampling with few analyses (no time series) being conducted, especially in Golestan Province.
- In many cases flow measurements were not available.
- Data on product types and actual production was limited.

Additional limitations were made obvious during the pollution load estimation phase of the

project, based on the IPC software. The emission factors for some industrial sectors were often unavailable, and microbiological load data did not always exist.

2.5. Effluent Discharge Requirements

The permitted standards in IR Iran are identical for both industrial and municipal discharges and are given in Appendix 2. It is worth noting that the effluent discharge requirements differ from those in the former USSR countries, Western Europe and America. The maximum values for the pollution parameters in the latter countries differ for different industrial enterprises, depending on the production process and discharge points. It is recommended that the government environmental authorities reconsider the effluent discharge requirements, and this necessity was stressed by the DoEs in the Caspian Provinces. Due to this fact, industrial enterprises, being totally without central wastewater treatment plants, have difficulty complying with existing standards. Furthermore existing Iranian effluent standards and effluent discharge requirements for metals are not specified. Appendix 3, gives the effluent discharge requirements for several industrial sectors [1] in comparison with the Iranian permitted standards in force.

Chapter 3. Environmental Considerations for the Caspian Provinces

3.1. Guilan Province

3.1.1. Rivers and surface waters

There are five wetlands in the Guilan Province but only one, the Anzali, runs to the Caspian Sea. The names of said wetlands are:

- Steel Wetland (130 ha, not connected to the Caspian Sea)
- **Anzali (202 km2, connected)**
- Boojah (200 ha, not connected)
- Kiashahr (120 ha, not connected)
- Amir Kelayeh (1231 ha, not connected)

Several parts of Anzali wetland fall within protected areas and contain unique landscape, ecosystems and animal/plant species or varieties which need to be preserved. Into this wetland flow 19 of the 35 rivers located in the Guilan Province. One of these is the Zartchoob River, into which all the domestic and industrial (often untreated) wastewater from Rasht City is discharged. The analysis of the Anzali's wetland water is given in Appendix 4. This table illustrates the poor quality of the Anzali's wetland water. In some samples the BOD concentration is above the optimum, as is the SS concentration. The high total coliform content verifies the presence of domestic wastewater.

The major rivers found in Guilan province are monitored by the Anzali laboratory and flow directly to the Caspian Sea. These are given below. The Baku CCPC has data regarding the water quality of these rivers. The general concerns regarding these rivers are contamination by organic substances and coliforms which again verify the profound presence of raw sewage.

- Mordabroud (Astara), Bandar-e-Astara (Astara port)
- Nokandeh, Nokandeh
- Jefroud, West of Anzali Lagoon-Bandar-e-Anzali
- Sefidroud, Banar-e-Kiashahr (Kiashahr port)
- Langueroud, Langueroud (Tchamkhaleh)

The following rivers all flow into the Anzali wetland:

1. Seijan
2. Ranjan Bakande
3. Ganodiy

4. Lelekka
5. Eachrood
6. Pir Bazar
7. NoKhaleh
8. HendKhaleh
9. Siyah Darvishan
10. Gosroubaa
11. Kanaleh moadan
12. Norgestan
13. Chameshol
14. Choleshahr
15. Espand
16. Halkaik
17. Chekovar
18. Behanbaar
19. Shilezaar

3.1.2. Anzali Laboratory

The aforementioned rivers are all monitored and chemical, physical and microbiological parameters are determined. Repeat of the measurements is costly and quite often the schedule is changed by skipping the sampling phase. Fifteen experts are employed by the Anzali Laboratory. This lab was found wanting new equipment and is thus unable to provide any heavy metal determination in waters or pesticide and oil & grease analysis of them. The parameters determined are given in Appendix 4. During the author's visit the following operational problems were identified:

- microbiological load determination;
- training course related to new analysis techniques;
- lack of office equipment (i.e. internet, computer, printer etc);
- total absence of benthos and phytoplankton determination equipment;
- unavailability of deionisation column.

3.1.3. Domestic Wastewater

The total absence of municipal wastewater treatment plants in the Iranian Caspian Area makes for an appalling domestic wastewater situation. The only municipal wastewater plant found in operation throughout the region is located in the vicinity of the Tchouka Industry Plant where accommodation complexes were erected to accommodate the company's employees. This WWTP involves the following stages:

- Screening
- Sedimentation tank
- Aeration

- Final clarification
- Chlorination

This plant is well maintained and in very good condition with final effluent quality being found within permitted standard parameters.

As mentioned, the permitted standards in IR Iran are identical for both industrial and municipal discharges and are given in Appendix 2.

3.1.4. Rasht Industrial Area

An integrated industrial area comprising 96 enterprises is found in the Rasht Industrial zone. Two rivers, the Ziarjoub and the Goah flow through this, each going on to join the main branch of the Pir Bazar. The Pir Bazar discharges into the eastern part of the Anzali Wetland. All generated wastewater from said industrial activity is discharged mainly into the Ziarjoub River. Although all 96 industries produce wastewater, only 16 operate wastewater treatment plants. The area's administration stressed that the construction of a central industrial wastewater plant is a matter of high priority. It was also mentioned that over the last few years it has become obligatory for an industry, once established, to construct its own wastewater treatment plant. Local administrative activity concentrates on the following subjects:

- Provision of land for the construction of industrial enterprise
- Supply of power
- Supply of water
- Road cleaning and landscape maintenance
- Solid waste disposal
- Fire protection
- Security

All the environmental issues related to the industrial area's territory fall under the Guilan DoE authority.

3.1.5. Industries Selected for visiting

Owing to time limitations, only 4 industries could be visited. Furthermore, due to the limited time available, the author's visits to the enterprises were short and could not, therefore, include wastewater management techniques. Detailed information about industries that could be visited is provided in Appendix 10. Noteworthy is that all the industries visited utilise wastewater treatment plants. Wastewater management is achieved with "end of pipe" techniques. As almost none of the visited enterprises utilise wastewater minimisation techniques, an environmental performance analysis should be conducted of polluting sectors in order to extract a concrete overview of the environmental performance of the Iranian industries.

3.2. Mazadaran Province

Two different centres for the monitoring and control of pollution sources are found in the Mazadaran province. The first is located at the Mazadaran DoE at Sari, boasting a ground floor laboratory, and the other is found at Chalous utilising a lab located in that territory. Two centres were necessary due to the size of the province and the fact that a single centre would be incapable of monitoring all the industries, pollution sources and rivers therein. Another laboratory also operates in the Mazadaran province (the Behsher laboratory), not far from Miankaleh wetland.

3.2.1. Rivers and surface waters

Miankaleh's water, which flows to the Caspian Sea, is characterised by high salinity. In order to avoid confusion its eastern part is named the Gorgan Gulf, the administration of which falls to the Golestan Province, and the western part is called Miankaleh wetland. Many agricultural channels discharge to Miankaleh wetland, while the Ghareshou River passes through the Golestan and Mazadaran provinces before flowing to the Gorgan Gulf. The latter two sources are primarily responsible for the pollution of the Miankaleh wetland. Data regarding the quality of Miankaleh wetland's water, sampled where the water meets the sea, is given in the following Table 3-1.

Table 3-1: The analysis of the Miankaleh's wetland (Gulf) water

Parameter	**Value**
Date sample taken	80/1/10 (summer 2001)
Time sample taken	11 :30 am
Specimen taken to	Golf Pier
Weather prevalent at time of sampling	Cloudy and rainy
Water temperature	15˚C
Nature of water	Turbid
DO mg/L	2,5 **(5)** ◢
BOD mg/L	50 **(10)** ◢
COD mg/L	121,3
Total Coli forms no/100 ml	240 **(1000)** ◢
Fecal Coli forms no/100 ml	210
◢ **optimum concentrations**	

The table above shows that the wetland's water is contaminated by organic matter with a low DO concentration due to the industrial and municipal discharge of various rivers into it. The Miankaleh wetland does not appear to be as contaminated by raw sewage as the Anzali wetland.

All the laboratories use a standardised form of pollutant determination and are all consequently similarly equipped. The parameters that are determined in all the laboratories in the vicinity of the Iranian coastal area are given in Appendix 4.

The major rivers found in Mazandaran province are monitored by either of the Sari or Chalous laboratories and flow directly to the Caspian Sea. Data regarding the water quality of these rivers can be found in the Baku CCPC.

Major rivers of Mazandaran Province:

- Ramsar (Ramsar)
- Shir-roud (Tonekabon)
- Nashtaroud (Azaroud)
- Babolroud (Babol)
- Tadjan (Sari)

3.2.2. Domestic Wastewater

Nowhere in the entire Mazadaran province can municipal wastewater plants be found in operation. Many cities utilise a central sewage system which discharges wastewater directly to rivers. Mazadaran province has many shoreline cities, which discharge wastewater either directly out to sea or to rivers just prior to their joining the sea.

3.2.3. Industries Selected for visiting

Due to time restrictions only 2 industries could be visited and these just briefly. Therefore once again wastewater management techniques could not be included. Detailed information of the industries visited is provided in Appendix 10. Again all the industries visited utilise wastewater treatment plants.

3.3. Golestan Province

The Golestan province is newly established and until recently fell under Mazadaran administration. In the Golestan province the same situation regarding municipal wastewater is found. Although all the big cities utilise a central sewage system, the wastewater is discharged directly into the province's two large rivers the Gorgan and Gharehsou. Typically the most recent data regarding the quality of these rivers is of 1996. The Golestan province is lightly industrialised with some 38 plants discharging (mostly correctly treated) wastewater directly into its rivers.

3.3.1. Golestan Environmental Laboratory

Being newly established, the Province's laboratory is superior to those found in the Guilan and Mazadaran provinces. This laboratory has the capability of conducting heavy metal

determination and Gas Chromatography, although for the want of a spare part the latter is currently not available. The laboratory carries out the following analyses:

- Microbiological Parameters
  - Total coli forms MPN/100 ml
  - Faecal coli forms
  - Streptococci
  - Salmonella
- Air Pollution Parameters
  - CO, Dust, SO2, Noise
- Physical Parameters
  - DO, Temperature, Turbidity, Salinity, Colour, Hardness, acidity, alkalinity, Cl-, Carbonate, bicarbonate.
- Chemical Pollution Parameters
  - pH, TSS, TDS, BOD5, COD, PO4-3, NO3-, NH4+, NH3, NO2-, Oil & Grease

3.3.2. Industries Selected for visiting

Due to the time limitations, only 1 industry could be visited and again wastewater management techniques were not included. Detailed information of this industry is provided in Appendix 10.

Chapter 4. Overview of the Industrial Structure in the Caspian Provinces of I.R. Iran and the Pattern of Discharges

The environmental categories presented in Table 2-2 were used as a guide for the environmental categorisation of all the industries located at the Caspian region. The following Table 4-1 presents the number of industries identified in each province, categorised by type, as well as the total number of industries. It should be noted that numbers are either based on data provided by the DoEs of each province via the preliminary and detailed questionnaires, or from personal interviews held following visits to each province. Industrial facilities not presently in operation are shown in brackets.

Table 4-1[2]: Industries identified in the Caspian provinces of I.R. Iran, presented by sector and by province[3]

Type of Industry	Guilan	Mazandaran	Golestan	Total
Aluminium Manufacturing	1	*n.f.*[4]	*n.f.*	1
Breweries & Drink Manufacturers	3	7	1	11
Cement Manufacturing	2	*n.f.*	*n.f.*	2
Chemical Industries	2	1	*n.f.*	3
Coal mining and production	*n.f.*	1	*n.f.*	1
Coke manufacturing	*n.f.*	*n.f.*	*n.f.*	0
Dairy production	7	6	1	14
Detergent Manufacturing	2	*n.f.*	*n.f.*	2
Dye and pigment manufacturing	1 (1)	*n.f.*	*n.f.*	1 (1)
Electrical/Electronic Manufacturing	3	*n.f.*	*n.f.*	3
Electroplating industry	*n.f.*	*n.f.*	*n.f.*	0
Fertilisers (Mixed)	*n.f.*	*n.f.*	*n.f.*	0
Fish Processing	11 (1)	11	*n.f.*	22 (1)
(Light) Food industry	11 (2)	4	1	16 (2)
Fruit & Vegetable processing	1	3	1	5
Glass/Porcelain Manufacturing	10	*n.f.*	*n.f.*	10
Grain Processing	5	1	*n.f.*	6
Iron & Steel manufacturing	2	*n.f.*	*n.f.*	2
Meat Processing	9	19	*n.f.*	28
Metal Works & Garages	2	3	*n.f.*	5
Mines	6	*n.f.*	*n.f.*	6

[2] Water Companies, hospitals, hotels and Railways are not included in this table.

[3] *All the above given data is based on the information received by the end of October 2001*

[4] n.f.: *not found*

Type of Industry	Guilan	Mazandaran	Golestan	Total
Miscellaneous Industries	12	*n.f.*	*n.f.*	12
Oil & Gas Exploitation – Onshore	*n.f.*	*n.f.*	*n.f.*	0
Oil & Gas Exploitation – Offshore	*n.f.*	*n.f.*	*n.f.*	0
Oil & Gas Exploration – Offshore	*n.f.*	*n.f.*	*n.f.*	0
Oil & Gas Exploration – Onshore	*n.f.*	*n.f.*	*n.f.*	0
Paper & Pulp Manufacturing	2	3	*n.f.*	5
Pesticides formulation	*n.f.*	*n.f.*	*n.f.*	0
Petrochemical Industries	*n.f.*	2	*n.f.*	2
Petroleum Refineries	*n.f.*	*n.f.*	*n.f.*	0
Pharmaceutical Industries	2	*n.f.*	*n.f.*	2
Plastics Industries	4	1	*n.f.*	5
Power Plants	2	*n.f.*	*n.f.*	2
Shipyards	*n.f.*	*n.f.*	*n.f.*	0
Sugar Manufacturing	1	*n.f.*	*n.f.*	1
Tanning & Leather Finishing	2	(1)	*n.f.*	2(1)
Tea Packing	2	2	*n.f.*	4
Textile industries	17	8	*n.f.*	25
Tobacco	3	1	*n.f.*	4
Vegetable Oil Processing	5	3	2	10
Wood & wood products	3	3	1	7
Industries not classified anywhere else	1	2	*n.f.*	3
TOTAL	134 (4)	81(1)[5]	7[6]	222 (5)

Note: Numbers in brackets indicate industries not in operation

The above Table 4-1 illustrates the strong presence of the food, fish processing and textile manufacturing industries along the Caspian shore of I.R Iran. I.R.Iran's major agricultural products include wheat, barley, fruits, cotton, rice, tobacco, olives, tea and sugar. The fish processing industry uses many kinds of fish, particularly kilka, salmon and sturgeon. The meat processing industry is also strongly represented with plants concentrated around urban centres.

Particularly in the Mazandaran province the meat processing and textile manufacturing industries are heavily represented.

Industrial sectors very much in evidence in other Caspian countries are not represented i.e. petroleum refineries and oil & gas exploitation. This, however, is temporary, according to

[5] *The number of industries identified by October 2001*

[6] *The industrial enterprises in Golestan are more than the given figure but data proved unavailable by the completion of this report.*

recent newspaper announcements of a new project underway to float an oilrig with drilling capabilities of up to 1km. The Iranian government is heavily committed financially to this project with a view to tapping the oil potential of its part of the Caspian Sea. It is estimated that the country's finances will boom upon oil exploitation with reservoirs estimated to reach between 6 and 9 billion barrels of oil.

Listed in Appendix 5 are all the industrial enterprises identified in the Caspian provinces. The results obtained through the data collection scheme are also herein presented. Primarily shown is all the basic information regarding the identified industries obtained through this survey. Data on annual production is forwarded, and this has been used to estimate the pollution loads in cases of total unavailability of data on effluent quality. Moreover, this data has, in some cases, been used to evaluate wastewater generation. Finally presented is data on water and discharges which has been used to estimate wastewater discharge and to identify treatment facilities and discharge points.

In addition to the above mentioned industrial facilities a large number of garages, hospitals, hotels, laundries and dry cleaners are present which may contribute to wastewater discharge. Though no detailed information has been obtained by this project the BOD_5, COD, N and P loads are assessed to be relatively limited.

Chapter 5. Overview of the Major Coastal Cities

Many cities are located in the Caspian coastal area of I.R. Iran and most of them utilise central sewage systems. Appendix 6 gives the list of Cities connected to central sewage systems, population figures thereof, initial and terminal discharge points and distances of these cities from the sea.

Chapter 6. Assessment of Pollution Loads from Industries

The initial survey included a number of facilities using no process water and producing only a discharge of domestic wastewater, and it was therefore possible to exclude several industries from the load inventory. Nevertheless all the information collected is presented in Appendix 5.

6.1. Pollution Load from industrial activities in Guilan Province

In Guilan province the textile industry has a strong presence, as does the food industry, including the fish processing and dairy sectors, though these to a lesser extent. The discharge pattern is that all the industrial discharge reaches the sea via rivers. Only a few enterprises discharge wastewater directly to the Caspian Sea.

The DoE Guilan mentioned the difficulty of verifying industrial water consumption as most plants draw ground water from wells on site therefore evading water bills. Most figures are based on what industrial administration declares. Moreover, the Anzali Laboratory lacks a modern-day flow meter and as such in certain cases wastewater flow calculation again relies on what industries declare.

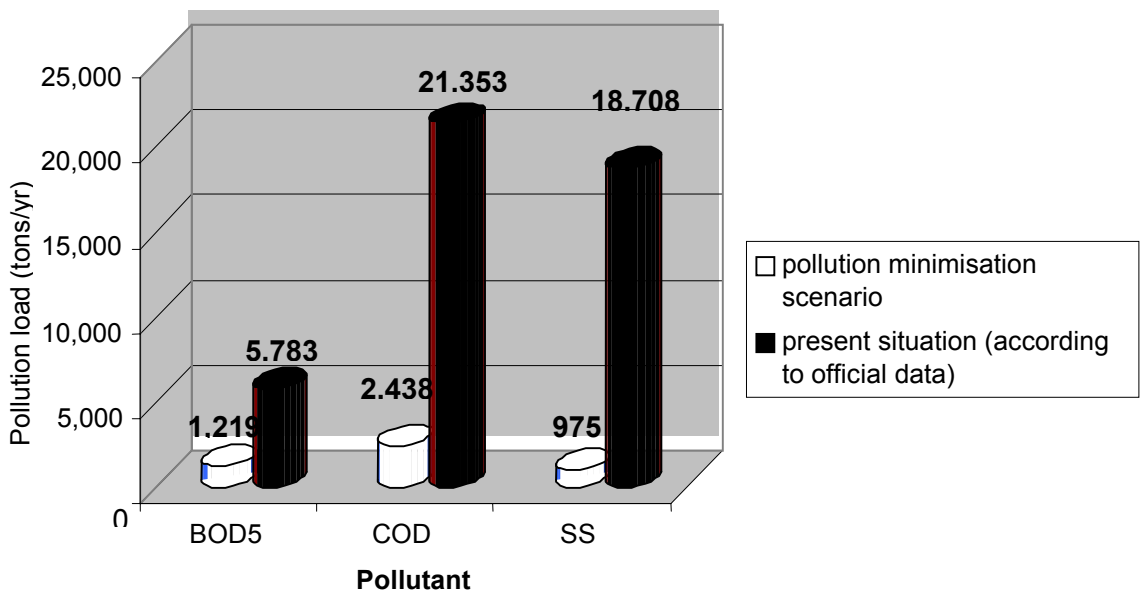
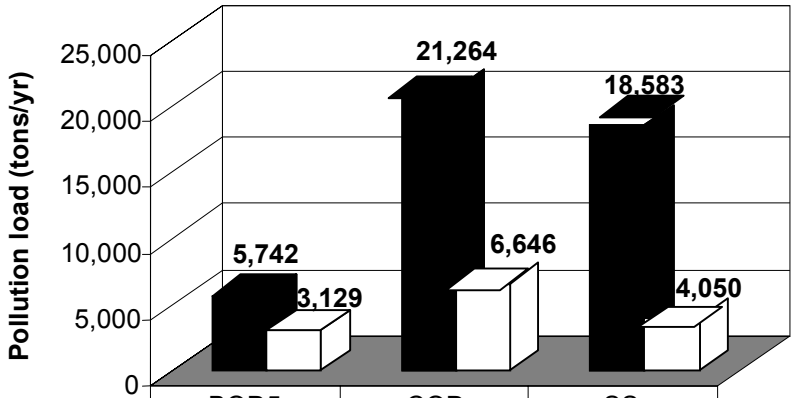


Figure 6-1: Illustration of Present pollution Load and Pollution minimisation scenario

The above bar chart illustrates the total pollution load released to the water body in the vicinity of the Guilan province compared to the notional load that would be released if industrial enterprises complied with the Iranian effluent discharge requirements. A 79% reduction of BOD5, 89% of COD and 95% of SS could be achieved were all the industrial enterprises to comply with the Iranian Standards.



	BOD5	COD	SS
■ Total pollution load	5,742	21,264	18,583
□ Pollution load from Industrial Area (out of total)	3,129	6,646	4,050

pollutant

Figure 6-2: Contribution to the total load from the Rasht industrial area

The above bar chart illustrates the Rasht Industrial Area's contribution to the total pollution load. The 54% of BOD5, the 31% COD and 22% of SS comes from industrial activity within the Rasht Industrial Area.

The industrial effluent quality analyses based on official data do not provide adequate data for all the industrial enterprises regarding Total Nitrogen and Phosphorus, oil & grease (which is simply not determined) nor for heavy metals, phenols and CN. For this reason the pollution loads from industrial activities were estimated for pollutants presenting inadequate data by using the Decision Support System for Integrated Pollution and Control (IPC) which is software developed by the World Bank and WHO/PAHO. The pollution loads are given in the following Table. This table also gives the loads from municipal discharges. It can be derived from this table that, although the load from industrial activity is considerable, that from municipal discharge is much higher.

Table 6-1 shows the pollution loads from both industrial activities and municipal discharges, thus presenting a comparison between the provinces.

6.2. Pollution Load from industrial activities in Mazandaran Province

By the completion of this report insufficient information had been obtained regarding the industrial structure of the Mazandaran province and, consequently, discharge points, actual production and data on effluent qualities for many industrial enterprises are not available. Moreover, in order to obtain reliable results from the IPC software based on emission factors, information on the type of treatment is necessary and this, in most cases, simply was not available. Because of the lack of sufficient data on effluent flow and quality it was decided in

this instance to calculate load based on emission factors. In Table 6-1 the estimated pollution loads are indicated in comparison with the loads from the other provinces and municipal discharges.

6.3. Pollution Load from Industrial Activities in Golestan Province

Unfortunately, by the completion of this report, available data was limited, being available for only 7 industrial enterprises. During the author's visit to Golestan Province the DoE Golestan promised to submit more data on industrial activities in the province, but this has yet to be received. Moreover, although data on effluent quality was available, this was only for some pollutants and no data on liquid wastes generated by industrial activities was available. Data on actual production and type of products was, however, available. Consequently, the pollution load estimation emission factors used were based on WHO publications [1] and IPC software [2]. It is worth repeating that the IPC software is used for rapid assessment and therefore the calculated pollution load is a fairly accurate estimation of the actual load. Table 6-1 shows the pollution loads from Golestan province.

Table 6-1: Pollution Loads from both industrial activities and urban wastewater.

Load/Province	BOD_5 (tons/yr)	COD (tons/yr)	TSS (tons/yr)	Oil and Grease (tons/yr)	Total Nitrogen (tons/yr)	Sulfates (tons/yr)	Total Phosphorus (tons/yr)	CN- (tons/yr)	Phenols (tons/yr)	Heavy Metals (tons/yr)
Guilan										
Industrial	5,742⊗	21,264⊗	18,583⊗	**618***	**508***	2,739⊗	**197***	**0.95***	**22.5***	**3.85***
Municipal	25,685		24,658		6,164		1,644			
Mazandaran										
Industrial	**22,816***	**23,127***	**23,178***	**11,818***	**45***	**n.a.**	**7.6***		**0.0308***	**0.37***
Municipal	29,160		27,993		6,998		1,866			
Golestan										
Industrial🏭	**214***	554⊗	**175***	**79***	**14***	n.a.	**3***			
Municipal	13,162		12,635		3,159		842			
TOTAL										
Industrial	28,772	44,945	41,936	12,515	567		207.6	0.95	22.5	4.22
Municipal	68,007		65,287		16,322		4,352			

⊗ Based on official data
* Calculated
🏭 Data was available for only 7 industries

6.4. Identification of the most polluting industrial enterprises

Following the limitations and the methodology presented in the paragraph 2.4; selected industries were classed as major industries. This chapter aims the identification of the major industries in the Caspian provinces of I.R. Iran. The information presented is basically based on the detailed questionnaires, information obtained during site visits, whereas in cases of lacking detailed information data from the preliminary survey were used.

The survey indicates that the major pollution load to the aquatic environment results mainly from the area of Rasht Industrial city and Anzali for Guilan province whereas for Mazandaran province the industries are spread in several cities like Sari, Tchalous, Babolshahr and Ghaemshahar. The industrial activities in Golestan province is of lower significance. Accordingly, the improved environmental performance of industries in the Guilan region and particularly for Rasht Industrial city and Anzali should be a priority issue for I.R. Iran.

The criteria for the selection of the major industrial enterprises are the following:

- Production rate
- Type of products (industrial sector)
- Amount of liquid effluents
- Discharge point
- Type of treatment

The Table 6-2 below illustrates the most polluting industries together with the existing wastewater practices and the associated pollution loads. For Mazandaran province in particular the assessment of the most polluting industries wasn't possible due to the lack of necessary information related with the above mentioned criteria. A more detailed list of the large-scale industrial enterprises in the coastal provinces of I.R. Iran and the related pollution loads is given in the Appendix 7.

Table 6-2 The most polluting industries in the coastal provinces of I.R. Iran

Name of industry	Product type	Generated pollution load	Applied on-site wastewater treatment	Remarks
Guilan				
Niknoosh Drink Co	Refreshment Manufacturing	high	none	At present this industry do not operate treatment plant but after pressure by the DoE Guilan it will be moved to Rasht Industrial Area
Zam-Zam	Refreshment Manufacturing	high	none	
Fouman Chemicals (Chimie) Co	Formulation of deodorants, shaving cream, engine oil, gear oil, pesticides, Greases & Brake fluid	high	none	
Guilan Electric Co	Electrical appliances	high	Mechanical, chemical	Not effective treatment
Aras Fish Meal Co	Fish powder, fish oil	high	none	Pilot plant for anaerobic treatment
Guilan Leather	leather	high	mechanical	More data required
Iran Fiber Private Company	Fibre	high	Pilot plant	Direct discharge to the sea
Mazandaran				
Kossar Food Industry	Fruit Juice Production	high	n.a.	Discharging to the sea
Fish Meal & Oil	Fish Meal, Fish oil	high	n.a	Lack of additional data
Golestan				
Shahid Bahonar Industry	Vegetable oil	high	under construction	channel and then to the Caspian sea

Chapter 7. Estimation of present loads of Urban Wastewater

To enable the estimation of total loads of treated and non-treated municipal wastewater discharged to the Caspian Sea, general assumptions concerning pollutant concentration and per capita flows were made. The assumptions regarding concentrations of key pollutants are summarised in the following Table 7-1.

Table 7-1: Assumed concentrations of key pollutants in municipal wastewater according to treatment level [3].

Treatment level	BOD mg/l	Total-N mg/l	Total-P mg/l	E. Coli Counts/100 ml
No treatment	125	30	8	1,000,000
M	75	25	7	500,000
MB	15	20	5	100,000
MBN	15	8	5	10,000
MBNP	15	8	1.5	1,000
Disinfection	-	-	-	100

M: Mechanical
MB: Mechanical + biological
MBN: Mechanical + biological + nitrogen removal
MBNP: Mechanical + biological + nitrogen and phosphorus removal
The per capita flow is assumed to be: 480 l/capita*day

The indicated discharge flows are based on the number of inhabitants, and a water consumption of 480 lt pr. capita/day, which is the water consumption level generally found in the Caspian Region. The load calculation is based on the water consumption because in the case of the Caspian provinces of I.R. Iran only the numbers of inhabitants were known.

The estimated loads of untreated municipal wastewater to water bodies, based on the above mentioned assumptions, are summarised in Table 7-2. A more detailed list of loads is given in Appendix 8.

Table 7-2: Loads of domestic wastewater, non-treated, discharged directly to water bodies

Province	Flow (10^6 m^3/year)	BOD_5 (tons/yr)	SS (tons/yr)	Total-N (tons/yr)	Total-P (tons/yr)	E. Coli (10^{15} c/yr)
Guilan	205	25,685	24,658	6,164	1,644	2,055
Mazandaran	233	29,160	27,993	6,998	1,866	2,333
Golestan	105	13,162	12,635	3,159	842	1,053
Total	***544***	***68,007***	***65,287***	***16,322***	***4,352***	***5,441***

7.1. Pollution minimisation scenario – EU standards (BOD, N and P-removal, disinfection)

The Future Scenario for pollution minimisation is based on the Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment. This Directive stipulates, depending on the type of recipient[7], the kind of treatment that is necessary in relation to the population equivalent of the spot area. If the municipal wastewater is treated in accordance with the EU standards for discharge to sensitive recipients, the effluent standards should be as follows:

Table 7-3: EU effluent standards for discharge of municipal wastewater to sensitive recipients

Parameter	10,000-100,000 p.e.	More than 100,000 p.e.
BOD5 (mg/l)	25	25
Total-N (mg/l)	15	10
Total-P (mg/l)	2.0	1.5

This means that all discharges above 10,000 p.e. must be enclosed by mechanical and biological treatment with N and P removal as well as by an appropriate disinfection unit for the removal of microbiological load. This stipulation is illustrated also in Table 7-4 where the Directive's requirements regarding treatment type are illustrated.

[7] The receiver water body can be more or less sensitive

Table 7-4: 91/271/EEC Directive's requirements regarding the type of treatment and the number of inhabitants

	Population Equivalent (p.e.)				
	0-2,000	2,000-10,000	10,000-15,000	15000-150000	150,000+
Sensitive recipient	In the case of existence of collection system appropriate treatment is necessary	Collection system and secondary treatment	Collection System and Secondary treatment and advanced treatment	Collection System and Secondary treatment and advanced treatment	Collection System and Secondary treatment and advanced treatment

Based on the above requirements and the appropriate disinfection of municipal discharges the future scenario was built for pollution load elimination. Concerning the future scenario the pollution load was calculated and is given in the following Table 7-5:

Table 7-5: Comparison of the present load and the load based on the future scenario from municipal discharges to water bodies

Province		**Flow (10^6 m^3/year)**	**BOD_5 (tons/yr)**	**SS (tons/yr)**	**Total-N (tons/yr)**	**Total-P (tons/yr)**	**E. Coli (10^{15} c/yr)**
Guilan	Present	205	25,685	24,658	6,164	1,644	2,055
	Future	**205**	**3,468**	**3,525**	**1,899**	**391**	**37**
Mazandaran	Present	233	29,160	27,993	6,998	1,866	2,333
	Future	**233**	**3,499**	**3,512**	**1,898**	**359**	**0.233**
Golestan	Present	105	13,162	12,635	3,159	842	1,053
	Future	**105**	**1,579**	**1,629**	**961**	**262**	**0.105**
Total	Present	***544***	***68,007***	***65,287***	***16,322***	***4,352***	***5,441***
	Future	***544***	**8,547**	**8,666**	**4,757**	**1,012**	**38**

7.2. Cost estimation for the future scenario

The cost estimation for the construction of the wastewater treatment plants is given in Appendix 9. As stated above all the major Caspian cities utilise central sewage systems, thereby minimising the cost, as a large budget is required to construct collection systems. Construction of the necessary wastewater treatment plants dictates an investment of 429 10^6 euro. The operational costs were estimated at 2145 10^3 euro per annum. In order to identify the critical priorities regarding the municipal discharges the following criteria were examined:

- Population of the city
- Distance from the sea
- Discharge point
- Contribution to pollution

Based on the above criteria certain priorities were identified, as given in the following Table 7-6. Also given in this Table is the estimated cost. It is worth noting that the cities identified as priorities to utilise WWTP contribute to the total present pollution from urban activities **48%.**

Table 7-6: Priorities regarding the WWTP construction for the pollution load minimisation

City/District	Population Thousands	Initial Discharge point	Final Discharge point	Distance from the Sea (km)	WWTP Process	Disin-fection	Investment Costs WWTP 10^6 EURO	Operation and maintenance Costs 10^3 EURO
Rasht/ Guilan	451.8	Zarjoob & GoharroudRiver	Anzali Wetland	20	MBNP	X	64.2	321
Sari/Maz	215	Neka River	Caspian Sea	25	MBNP	X	30.5	153
Gorgan/Golestan	194.5	Gharehsou River	Gorgan Gulf	32	MBNP	X	27.6	138
Tonekabon / Mazadaran	103	Chesmek River	Caspian Sea	Near	MBNP	X	14.6	73
Anzali port/ Guilan	100	Sea	Sea	Near	MBNP	X	14.2	71
Feraidon Kenar+Babolsar / Maza	89	FeraidonKenar Directly to Caspian Sea (branch of Haraz River) +Babolsar to Babol River	Caspian Sea	Near	MBNP	X	12.6	63
NohShahr / Mazadaran	69	Directly to Caspian Sea	Caspian Sea	Near	MBNP	X	9.8	49
Nour+Royan / Mazadaran	68	Nour to Lavich River and Royan to Galan River	Caspian Sea	Near	MBNP	X	9.7	48
Mahmounabad/Maz	63.7	Mahmoudabad branch of Haraz River	Caspian Sea	Near	MBNP	X	9.0	45
Chalus +Marzanabad/ Mazadaran	50	Chalous River	Caspian Sea	Near	MBNP	X	7.1	36
Bandartorkaman/Goles	39.7	Directly to Caspian Sea	Sea	Near	MBNP	X	5.6	28
Talesh/ Guilan	35.9	KarganRoud River	Sea	Near	MBNP	X	5.1	25
RamSar / Mazadaran	19	Safar river	Caspian Sea	Near	MBNP	X	2.7	13
Total Iran	***1,499***						***213***	***1,064***

MBNP: Mechanical + Biological + Removal of N & P

Chapter 8. Conclusions

Municipal wastewater discharge is the primary environmental pollution problem in the Iranian Caspian coastal area. A population of more than 11,000,000 inhabitants is connected to central sewage systems, which in most cases discharge to rivers and in others directly out to sea. The pollution load from human activities is much higher than that from industrial activities, particularly in the cases of total nitrogen and phosphorus. The industrial activities cause organic loading of 31%, whereas the remainder falls to municipal discharges. The municipal wastewater discharge to rivers causes degradation of natural protected areas, as is shown by the quality of Anzali's and Miankaleh's wetlands waters.

In order to identify priorities regarding the treatment of urban wastewater, a scenario was examined whereby the distances of cities from the sea, their relative discharge points and populations were selected as critical parameters. The estimated cost for the construction of such plants was calculated at 213 million euros and the operation costs at 1million euros.

The Guilan Region is industrialised with most of its enterprises located in the Rasht industrial zone which lacks a central industrial wastewater plant. Consequently all the industrial wastewater reaches the degraded Anzali wetland. The quality of Anzali's water is poor, especially when it reaches the Sea. The construction of an industrial wastewater treatment plant within the territory of Rasht industrial area is imperative. There is a plan in the Mazandaran province to establish an industrial area, upon which many of the enterprises should be accommodated. Insufficient information regarding this subject had been collected by the time of the completion of this report. The quality of the Miankaleh water is poor but this is mainly caused by municipal discharges. Golestan province is not heavily industrialised, with approximately 30 industries discharging liquid effluents to rivers. These industries are evenly distributed across the area of the Golestan province and some of them utilise wastewater treatment plants.

Almost all the industrial sectors (except oil & gas exploration and exploitation units) are located in the Iranian Caspian coastal area. Many of the industrial enterprises are textiles, with the food industry also strongly represented. Due to this fact heavy metals, phenols and cyanide loads are not found to be high, due to the total absence of chemical and petrochemical industries. Consequently the total loading of oil & grease is also low. Despite this the food industry's contribution to organic loading is significant, and, as mentioned above, represents 31% of the total organic loading (industrial + municipal discharges).

Almost all the industrial enterprises release liquid effluents to river waters. Some of the industrial enterprises utilise sound industrial WWTPs with wastewater being adequately treated prior to discharge into water bodies. Moreover, some industries have gone further, introducing waste minimisation techniques. Furthermore, many industries utilise "end of pipe" treatments. Throughout the provinces DoEs are very active and in many cases an industry's choice to ignore frequent recommendations made by DoEs regarding establishment of appropriate treatment systems results in said industry's closure. The DoEs occasionally face staffing shortages and inadequate database systems which often cause organizational problems.

The coastal laboratories determine many physical and chemical parameters but are poorly equipped to conduct heavy metal determination, PCBs, pesticides (due to the absence of gas chromatographers) and atomic absorption. In some cases personnel are hindered by shortages of office equipment: more specifically, no computer, fax or printer is available.

Chapter 9. Recommendations

Municipal wastewater management is a matter of immense priority due to the high pollution loads that weak industrial management permits to be transferred to the sea via rivers.

The construction of an industrial wastewater treatment plant is imperative to the Rasht industrial zone and the swift preparation of a master plan addressing this is recommended.

The permitted standards are identical for both industrial and municipal discharges. The DoEs should develop emission-limit values and enforce different standards for each industry or industrial sector depending on the wastewater's final receptacle.

Almost all the Iranian coastal laboratories neglect important parameters necessary for the determination of the quality of waters; even the modern Gorgan laboratory determines just a few of them. Parameters ideally included in a scheduled, routine analysis are:

- Heavy metals
- Hydrocarbons
- Oil & Grease
- Phenols
- Pesticides
- Sulphates
- Microbiological content

Field kits for faecal coli form are available but expensive. A trained microbiologist would also be of assistance in conducting proper test procedures.

Further to the analysis equipment necessary to the coastal laboratories, technical support should be provided which should include the supply of computers, printers and internet access. Moreover, as mentioned by the laboratories' personnel, training on modern methods of water and wastewater analysis is necessary.

Following discussions with authoritative figures of the DoEs it was agreed that the establishment of a database for entering data regarding chemical analysis of industrial effluents and river waters, as well as general data on industries, is a matter of high priority. In most cases all data is stored manually on paper, thus hindering both its retrieval and update.

The establishment of training programs concerned with the environmental performance of industry and environmental management systems is recommended.

Chapter 10. References

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Appendix 1: List of Contact Persons

CRTC Tehran

Name	: Mr. Mohammad Reza Sheikholeslami
Position	: Regional Consultant, Theme for Effective Regional Assessment of Contaminant Levels "ERACL"
Telephone number	: +98 (21) 890 1096
Fax number	: +98 (21) 8907223
e-mail	: sheikh_mr@hotmail.com

Guilan Province

Name	: Dr. Nezami SH.A.
Position	: General Director of Department of Environment Guilan
Telephone number	: +98 131 8827040
Fax number	: +98 131 8828095
e-mail	: doe.gilan@tavana.net

Name	: Mr. Mahyar Sakari
Position	: Deputy in Natural Environment and Biodiversity (Department of Environment Guilan)
Telephone number	: +98 131 8824626-7
Fax number	: +98 131 8828095
e-mail	: doe.gilan@tavana.net

Name	: Mr. Alizadeh
Position	: Industrial Pollution and Control (Department of Environment Guilan)
Telephone number	: +98 131 8824626-7
Fax number	: +98 131 8828095
e-mail	: doe.gilan@tavana.net

Name	: Mr. Mohammadvand
Position	: Anzali Environmental Laboratory
Telephone number	: +98 181 38901
Fax number	: +98 181 38901
e-mail	:

Mazadaran Province

Name	: Dr. Mehrdadi
Position	: General Director of Department of Environment Mazadaran
Telephone number	: +98 151 2263367-8
Fax number	: +98 151 2263929
e-mail	: m_shmz@hotmail.com

Name	: Mr. Mohammad Hosseini
Position	: Laboratory Expert (Department of Environment Mazadaran)
Telephone number	: +98 151 2263367-8
Fax number	: +98 151 2263929
e-mail	: m_shmz@hotmail.com

Name	: Mrs. Atefeh Rahbar
Position	: Laboratory Chief (Department of Environment Mazadaran)
Telephone number	: +98 151 2263367-8
Fax number	: +98 151 2263929
e-mail	: m_shmz@hotmail.com

Golestan Province

Name	: Mr. Esmail Mohajer
Position	: General Director of Department of Environment Golestan
Telephone number	: +98 171 2220728
Fax number	: +98 171 2239150
e-mail	:

Name	: Mr. Hossein Morazdou
Position	: Chief of Laboratory (Department of Environment Golestan)
Telephone number	: +98 171 2220728
Fax number	: +98 171 2239150
e-mail	:

Name	: Mr. Mamadeza Mollabozi
Position	: Public Participation (Department of Environment Golestan)
Telephone number	: +98 171 2220728
Fax number	: +98 171 2239150
e-mail	:

Appendix 2: Permissible standards for both industrial and municipal discharges

	Parameter	Units	Values
1	pH		6.5-8.5
2	DO	(mg/lt)	>2
3	BOD	(mg/lt)	<50
4	COD	(mg/lt)	<100
5	TDS	(mg/lt)	--
6	TSS	(mg/lt)	<40
7	EC	(µmho/cm)	--
8	Colour .	(TCU)	<75
9	Turbidity	(NTU)	<50
10	T. Coliforms	(No/100 ml)	<1000
	F. Coliforms	(No/100 ml)	<400

Appendix 3: Effluent Discharge Requirements – comparison of World Bank Guidelines and Iranian Standards in permit

EFFLUENT DISCHARGE REQUIREMENTS, Miscellaneous parameters (mg/lt)													
	Remarks	**BOD_5**	**COD**	**TSS**	**O&G**	**Phenol**	**CN^-**	**NH_4**	**N**	**P**	**F**	**Cl**	**Coliform MPN/100 ml**
Iranian Standards in Permit		**<50**	**<100**	**<40**									**<1000**
Aluminium Manufacturing	HC=5		150	50							20		
Base Metal & Iron Ore Mining			150	50	10		Free=0.1 Total=1						
Breweries & Drink Manufacturers		50	250	50	10			10		5			
Cement Manufacturing				50									
Chlor-Alkali Industry			150	20								0.2	
Coal Mining and Production				50	10								
Coke Manufacturing	benzene: 0.05, dibenz(a,h)anthracene: 0.05, benzo(a)pyrene:0.05	30	150	50	10	0.5	Total=0.2		10				
Dairy production/Ice Creams		50	250	50	10				10	2			400
Detergent Manufacturing													
Dye Manufacturing		30	150	50	10	0.5							
Electrical/Electronic Manufacturing	Chlorocarbons and hydrochlorocarbons: 0.5	50			10		Free=0.1 Total=1	10		5	20		
Fertilizers (Mixed)				50	10			10		5	20		
Fruit & Vegetable Processing		50	250	50	10	0.5			10	5			
Glass Manufacturing/Porcelain			250	50	10								
Iron & Steel Manufacturing			250	50	10	0.5	Free=0.1 Total=1						

EFFLUENT DISCHARGE REQUIREMENTS, Miscellaneous parameters (mg/lt)													
	Remarks	**BOD_5**	**COD**	**TSS**	**O&G**	**Phenol**	**CN^-**	**NH_4**	**N**	**P**	**F**	**Cl**	**Coliform MPN/100 ml**
Iranian Standards in Permit		**<50**	**<100**	**<40**									**<1000**
Meat Processing		50	250	50	10	0.5			10	5			400
Oil & Gas Development (on shore)	Sulfide:1, AOX:1, organochlorides:0.05, nitroorganics:0.05	50		50	20	1							
Paper & Pulp Manufacturing	AOX:40 mg/lt. Sulfide: 15 kg/t		300						0.4 kg/t	0.05kg/t			
Petrochemical Manufacturing	Benzene: 0.05, vinyl chloride:0.05, sulfide:1	30	150	30	10	0.5			10				
Phamaceutical Manufacturing	AOX:1 mg/lt	30	150	10	10	0.5							
Power Plants				50	10							total residual:0.2	
Refineries	benzene: 0.05, sulfide:1, benzo(a)pyrene:0.05	30	150	30	10	0.5			10				
Sugar manufacturing		50	250	50	10			10		2			
Tanning & Leather Finishing	Sulfide:1	50	250	50	10			10		2			400
Textiles		50	250	50	10	0.5							
Vegetable Oil Processing		50	250	50	10				10				
Wood preserving Industries	PAHs (each):0.05, pesticides:0.05, dioxins/furans (sum of all):0.0005		150	50	10	0.5							

EFFLUENT DISCHARGE REQUIREMENTS, Metals (mg/lt) (none of the metals is included in the Iranian standards)															
	Remarks	Ag	Al	As	Cd	Cr+6	Cr	Cu	Fe	Hg	Ni	Pb	Sn	Zn	Total Metals
Aluminium Manufacturing			0.2												
Base Metal & Iron Ore Mining				0.1	0.1	0.1		0.5	3.5	0.01	0.5	0.2		2	10
Breweries & Drink Manufacturers															
Cement Manufacturing															
Chlor-Alkali Industry										3.5					10
Coal Mining and Production															
Coke Manufacturing															
Dairy production/Ice Creams															
Detergent Manufacturing															
Dye Manufacturing						0.1		0.5						2	10
Electrical/Electronic Manufacturing				0.1	0.1	0.1		0.5		0.01	0.5	0.1	2		10
Fertilizers (Mixed)					0.1										10
Fruit & Vegetable Processing															
Glass Manufacturing/Porcelain												0.1			10
Iron & Steel Manufacturing					0.1		0.5			0.01		0.2		2	
Meat Processing															
Oil & Gas Development (on shore)															5
Paper & Pulp Manufacturing															
Petrochemical Manufacturing					0.1	0.1		0.5							
Phamaceutical Manufacturing				0.1	0.1	0.1				0.01					
Power Plants							0.5	0.5	1					1	
Refineries						0.1	0.5					0.1			
Sugar manufacturing															
Tanning & Leather Finishing						0.1	0.5								
Textiles	Co:0.5						0.5	0.5			0.5			2	
Vegetable Oil Processing															
Wood preserving Industries				0.1		0.1	0.5	0.5							

Appendix 4: The Analysis of the Anzali's Wetland Water

Head Office of Environment Protection of Guilan District
Anzali Port Headquarters of Environment Research
Date of taking of Specimen: (80/5/13) Summer 2001

Number of samples taken	1-6	1-7	1-8	1-9	20
Place of taking of a sample	Pir-Bazar	NoKhale	HendKHale	Siyah-Darvishan	Anzali bridge
Weather forecast during taking of sample	Half -cloudy				
Weather temperature [^{o}C]	27	28	26	25	25
Water temperature [^{o}C]	30	30	30	30	30
Time	10;34	10:36	11:00	11:50	12:25
Settle able solids [mg/lt]					
T.D.S 180 ^{o}C [mg/lt]	1 000	2 300	4 300	6 200	7 600
T.S.S 105 ^{o}C [mg/lt]	64	10	139	416	227
PH	8,7	9,05	8,45	8,65	8,5
Acidity [mg/lt – CaCO3]	-	-	-		
Ph-Alkalinity [mg/lt – CaCO3]	35	55	27	49	38
Total Alkalinity [mg/lt – CaCO3]	388	354	295	287	229
Conductivity [mmhos/cm]	2 038	4 575	8 706	12 353	15 829
Turbidity [FTU]					
Orthophosphates [mg/lt – P]	0,5	0,44	0,48	0,43	0,04
Total phosphate [mg/lt – P]	0,58	0,805	0,58	0,57	0,115
N – Nitrite [mg/lt – N]	0,16	0,39	0,008	0,011	0,007
N – Ammonium [mg/lt – N]	8,9	4,65	0,295	0,195	0,714
N – Nitrate[mg/lt – N]	0,048	0,019	0,175	0,176	0,174
DO [mg/lt]	7,9	7,94	8,02	11,02	5,48

optimum SS concentration 10 mg/lt
optimum pH 6.5-8.5
acceptable DO concentration 5 mg/lt

The Analysis of the Anzali's Wetland Water

BOD [mg/lt]	19,5[1]	16	11,5	8	5
COD [mg/lt]	70	94	200	84	276
Total Hardness [mg/lt – CaCO3]	500	1 004	1 912	1 252	3 744
Calcium [mg/lt – Ca]	80	93	178	82	135
Magnesium [mg/lt – Mg]	73	201	352	255	828,5
Sodium [mg/lt – Na]	225	450	1 230	2 000	2 750
Potassium [mg/lt – K]	11,2	15,2	42	680	880
Chloride [mg/lt – Cl]	380,56	1 170,08	2 414	3 834	5 225,6
Sulphate [mg/lt – S]	245	685	1 600	2 150	3 350
Total Coli forms [No/100ml]	930[2]	2 100	230	2 400	4 600
Fecal Coli forms	70	230	90	630	2 400

[1] optimum BOD concentration 10 mg/lt
[2] optimum Total Coliform concentration 1000 c/100 ml

Appendix 5: Industrial Data

Table 5-1: Industries identified in the Guilan Region								
Name	**Type of Products**	**Treatment**	**Discharge point**	**Location**	**Preliminary Questionnaire returned**	**Detailed Questionnaire returned**	**Data on effluent quality**	**Factory Visit**
Aluminium Manufacturing (Non Ferrous Metals Manufacturing)								
Guilan Aliyan Company	Aluminium (low production	No	Settlement tank	Rasht, Fouman Rd	X	**No**	**n.a.**	No
Breweries & Drink Manufacturers								
Tchaboksar Khazar Noush	orange juice, condiments	No (they will establish)	Sea via Channel	Tchaboksar	**No**	**No**	X	No
Niknoosh Drink Co	Non alcoholic refreshments	No. After pressure from DoE this co. will be moved to Rasht industrial city	Siahrood (Ziarjoob) river (Anzali wetlant finally)	Ansari str/Rasht	X	X	X	No
Zamzam Co	Refreshment	No	Ziarjoob River	Rasht/Teheran Rd	**No**	**No**	X	No
Cement Manufacturing								
Lushan Cement Co	Cement	No wastewater	Septic tank for municipal wastewater	Lushan	**No**	X	X	No
Khazar Cement	Cement	Only municipal wastewater	Only municipal wastewater	Lushan	**No**	X	X	No
Chemical Industries								
Guilan Behdasht Production Co	Toothpaste, Lotion&Cream	Septic tank for municipal WW	No wastewater only packing process	Ramsar Rd, Sarvelat, Chaboksar	X	**No**	**n.a.**	No
Fouman Chemicals (Chimie) Co	Pesticides, engine oils, brake fluids etc	No	Ziarjoob and finally Anzali wetland	Industrial City Rasht				