PN ABU-741
94427

Report Submitted to:

Susan Vernon-Gerstenfeld

Ecuador Project Center

By

Antoinette Burns

Laura Guillette

Navin E. Rajashekar

Rudy Soriano

In Cooperation With

DR. Francisco Romay and ING. Jorge Duque

Mechanical Engineering Department

Escuela Superior Politecnica del Litoral

POLLUTION GENERATED BY PRODUCTIVE ACTIVITIES

December 4, 1993

This project is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the positions or opinions of ESPOL or Worcester Polytechnic Institute.

This report is the product of an education program, and is intended to serve as partial documentation for the evaluation of academic achievement. The report should not be constued as a working document by the reader.

December 3, 1993

Mr. Alfredo Torres, Director
Department of Mechanical Engineering
Escuela Superior Politecnica del Litoral
Guayaquil, Ecuador

Dear Mr. Torres:

Enclosed is our project entitled Pollution Generated By Productive Activities. It was written at the Escuela Superior Politecnica del Litoral during the period October 17 through December 3, 1993. Preliminary work was completed in Worcester, Massachusetts, prior to our arrival in Ecuador. Copies of this report are simultaneously being submitted to Professor Susan Vernon-Gerstenfeld for evaluation. Upon faculty review, the original copy of this report will be cataloged in the Gordon Library at Worcester Polytechnic Institute. We appreciate the time that you and our advisors, Dr. Fransciso Romay and Ing. Jorge Duque, have devoted to us.

Sincerely,

Antoinette Burns

Laura Guillette

Navin Rajashekar

Rudy Soriano

Report Submitted to:

Susan Vernon-Gerstenfeld

Ecuador Project Center

By

Antoinette Burns

Laura Guillette

Navin E. Rajashekar

Rudy Soriano

In Cooperation With

DR. Francisco Romay and ING. Jorge Duque

Mechanical Engineering Department

Escuela Superior Politecnica del Litoral

POLLUTION GENERATED BY PRODUCTIVE ACTIVITIES

December 4, 1993

This project is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the positions or opinions of ESPOL or Worcester Polytechnic Institute.

This report is the product of an education program, and is intended to serve as partial documentation for the evaluation of academic achievement. The report should not be constued as a working document by the reader.

Abstract

This project is an investigation of how several biological, social, and economic areas have been impacted by the industrial contamination of the Estero Salado in Guayaquil, Ecuador. Information about these impacts was obtained from the previous research of several organizations, along with a series of interviews with local residents, ESPOL faculty members, environmental agencies, and companies. This material was compiled to develop a preliminary environmental impact assessment and methods for using it as a foundation for generating a more comprehensive assessment. Included in the recommendations, are various proposals for using the comprehensive impact assessment as a tool for creating environmental awareness and eliminating future industrial contamination of the Estero Salado.

Authorship Page

This report was completed by Antoinette Burns, Laura Guillette, Navin Rajashekar and Rudy Soriano. All members contributed equally to the completion of this project and take full responsibility for its entirety.

Acknowledgements

The completion of this project would not have been possible without the contributions of several individuals. The generosity of their time and services provided immeasurable assistance. We extend our gratitude to Dr. Susan Vernon-Gerstenfeld, Dr. Francisco Romay, Ing. Jorge Duque, Dr. James Rollings, and Ing. Alfredo Torres.

Table of Contents

I. Executive Summary.....1

II. Introduction.....5

III. Literature Review.....7

III.1. Ecuador.....7

A. Geography.....7

B. Demographics.....8

C. Economy.....8

D. Resources and Industry.....9

III.2. Environmental Management in Ecuador.....10

A. Government Structure.....10

B. Citizenship.....11

C. Local Governments.....11

D. Environmental Agencies.....12

E. Environmental Laws.....14

III.3. Environmental Impact Assessment.....15

A. Description.....15

B. General Procedure.....17

C. Leopold Matrix.....19

III.4. Biological Water Quality.....22

A. Physical Characteristics.....23

B. Estuarine Organisms.....27

C. Estuary Ecology.....30

III.5. Estero Salado.....32

A. History.....32

B. Four Main Areas of the Estero Salado.....34

C. Seasons.....36
D. Fishing.....37
E. Algae.....38
F. Mangroves.....38
III.6. Water Quality and Common Pollutants.....40
A. Dissolved Oxygen.....41
B. Dissolved Carbon Dioxide.....41
C. Measuring Methods.....42
D. Physical Pollution Indicators.....45
E. Dissolved Solids.....47
F. pH.....47
G. Nitrates and Phosphates.....48
H. Organic Pollutants.....49
I. Inorganic Pollutants.....52
J. Biological Pollution Indicators.....53
III.7. Health Hazards.....57
III.8. Water Purification.....58
III.9. Waste Water Treatment.....60
A. Preliminary.....60
B. Primary.....61
C. Secondary.....61
D. Tertiary.....63
IV. Methodology.....65
V. Data Presentation.....70
V.1. Estuary Trip.....70
V.2. Sewage and Migration for the City of Guayaquil...73
V.3. Industries.....74

A. Location.....74
B. Types.....75
V.4. Water Quality Data.....75
V.5. Environmental Agency Interviews.....76
A. IEOS.....76
B. DIGMER.....77
V.6. Industry Interviews.....79
A. Oleica.....79
B. Cridesa.....82
C. Poliquimicos del Ecuador.....84
D. Durex.....86
V.7. Community Interviews.....89
A. Centro de Salud Publica.....89
B. Local Residents.....90
VI. Conclusions and Recommendations.....93
VII. Appendices.....101
A. Related Organizations.....101
B. Questionnaires.....104
1. Industry Questionnaire.....104
2. Environmental Agency Questionnaire....106
3. Social Questionnaire.....107
C. Estero Salado Maps.....109
1. General Map.....109
2. Sewage Map.....111
3. Water Quality Data Map.....113
D. 1989 IEOS Regulations.....115
E. Quito Law.....133

F. Algae.....158

VIII. References.....161

I. Executive Summary

The purpose of this project was to collect information for developing a preliminary environmental impact assessment relating to the industrial pollution in the Miraflores and Urdesa branches of the Estero Salado. This preliminary environmental impact assessment identifies the major problem areas, outlines a method for further investigation, and provides general suggestions to resolve the problem.

The Miraflores and Urdesa branches, located in the northern section of Guayaquil, are the two most heavily contaminated branches of the estuary. The information we gathered concentrated on the biological, social, and economic effects of industrial pollution in those two areas.

Biological information included the effects on flora, fauna and water quality. Social information included the effects on health, recreation and immigration, and economic information included the cost of treatment facilities. Information was gathered from several libraries, through interviews with various faculty members, local residents, companies and environmental agencies, and also from previous research of the Estero Salado.

Many of the companies in Guayaquil, located along the streets Via a Daule, Avenida Julio Carlos

Arosemena, and Avenida Juan Tanca Marengo, do not have access to city sewage. Although several companies do have treatment facilities, they are not all working properly. As a result, industrial wastes with high levels of pollutants are discharged into storm water channels that empty into the Estero Salado.

The Ecuadorian Water Commission, made up of IEOS, DIGMER and INERHI, was formed in 1989 as a result of the 1976 national pollution control law. One of the duties of the Water Commission is to regulate the uncontrolled dumping of industrial wastes. However, these environmental agencies are not consistently enforcing the regulations, and many industries have no knowledge of or involvement with them.

Consequently, this estuary, that was once used as a recreational park for swimming and fishing, is now virtually lifeless. Not only is the area aesthetically displeasing with significant decreases in flora and fauna, but it is also unsafe for any recreational activities.

To improve the situation and to avoid future problems, we have developed a method for conducting a follow up, quantitative environmental impact assessment. We propose that this impact assessment be used as a tool for creating the awareness necessary for improving the situation.

We suggest that education is the first step in creating environmental awareness. Sparking an environmental conscience in young school children and informing adults how their lives are impacted by this contamination are just two possibilities within environmental education.

Companies must also be informed of the effects of the contamination. Proposing alternative methods for optimizing production while minimizing waste can be discussed with every company. This discussion would also include possibilities of treatment facilities.

The government and environmental agencies must also be informed of the pollution problem. This must include a reassessment of their control of industrial discharges. More control could be obtained by increasing the fines for noncompliance with discharge regulations. This would give the Municipality revenue that could be used to complete sewage connections and renovate the city's treatment facility. Increasing the fines would also make it more expensive for the companies to pollute than to build treatment facilities. Companies with similar discharges can build a common treatment facility if they have financial difficulties.

We expect this project to serve as a basis for a quantitative impact assessment of the Miraflores and

Urdesa branches of the Estero Salado. A quantitative impact assessment will lay the foundation for a specific pollution clean-up and prevention program for industrial activity along these two branches.

II. Introduction

This project serves as a preliminary, qualitative environmental impact assessment of the two most heavily polluted branches of the Estero Salado in Guayaquil, Ecuador, as shown on the general map included in Appendix C. The ecosystem in these parts of the estuary is dead due to many causes, one of them being the uncontrolled industrial dumping of liquid waste into the Estero Salado or into storm sewers which flow directly into it. The assessment includes an examination of the pollution generated by industrial activities on the Estero Salado in three main topic areas: the economic, social and biological impacts of the pollution found there. The purpose of conducting a preliminary impact assessment was to establish a foundation for a large scale environmental impact assessment, and to propose general treatments for the area.

In order to develop an effective environmental impact assessment a literature review of relevant material was prepared. Included in the literature review is basic information about Ecuador, environmental management, environmental impact assessments, biological water quality, the Estero Salado, water quality and common pollutants, health hazards, water purification, and waste water treatment,

information all intended to familiarize the reader and the project group.

The information needed for this project was collected through various libraries in Worcester, Massachusetts, and a series of interviews with many different industries, agencies, and ESPOL faculty in Guayaquil and Quito, Ecuador.

An Interactive Qualifying Project is a degree requirement established by Worcester Polytechnic Institute in Worcester, Massachusetts. The purpose of an IQP is to research the relationships between science, technology and the surrounding society. Not only are we assessing the biological and economic effects of industrial pollution in the Estero Salado, we are also determining the environmental repercussions on the surrounding community. By performing both a technical and social analysis of the problem, we are fulfilling the IQP requirement.

This report was prepared by members of Worcester Polytechnic Institute Ecuador Project Center. The relationship of the Center to Escuela Superior Politecnica del Litoral, ESPOL, and the relevance of the topic to ESPOL are presented in Appendix A.

III. Literature Review

III.1. Ecuador

III.1.A. Geography

Ecuador, a country on the Pacific Coast of South America, is comprised of a geographical area of 270,670 square kilometers. Included in this area are the Andean highlands, the Amazon Jungle, the coastal region, and the Galapagos islands (Aspiazu, 1993, pp. 11).

The diverse ecosystems that are found in Ecuador make it biologically one of the richest countries in the world. The area of Ecuador is .02 percent of the earth's surface, yet, within its small area, there are 10 percent of the world's total bird species. Within the Central Highlands at 9,210 feet, lies Quito, the oldest city in South America and the capital of Ecuador. Quito, as of 1990, had a population of 1,112,575 people. It is one of the highest cities in South America. Also located in the highlands is Cuenca, the third largest city in Ecuador (Aspiazu, 1993, pp. 79-83).

Guayaquil, with a population of 1,513,437 people in 1990, is located on the Pacific Coast and is Ecuador's largest city. The largest port city on South America's Pacific coast, it is also the commercial and social center of the country, and it is the gateway to the Galapagos Islands.

The Galapagos Islands, a protected national park located 622 miles off of Ecuador's Pacific Coast, were formed from lava and volcanic rock approximately 3 to 5 million years ago. The islands are the smallest region of Ecuador, having only 9,785 people in 1990 but are a popular place for tourism (Aspiazu, 1993, pp. 83).

III.1.B. Demographics

The total population of Ecuador was 10,075,407 people in 1990, of which more than half are located in the urban areas. In fact, in 1990 more than 27 percent of the population were in Guayaquil and Quito alone. As a result, there is an increase in pollution and a problem with overcrowding.

Spanish is the major language, yet Quechua, an indian language, is spoken in many of the villages. There are three ethnic groups: Indian, comprising approximately 50 percent of the population; Meztizo, 40 percent; and White, 9 percent (Aspiazu, 1993, pp. 88).

III.1.C. Economy

As of 1992, the per capita Gross National Product was $1,030. The annual GNP growth is 1.7 percent with 16 percent of the GNP for agriculture, 31 percent for industry, 53 percent for services and .6 percent for defense (PC Globe).

III.1.D. Resources and Industry

Ecuador's natural resources include petroleum, fish, shrimp, timber, gold, and limestone. The agriculture includes sugarcane, bananas, rice, palm products, corn, coffee, potatoes, roundwood and cacao, including pork, cattle, sheep, and chickens as livestock. Among the major industries are foodstuffs, beverages, petroleum products, textile products, pharmaceutical, lumber, and chemicals.

Industrial machinery, raw materials, building materials, vehicles, consumer goods, fuels, lubricants, transport equipment, and chemicals are the country's major imports, while petroleum products, shrimp, bananas, coffee, and cocoa are the major exports.

Guayaquil is the largest industrial center in the country. There are approximately 3000 industries that contribute to the diversified economy of the city. According to one survey of 159 main industries in the city, Guayaquil's production can be described as 34.6% food production related, 25.4% chemical production related, 15.72% metallic products, 10% non-metallic minerals, 5.7% textiles and 2.6% other (Coloma, 1993, pp. 71).

III.2. Environmental Management in Ecuador

Different institutions are involved in management of the environment in Ecuador. The federal government makes national environmental laws, local governments make local environmental laws, and various environmental agencies help in making and regulating these laws.

III.2.A. Government Structure

The republican democrat government in Ecuador is similar to that of the United States. The last constitution came into effect in 1979, becoming Ecuador's eighteenth constitution since its independence from Spain in 1822. As a result of the terms of the constitution, the country is governed by an executive president and a vice-president. Both officials are popularly elected for a single four year term.

The Ecuadorian Congress includes both the Chamber of Representatives and the Senate. Within the Chamber of Representatives, there are 69 deputies each elected for a five year term. The deputies are elected by the citizens of each province. One deputy is elected for every 80,000 inhabitants. The Senate includes two elected senators from each province and fifteen functional senators who are appointed by special

economic and cultural groups.

The rest of the government, including a unicameral legislature, is appointed by the president and the vice-president. The judiciary plays a very small role traditionally as well in the governing of Ecuador. Most of the law enforcement is done through the local governments (Encyclopedia Americana, 1992, pp. 620-21).

Ecuador is divided into twenty-one provinces, ten in the highlands, five in the coastal lowlands, five in the eastern lowlands, and one for the Galapagos Islands. The provinces are divided into cantons, and each canton is divided into parishes. Each province has a governor, each canton has a Jefe Politico, and each parish has a Teniente Politico, all of whom are appointed by the central government (Aspiazu, 1993, pp. 79-80).

III.2.B. Citizenship

Ecuadorian citizens over the age of eighteen must vote in the national and local elections: any citizens who do not vote are fined.

III.2.C. Local Governments

All the cities in Ecuador contain a Municipality which perform certain activities. One of the departments at the Municipality in Quito is the

Department of Environmental Issues, which is in charge of regulating and controlling the process of issuing the Certificates of Environmental Quality, which industries need to be considered environmentally sound and to operate legally.

The Department of Environmental Issues along with the Planification Department is also in charge of authorizing the construction of new industries. To obtain clearance from the Department of Environmental Issues, the new industry must present their plans and prove that these plans will be environmentally sound. The industry must then go to the Planification Department to get approval of the plans for the construction of the industry.

III.2.D. Environmental Agencies

Many environmental agencies exist in Ecuador to aid the federal and local governments in environmental law making and regulating. A few of the agencies interviewed for this project include: IEOS, DIGMER, and the Fundacion Natura.

IEOS, Instituto Ecuatoriano de Obras Sanitarias, is a national organization that monitors the impacts related to any sanitary project in the country. It also has the power to control the regulations involving industrial waste and domestic organic discharges.

DIGMER, Direccion General de la Marina Mercante, is an environmental agency within the Ecuadorian Army. The Contamination Control Department of DIGMER is located in Guayaquil, and was established in 1974 to control the pollution of the waterways of Ecuador. DIGMER tests the industrial waste water discharges and can shut an industry down if they do not pay the fines established by the 1989 regulations.

La Fundacion Natura is a non-profit organization created in 1978 to promote environmental conservation in Ecuador. The organization has been subsidized by local benefactors and groups including: MacArthur, Nature Conservation, World Wildlife Fund, the United Nations, and the US Agency for International Development.

The objectives of Fundacion Natura include educating the community to increase social awareness, collecting and distributing information regarding present environmental situations, and executing development projects for conserving the environment.

The three Fundacion Natura chapters in Ecuador are located in Quito, Guayaquil, and Azogues. The Guayaquil chapter was established in 1984 and is responsible for environmental problems along the coast of Ecuador.

III.2.E. Environmental Laws

The IEOS Water Pollution Regulations, described in Appendix D, were created in 1989 in accordance with the 1976 Environmental Pollution Prevention and Control Law established by the Ecuadorian government. This law establishes pollution control and prevention guidelines for the protection of all Ecuadorian bodies of water. Included in these guidelines, are the water quality parameters to be used for deciding the safety of drinking water and industrial waste water discharges.

As a result of this law, the Water Commission was formed among IEOS, DIGMER, and INERHI. The Commission is in charge of proposing regulations for industrial waste water discharges and monitoring the industries to insure that these regulations are followed. The Water Commission has the power to take random water samples of any industry to verify that the industrial discharges are not contaminating the environment.

By order of this law, industries are required to register lab reports of their discharges with the IEOS agency 3 times a year. If the industries do not comply with these regulations, they are fined by the Water Commission with the possibility of being shut down.

Another environmental law, found in Appendix E, was issued a year ago by the Municipalidad de Quito. This law was created as a device to control the city's

pollution, and it establishes guidelines for protecting the city's water channels and air ways from further pollution.

The law suggests that a Certificate of Environmental Quality be given to environmentally sound industries. The pollution levels for known water pollutants, disposal guidelines, infractions, consequences, and inspection procedures are also listed in this law.

The Master Sewage Plan for Guayaquil for the period 1986-2006 was established by EMAG, Empresa Municipal de Alcantarillado de Guayaquil. This plan describes all of the areas presently connected to the sewage system in the city of Guayaquil, and it also suggests areas that should be connected in future years.

The plan includes maps and a complete demographic description of the city of Guayaquil. In addition, it discusses waste water prevention, treatment procedures, and the use of algae as a pollution indicator.

III.3. Environmental Impact Assessment

III.3.A. Description

An environmental impact assessment identifies, interprets, predicts, and communicates information about the impact of a particular action on the

environment. The assessment describes the action, forecasts the size and importance of the environmental effects, describes the indicators used to attain the size of the effects, and makes recommendations for alternative and restorative actions (SCOPE, 1975, pp. 8-9)

A complete assessment encompasses the social, physical, biological, and economic impacts for short, medium, and long terms; however, the well-being of humans is the main concern. Various components such as health, social patterns, and personal security are analyzed and ordered by priority. How present lifestyles will be affected and the possibility of danger to humans are analyzed.

Specific environmental changes and the rate at which they occur are considered to be of equal significance, since rapid changes create strains and may result in irreversible damages within an ecosystem. The rate of reversibility determines the amount of time required for a system to recover from a certain degree of damage. An ecosystem may have time to adapt and stabilize if the environmental changes are gradual and controlled (SCOPE, 1975, pp. 15-20).

III.3.B. General Procedure

First, the initial state of an area is generally determined by using either quantitative or qualitative measurements (SCOPE, 1975, pp. 36). Qualitative measurements have a higher degree of uncertainty since biologic ecosystems react differently to various stressors. Next, situations with and without treatment or prevention are predicted using various impact indicators. These predictions can be represented with a checklist, matrix, or flow diagram. All three of these methods represent a cause and effect relationship that allows an analyst to view the relationships between actions and possible impacts. Comparing the relationships helps to determine the level of necessity and the most effective method for correction (SCOPE, 1975, pp. 42-43).

The various impact indicators used for measuring the environmental effects are different for every situation. It is possible to study many areas in one assessment; thus it is important to choose indicators that are suitable to particular conditions and will result in relevant data.

The estimation of the overall environmental impact is achieved through a series of steps. First, the variables describing the environment are reduced to the ones most relevant to a certain impact indicator.

Every proposed reaction is related to an indicator on a numerical scale, and these scales are then compared to determine an overall impact. The analyst weighs the results and prioritizes the necessary actions.

There are a great variety of methods employed for prediction of natural processes. For making qualitative predictions, researchers can say that the environmental situation worsened, did not change, or improved. Numerical scaling can also be used. It must be noted that whatever prediction method is used, the environment will not behave exactly as predicted. The analyst's job is to provide some general guidelines based on data that is as accurate and complete as possible (SCOPE, 1975, pp. 43-45).

There are three main ways to interpret the information used in prediction. The first one involves determining a set of values for each impact indicator. Indicators are set into subgroups and by checking off the ones that are used, the analyst can create a picture by viewing the clustering of check marks in the different subsets. The second way of interpreting the information is by ranking the alternatives within the impact categories. The alternatives or cleanup plans are evaluated against the different environmental impacts to see how each plan addresses each impact. However, weights are not assigned to the different

indicators, so the total effect an alternative has on the different impacts cannot be compared (SCOPE, 1975, pp. 45).

The last method is that of normalization and mathematical weighting. Impact indicators are scaled in units that can be compared and numerical importance is assigned. There is controversy as to the weight given to certain indicators in comparison to others; therefore contributing to a large amount of systems to choose from (SCOPE, 1975, pp. 45).

III.3.C. Leopold Matrix

One of the more popular methods for environmental impact studies is the Leopold Matrix System. Developed for the United States Geological Survey, this system was created to serve as a guide for the assessment and evaluation of impacts related to construction projects. It consists of a checklist incorporating qualitative information on cause and effects relationships and is also an effective way to display information. The system consists of choosing the most pertinent choices out of a comprehensive list of all potential impacts and causes of an action (SCOPE, 1975, pp. 53-58).

The focus of the environmental matrix consists of an open-cell matrix with 100 specific actions located along the horizontal axis, and 88 environmental

parameters or conditions, located along the vertical axis, as shown on pages 54-55 in the book Environmental Impact Assessment by the Workshop on Impact Studies in the Environment, 1974. The impact is determined by looking at the interaction between the action and the environmental parameters. Every action and its possible impact on the environment are accurately described in the diagonal of a block matrix of corresponding interactions.

The second stage consists of describing the interaction in terms of its magnitude and importance. The magnitude of the impact is measured on a scale from 1 to 10, with 1 representing a small impact and 10 representing a large impact. In order to establish the magnitude, the action must be related to the consequence. Consequences can be positive or negative, and are represented with a + or -. The scale of the importance of the impact is also measured from 1 to 10:

Consequence	Qualification
Small	1 - 3
Regular	4 - 5
Large	6 - 7
Extremely large	8 - 10

In order to use the Leopold Matrix, the following procedure is used:

1) Determine the evaluation area.

2) Determine the actions that will be examined in the area.

3) Determine for every action what impacts are possible and place a slash in those boxes.

4) Determine the magnitude of each possible impact on a scale from 1 to 10, and determine whether each magnitude is positive or negative. Place this value in the upper left corner of the each box containing a slash.

5) Determine the weight or importance of the possible impact, rating on a scale from 1 to 10. Place this value in the lower right corner of these same boxes.

6) The desired values are obtained by multiplying the weight by the magnitude.

7) Sum the positive values then sum the negative values.

8) Sum these two numbers together to get the overall impact for each action.

9) Establish conclusions and include them in a written discussion about the significance of the impacts.

The Leopold matrix does not distinguish between short-term and long-term impacts. Separate matrices are created in the case of obtaining information for

each period of time. Also separate matrices must be created when analyzing with-action and without-action states.

With-action states occur when corrective measures have been implemented, whereas without-action states occur when no corrective measures have been taken. In this method, double counting of impacts is possible due to the fact that a single impact can be caused by different actions (SCOPE, 1975, pp. 53-58).

III.4. Biological Water Quality

Estuaries are places in which fresh water from rivers mixes with the salt water from the ocean. There are many different types of estuaries, but they all have similar characteristics, including their interaction with humans. There is a close interaction between humans and estuaries because many of the major cities of the world are located on estuaries, including our area of study, Guayaquil, Ecuador.

There are four major types of estuaries: tectonic, semi-enclosed or lagoon, fjord, and coastal plain. The one of interest is the later of the four: namely coastal plain estuaries. This is the most common type of estuary, formed during the end of the last ice age by the rising sea level. All estuaries may be classified in yet another way, by their

salinity, or salt content. In most estuaries, the fresh water from the rivers is less dense than the salt water, and therefore floats on top of the salt water making the water on the surface of the estuary less saline than the deeper waters. This type of estuary is called a positive or salt wedge estuary. Other types include marine-dominated estuaries in which the water is completely mixed in all areas. Negative or evaporative estuaries occur in desert climates where the rate of evaporation is very high and estuary input is very small. Seasonal or intermittent estuaries occur where the area has a clearly marked wet and dry season, such as in the Mediterranean countries. In all types of estuaries, the salinity varies greatly with the topography of the area, the amount of fresh water entering the estuary, the tides, and the changes that occur with the seasons.

III.4.A. Physical Characteristics

The tides have a great influence on the salinity of the water in an estuary. All estuaries have a certain area in which the salinity fluctuates with every low and high tide. Another large influence on water salinity is caused by the Coriolis force. The Coriolis force is a result of the earth's rotation. This force deflects the flowing water and causes

changes in salinity. The deflection of the water caused by the Coriolis force is opposite in the northern hemisphere compared to that of the southern hemisphere. More study needs to be performed to determine whether this phenomenon has any effect on the Estero Salado because it is located only slightly south of the equator.

Seasonal changes influence the salinity of an Estuary as well. The weather of Ecuador has a significant influence on water salinity because of the drastic differences between the wet and dry seasons; there is little to no precipitation in the dry season, and it frequently rains in the wet season.

The last area of great influence is the substrate, the mud and sand on the bottom of the estuary, which is usually very high in salinity. The substrate is formed from particles in the ocean and rivers that settle to the bottom of the estuary. These particles can also originate from the dumping of wastes either directly into the estuary or into the rivers and oceans that flow into them. The physical characteristics of the substrate depends on the geography of the area. An estuary having larger currents will have a substrate that is more sand and gravel than mud.

The two branches studied in this project contain large amounts of sludge, a result of decomposing

organic matter. From the information obtained, we know that the Estero Salado would have more of a mud substrate because the area of study is secluded from the sea. As a result, the currents from the tides are not very high. The silt is very rich in inorganic materials which would be used as food for estuarian organisms. This silt and salinity of the water would be severely disturbed in the case of flood and animal mortality would result; therefore, the chances of floods will be studied there as well. This information is also dependant on another feature of the estuary, temperature (Nybakken, 1988, pp. 75-80).

Temperature in estuaries varies more than in the oceans nearby. The variation is caused by the smaller amount of water, larger surface area, and input from the freshwater rivers. Especially in countries with a differentiated wet and dry season, the temperature of the water in the rivers varies more than in the ocean. The temperature also varies vertically, salt water temperature tending to be on the bottom and the freshwater temperature tending to be on the top because fresh water is less dense.

How quickly the two temperatures mix depends on numerous things including wave action and currents. If any exist, waves in estuaries tend to be very small because estuaries are surrounded by land on three

sides. The currents of the water are caused by the tides and by the currents from the rivers. The largest currents in an estuary would be in the middle of the largest channels. The two branches of the Estero Salado that will be studied are not in this part of the estuary and should have very calm waters with small currents. The calm water can also be attributed to the small area of the branches. Erosion occurs in the area of large currents and, should not be a large problem in our area of study. The lack of currents could lead to other problems, including reduced oxygen content which leads to mortality of organisms in that part of the estuary (Nybakken, 1988, pp. 76-80).

An important aspect of estuaries is the flushing time. This is the time interval in which a given water mass is discharged from the estuary. It is an important measure of the stability of the estuarine system. Long flushing times are important for the maintenance of the plankton communities.

Another measure of the physical quality of an estuary is its turbidity, the measure of substrate or foreign particles that are stirred up in the water. The level of turbidity is highest during the times of maximum river flow, which would be during the rainy season. The effects of high turbidity are a decrease in the penetration of light which decreases

photosynthesis by phytoplankton and other marine plants, which, in turn, decreases the level of oxygen in the water. Other variables affecting the oxygen level are the influx of fresh and salt water, the shallowness, turbulence, and wind mixing.

The solubility of oxygen in water changes with temperature and salinity, so that the amount of oxygen in the water at a given time changes according to those parameters. The level of oxygen in the substrate is lowest where there is a large oxygen demand (Nybakken, 1988, pp. 80-83).

III.4.B. Estuarine Organisms

Animals in an estuary can be classified into three categories: marine, freshwater and brackish water or estuarine animals.

Most of the animals fall into the marine category because this category contains the most numbers of species, split into two subgroups: stenohaline and euryhaline. Stenohaline marine animals are unable or barely able to tolerate salinity changes; therefore they are only found at the mouths of estuaries, where the salinity is 30 percent or above. These species are the same species that are found in the open sea. Euryhaline marine animals are capable of tolerating varying amounts of salinity below 30 percent. Most of

these animals can tolerate salinity levels as low as 15 percent, but there a few species that can tolerate it at less than 5 percent.

Freshwater animals are animals who live in the rivers and cannot live in water having salinity greater than 5 percent. They are, therefore, restricted to the upper parts of the estuary. Brackish water, or true estuarine animals, are the species found in the middle parts of the estuary, where the salinity varies from 5 to 20 percent. These animals include oysters, small gastropods, crabs, and shrimp. Crabs and oysters are common in the Estero Salado. The oysters are completely exhausted and crabs are still fished by the local people.

Some biologist are considering a fourth category consisting of various migratory fishes that pass through the estuary on the way to breeding grounds. Examples include salmon and eels. Also included in this group are species that spend only part of their lives in the estuary, including certain species of shrimp.

The number of animals living in estuaries is significantly lower than in the pure salt water or pure fresh water, due to the inability of animals to tolerate salinity changes. Estuarine organisms primarily come from marine organisms instead of fresh

water organisms. Various explanations exist for why such few estuarine species exist. One explanation is that only a few species have been able to evolve the specific organelle, or body parts, to allow them to tolerate salinity changes. This explanation includes the possibility of more species evolving in the future. Another explanation is that estuaries have not existed long enough for these species to evolve, and the estuaries, therefore, need more time. Aside from animals, there are various other types of organisms in an estuary.

Estuarine vegetation is very limited. Most parts of estuaries consist of the mud substrate which is unsuitable for attachment by many plants. Estuaries also generally have a high turbidity which does not allow for light penetration to the plants for photosynthesis. These facts result in little plant life at the bottom of estuaries. Most of the upper layers of estuaries contain a limited number of plants, however. These include beds of sea grasses, certain species of sea algae, blue-green algae, and species of mangrove forests in the tropics. Bacteria exists in the estuaries as well. Both the water and the mud substrate are rich in bacteria due to the abundance of organic matter. Estuaries contain thousands times more bacteria than does pure seawater.

This bacteria serves as an important resource for many species of animals and contributes greatly to the productivity of the estuary.

III.4.C. Estuary Ecology

The productivity of the estuary is dependent on certain organisms. The primary producers are the phytoplankton, the benthic diatoms, seagrasses and various algae mats. These organisms are a major source of the high level of organic material in the estuary. A lot of this material, called detritus, is carried down the rivers from upstream. These organisms also contribute to this detritus found in the salt marshes which are the nurseries for fishes, shrimps and crabs. There are few animals which feed off the plants, so these plants must be broken down into detritus by the bacteria, that is eaten by the animals in the estuary. This is the start of the food chain of the estuary. Detritus is the basis for the chain, being consumed directly by the animals. The detritus is found in two forms, floating in the water or mixed with the mud in the substrate, but both types are equally consumed.

The abundance of food in the estuaries is the reason for its use as a feeding ground by migratory adults of many species of birds and fish. However, this abundance of nutrient levels does not guarantee a

balance. Estuaries tend to be very unbalanced, with nitrogen levels being very low. In most areas of the world, the phytoplankton and zooplankton appear in cycle, depending on the season and local weather. If the cycle is destroyed it could be fatal to certain organisms that depend on these cycles for survival.

One area of great importance in Ecuador is the salt marshes, which border the estuary. They are a transition area between aquatic and terrestrial ecosystems, which protects the marine shores and many species of animals who breed there, including shrimp. The salt marshes are more easily affected by human actions than the rest of the estuary. Some disturbances are diking, dredging, channeling water, pollution, introduction of exotic species and construction of structures such as houses or buildings. These disturbances lead to large-scale changes in the salt marsh and the estuary. Over time, the salt marsh becomes smaller and smaller due to human interaction. This could be a problem in Guayaquil since the economy of the region is heavily dependent on the shrimp industry. The shrimp industry will continue to have a decrease in production as the pollution problem gets larger. Measures should be taken to investigate the salt marsh and estuary pollution. A coherent program must be implemented to develop a sustainable shrimp

industry (Nybakken, 1988, pp. 85-90).

III.5. Estero Salado

III.5.A. History

Information about the history of the Estero Salado was obtained through an interview with Dr. Nicolas Campana, a Water Contamination and Chemical Oceanography professor at ESPOL. He also worked as the National Head of Marine Contamination for DIGMER from 1970-1980.

When Guayaquil was founded in 1535, the Guayas River was used as the transport medium for inland travel. At the same time, the Estero Salado was full of mangroves and many fishermen. As the economic importance of fishing grew, the city also grew.

Problems with pollution of the Guayas water-ways started in the early 1940's during World War Two when Ecuador produced balsa wood for the Allies. As a result, the city grew, but basic resources were not provided for the growing sectors of the city. To protect the Estero Salado a law was issued ordering all residual waste water to be dumped into the Guayas river.

In 1958, the Estero Salado was still clean enough for people to bathe freely in, and to fish for mussels, shrimp, and fish. At that time the northern part of the

city, north of what is known today as Urdesa, was not populated.

In 1960, the quality of water in the Estero Salado started to deteriorate with the construction of the ciudadela Urdesa. In that same year, the construction of two wastewater treatment plants had begun. Both plants still exist today for primary treatment of sewage; Planta El Progreso in the northern part of Guayaquil and Planta El Guasmo in the south part of the city. Both plants are completely inoperative due to the destruction of equipment and pumps; therefore, the raw sewage is pumped directly into the Guayas river.

The main causes of pollution of the Estero Salado are rooted in the 60's when Carlos Guevara Moreno exploited the city. His successor, Assad Bucaram, had good intentions for the city but he was not able to plan for the future urbanization of Guayaquil. Bucaram initiated the building of the "shanty towns." As the city grew, the municipality failed to provide basic and essential resources for the new neighborhoods. Without services such as water, electricity, and sewers, people started dumping their wastes into the Estero Salado.

Growth in the city has occurred at a tremendous rate since Bucaram's municipality. Neighborhoods were poorly designed because there were no zoning laws in existence.

The increased growth, lack of basic services, and the lack of zoning laws contributed to a drastic increase of pollution in the Estero Salado.

The first pollution prevention law was issued in 1976. This law was vague, but it did call for an industrial pollution prevention regulations to be made by IEOS fifteen days after the law was issued; however, the agency did not finish the regulation until 1989. As a result, the industries continued to pollute the area. The law is included in Appendix D and summarized in section III.2.C.

III.5.B. Four Main Areas of the Estero Salado

The Estero Salado can be divided into four areas based on the physical and chemical analysis of the water and the distribution of the species of the algae. The first sector is the two branches north of the Cinco de Junio bridge including the Urdesa and Miraflores sections of the city of Guayaquil. These branches were the zone for the spawning and growth of shrimp larvae of the genus Penaeus vannamei, P. occidentalis, and P. stylirostris. In the past, the local fisherman captured these young organisms at middle tide and sold them to shrimp companies where they were developed and fattened in shrimp ponds. These parts of the estuary no longer contain these species due to the

contamination.

The second area is the portion extending from the Portete bridge and includes the southwestern sections of the city. This sections includes all of the following branches: Limones, Santa Ana, Salado, San Francisco, Mongon and Plano Seco. This section is characterized by good water quality and extensive areas of mangroves. These mangroves act as regulators of the quality of the water and are useful food and shelter for a variety of marine animals. Plastic and other garbage gets caught in the roots of the mangroves in other more northern parts of the estuary but the tidal flow prevents that from occurring in this area. A good distribution and diversity of fish and microorganisms are densely populated here. This area is also the spawning area of shrimp to be captured by local fishermen for cultivation in shrimp ponds.

The third section is the part of the estuary extending out from Puerto Maritimo all the way down to the Gulf of Guayaquil. This area includes the estuary which embraces the following islands: La Esperanza, Las Conchitas, La Orosco, Las Cajas, Rocanita, San Ignacio, Las Quiñones, & Bellavista. This section is also densely populated with mangrove trees that are influenced greatly by the tides.

The final section encompasses the primary fishing

areas including Los Esteros, Chupadores Chico, Chupadores Grande, Estero Moquiñaña, Canales del Morro and Cascajal. The third and fourth sections are areas of great exploitation of fish resources by industries as well as by the local community. Here many species of fish, mollusks and crustaceans live because of the excellent natural conditions for their reproduction and development. Commercial crabs of the genus Udides occidentalis ortmann and Cardisona crassum smith are abundant and are caught for the local market. The abundance of the animals varies from time to time due to two conditions: the physical condition of the surroundings, such as climate changes; and the oceanographic conditions, such as the temperature and salinity.

III.5.C. Seasons

During the winter season, which extends from January to April, there are excellent catches of decapod crustaceans of the genus Panaeus vannamei, P. occidentalis, P. stylirostris and others. The fish population decreases during this time, however, due to the decrease of plankton in the waters and leading to the migration of many fish species.

At the beginning of the summer, including the months of May and June, large populations of fish

reappear, primarily from the family Mugilidas. The temperature decreases and the salinity recuperates causing the increase of the plankton, which is used by the fish for food and to lay their eggs.

A third period of seasonal fluctuation occurs during the months of July and August. This is the most optimal time of the year in terms of stability and temperature, which is between 26.0 and 26.5 C. This condition is excellent for the metabolism, development and reproduction of many species of fish, including the following families: Arlidae, batrachoidae, centropomidae and clupeidae.

At the end of the summer, including the months from September through December, there are many varieties and abundances of fish and zooplankton. More than 50 percent of the fish species are in the juvenile state at that time and another large percentage is in the fish egg stage.

III.5.D. Fishing

There are two types of fishing in the Estero Salado region, commercial and domestic. Commercial fishing is done mostly by companies and local fishermen who sell their fish to markets. Domestic fishermen are local fishermen who fish for pleasure. In both cases, the tides play a large factor in the capturing of the

fish. Experienced fishermen use soaked nets, which are arranged across the entire width of the estuary branch, forcing the fish to be trapped when the tide goes back out.

III.5.E. Algae

Many factors influence favorable conditions for maintaining algae life in the Estero Salado. Movements of the tides, entrance and exit of vertebrae and invertebrate organisms, and the endogenous rhythms of the organisms are all contributing factors in the presence of algae in the Estero Salado.

Many types of algae might be found in the Estero Salado area, as shown in Appendix F. All of the algae can bring problems to the water supply. The actions of the algae vary with each species but copper sulfate and sulfuric acid eliminates most of the species.

III.5.F. Mangroves

Mangroves are tree and shrub communities in tropical estuarine systems which occupy vast extensions of muddy zones and favor elevated temperature and humidity. These plants, which are 45 to 50 meters in height, represent an incredibly rich ecosystem, serving as shelter and as sustenance for the fauna in the water. The leaves that fall into the water and on the

surface continuously contribute to the growth of bacteria. This bacteria forms detritus food that attracts many species of fish, and creates an excellent area for the development of larvae for many types of marine organisms.

The communities of fish and other marine animals look for the mangrove zone as appropriate surroundings for the development of their young and thus keeping the biological cycle going. The foliage of the mangroves is an effective shield from the solar radiation and serves as a refuge for many organisms. Bivalves, gastropods, decapods and crabs contribute to the ventilation of the ocean floor by means of constructing holes or burrows in the substrate under the mangroves that oxygenize the soil (Nybakken, 1988, pp. 85-90).

This substrate is usually neutral or slightly acidic. The mangroves can withstand a Ph range from 4.8 to 8.8 and are accustomed to hydrosulfuric acid in the substrate, but there must also be an adequate supply of water and nutrients in the surroundings. Under these conditions, the mangroves will produce approximately 10 grams of organic material per square meter per year, making it one of the most productive ecosystems in the world. This important ecosystem is jeopardized when the mangroves are cut down for domestic or industrial use.

It is estimated that 7 to 15 metric tons of mangrove trees are cut down every year. They are used for the production of wood for firewood and construction of buildings, furniture, boats and piers. They can be used by textile and leather companies to make synthetic products and therefore preserve the materials and reduce cost. Also, the salt in the branches of the mangrove trees that are floating in the water can be extracted for the production of salt. The mangroves are beneficial in large numbers during storms because they protect the land and surroundings from flooding (Corrales, 1990, Ch. 2).

III.6. Water Quality And Common Pollutants

The quality of water in the Estero Salado is determined by the use of several pollution indicators. These indicators include measurement of Dissolved Oxygen, Biochemical Oxygen Demand or BOD, Chemical Oxygen Demand or COD, temperature, total suspended solids, color, total dissolved solids, ph, Nitrates, Phosphates, ammonia, and Carbon Dioxide. Combinations of these indicators is used to determine the extent of the pollution in the Estero Salado.

III.6.A. Dissolved Oxygen

Oxygen is one of many dissolved gases that is present in water. It is essential to life in the water and is crucial to the maintenance of water quality; Therefore, it is the most important of all the dissolved gases. Without oxygen, life in the water would be non-existent since fish and other marine life utilize oxygen during respiration. Bacteria use dissolved oxygen to decompose organic and certain inorganic matter. This process is important to the water's ability to sustain natural self-purification. Extremely low concentrations of or an absence of dissolved oxygen in the water will result in the death of the water of the estuary (Klein, 1962, pp. 217).

Concentrations of dissolved oxygen range anywhere from 14.7 parts per million to 7.2 parts per million. Factors that affect the concentration of dissolved oxygen are temperature, salinity, and decomposition activity. Higher levels of temperature, salinity, and decomposition lowers the concentration of dissolved oxygen in the water (Meserve, 1974, pp. 136).

III.6.B. Dissolved Carbon Dioxide

Dissolved carbon dioxide is a by-product of aerobic and anaerobic decomposition. Aerobic decomposition occurs in the presence of oxygen while

anaerobic decomposition occurs in the absence of oxygen. Acids also release large amounts of carbon dioxide from bicarbonate that naturally exists in the water. In large concentrations dissolved carbon-dioxide can be lethal to fish and their eggs (ASTM, 1969, pp. 13).

III.6.C. Measuring Methods

Biochemical Oxygen Demand or BOD is a measure of the quantity of oxygen used by bacteria for the decomposition of organic and certain inorganic matter aerobically. Pollutants having high levels of BOD will exhaust the water's dissolved oxygen supply.

The BOD test is based on the assumption that all organic matter that can be biodegraded will be oxidized to carbon dioxide and water by microorganisms. The rate at which the oxygen is consumed is directly proportional to the concentration of degradable organic matter remaining at any time (Davis, 1991, pp. 267-278). The rate constant of BOD is determined by three factors: the nature of the waste, the ability of organisms to use the waste, and the temperature. Not all organic compounds biodegrade at the same rate and this affects the determination of the amount of organic waste in the water, when using a five day test.

Different microorganisms degrade different organic

compounds. The microorganisms that exist are the ones that break down the organic compounds that are largest in quantity. Therefore organic compounds that exist in small quantities are inefficiently broken down. Temperature of the water affects the rate of BOD. Higher water temperatures increase the rate of biological decomposition (Davis, 1991, pp. 267-268).

The complete determination of the BOD of pollutants is a process that takes thirty five days. This is the time required for bacteria to completely break down organic matter. To completely determine the oxygen demand of waste water both CBOD, carbonaceous biochemical oxygen demand, and NBOD, nitrogenous biochemical oxygen demand, must be measured. In the determination of five day BOD, BOD_5, the assumption is that only the carbon in organic matter oxidized. But in fact, nitrogen, found in proteins, is also oxidized by special nitrifying bacteria. This process is called nitrification. The effects of nitrification are not detectable in the BOD_5 test because nitrification reaches a significant rate after more than five days, when the population of nitrifying bacteria reaches a significant amount. NBOD and CBOD must be considered separately because of the different rates and mechanisms involved. Therefore, ultimate BOD is a complete determination of the oxygen demand of organic

matter.

The five day BOD test was chosen because the test was developed in England where rivers run their course into the sea within a period of five days. Therefore, it was not necessary to calculate BOD for the full thirty five days. Since the five day BOD test gave a fairly reliable estimation of the organic pollution it was accepted internationally as a standard. Because of the time required to calculate BOD, it is not feasible to use this method in the monitoring pollutant levels (Klein, 1967, pp .31). A process called COD or Chemical Oxygen Demand was developed to monitor pollutant levels daily.

Chemical Oxygen Demand or COD is another parameter used when monitoring pollution levels. In the COD test, organic matter is converted to CO_2 regardless of the biological assimilability of the substances. As a result, COD values are greater than BOD values. Potassium dichromate, an oxidizing agent, is the chemical used to determine the oxygen demand of waste water. The COD process only takes three hours to complete and therefore, is extensively used to determine the oxygen demand of industrial wastes. COD is not as accurate a method as BOD, so both are used in conjunction with each other to determine pollution levels. The BOD method is faulty in establishing

pollution levels because it does not take into account non-biodegradable toxic and non-toxic inorganics (Klein, 1962, pp. 30-31).

III.6.D. Physical Pollution Indicators

Thermal pollution is largely due to industries along the estuary discharging their cooling waters into the estuary. The result of this form of pollution is an increase in the water temperature. This increase in temperature drastically affects the concentrations of dissolved oxygen in the water. The problem is more prevalent in warmer climates, because the water is already warm, and therefore heat does not readily dissipate into the atmosphere. Dissolved oxygen concentrations then fall to extremely low levels causing the death of aquatic life and hindering the self-purification process. If the level of dissolved oxygen is not reduced to dangerously low levels, aquatic life can adjust to gradual temperature changes. But drastic changes in water temperature will kill aquatic life (ASTM, 1969, pp. 86-87).

An increase in the temperature of water will also increase the toxicity of certain pollutants. Smaller concentrations of these pollutants would be lethal (Klein, 1962, pp. 347).

Suspended solids are either organic, inorganic, or

a mixture of both organic and inorganic. Organic solids in suspension pose a problem when they settle to the bottom and when they stay on top of the water. When suspended organic solids settle to the bottom of the estuary bed, they decompose slowly and have high levels of BOD. Organic suspended solids that stay in the top of the water result in objectionable odors when they decompose (Klein, 1962, pp. 52).

Suspended solids also add to the turbidity or cloudiness of water. This cloudiness results in a decrease of the amount of sunlight entering the water (Meserve, 1974, pp. 19). This sunlight is essential to the survival of plant life. Plants utilize the sunlight to absorb carbon dioxide from the water and convert it to oxygen. The presence of suspended solids affects the water's ability to purify itself in multiple ways (Klein, 1962, pp. 52).

The color of water is usually the result of organic matter, from sewage or trade waste, or from naturally occurring metallic ions. Color pollution is not toxic to aquatic life except in extremely large concentrations. The color of water is generally not a good indicator of the extent of pollution in the water nor is the coloring of water usually the result of toxic substances. The effect of color pollution is felt mainly by the industries that use the water. Most

industrial processes require that the water be relatively clear (Klein, 1962, pp. 44-45).

III.6.E. Dissolved Solids

Dissolved solids are solids that separate into individual molecules and ions. These molecules and ions are organic solids, volatile solids, or dissolved mineral solids (Meserve, 1974, pp. 22). A sudden increase in levels of dissolved solids is an indication of pollution. Salts of heavy metals and other soluble salts are dissolved solids that pose a serious problem. Soluble salts are corrosive to metal and concrete structures. This corrosion can be extremely expensive for industries that use the water in their industrial processes and for the city that builds bridges on the water. Salts of heavy metals can be toxic to marine life in large amounts (Klein, 1962, pp. 42-43).

III.5.F. pH

High levels of acidity or alkalinity in the water is a critical problem. Water with a pH of 7 is neutral, lower than 7 is acidic and higher than 7 is basic. Fish life requires a pH higher than 5, therefore a low pH level will cause death to fish and other marine life. Although, certain plant life can survive at different pH levels, high or low, sudden

fluctuations in pH levels will result in the death of all plant life and further diminish or terminate the self-purification process of the water. Also acidic and alkaline conditions cause concrete and steel structures to corrode, which has negative affects on the industries and the city (Klein, 1962, pp. 38-39).

III.6.G. Nitrates and Phosphates

Nitrogen and phosphorous are nutrients that are essential to life in the water but an excessive amount of these nutrients upsets the natural food chain. They are mainly used in the agricultural industry as fertilizer, therefore, they enter the water through agricultural runoff (Meserve, 1974, pp. 76). When the natural food chain is disturbed some organisms grow in larger quantities at the expense of others (Davis, 1991, pp. 264). Nitrates in the form of NH_3-N are toxic to fish and the conversion of NH_4+ to NO_3- consumes large quantities of dissolved oxygen. The lack of dissolved oxygen is lethal to aquatic life and will inhibit the self-purification process of the water. Nitrates and phosphates contribute to the excessive growth of algae. These excessive growths of algae will eventually die and decompose. The decomposition process exhausts the dissolved oxygen in the water. Also, certain algae are poisonous to the

aquatic life. Algae is generally unsightly and results in objectionable odors when it decomposes (Klein, 1962, pp. 82-83).

III.6.H. Organic Pollutants

Frequently occurring organic pollutants are proteins, fats, and carbohydrates. These pollutants are found in sewage and trade wastes. Proteins are found in egg yolk, bones and animal tissue, wool, natural silk, milk, and wheat. When proteins decompose, the results are foul odors. Canning factories, slaughter houses, dairies, and tanneries produce protein as a waste product. Fat wastes are produced from the wool scouring process, the soap manufacturing industry, and the laundry industry. When fats decompose, they also produce pungent odors. Carbohydrates are found in the wastes of the papermaking and textile printing industries (Klein, 1962, pp. 25-29).

Some of the more damaging organic pollutants include soaps, waxes, resins, rubber, coal, oil, and toxic organic chemicals. Metallic soaps are used in industries as lubricants, greases, and in the manufacturing of paints and varnish. Soaps are found in sewage and textile wastes. Waxes are also a waste product of the textile industry. Rubber is a waste from the manufacturing of rubber and the process of

waxing paper. Coal waste is produced from coal washing plants. All of these pollutants are also naturally occurring. However, in mass quantities they can hamper the natural self purification process of water ways by exhausting the dissolved oxygen in the water (Klein, 1962, pp. 27-29).

Oil, one of the more damaging pollutants, comes from many sources: barges, tankers, boats, industrial wastes, metallurgical industries, engineering works, garages and any trade that uses oils as lubricants or as a fuel. Since oil is lighter than water, it spreads out and forms a thin layer on the surface. This layer of oil stops oxygen from entering the water, and reduces the amount of oxygen in the water as it biodegrade. The oil can also cause difficulties in the treatment of sewage (Klein, 1962, pp. 29-31).

Trade waste from the manufacturers of coal gas, organic chemicals, and insecticides contain toxic organic compounds such as phenols, tar bases, cyanides, and DDT. These toxic organic compounds will kill any beneficial bacteria in the water and other marine life. Tar waste is produced by the distillation of coal, peat, wood, bituminous shale, and naturally occurring materials. Tar contains toxic substances such as phenols and organic bases which can be extremely harmful to bacteria, fish and other aquatic life

(Klein, 1962, pp. 35).

Most organic compounds can be broken down by micro-organisms in the water. Certain bacteria can break down some of the toxic organics such as phenols and cyanides. There are toxic organic compounds that resist breakdown from bacteria such as hydrocarbons, ethers, polyoxy structures, some vinyl compounds, alkyl benzene sulphonates, many synthetic pesticides, cellulose, peat and coal. The organic pollution must be in small amounts in order to enable the bacteria to break down the compounds. Large amounts of organic pollution exhaust the dissolved oxygen in the water, therefore, not allowing the bacteria to breakdown anymore organic matter (Klein, 1962, pp. 35).

Some organic matter do not require oxygen to be decomposed such as nitrates, sulphates, and phosphates. These organics are broken down by anaerobic bacteria, which do not require the dissolved oxygen in the water. Instead, the bacteria obtains the oxygen from those organic compounds. This process is known as putrefaction and leads to evil smelling end products. Organic suspended matter is found in sewage, dairy waste, and coal washeries (Klein, 1962, pp. 35).

III.6.I. Inorganic Pollutants

Inorganic acids and alkalis kill bacteria, micro-organisms, fish and other marine life by changing the pH value of the water. Industries responsible for large amounts of acid waste are iron pickling, the manufactures of titanium dioxide, viscose rayon, and transparent paper. Through reactions with the mud and existing sludge in the water the acids and alkalis release foul odors (Klein, 1962, pp. 38-39).

Common toxic inorganic substances include free chlorine, cyanide, chloramines, ammonia, hydrogen sulphide, soluble sulfides, and salts of heavy metals such as copper, zinc, lead, nickel, chromium, cadmium, silver, mercury, uranium, vanadium, thorium, etc. (Klein, 1962, pp. 42). Cyanide is used in the electroplating industries and is an extremely poisonous inorganic compound (Morton, 1976, pp. 15). Zinc and copper are among the more toxic heavy metals because in relatively small amounts they can be very toxic to fish and other biological life (Klein, 1962, pp. 42).

Salts of heavy metals kill fish by causing the mucus in their gills to choke them (Klein, 1962, pp. 42). Mercury, lead, and cadmium are some of the more common toxic heavy metals (Morton, 1976, pp. 15). Soluble salts such as chlorides, sulphates, nitrates, bicarbonates, and phosphates of sodium, potassium,

calcium, magnesium, iron, and manganese are found in the effluents of salt works. Wastes that contain brine add large amounts of sodium chloride, a salt, into the water. Brine is employed in water softening plants using ion-exchange methods for softening. Excess amounts of sodium chloride can make fresh water unsuitable to its indigenous life and can even make salt water unsuitable for its indigenous life (Klein, 1962, pp. 42-43). Inorganic suspended matter such as talc (magnesium silicate), china clay (or kaolin, an aluminum silicate), chalk ($CaCO_3$), gypsum ($CaSO_4$), titanium dioxide (TiO_2), zinc sulphide (ZnS), barium sulphate ($BaSO_4$),etc. can be found in paper making waste (Klein, 1962, pp. 44-49).

III.6.J. Biological Pollution Indicators

Protistas, plants and animals are the three major types of microorganisms found in surface water and waste water. Protistas include bacteria, fungi, protozoa, and algae. Plants include seed plants, ferns, mosses and liverworts. Animals include all invertebrate and vertebrate animals. Viruses are also found in waste water, but are classified according to their host organism. Protistas are the most important organisms to study when analyzing waste water. Bacteria, for example, play a very important

role in decomposition and stabilization of organic matter. Coliform bacteria is used as an indicator of domestic waste. Algae produce blooms, or floating colonies, which completely cover the surface of the water. These blooms are great indicators of high contents of biological nutrients. Algae also causes taste and odor problems. Protozoa, including amoebas, flagellates and ciliates, feed on bacteria and other protistas. They are extremely important in the biological treatment processes because they maintain a natural balance among the microorganisms (Metcalf, 1972, pp. 104-113).

Many pathogenic organisms are found in waste water. The most abundant type are bacterial pathogenic organisms which are discharged by infected human beings. These organisms cause diseases such as typhoid fever, paratyphoid fever, dysentery, diarrhea and cholera. They are highly infectious and cause thousands of death each year in areas having poor sanitation. Identification of these organisms is very difficult and time consuming because they are hard to isolate. For this reason, coliform organisms are used as an indicator for the presence of feces and pathogenic organisms in waste water because they are more numerous and easy to test for.

Coliform organisms are rod-shaped bacteria found

in the intestinal tract of humans. Every human being discharges between 100 to 400 billion coliform organisms per day. These organisms are harmless to humans and are useful in destroying organic matter in biological waste-treatment processes. If these organisms are present in waste water, then pathogenic organism may also be present, but if these organisms are not present, then the water is free from disease-producing organisms. Coliform organisms include the genera Escherichia and Aerobacter. They are separated into three groups: total coliforms, fecal coliforms and fecal streptococci.

Testing for these coliforms is done by numerous methods. One method to determine the number of coliforms in a given volume of water is called MPN or most probable number. This method is based on a statistical analysis of the number of positive and negative results obtained when testing multiple portions of equal volume. MPN is a statistical estimate of the concentration of coliform organisms, not an absolute concentration.

Human beings discharge significantly different quantities of fecal coliforms and fecal streptococci than animals do. The ratio of fecal coliforms to fecal streptococci can be used to show whether a suspected contamination is coming from humans or animals. This

ratio is less than 1 for animals whereas it is more than 4 for humans. This test should also be performed before construction of a treatment facility for discharges since the type of treatment used depends on the percentage of human and animal discharges in the water (Metcalf, 1972, pp. 104-113).

Viruses are extremely important in waste water treatment because they are excreted in large dosages by human beings. Most of these viruses are harmless, but some are extremely dangerous. One example is hepatitis, in which 10,000 to 100,000 dosages per gram of feces are excreted by an infected human. Viruses can live as long as 41 days in stagnant water and waste water at 20 C or for 6 days in a river.

Plants and animals range in size from microscopic to macroscopic organisms. Many qualities can be determined from the presence of certain plants and animals, including the condition of the water, the toxicity of waste water and the effectiveness of secondary treatment.

To determine the toxicity of waste water in relation to biological life, a bioassay test is performed. This test determines the median tolerance limit, or TL_m, which is the concentration of waste in which 50 percent of the test animals are able to survive in a given time period. The test organism can

be any animal typically found in the water being tested, but most often is a species of fish (Metcalf, 1972, pp. 104-113).

III.7. Health Hazards

Polluted water is a major public health hazard because of its ability to rapidly spread any infectious diseases. The World Health Organization estimates that 80 percent of all sickness, disease, and deaths of infants and children in developing countries is the result of polluted water (Wright, 1993, pp. 247). Some of the more common diseases spread by polluted water include: typhoid fever, cholera, salmonellosis, infectious hepatitis, poliomyelitic, dysentery, giardiasis, and numerous parasitic diseases.

Many people associate good health with modern medicine, but good health is more a result of disease prevention through public-health measures (Wright, 1993, pp. 292). There are 1.2 billion people in the world who do not have access to treated drinking water, yet there is an even greater number of people who live with poor or no sewage collection or water treatment. This low treatment rate means that large portions of the world are vulnerable to epidemics of any and all diseases spread through polluted water (Wright, 1993, pp. 292). Public-health measures that

prevent this disease cycle and safeguard human health involve purification and disinfection of public water supplies and the sanitary collection and treatment of sewage wastes.

III.8. Water Purification

Water purification is any method that will remove one or more of the materials that make water unsuitable for a given use. There are several methods that may be combined in the purification process which include:

1) Settling. Settling is used to remove soil particles and other solid material carried by flowing water. The water is kept relatively still, which allows the solids to settle, and the clarified water is removed from the top. Alum, a compound of aluminum and sulfate with a positive three charge, is added to the process and aids in pulling out the clay and other negatively charged particles by coagulation processes (Wright, 1993, pp. 247)
2) Filtration. The water flows through a porous material which filters out any materials larger than the pores. A bed of sand is commonly used in filtration.
3) Adsorption. The water passes through an adsorbing material that binds with certain pollutants and

clumps are formed. These clumps of material are easily removed from the water. Activated carbon is a typical adsorption material used to remove organic compounds.

4) Biological oxidation. The water flows through a system that supports the growth of detritus feeders and decomposers. The organic material in the water is fed upon and broken down by these organisms and then removed. Anaerobic decomposition occurs in two steps. First complex organic compounds are fermented to fatty acids. The acids are the converted to methane. The end products of anaerobic decomposition are carbon dioxide, methane, water, ammonia, hydrogen sulfide, and mercaptans. Aerobic decomposition is preferred over anaerobic decomposition when the waste is dilute, because in aerobic decomposition cell production is high resulting in large quantities of biological sludge. When the waste levels are concentrated, anaerobic decomposition is preferred because cell production is low and minimal levels of biological sludge results. In the absence of oxygen, anaerobic decomposition will most definitely take place (Davis, 1991, pp. 317-318).

5) Distillation. Distillation is the evaporation and

condensation of water. All the materials present in the water before the evaporation step remain behind in a holding tank and are not present when the water vapor is condensed (Wright, 1993, pp. 247).

6) Disinfection: The water is treated with chlorine, ozone, or ultraviolet light to kill any disease-causing organisms.

III.9. Waste Water Treatment

Waste water treatment is the process used to clean polluted water, and it involves four steps: preliminary treatment, primary treatment, secondary treatment, and tertiary treatment. These four steps vary according to the type of polluted water that is being treated, but the general methods are discussed in this literature review.

III.9.A. Preliminary Treatment

Preliminary treatment is used to remove debris and grit from the waste water. Debris includes rags, plastic bags, and other large objects found in untreated water, and grit is coarse sand and gravel.

The polluted water flows first through a bar screen which collects the debris. The debris is then mechanically raked from the screen. After the water

passes through the bar screen, it flows through a grit-settling tank. The velocity of the water is decreased to one to two feet per second, the grit settles to the bottom of the tank and is then removed.

III.9.B. Primary Treatment

Primary treatment removes particulate organic materials from the polluted water. Particulate organic materials include visible particles of organic matter, living bacteria, and microorganisms.

The water leaves the grit-settling tank and flows very slowly through a primary clarifying tank where it is nearly motionless for several hours. Thirty to fifty percent of the total organic material settles to the bottom of the tank and is then removed. At the same time, fatty and oily material floats to the surface and is skimmed off.

III.9.C. Secondary Treatment

Secondary treatment removes colloidal and dissolved organic materials which are very fine particles that will not settle in still water. This step is also referred to as biological treatment since it uses organisms, natural decomposers, and detritus feeders to break down the colloidal and dissolved organic materials into carbon dioxide and water.

The most common procedures for secondary treatment are (1) trickling filters, (2) activated sludge process, (3) oxidation ponds or lagoons, and (4) Anaerobic filters (Davis, 1991, pp. 343). Due to the high cost of the first two procedures, oxidation ponds and anaerobic filters are commonly used in developing countries.

An oxidation pond is a pond that receives partially treated waste water and has been used for many years as a waste water treatment system for small communities. The three different types of ponds include: aerobic ponds, anaerobic ponds, and facultative ponds.

An aerobic pond is a shallow pond, less than 1 meter in depth, where dissolved oxygen is maintained throughout the entire depth, mainly by the action of photosynthesis. Light penetrates to the bottom of the pond which maintains the active algae photosynthesis throughout the entire system and supplies large amounts of oxygen (Davis, 1991, pp. 366). During darkness hours, wind mixing provides a high degree of surface reaeration.

Anaerobic ponds are used primarily as a pre-treatment process and are particularly suited for the treatment of high-temperature, high-strength waste waters. An anaerobic pond is a deep pond that receives

high organic loading so that anaerobic conditions are maintained throughout the entire pond depth. Photosynthesis is reduced by decreasing the surface area and increasing the depth.

Facultative ponds are 1 to 2.5 meters deep with an anaerobic lower zone, a facultative middle zone, and an aerobic upper zone maintained by photosynthesis and surface reaeration. The facultative zone is aerobic during daylight hours and anaerobic during the hours of darkness. Facultative ponds are the most common type of pond selected as waste water treatment systems for small communities. The capital, operating, and maintenance costs are less than any other biological system.

III.9.D. Tertiary Treatment

Tertiary treatment is also referred to as advanced waste water treatment and removes various nutrients from the water. The method of tertiary treatment varies depending on the future use of the water. However, the most common nutrients that need to be removed are phosphate and nitrogen.

To remove phosphate from the water, calcium carbonate is mixed with the water and reacts with the phosphate. A precipitate is formed and is then removed with future settling of the water. Nitrogen removal is

a biological process that converts ammonium and nitrate ions into nitrogen gas which is then released as part of the natural nitrogen cycle. Alternatives to tertiary treatment that may be appropriate for implementation in the Estero Salado region include:

1) The nutrient rich water could be used for irrigation, therefore, it could be sold to help off set the operation costs.
2) Wildlife habitat could be re-created, protecting downstream water quality by constructing a wetland or aquatic system.
3) Nutrient removal ponds full of water hyacinths, reeds, or cattails could be created. This plant material could be used for weaving or as cattle feed.

IV. Methodology

Originally, our project was intended to create an environmental impact assessment of pollution generated by industrial activities along the entire Estero Salado, Guayas River and Daule River, located in Guayaquil, Ecuador. This geographical location proved to be too large to complete an impact assessment in a seven week period. Therefore, the area was condensed to include the two most heavily polluted branches of the Estero Salado. These two branches are located in the citadels Miraflores and Urdesa, shown on the general map included in Appendix C.

We also realized that a full environmental impact assessment could not be completed in a seven week period; therefore, we decided to create a preliminary environmental impact assessment. This preliminary environmental impact assessment is primarily a qualitative assessment of the industrial pollution caused by the numerous industries located along or near the two branches of the Estero Salado. This preliminary assessment can be used as a base for a more in-depth quantitative assessment.

In order to complete a primarily qualitative preliminary environmental impact assessment of the Estero Salado, our group obtained a variety of information that relates to the biological, economic

and social effects of the pollution generated by the numerous industries located along the estuary. We studied the biological effects on the flora, fauna, and on the water quality. We also studied the economic effects of the estimated cost of clean-up and of treatment facilities. The social effects that we studied include health, recreation, and immigration.

To obtain biological information about the Estero Salado, we visited the estuary and familiarized ourselves visually with the area of study and the extent of the pollution found there. This visit was done twice, once at low tide and once a high tide, in order to see the differences. Next, we interviewed Doctor Nicolas Campana at the CICYT office of ESPOL and received background information about the history of the pollution and results of various studies on the marine life of the Estero Salado. Finally, visits to the Fundacion Natura library and the ESPOL-UNO project office provided us with information about the flora, fauna, and water quality.

To obtain economic information, we interviewed the Municipality of Quito and various environmental agencies including: IEOS and DIGMER to gather background information on environmental laws and regulations for industries in Ecuador. The questionnaire used for these interviews is included in

Appendix B.

The background information included how the laws are generated and regulated, to whom the laws pertain, how laws differ in various cities, and the costs of implementing the laws for the industries, agencies, and the government. Specific laws, proposals and ordinances we focused on include the Master Sewage Plan of the Municipality of Guayaquil 1986-2006, the National Pollution Prevention Law of 1976, Regulations for Industrial Waste Control of 1989 by IEOS, and Ordinance of the Municipality of Quito in 1992.

Also shown in Appendix B, is the questionnaire that we developed to be used to interview the following industries in Guayaquil: Oleica, Cridesa, Poliquimicos del Ecuador, and Durex. We obtained an abundance of information from these interviews including information about:

1) Their manufacturing processes and products, including their raw materials.
2) Their present market position.
3) The estimated worth of the industry.
4) Their internal and external problems.
5) The quantity, quality, and source of the water that they receive.
6) Their treatment facility status including amount of waste treated and location of discharges.

7) Their sewage network connection and costs.
8) Their leadership roles in and outside of the company.
9) Problems with the municipality and environmental agencies including their knowledge and experiences with the IEOS regulations.
10) Environmental problems in Guayaquil.
11) Difficulty in changing manufacturing processes.
12) Opinions on auditing for environmentally sound guidelines.

To obtain information relating to the social effects of the pollution, the group interviewed the Direccion Provincial de Salud del Guayas to obtain information about the health issues that may be caused by the contamination of the estuary. Also, important migration and sewage connection statistics for the city of Guayaquil, specifically around the two branches of the estuary, was gathered from the National Institute of Statistics. Lastly, the group conducted interviews with several local residents to obtain information on how the industrial pollution of the estuary has affected their health, property value and overall lifestyle.

The method of collecting information was adapted from the model provided in the book, Environmental Impact Assessment, Principles and Procedures, written by the Scientific Committee on Problems of the Environment, 1974. Once the information was collected, we developed a preliminary impact assessment including: a description of the current situation based on the results of our findings, causes and effects of the pollution in the Estero Salado, and sample matrices that could be used for a more in-depth assessment of the pollution of the Estero Salado.

Once we developed the preliminary impact assessment, we proposed various changes that could be implemented to reduce the effects of the industrial pollution of the Estero Salado.

V. Data Presentation

V.1. Estero Trip

The purpose of a trip to the Estero Salado was to gain a visual representation of the industrial contamination in the area. A visualization of the area enabled the group to better determine the present and future impacts of the industrial contamination. The information was gathered in two trips, one during high tide and one during low tide. The trip included eleven stops which covered various storm channels, and the Miraflores and Urdesa branches of the Estero Salado.

The pollution seen in the Miraflores branch is a result of several industries along Avenida Carlos Julio Arosemena dumping their wastes directly into the estuary and also from the polluted storm channels that flow directly into this branch. The channels were intended to act as drainage sites during excessive rain, yet they are presently polluted because several industries along Via a Daule use them as a discharge site for their liquid wastes.

There are a number of different storm channels running along the roads or between houses throughout the northern part of Guayaquil. The pollution in the water is very apparent since the water has a bright green color and emits a strong nauseating odor. There are also large amounts of trash floating on the surface

and accumulating on the sides of the channels.

The "canal de la muerte," or the death channel, is the most heavily polluted channel in the area. The color of the water in this channel is green with some hues of blue, and the vegetation in the surrounding area is limited to a few bushes and algae. The channels become wider as they flow downstream, and the surrounding area changes from industrial to residential where the channels join the estuary. Several residences along the shore are only a few feet from the water and appear to face the possibility of flooding during the rainy season.

The effects of low tide are more pronounced in the Miraflores branch than in the Urdesa branch of the Estero Salado. The water level in the Miraflores branch becomes extremely low and the smell becomes increasingly stronger as low tide sets in. Large quantities of black sludge can be seen which were only visible in certain areas during high tide, and the estuary becomes more aesthetically displeasing. The low water level also reveals a drainage pipe discharging blue water into this part of the branch.

At the bottom of the Miraflores branch, the scenery changes. The water becomes dark green and the smell decreases. The amount of vegetation increases, with traces of mangroves, grass and bushes along the

shore. However, wood and plastic articles can still be seen floating on the surface. Dark black mud has accumulated along the shores of this section, possibly showing that the Estero suffers from sedimentation.

There are several other pipes that empty waste water illegally into the Estero, and one of these pipes was discharging underwater. The branch at this point passes through an upper to middle class housing neighborhood. Most of these houses were built in the sixties, but new housing is still being built around the polluted branch.

Located at the top of the Urdesa branch, in the La Alborada neighborhood, is a storm channel that empties directly into the Estero. The channel is a dumping site for industrial and domestic waste. The water is green and raw sewage can be seen floating on the surface of the water. A strong smell permeates throughout this residential and industrial area.

At the point where the channel enters the Urdesa branch, there is a raw sewage pumping station, and mangroves are seen along the shore. The channel around the station is completely covered by hyacinths as a result of excessive amounts of nitrogen in the water.

Along the Urdesa branch there are two privately owned and operated aeration pumps used to oxygenate the water. Existing housing complexes and new developments

appear to be contributing to the pollution in the area. The area is commercial and residential, with mangroves and algae growths at random spots all along this branch.

Garbage floats on top of the water and collects along the shore of this branch also, but there is practically no smell. The water is red, green, and white in different areas of the branch, yet it is turbid everywhere.

At the point where the Urdesa and Miraflores branches meet, there appears to be potential for flooding during the rainy season. A bridge, located at the intersection of the Miraflores and Urdesa branches, actually acts as a dam to decrease the flow of water out of the Urdesa branch and into the main part of the Estero. By decreasing the out flow of water, the sight and smell of the pollution in the residential area are reduced. The water is channeled through four concrete pipes running underneath the bridge that can be seen during low tide. The water level is significantly higher in the Urdesa branch before the dam, and there was no significant change in the water level between high and low tides.

V.2. Sewage and Migration for the City of Guayaquil

In the area around Avenida Julio Carlos Arosemena,

Avenida Juan Tanca Marengo and Via a Daule, there are 40 zones registered by the 1990 census. Eight of these zones are along the Miraflores and Urdesa branches of the Estero Salado, where the percentage of immigration varies. Along these branches, 30 percent of the population are immigrants but it reaches as much as 50 - 60 percent north of the branches. The northern part of the city contains the highest percentage of immigrants (Instituto Nacional de Estadistica INEC 1991).

Sewage and septic tanks cover the same 40 zones previously described. In the 8 zones along the two branches, 90 - 100 percent of the residents are connected to the city sewage system. The percentage drops to .6 - 20 percent in the northern parts of the city including the area around Via a Daule (Instituto Nacional de Estadistica INEC 1991).

V.3. Industries

V.3.A. Location

A large part of the industries in Guayaquil are located along Via Daule where there is no sewage connection to the city, as shown on the Sewage map in Appendix C. These industries discharge their liquid wastes into the storm channels, which run along the street and some of which flow directly into the

Miraflores and Urdesa branches of the Estero Salado (Corrales, 1990, Ch. 2).

V.3.B. Types

In 1987, 1,309 industries were functioning in Guayaquil (Corrales, 1990, Ch.3). The industries are categorized as shown below:

Type	Number
Foodstuffs, Beverages & Tobacco	290
Textiles, Clothing & Leather Goods	102
Wood & Wood Products	77
Paper & Printing Shops	108
Chemicals	250
Non-Metallic Mineral Products	65
Basic Metals	40
Metal Products & Machinery	343
Other Manufacturing Industries	26
TOTAL	1,309

V.4. Water Quality Data

The combination of various industrial discharges changes the chemical, physical and bacteriological components of the water in the Estero Salado. The BOD, dissolved oxygen and fecal coliform levels were measured by the Sewerage Agency of Guayaquil at three

quality map in Appendix C. Point number one is at the Cinco de Junio bridge before the two branches split. The second point is approximately half the distance up the Urdesa branch and the third point is near the end of the Miraflores branch (Corrales, 1990, Ch.3).

The number of fecal coliforms increases from between 10,000 and 100,000 NMO/100ml at point one, to between 100,000 and 1,000,000 NMO/100ml at point two, up to greater then 10,000,000 NMO/100ml at point 3. The BOD level increased as well. It was between 10 and 20 mg/l at both points one and two, but increased to between 50 and 100 mg/l at point 3. The dissolved oxygen decreased from 2 to 3 mg/l at points 1 and 2, to 0 mg/l at point 3 (Corrales, 1990, Ch.3).

All of this data signifies that the quality of water is lower in the Miraflores branch than in the Urdesa branch and the quality improves the closer you get to the sea (Corrales, 1990, Ch. 3).

V.5. Environmental Agency Interviews

V.5.A. IEOS

IEOS spent a great deal of time preparing the guidelines for pollution control called for by the 1976 National Pollution Prevention Law. The reason for this was that there existed political conflicts about who was to prepare the guidelines and what types of

information they would include. The law elaboration process took time since these were the first national pollution parameters issued.

The guidelines, released in 1989, covered three main areas: air, water, and land. It was not until 1991, however, that the law began to work. The law called for all industries to register their discharges with the agency. Presently there are 161 industries and groups registered. Groups are comprised of small industries that produce similar things and are concentrated in the same geographical area.

In order for an company to receive the Certificate of Environmental Quality, the industry has to provide complete information on the water quality of the discharges from their plants. This information is obtained by experimentation, done by the industries themselves, or by hired consulting firms. This process is expensive, but once the certificate is issued, it is valid until the company makes any changes in their manufacturing process that might affect the quality of the water being discharged. The company is responsible for declaring these changes. If they do not, IEOS has the power to close down the company.

V.5.B. DIGMER

We spoke with the Contamination Control Department

in Guayaquil. DIGMER has the capability to perform discharge level tests if the industry does not have their own laboratory facilities; however the industry is charged for this service. Although we inquired about the amount of this charge, the information was not released.

DIGMER feels that the companies are financially able to construct treatment facilities, but it is easier for them to pay a yearly fine. As a result, they believe the sanctions are not an effective method for improving the environment.

Since the IEOS regulations came out in 1989, DIGMER has noticed a large increase in pressure from the public to clean up the environment. Although DIGMER feels that social aspects are affected the most by the pollution, they were unwilling to elaborate on this. As a result, DIGMER informed us of a group that has been assembled at the Municipality to investigate the pollution of the Estero Salado. It was suggested that we attempt to speak with some members of this group and also with other environmental agencies to obtain data and opinions on the areas most affected by the pollution.

V.6. Industry Interviews

V.6.A. Oleica

Oleica, located on Via a Daule, is the fourth largest vegetable oil and soap producing company in Ecuador, producing 12 percent of the nations vegetable oil. When the company began, their primary product was vegetable oil, but they have expanded to include soap products also. Oleica is a family run business with workers who have been with the company for many years. They employ 400 people who work two shifts of twelve hours each. Their estimated worth is approximately $15 million .

The process of producing oil involves a number of different procedures and waste products. Oil is extracted from soybeans, sunflowers or other seeds. First, the seeds are cleaned and large quantities of dust and garbage are produced. After cleaning, the seeds are dried and stored in silos. To prepare them for extraction, they are sent through rollers to break the shells of the seeds and crush them into tiny pellets.

These pellets are then mixed with hexane, and the hexane attaches to the oil inside the pellets. Once the hexane-oil compound is extracted, the leftover pellets form a cake-like product. The hexane is removed from the oil by distillation and condensation

and from the cake through a filtering process. This hexane is recovered and reused, and the cake is sold as animal feed.

The crude oil is refined to remove the excess fatty acids, moisture, phosphalids, sugars, pigments and odors. To refine the crude oil, sodium hydroxide (NaOH) and hydrogen phosphate (H_3PO_4) are added to the oil through a centrifuge method. This method produces two by-products, soap stock and water containing soap stock plus other chemicals.

The refined oil now contains soap and moisture. To release the moisture, the refined oil is dried. A special soil is used to absorb the soap, which is filtered out later. This filtered soil, containing 40 percent oil, is a waste product.

The oil is bleached with a special air containing activated acids. During the bleaching process, gases are released into the air that contain small amounts of oil and fats. The bleached oil contains a strong odor and is deodorized in a process that involves mercury. The bleached and deodorized oil is now ready to be packaged for sale.

Many liquid and solid wastes are created during the above processes. The solid wastes are dumped in the back of the facilities where it burns spontaneously due to the oil in the waste and the heat from the sun.

Oleica has a treatment facility for their liquid wastes.

The waste water from soap production is sent through a grease separation process. This process includes a pool separated into five sections. The heavy materials settle to the bottom and the oil is skimmed off the top. The white liquid under the oil passes through pipes to the oxidation pond. Here the creamy white liquid is oxygenated and released into a pipe which goes to the sewage system of the city of Guayaquil.

Behind the facilities is the storm channel called the "death channel." The group was told by Olieca that they do not dump their liquid or solid wastes into this canal. However, when the group received a tour of the facilities, we noticed the liquid waste from the oxidation pond leaking into the canal.

Oleica receives its water from the city of Guayaquil, and it is not necessary for the company to treat it before use. According to their representative, they are aware of the 1989 IEOS regulations and comply with these regulations by submitting their discharge test results three times a year. They say that the only problem that the company has with IEOS is regarding their residual waters. The regulations require that there be no oil in residual

waters, yet Oleica has difficulty removing 100 percent of the oil. Oleica feels that they are doing the best they can since they have a treatment facility and most other industries in Guayaquil do not.

V.6.B. Cridesa

Cridesa, a glass manufacturing industry, was constructed 12 years ago. Their main products are glass bottles and jars. Their market is mainly through exportation due to the severity of the local market. They are funded by their mother company in the United States, Owen-Illnois located in Ohio. This company contains a technology center which financially helps the overseas companies to deal with the wastes produced by the industry.

In order to optimize production, the facility functions twenty-four hours per day, seven days per week. Their raw materials include: sand, soda ash, limestone and colored glass. They have very little solid or liquid waste because the glass is recycled. Also, they work with other companies to recycle scraps.

They receive water from the city, but they have to soften it before using it, which is common in glass industries. In the glass making process, oil is added as a lubricant, so there is a small amount of oil in the water after it has been used.

Cridesa has three oxidation ponds where oil is skimmed off the surface of the water. The treated liquid waste is discharged into the city sewage system, but it is only slightly polluted. An environmental engineer, hired by the company, inspects the plant a few times per year to make sure that it is environmentally sound. There are also yearly internal inspections by company personnel.

They have never been inspected by the Municipality or any environmental agencies. They voluntarily supply their waste water treatment results to the Ministry of Health in Guayaquil and to IEOS in compliance with the 1989 regulations. All of these results are obtained through laboratory tests performed at the company by hired personnel. Cridesa also cleans their oxidation tanks once a year as part of the company's maintenance program. The cost of these expenditures are very little compared to the total cost of running the facility.

One of the major problems that Cridesa has is regarding electricity. Electricity shutdowns occur often and without warning, damage the equipment, and cause delays in production. This problem could be solved by installing generators in the facility, but laws prohibit the company from generating their own electricity.

Cridesa also has problems with extremely high electric and water bills. These high bills are the result of people living outside of the facility stealing water and electricity. Tighter security must be implemented at the company's expense to prevent these occurrences.

The company is a member of the environmental committee within the Chamber of Industries, and they are staying involved with the industries in the area. They believe that the United States governmental agencies are good and similar groups should be formed by the Ecuador government.

V.6.C. Poliquimicos del Ecuador

Poliquimicos del Ecuador, located on Via a Daule, is a national privately owned chemical company constructed 15 years ago. The industry's market is primarily exportation to other countries, especially to Columbia, Peru and Venezuela.

Their only product is Sorbitol, an alcohol used by many other industries including pharmaceuticals, food industries, paper companies, tobacco industries, and other chemical industries. Sorbitol, with the chemical formula $C_6H_{14}O_6$, is produced using the following raw materials: dextrose, hydrogen, nickel and water. Dextrose, a sugar, is the main ingredient

and is completely used in the process. The hydrogen and water are chemically combined with the dextrose to form sorbitol, using the nickel as a catalyst.

They receive the water, used in their process, from the city of Guayaquil. The water must be treated before it can be used in the process because it contains too many minerals. They have very little solid wastes, but their liquid waste contains sodium hydroxide, NaOH. This solution has a very high pH and must be neutralized with an acid before being discharged. This treatment involves stabilizing the waste with sulfuric acid and then oxygenating it in two oxidation pools located at the plant. In the oxidation pools, the solids, mainly nickel, are allowed to settle to the bottom and are removed and taken to the city dump.

This area of the city of Guayaquil is not connected to the sewage network so Poliquimicos is not connected to the sewage system. The nearest connection site is two kilometers away. Their treated liquid waste is, therefore, discharged into the storm drain located in front of the facility. The water is dark and turbid but did not appear to be very polluted. Poliquimicos is aware that this storm drain eventually empties into the Miraflores branch of the Estero Salado, but the choices of discharge sites are limited

because of the lack of connection to a sewage network.

Poliquimicos del Ecuador is aware of the 1989 laws made by IEOS for industrial discharges, and their representative says that the company reports their discharge tests to IEOS every year as required. These tests are done on the premises of the company in their physical/chemical laboratory by chemical engineers hired by Poliquimicos. They maintain that they do not have any problems now and have not had any problems in the past with the Municipality or with Environmental Agencies regarding their liquid discharges.

This is a large company in Ecuador, but most of the companies in Ecuador are smaller companies that cannot afford expensive treatment facilities. Poliquimicos attempts to use and reuse as much materials as possible and believes that other companies should do the same. They acknowledge that this is not done.

The group was given a tour of the facility, but it was not working due to monthly maintenance. The facility is kept very clean and the oxidation tanks appeared to be working very well.

V.6.D. Durex

Durex, located on Via Daule, is the largest manufacturer of refrigerators, ovens, and pots in

Ecuador. Our interview consisted mainly of a tour of the manufacturing and treatment facilities, which consisted of two large warehouses and three treatment pools. One warehouse was used entirely for storage, and the other housed the assembly lines for all their products.

The tour began in the area where the sheet metal is cut into different sizes. The cut metal then enters one of the three assembly lines to be shaped into their respective product. After the metal is shaped, the pieces are dipped in sulfuric acid to prepare the metal for the application of paint. Once the pots are painted, they are coated with ceramic. All of the pieces are then dried in large ovens, sent down their respective assembly lines, and inspected.

Both solid and liquid wastes are created during the various manufacturing processes. Solid wastes include scrap metals and plastics which are sold or reused. The scrap metal is created during the cutting of the sheet metal, and the scraps of plastics are created during the molding process for the insides of the refrigerators. The three liquid wastes, sulfuric acid, ceramic and paint, are acquired during the above mentioned painting process.

The liquid waste is treated in three pools before being discharged. In one pool, the water containing

sulfuric acid is neutralized with Sodium Hydroxide, NaOH. In another pool, the heavy metals from the paint settle to the bottom, and the oil, grease and coloring are skimmed off the surface. The third pool contains water polluted by ceramic, and the same treatment process is used as in the second pool. The treated water is discharged directly into the storm channel in front of the facility. Durex is aware that this storm channel empties into the Estero Salado, but they are limited in discharge sites due to the lack of sewage connections in that part of Guayaquil.

The water Durex receives is from the city of Guayaquil, but they are not concerned with its quality since it is not used in the production process. Durex is aware of the 1989 waste water regulations established by IEOS, and they informed us that they comply with these regulations by testing their liquid discharges and reporting the results to IEOS every month. Although they have not had any problems with the Muncipality or any environmental agencies regarding their discharges, they do consider industrial residual waters to be a problem in the city of Guayaquil.

Internal problems encountered at the facility all relate to the age of the facility. The assembly line techniques are outdated and the machinery needs to be replaced with more efficient equipment. They also

encounter difficulty in forecasting the market which leads to occasional storage problems. In order to optimize production and minimize waste, Durex is presently involved in a two year restructuring process.

V.7. Community Interviews

V.7.A. Centro de Salud Publica

The group spoke with Ingeniero Jorge Cisneros at the Department of Environmental Sanitation of the Direccion Provincial de Salud del Guayas. The department is in charge of tap water quality before it is consumed domestically and industrially. It is in charge of dealing with the water, trash, insects, hygiene and contamination in the city. Presently, their focus is the water quality. The agency performs around 250 to 300 water sample tests all around the city every week. These tests determine the presence of fecal coliforms that could cause disease in humans.

The Health Department has noticed an increase in the amount of patients who have become ill due to water related diseases in recent years. Most of these diseases occur during the rainy season when the storm channels become flooded. Pools of water form and this stagnant water propagates the growth of disease transmitting insects such as mosquitoes. The two most common diseases transmitted by these insects are yellow

fever and "dengue". Other diseases can be contracted from swimming in the estuary or wading in the stagnant pools. These diseases include parasite type diseases, cholera, and typhoid fever.

The Health Department feels that the contamination of the estuary is the result of the actions of many people. First, the municipality has not recently renovated or cleaned many of the pipes in the city. The private companies that distribute water transport it in tanks that have never been cleaned. The people from the "invasiones" also contaminate the water by breaking the pipes, stealing the water, and by not properly sealing the leaks.

The Code of Health was issued in 1945 as the basis for water control. This was followed by the 1976 National Pollution Prevention Law and the 1989 IEOS Regulations. Ingeniero Cisneros realizes that industries do not comply with these regulations, and he believes that The Health Department is responsible for increasing social awareness and protecting the community.

V.7.B. Local Residents

The group spoke with Magdalena Torres de Rizzo, the sister of one of the ESPOL faculty, at her house on Avenida Francisco Boloña. Her house is situated on the

Urdesa branch of the Estero Salado, and she moved there twenty years ago for the tranquility and the pleasing view of the estuary. At that time, there was no pollution in the estuary, and the dam at the entrance to the Urdesa branch had just been built.

This dam was built by the developer to maintain a high water level and dilute the predicted pollution. As the pollution increased, the dam made Urdesa a more appealing place to live and increased the price of the land there.

Even though the Urdesa branch is polluted, there is no displeasing odor emanating from it. Señora Torres' only complaint is that the Estero is aesthetically displeasing. This area of the city is connected to the sewage system so all of the waste from her house is discharged elsewhere rather than in the estuary. She receives her water from the city but has no complaints about its quality. She has not noticed any immigration into or emigration out of the area.

The pollution became a problem in 1982 when the Municipality built storm channels in the northern parts of the city. The "invasiones" or poor housing and companies without sewage began discharging into these storm channels, which emptied into the two branches of the Estero Salado. The Urdesa branch received most of the domestic discharges from the "invasiones" and very

little discharge from the industries.

Approximately six months ago, neighbors informed her that they had purchased two aeration tanks to put in the estuary. These tanks initially cost the owners six millions sucres. They run twenty-four hours a day and the electric bill is high, approximately 300,000 sucres per month. The owner also pays another 200,000 sucres per month in maintenance. These aeration devices are expensive to run and maintain, so the owners of these aeration devices are trying to receive financial help from the Municipality.

Mrs. Torres did not feel that other people in the area were very concerned about the pollution. She had heard of a few community meetings but had not attended any of them.

Señora Torres felt that the estuary could be cleaned up but it would be very expensive. She believed that the aeration tanks were a good start in the cleanup process, but measures for controlling industrial discharges should be established by the city.

VI. Conclusion and Recommendations

The industrial contamination of the Estero Salado is a result of three major problems; lack of city sewage connections, improper industrial treatment facilities, and poor regulation enforcement. Industries that do not have access to city sewage are forced to dispose of their liquid wastes by whatever means possible. The liquid wastes they discharge are improperly treated and contain various levels of pollutants.

Although the method of regulating the levels of discharge was established by the 1989 IEOS regulations and developed by the Water Commission, companies do not necessarily comply. Moreover, inspecting companies is not a priority to the Water Commission, and many visits are canceled or by passed due to lack of vehicles and time. As a result, many companies have no involvement or knowledge of the environmental agencies in charge of regulation.

Due to this uncontrolled dumping, the Miraflores and Urdesa branches of the Estero Salado are virtually lifeless. Not only is the area aesthetically displeasing with significant decreases in flora and fauna, but it is also unsafe for any recreational activities.

To reduce and eventually eliminate the

contamination of the Estero Salado, the first step is to create awareness of the problem. Industries, environmental agencies, the government and the community should all be informed of the severity of the present situation and that immediate actions are necessary to improve it.

To create awareness, we suggest that a much more in-depth quantitative impact assessment be conducted. We feel that an outside organization, such as an educational institution or a private agency, should conduct the research to ensure that the information will contain no biases.

To develop this assessment, we propose the following method and matrices developed from our research and the procedure created by Dr. Leopold, which is summarized in section III.3.C of the literature review.

First, we suggest using a questionnaire to gain a numerical analysis of the situation. The questionnaire would contain a list of industrial processes and the areas that might be impacted by them. Included with the questionnaire, would be descriptions of the different processes and the wastes created from them. The severity of how each industrial process impacts the specific areas can be ranked on a scale from one to ten. This questionnaire could be distributed to

environmental agencies, industries, government officials, and residents to have them assess the present condition.

It is essential to inform the people asked to fill out the questionnaire, that their responses are confidential and will not be held against them. It is also necessary to explain that the information being collected is required for completing an analysis of the effects of the industrial pollution and for developing a method to provide assistance.

Once these questionnaires are filled out and collected, the numerical responses for each industrial process should be averaged and recorded in matrices. The matrices should contain the same industrial processes and areas of impact that are found in the questionnaires. The sample matrices we have developed (See Figures 1 and 2) are for an appliance company and a vegetable oil company; however, to establish a more comprehensive assessment, we suggest that questionnaires and matrices be developed for each different type of company contributing to the contamination of the Estero Salado.

Information on the industrial processes used in each company, can be obtained through interviews and tours of the individual facilities. As mentioned before, the companies need to be informed that these

inquiries are intended to eventually bring them assistance in dealing with waste treatment and disposal.

Recording the numbers in matrices will provide a visualization of the extent of the pollution and which particular processes cause the most damage. These matrices can then be used as tools for formulating awareness.

We propose that educating the general public is the first step towards stimulating environmental awareness. Targeting the youth in schools, is one low cost method we recommend that may spark interests and encourage future environmental concern. A field trip to the Estero would let the children see and smell the pollution for themselves. We also suggest encouraging the school systems to initiate a pollution prevention week or program in which the children are asked to generate ways they can help clean the estuary.

Another alternative, would be to approach Fundacion Natura for agencies or organizations that have available funds for environmental education. We advise using the money to create television and newspaper advertisements that inform the public of how their lifestyles are affected by the uncontrolled industrial discharges emptying into the Estero Salado. These advertisements could contain biological, health

and safety factors, the future for the youth, and the lack of regulation by the government and the industries.

One possible outcome might be that people will write letters to government officials or boycott certain products. Since industries need the public to purchase their products, and the goverment survives on public support, these advertisements may stimulate coordination between the government, environmental agencies, and industries.

The next step we suggest is educating the companies. Using the matrices, the companies can be shown which processes are the most harmful to society and what damage they really cause. Alternative methods for optimizing their manufacturing processes with cheaper and less polluting raw materials, and implementing proper treatment facilities can be discussed.

The matrices could also be presented to the national government and environmental agencies to encourage them to acknowledge the problems in industrial discharge regulation and to reasses their control in the environmental management program.

One recommendation we have for creating more control, is to increase the fines for noncompliance with discharge regulations. This increase may be

beneficial in two areas. First, the money collected from these fines could be used to complete the city sewage connections and rennovate the city's treatment facility. Second, this increase will make it more expensive for the companies to pollute than to build a proper treatment facility.

The companies may still have finacial difficulties establishing treatment facilities, so we propose that companies with similar discharges cooperate in building a common treatment facility. This will help to decrease their contstruction and maintenance costs.

Another alternative to constructing individual treatment facilities, would be to charge the companies a monthly fee for discharging their wastes into a privately owned treatment facility. This fee could be determined depending on the level of pollutants and the amount of liquid discharges.

SAMPLE MATRIX #1
VEGETABLE OIL COMPANY

INDUSTRIAL PROCESSES

IMPACTS	SEED CLEANING	PREPARATION	EXTRACTION	OIL REFINING	DRYING	BLEACHING	FILTERING	DEODORIZING	STORAGE
FLORA									
FAUNA									
WATER QUALITY									
CLEANUP COSTS									
TREATMENT FACILITY COSTS									
HUMAN HEALTH									
RECREATION									
IMMIGRATION /EMIGRATION									
AESTHETICS									

FIGURE 1

SAMPLE MATRIX #2
APPLIANCES COMPANY

FIGURE 2

INDUSTRIAL PROCESSES

IMPACTS	STEEL CUTTING	SHAPING AND MOLDING	DIPPING	PAINTING	DRYING AND CLEANING	PLASTIC MOLDING	INSULATION	SOLDERING	ASSEMBLY	QUALITY CHECKING	STORAGE
FLORA											
FAUNA											
WATER QUALITY											
CLEANUP COSTS											
TREATMENT FACILITY COSTS											
HUMAN HEALTH											
RECREATION											
IMMIGRATION /EMIGRATION											
AESTHETICS											

VII. Appendices

Appendix A. Related Organizations

USAID

The United States Agency for International Development (USAID), formed in 1961, is a department of the International Development Cooperation Agency, which in turn is part of the Department of State.

AID's mission is to provide economic assistance to developing nations on a grassroots level. The assistance AID provides is on a grassroots level because it was realized that the grandiose aid schemes of the past padded the pockets of a few people, but was generally not advantageous for the local populations.

In 1991, AID began a program called University Development Linkages Program (UDLP). This program awarded ten institutions in the United States money to pursue linkages with foreign universities in developing countries. The Worcester Polytechnic Institute-Escuela Superior Politecnica del Litoral linkage was granted one of these awards. It is under this system that the Ecuador Project Center operates.

ESPOL

La Escuela Superior Politecnica del Litoral (ESPOL) is an engineering and technology school located on the outskirts of Guayaquil, Ecuador. The school's

intent is to develop professionals skilled in science and technology who can use their skills to help develop the nation. Indeed, ESPOL is one of the major institutions in Ecuador involved in this endeavor. ESPOL is a public institution, receiving over 80 percent of its operating funds from the Ecuadorian government. ESPOL, therefore, recognizes a certain responsibility to work closely with the government to generate technologies that are necessary for national development. It encourages its faculty to work with the public and private institutions on activities that support development of the national economy. They especially would like the faculty to involve students in their undertakings.

ESPOL's undergraduate programs of study are organized into four major groups: mechanical engineering, electrical engineering, earth sciences, and maritime and ocean sciences. At present the only graduate-level degree is in business administration. Their technology programs are in the areas of agricultural technology, aguacultural technology, and furniture and wood. The undergraduate degrees are meant to produce professionals who will become leaders in Ecuadorian society. It is through the technology programs that ESPOL tries to directly help national development by training people in these fields.

ESPOL's mission statement explains that they plan to develop international exchanges for their students and faculty. It is in this context that ESPOL fits in to USAID's university linkage program, along with WPI's Strategic Plan 1990-2000 (Coyle, DiBiase, Watson, 1992).

Appendix B. Questionnaires

1. Industry Questionnaire

INTRODUCTION: We are members of the Worcester Polytechnic Institute-ESPOL inter-institutional group and we are assessing
the overall situation of the microindustries in Guayaquil. Your company has been chosen as one of the leading industries in your field and we would like to ask you some questions.

1) What does this industry produce and by what process? What raw materials do you use? Who is in charge of what in the industry?
2) What is your present market position? How do you manage to do so well in the market?
3) What is the estimate worth of the industry, how much they think they are worth?
4) What problems do you have? (competition)
5) What internal problems do you have? Any problems with the workers?
6) How much water do you receive and where do you receive it from? How is the water quality you receive?
7) Do you currently have a treatment facility, if so how does it work and how much waste is treated by it? If not, where and how much residual waters do

you dump?

8) Are you connected to a sewage network, if so, what costs are involved with this, this it adequate for your needs, and do you know where the sewer empties into?

9) How hard would it be for you to implement a water treatment facility? What leadership role would your industry take if an order was issued imposing this situation? Are you aware of the 1989 regulations released by IEOS?

10) Have you had any problems in the past with the Municipality or with environmental agencies concerning residual waters, if so, what sorts of problems?

11) Do you consider residual waters to be an environmental problem here in Guayaquil, if so, to what extent and why?

12) How hard do you think it would be to change your present manufacturing processes (optimizing them) in order to reduce waste?

13) Would you find it helpful if the Municipality, a university, a private consultant, or an environmental agency conducted an audit providing you with environmentally sound guidelines for your industry?

2. Environmental Agency Questionnaire

INTRODUCTION: We are members of the Worcester Polytechnic Institute-ESPOL inter-institutional Project group. We are preparing a preliminary environmental impact assessment of the industrial pollution of the Estero Salado in Guayaquil, Ecuador. We would like to ask you a few questions.

1) What are the activities of your agency? Who do you control and who is in control of you?
2) What are some of the major environmental influences of your agency?
3) How are you perceived by the public and local industries?
4) Are you in charge of creating, implementing, or regulating any environmental laws regarding industrial waste water discharges, if so, what problems or complaints have you been confronted with?
5) Are you aware of any conflicting environmental laws or regulations for industrial waste water discharges?
6) Are there currently any national or local limits on industrial waste water discharges?
7) Do regulations or laws differ for new industries than for already existing ones?

3. Social Questionnaire

1) How long have you lived along the estuary?

2) Why did you choose to live here?

3) At one point, did you ever use the estuary for recreational purposes? If so, when did you stop and why?

4) Currently does the pollution affect your life in any way? If so in what ways and how could this been changed?

5) Has any you know had any health problems because of the pollution in the estuary?

6) At what point did the estuary become heavily contaminated?

7) Have you noticed any immigration into or emigration out of your neighborhood? If so, for what reasons?

8) Have you noticed any actions by the Municipality or environmental agencies to clean up the estuary? If so, are these actions enough?

9) Where do you obtain your water from, the city or other sources?

10) Are you connected to the sewage system of the city?

11) What are the feelings of your neighbors regarding the pollution?

12) Have there been any community organizations

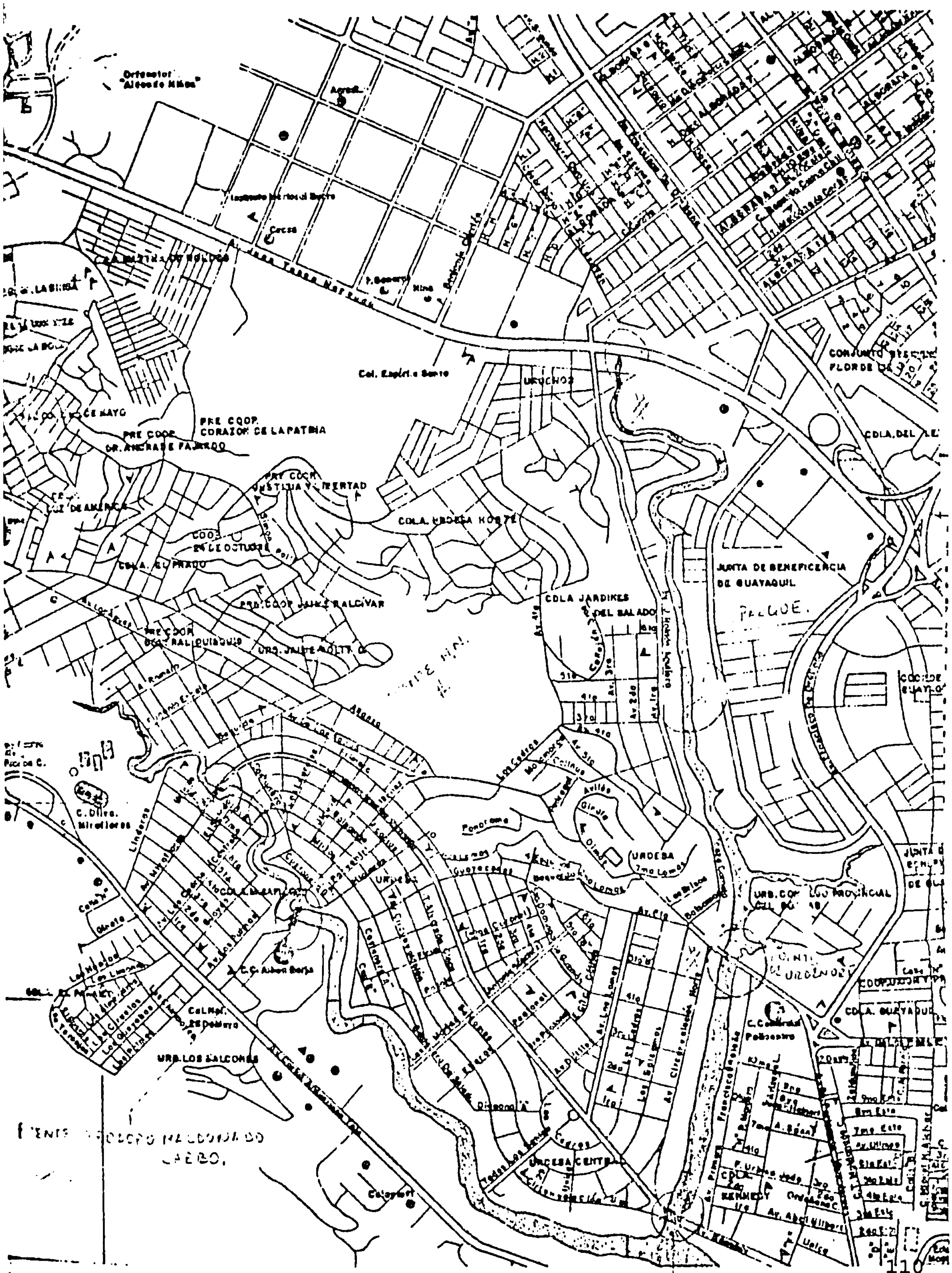
developed to clean up the estuary? If so, are you involved with them?

13) What are some of the solutions for cleaning the estuary?

Appendix C. Estero Salado Maps

1. General Map

Shown on this map are the Miraflores and Urdesa branches of the Estero Salado and the neighborhoods surrounding them. The two branches split at the Kennedy Avenue Bridge. The Miraflores branch extends north-west along Avenida Julio Carlos Arosemena. The Urdesa branch extends north to Avenida Juan Tanca Merengo.



PUENTE DE LA AV. KENNEDY.

2. Sewage Map

Shown on this map are the areas of the city of Guayaquil with sewage connection and areas where there are industrial, municipal and domestic discharges. The industries located along Via a Daule, Avenida Juan Tanca Merengo and Avenida Julio Carlos Arosemena lack sewage and large amount of liquid discharges flow in storm channels south into the Miraflores and Urdesa branches of the Estero Salado.

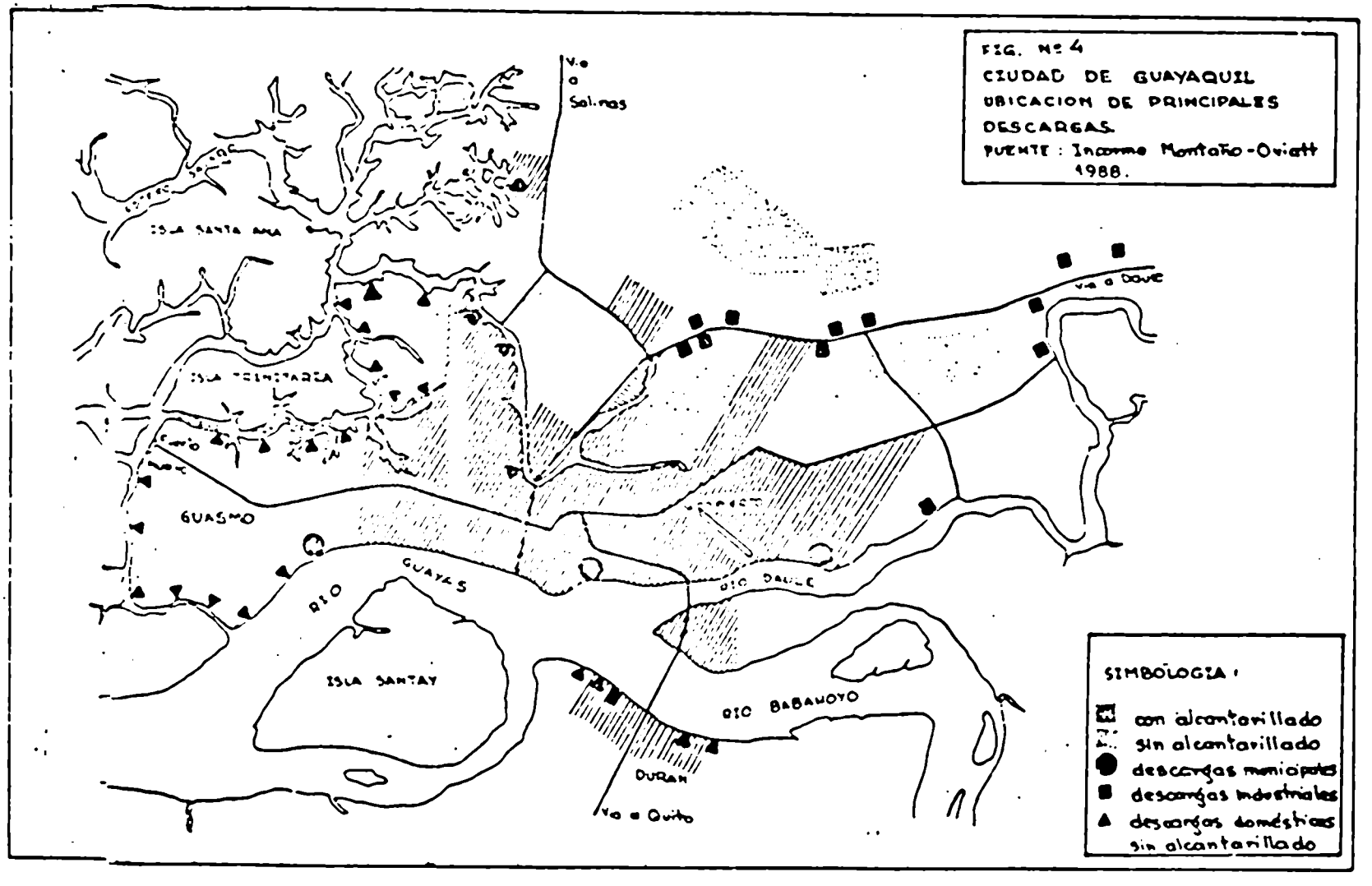
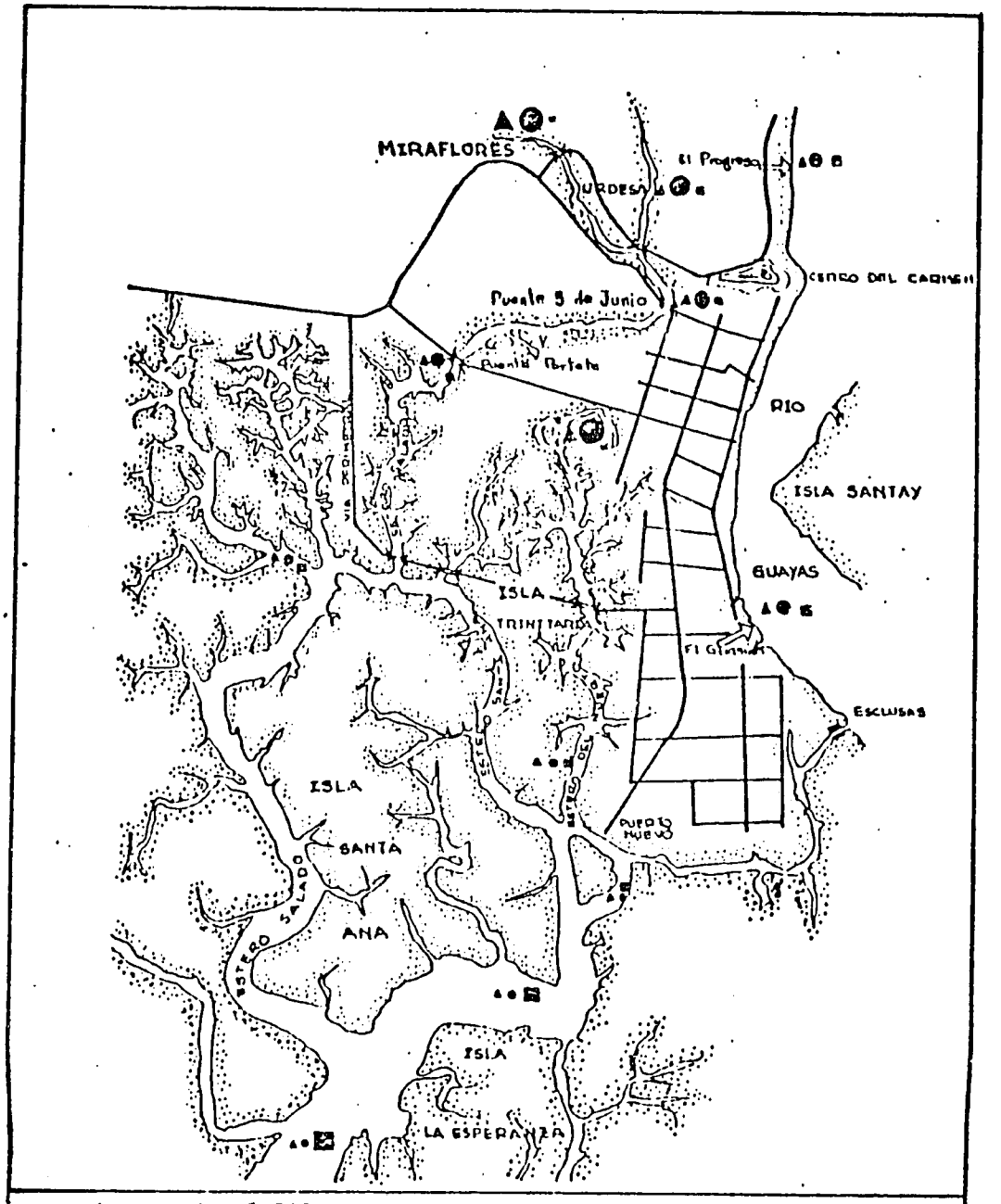


FIG. Nº 4
CIUDAD DE GUAYAQUIL
UBICACION DE PRINCIPALES
DESCARGAS.
FUENTE : Inconmo Montaño-Oviatt
1988.
Vía a Salinas
ISLA SANTA ANA
ISLA TRINITARIA
GUASMO
RIO GUAYAS
ISLA SANTAY
RIO DAULE
RIO BABAHOYO
DURAN
Vía a Quito
Vía a Daule
SIMBOLOGIA :
con alcantarillado
sin alcantarillado
descargas municipales
descargas industriales
descargas domésticas
sin alcantarillado

3. Water Quality Data Map

Shown on this map are the measurements of Fecal Coliforms, Dissolved Oxygen and Biological Oxygen Demand along several points of the Estero Salado including three points along the Miraflores and Urdesa branches. Fecal Coliforms, measured in NMP/100 ml, are signified by circles. Dissolved oxygen, measured in mg/l, are signified by squares. Biological Oxygen Demand, measured in mg/l, are signified by triangles.



COLIFORMES FECALES (NMP/100 ml)	OXIGENO DISUELTO (mg/l)	DEM BIOQ. OXIGENO (mg/l)
10'000.000	6 - 7	50 - 100
1'000.000 - 100 000	5 - 6	20 - 50
100 000 - 10 000	4 - 5	10 - 20
10 000 - 1.000	3 - 4	0 - 10
1.000 - 100	2 - 3	
0 - 10	0	

FIG Nº 5 . NIVEL DE CONTAMINACION DEL ESTERO SALADO
FUENTE : EMAG, 1987.

Appendix D. 1989 IEOS Regulations

FIDEL CARTERON ALAVA
INGENIERO CIVIL

Nº 2141

EL MINISTRO DE SALUD PUBLICA

Considerando:

Que de conformidad con el Art. 6º del Código de la Salud, el Saneamiento Ambiental comprende el conjunto de actividades dedicadas a acondicionar y controlar el ambiente en que vive el hombre, a fin de proteger su salud;

Que la Ley de Prevención y Control de la Contaminación Ambiental, expedida mediante Decreto Supremo Nº 374 del 21 de mayo de 1976, publicada en el Registro Oficial Nº 97 de 31 de mayo de 1976, tiene como finalidad fundamental precautelar la buena utilización de los recursos naturales del país, en pro del bienestar individual y colectivo;

Que el agua es un elemento indispensable para la vida del hombre, los animales y las plantas, por lo cual es necesario preservarla de la contaminación, estableciendo normas de control;

Que los Arts. 18 y 19 de la mencionada Ley de Prevención y Control de la Contaminación Ambiental, establecen el control sobre los residuos líquidos, la construcción, operación y mantenimiento de las plantas de tratamiento de aguas residuales por el Ministerio de Salud Pública; y,

En uso de las atribuciones que le confiere el Art. 12 del Código de la Salud y los artículos 10, literal n), y 17 de la Ley de Prevención y Control de la Contaminación Ambiental,

Acuerda:

Expedir el Reglamento para la Prevención y Control de la Contaminación Ambiental, en lo relativo al recurso agua.

TITULO I

CAPITULO I

Ambito de Aplicación

Art. 1º— El presente Reglamento regula las actividades y fuentes que produzcan contaminación del agua, en aplicación de la Ley para la Prevención y Control de la Contaminación Ambiental y del Código de la Salud.

CAPITULO II

De las Definiciones

Art. 2º— Todo aquello que en el presente Reglamento se refiera al recurso agua, se entenderá por tal a las aguas superficiales, subterráneas, marinas y estuarinas, incluidas las aguas servidas.

Art. 3º— Para efectos de la aplicación del presente Reglamento, se establecen las siguientes definiciones:

— Agua dulce es aquella que no contiene importantes cantidades de sales.

— Agua costera es el agua adyacente a la tierra firme, cuyas propiedades físicas están directamente influenciadas por las condiciones continentales.

— Agua marina es el agua de los mares y se distinguen por su elevada salinidad, también conocida como agua salada. Las aguas marinas corresponden a las aguas territoriales en la extensión y términos que fije el derecho internacional, las aguas marinas interiores y las de los lagunas y esteros que se comuniquen, permanentemente.

— Aguas estuarinas son las correspondientes a los tramos de río que se hallan bajo la influencia de las mareas y que están limitadas en extensión hasta la zona donde la concentración de cloruros es de 250 mg/l o mayor durante los caudales de estiaje.

— Aguas negras son aquas que contienen materiales sin depurar.

— Aguas residuales son los líquidos de composición variada provenientes de usos municipal, industrial, comercial, agrícola, pecuario o de otra índole, ya sea pública o privada y que por tal motivo haya sufrido degradación en su calidad original.

— Agua subterránea es toda agua del subsuelo, especialmente la que se encuentra en la zona de saturación.

— Aguas superficiales son las masas de agua que se encuentran sobre la superficie de la tierra.

— Bioensayo acuático es el procedimiento por el cual se usan las respuestas de organismos acuáticos, para detectar o medir la presencia o efectos de una o más sustancias, elementos, compuestos, desechos o factores ambientales solos o en combinación.

— Capacidad de asimilación es la propiedad que tiene un cuerpo receptor para restablecer su calidad, en forma tal que no se viole en cuerpo ni en espacio la norma de calidad establecida.

— Capacidad de dilución es la cantidad de cualquier elemento, compuesto o sustancia que puede recibir un cuerpo receptor, en forma tal que no exceda en ningún momento, al lugar la concentración máxima de dicho elemento, compuesto o sustancia establecida en la norma de calidad del cuerpo receptor correspondiente.

— Caracterización de un agua residual es la determinación precisa de su calidad físico-química y bacteriológica de modo que claramente se distinga de las demás.

— Carga es el producto de la concentración promedio por el caudal promedio, determinados en el mismo sitio.

— Carga máxima permisible es el límite de carga que puede ser aceptado en la descarga a un cuerpo receptor.

— Concentración en las disoluciones es la masa, volumen o número de moles de soluto presente, en proporción a la cantidad de disolvente o de disolución total.

— Se denomina CL 96/50 a la concentración de una sustancia, elemento o compuesto, sólos o en combinación que produce la muerte al cincuenta por ciento de los organismos sometidos a bioensayos, en un período de noventa y seis (96) horas.

— Agua contaminada es toda aquella corriente o no que presente deterioro de sus características físicas, químicas o biológicas, debido a la influencia de cualquier elemento o materia sólida, líquida, gaseosa, radioactiva o cualquier otra sustancia y que den por resultado la limitación parcial o total de ellas para el uso doméstico, industrial, agrícola, de pesca, recreativo y otros.

— Cuerpo receptor es toda red colectora, río, cuenca, cauce o depósito de aguas que sea susceptible de recibir directa o indirectamente la descarga de aguas residuales.

— Depuración es la remoción de sustancias objetables de las aguas residuales, para disminuir su impacto ambiental.

— Descarga es la entrega de las aguas residuales a un cuerpo receptor.

— Descarga no puntual es aquella en la cual no se puede precisar el punto exacto de descarga al cuerpo receptor, tal es el caso de descargas provenientes de escorrentía, aplicación de agroquímicos u otros similares.

— Impacto ambiental es el conjunto de reacciones que se producen en el medio ambiente y en el cuerpo receptor ante la descarga de aguas contaminadas.

— Isohalina es la línea imaginaria que une los puntos de igual salinidad en un lugar geográfico determinado.

— Polución del agua es su contaminación por materias tales como aguas de alcantarillas, productos químicos, detergentes y desagues de fertilizantes.

— Toxicidad es la propiedad que tiene una sustancia, elemento o compuesto, de causar daños en la salud humana o la muerte de un organismo vivo.

— Toxicidad agua es la propiedad de una sustancia, elemento, compuesto, desecho o factor ambiental, de causar efecto letal u otro efecto nocivo en cuatro (4) días o menos a los organismos utilizados para el bioensayo acuático.

— Toxicidad crónica es la propiedad de una sustancia, elemento, compuesto, desecho o factor ambiental, de causar cambios en el apetito, crecimiento, metabolismo, reproducción, movilidad o la muerte o producir mutaciones después de los cuatro (4) días a los organismos utilizados para el bioensayo acuático.

— Tratamiento convencional para potabilizar las aguas son las siguientes: coagulación, floculación, sedimentación, filtración y desinfección.

— Usuario es toda persona natural o jurídica de derecho público o privado, que utilice agua tomada directamente de una fuente o de una red, o cuya actividad pueda producir una descarga directa o indirecta.

— Zona de mezcla es el área técnicamente determinada a partir del sitio de descarga, indispensable para que se produzca mezcla homogénea de ésta con el cuerpo receptor.

Art. 4º— Los criterios de calidad establecidos en el presente Reglamento son guías para ser utilizados en el ordenamiento, asignación de usos y determinación de las características del agua para cada uso.

TITULO II

CAPITULO II

De los Organismos Competentes

Art. 5º— La aplicación del presente Reglamento compete a los siguientes organismos:

a) Al Instituto Ecuatoriano de Obras Sanitarias (IEOS), en materia de prevención y control de la contaminación del agua de consumo humano y de aguas residuales domésticas e industriales; así mismo, fija el grado de tratamiento que deben tener los residuos líquidos a descargarse en un cuerpo receptor;

b) Al Instituto Ecuatoriano de Recursos Hidráulicos (INERHI), en materia de prevención de la contaminación y control de la calidad de las aguas continentales e insulares, en concordancia con lo dispuesto en la Ley de Aguas y su Reglamento;

c) Al Ministerio de Defensa Nacional, por intermedio de la Dirección General de la Marina Mercante y del Litoral (DIGMER), en materia de prevención de la contaminación y control de la calidad de las aguas costeras y ríos navegables, de acuerdo a lo establecido en el Código de Policía Marítima.

Las autoridades de organismos nacionales, regionales y seccionales deberán apoyar a las instituciones mencionadas, sin perjuicio de las atribuciones que les son propias.

Art. 6º— La Comisión Técnica del Recurso Agua creada por el Comité Interinstitucional de Protección del Ambiente, estará constituida por el IEOS, INERHI, DIGMER, y le corresponderá asesorar técnicamente al citado Comité en materia de aplicación del presente Reglamento y proponer reformas a los criterios de calidad y normas de descarga.

TITULO III

CAPITULO I

De la Prevención y Control de la Contaminación de Aguas

Art. 7º— La prevención y el control de la contaminación de las aguas, tendientes a preservar y recuperar la calidad de los cuerpos de agua, deberán realizarse en los términos de este Reglamento.

Art. 8º— Las aguas residuales, previamente a su descarga, deberán ser tratadas sea cual fuere su origen: público o privado, de conformidad con los usos determinados en este Reglamento y en el Plan Nacional Hidráulico elaborado por el INERHI.

CAPITULO II

De los Usos de las Aguas Superficiales, Subterráneas, Marítimas y Estuarinas

Art. 9º— Para los efectos del presente Reglamento, se tendrán en cuenta los siguientes usos del agua, sin que su enunciado signifique orden de prioridad:

FIDEL CAMCHONG ALAVA
INGENIERO CIVIL
REG. PROF. 01-G-1199

a) Consumo humano y doméstico;
b) Preservación de flora y fauna;
c) Agrícola;
d) Pecuario;
e) Recreativo;
f) Industrial;
g) Transporte; y,
h) Estético.

Art. 10º— Se entiende por uso del agua para consumo humano y doméstico su empleo en actividades tales como:

a) Bebida directa y preparación de alimentos para consumo inmediato;

b) Satisfacción de necesidades domésticas, individuales o colectivas, tales como higiene personal y limpieza de elementos, materiales o utensilios;

c) Fabricación o procesamiento de alimentos en general y en especial los destinados a su comercialización o distribución; y,

d) Fabricación o procesamiento de medicamentos, cosméticos, aditivos y productos similares.

Art. 11º— Se entiende por uso del agua para preservación de flora y fauna, su empleo en actividades destinadas a mantener la vida natural de los ecosistemas asociados, sin causar alteraciones sensibles en ellos, o para actividades que permitan la reproducción, supervivencia, crecimiento, extracción y aprovechamiento de especies hidrobiológicas en cualquiera de sus formas, tal como en los casos de pesca y acuacultura.

Art. 12º— Se entiende por uso agrícola del agua, su empleo para la irrigación de cultivos y otras actividades conexas o complementarias, que establezcan los organismos competentes.

Art. 13º— Por uso pecuario del agua, se entiende su utilización para el abrevadero de animales, así como para otras actividades conexas y complementarias que establezcan los organismos competentes.

Art. 14º— Se entiende por uso del agua para fines recreativos, la utilización en la que existe:

a) Contacto primario, como en la natación y el buceo, incluido los baños medicinales; y

b) Contacto secundario, como en los deportes náuticos y la pesca.

Art. 15º— Se entiende por uso industrial del agua, su empleo en actividades tales como:

a) Procesos industriales y/o manufactureros de transformación o explotación, así como aquellos conexos o complementarios que establezcan el IEOS, INEMHI y DIGMER;

b) Generación de energía; y,

c) Minería

Art. 16º— Se entiende por uso del agua para transporte su empleo para la navegación de cualquier tipo de embarcación o para la movilización de materiales por conducto directo.

Art. 17º— El uso estético del agua se refiere al mantenimiento de las condiciones naturales y al mejoramiento y creación de la belleza escénica

CAPITULO III

De los Criterios de Calidad de las Aguas en Función de sus Usos.

Art. 18º— Los criterios de calidad de las aguas que para consumo humano y doméstico requieran tratamiento convencional, son los que se indican a continuación:

PARAMETRO	EXPRESADO COMO	UNIDAD	VALOR MAXIMO PERMISIBLE
Temperatura		°C	Condición Natural ± 3
Potencial de Hidrógeno	pH		6 — 9
Oxígeno Disuelto	O.D.	mg/l	80% del Oxígeno de Saturación y no menor a 6mg/l
Demanda Bioquímica de Oxígeno	D.B.O. 5	mg/l	10%. DBO5 admisible y máximo 2 mg/l
Bacterias Coliformes	NMP/100cm3	Coli. Tot.	3000
		Coli. Fecal	600
Aceites y Grasas	Película visible		Ausencia
Sólidos disueltos		mg/l	1000
Turbiedad		UTF	100
Color	Color Real	Unidades de color	100
Olor y sabor			Es permitido olor y sabor removible por tratamiento convencional
Materia Flotante			Ausencia
Amoniaco	N—amoniacal	mg/l	1,0
Arsénico	As	mg/l	0,05
Bario	Ba	mg/l	1,0
Cadmio	Cd	mg/l	0,01

Cianuro	CN-	mg/l	0,2
Cinc	Zn	mg/l	5,0
Cloruros	Cl	mg/l	250,0
Cobre	Cu	mg/l	1,0
Compuestos Fenólicos	Fenol	mg/l	0,002
Cromo	+6 Cr	mg/l	0,05
Difenil Policlorados	Concentración de agente activo		No detectable
Mercurio	Hg	mg/l	0,002
Nitratos	N nitratos	mg/l	10,00
Nitritos	N nitritos	mg/l	1,0
Plata	Ag	mg/l	0,05
Plomo	Pb	mg/l	0,05
Selenio	Se	mg/l	0,01
Sulfatos	SO_4^{2}	mg/l	400,0
Tensoactivos	Sustancias activas al azul de metileno	mg/l	0,5

Art. 19.— Los criterios de calidad para las aguas de consumo humano y doméstico y que para su potabilización requieren sólo desinfección, son los siguientes:

PARAMETRO	EXPRESADO COMO	UNIDAD	VALOR MAXIMO PERMISIBLE
Temperatura		°C	Condición Natural ± 3
Potencial de Hidrógeno	pH		6 — 9
Oxígeno disuelto	O.D	mg/l	80% Oxígeno de Saturación y no menor a 5mg/l
Demanda Bioquímica de Oxígeno	D.B.O. 5	mg/l	10% BO5 admisible y más no 2 mg/l
Bacterias Coliformes	NMP/100cm3	Coli. Total	100
		Coli. Fecal	20
Aceites y grasas	Película visible		Ausencia
Sólidos disueltos		mg/l	1000
Turbiedad		UTF	10
Color	Color real	Unidades de color	20
Olor y sabor			Ausencia
Materia flotante			Ausencia
Amoniaco	N-amoniacal	mg/l	1,0
Arsénico	As	mg/l	0,05
Bario	Ba	mg/l	1,0
Cadmio	Cd	mg/l	0,01
Cianuro	CN-	mg/l	0,2
Cinc	Zn	mg/l	5,0
Cloruros	Cl	mg/l	250,0
Cobre	Cu	mg/l	1,0
Compuestos fenólicos	Fenol	mg/l	0,002
Cromo	+6 Cr	mg/l	0,05
Difenil policlorados	Concentración de agente activo	mg/l	No detectable
Mercurio	Hg	mg/l	0,002
Nitratos	N-nitratos	mg/l	10,00
Nitritos	N-nitritos	mg/l	1,0
Plata	Ag	mg/l	0,05
Plomo	Pb	mg/l	0,05
Selenio	Se		0,01
Sulfatos	SO_4^{2}	mg/l	400,0
Tensoactivos	Sustancias activas al azul de metileno	mg/l	0,5

FUNDACION NATURA
BIBLIOTECA

Art. 20.— Los criterios de calidad admisibles para las aguas destinadas a uso agrícola son los siguientes:

PARAMETRO	EXPRESADO COMO	UNIDAD	VALOR MAXIMO PERMISIBLE
Aluminio	Al	mg/l	5.0
Arsénico	As	mg/l	0.1
Berilio	Be	mg/l	0.1
Boro	B	mg/l	1.0
Cadmio	Cd	mg/l	0.01
Cinc	Zn	mg/l	2.0
Cobalto	Co	mg/l	0.05
Cobre	Cu	mg/l	2.0
Cromo	Cr	mg/l	0.2
Flúor	F	mg/l	0.1
Hierro	Fe	mg/l	1.0
Litio	Li	mg/l	5.0
Manganeso	Mn	mg/l	2.5
Molibdeno	Mo	mg/l	0.2
Níquel	Ni	mg/l	0.01
Potencial de Hidrógeno	pH		8.2
Plomo	Pb	mg/l	6.5
Selenio	Se	mg/l	0.05
Vanadio	V	mg/l	0.02
Bacterias coliformes	NMP/100 cm3	Coli total	0.1
Huevos de parásitos			1000
Aceites y grasas	Película visible		Ausencia
Materia flotante			Ausencia
			Ausencia

Además de los criterios anteriores se utilizarán también las siguientes guías para la interpretación de la calidad del agua para riego:

PROBLEMA POTENCIAL	UNIDADES	GRADO DE RESTRICCION Ninguno	Ligero-Moderado	Severo
Salinidad (1)				
CE (2)	Milimhos/cm	0.7	0.7 — 3.0	> 3.0
SDT (3)	mg/l	450	450 — 2000	> 2000
Infiltración (4)				
RAS = 0—3 y CE =		0.7	0.7 — 0.2	< 0.2
= 3—6 =		1.2	1.2 — 0.3	< 0.3
= 6—12 =		1.9	1.9 — 0.5	< 0.5
= 12—20 =		2.9	2.9 — 1.3	< 1.3
= 20—40 =		5.0	5.0 — 2.9	< 2.9
Toxicidad para los cultivos (5)				
Sodio				
Irrigación superficial RAS (6)				
aspersión	meq/l	3.0	3 — 9	> 9
Cloruros		3.0	3	
Irrigación superficial				
aspersión	meq/l	4.0	4 — 10	> 10
Boro	mg/l	3.0	3	
Efectos misceláneos (7)		0.7	0.7 — 3.0	> 3.0
Nitrógeno (N—NO3—)	mg/l	5	5 — 30	> 30
Bicarbonato (HCO3—)	meq/l	1.5	1.5 — 8.5	> 8.5
(solo aspersión)				
pH	Rango normal	6.5 — 8.4		

(1) Afecta a la disponibilidad de agua para los cultivos

(2) Conductividad Eléctrica del agua de riego
(1 milimhos/cm = 1000 microhmios/cm)

(3) Sólidos disueltos totales

(4) Afecta a la tasa de infiltración del agua en el suelo

(5) Afecta a la sensibilidad de los cultivos

(6) RAS. Relación de absorción de sodio ajustada

(7) Afecta a los cultivos susceptibles.

Art. 21.— Las aguas destinadas a uso pecuario deberán los siguientes criterios de calidad:

PARAMETRO	EXPRESADO COMO	UNIDAD	VALOR MAXIMO PERMISIBLE
Aluminio	Al	mg/l	5,0
Arsénico	As	mg/l	0,2
Boro	B	mg/l	5,0
Cadmio	Cd	mg/l	0,05
Cinc	Zn	mg/l	25,0
Cobre	Cu	mg/l	0,5
Cromo	Cr^{+6}	mg/l	1,0
Mercurio	Hg	mg/l	0,01
Nitratos + Nitritos	N	mg/l	10,0
Nitritos	N-nitritos	mg/l	1,0
Plomo	Pb	mg/l	0,05
Sólidos disueltos totales	SDT	mg/l	3000,00

Art. 22.— Los criterios de calidad para aguas destinadas a usos recreativos mediante contacto primario* son:

PARAMETRO	EXPRESADO COMO	UNIDAD	VALOR MAXIMO PERMISIBLE
Bacterias coliformes	NMP/100 cm3	Coli. Fecal	200
		Coli. Total	1000
Compuestos fenólicos	Fenol	mg/l	0,002
Oxígeno disuelto	O.D.	mg	80% concentración de saturación y no menor a 6 mg/l
Potencial de Hidrógeno	pH		6,5 — 8,5
Tensoactivos	Sustancias activas al azul de metileno	mg/l	0,5
Grasas y aceites	Película visible		Ausencia
Material Flotante			Ausencia
Relación Nitrógeno-Fósforo (orgánico)			15:1

La visibilidad al disco Secchi será de por lo menos 2m. de profundidad.

* Siempre y cuando no se refiera a piscinas.

Art. 23.— Los criterios de calidad admisibles para aguas utilizadas con fines recreativos, mediante contacto secundario, son:

PARAMETRO	EXPRESADO COMO	UNIDAD	VALOR MAXIMO PERMISIBLE
Bacterias coliformes	NMP/100 cm3	Coli. Tot.	1000
Oxígeno Disuelto	O.D.	mg/l	80% concentración de saturación
Potencial de Hidrógeno	pH		6-9
Tensoactivos	Sustancias activas al azul de metileno	mg/l	0,5
Grasas y aceites	Película visible		Ausencia
Materia Flotante			Ausencia

Art. 24.— Las aguas que sean utilizadas para uso estético tendrán los siguientes criterios de calidad admisibles:

a) Ausencia de material flotante y de espumas, provenientes de la actividad humana;

b) Ausencia de grasas y aceites que formen película visible;

c) Ausencia de sustancias productoras de color, sabor y turbiedad detectables;

d) Sustancias y condiciones o combinaciones concentraciones que produzcan vida acuática sensible; y,

e) El oxígeno disuelto será el 80% del oxígeno de saturación y no menor a 6 mg/l.

BEST AVAILABLE COPY

121

FIDEL CANQUERINO ALAVA
INGENIERO CIVIL
REG. PROF. [illegible]

Art. 25º— Los criterios de calidad admisibles para la preservación de flora y fauna en aguas dulces, frías o cálidas y en aguas marinas y estuarianas, son los siguientes:

PARAMETRO	EXPRESADO COMO	Unidades	Valor Máximo Permisible Agua Fría dulce	Agua Cálida dulce	Agua Marina y estuariana
Clorofenoles	Clorofenol	mg/l	0,5	0,5	0,5
Difenilos	Concentración de	mg/l	0,001	0,001	0,001
	agente activo	mg/l	80% O.	60% O	80% O.
Oxígeno disuelto	D.D.		Sat. no menor a 6mg/l	Sat. no menor a 5mg/l	Sat. no menor a 6mg/l
Potencial de Hidrógeno	pH		6,5 9,0	4,5 9,0	6,5 9,5
Sulfuro de Hidrógeno ionizado	H2S	mg/l	0,0002	0,0002	0,0002
Amoníaco	NH3	mg/l	96 0,1CL 50	96 0,1CL 50	96 0,1CL 50
Arsénico	As	mg/l	96 0,1CL 50	96 0,1CL 50	96 0,1CL 50
Bario	Ba	mg/l	96 0,1CL 50	96 0,1CL 50	96 0,1CL 50
Berilio	Be	mg/l	96 0,1CL 50	96 0,1CL 50	96 0,1CL 50
Cadmio	Cd	m/l	96 0,01CL 50	96 0,01CL 50	96 0,01CL 50
Cianuro libre	CN-	mg/l	96 0,05CL 50	96 0,05CL 50	96 0,05CL 50
Cinc	Zn	m/l	96 0,01CL 50	96 0,01CL 50	96 0,01CL 50
Cloro residual	Cl2	mg/l	96 0,1CL 50	96 0,1CL 50	96 0,1CL 50
Cobre	Cu	mg/l	96 0,1CL 50	96 0,1CL 50	96 0,1CL 50
Cromo hexavalente	Cr^{+6}	m/l	96 0,01CL 50	96 0,01CL 50	96 0,01CL 50
Fenoles monohídricos	Fenoles	mg/l	96 1,0CL 50	96 1,0CL 50	96 1,0CL 50
Grasas y aceites	Película visible	mg/l	Ausencia	Ausencia	Ausencia

BEST AVAILABLE COPY

Hierro	Fe	mg/l	96 0,1CL 50	96 0,1CL 50	96 0,1CL 50
Manganeso	Mn	mg/l	96 0,1CL 50	96 0,1CL 50	96 0,1CL 50
Mercurio	Hg	mg/l	96 0,01CL 50	96 0,01CL 50	96 0,01CL 50
Níquel	Ni	mg/l	96 0,01CL 50	96 0,01CL 50	96 0,01CL 50
Plaguicidas organoclorados (cada tipo)	Concentración de agente activo	mg/l	96 0,001CL 50	96 0,001CL 50	96 0,001CL 50
Plaguicidas organofosforados (cada tipo)	Concentración de agente activo	mg/l	96 0,05CL 50	96 0,05CL 50	96 0,05CL 50
Plata	Ag	mg/l	96 0,01CL 50	96 0,01CL 50	96 0,01CL 50
Plomo	Pb	mg/l	96 0,01CL 50	96 0,01C 50	96 0,01CL 50
Selenio	Se	mg/l	96 0,01CL 50	96 0,01CL 50	96 0,01CL 50
Tensoactivos	Sustancias activas al azul de met.	mg/l	96 0,143CL 50	[illegible] 0,143CL [illegible]	96 0,143CL 50
Temperatura	°C		Condiciones naturales ± 3 máxima de 32		
Bacterias Coliformes	NMP/100cm3			70 Coli fecal	

Además de los parámetros indicados, se tendrá en cuenta los siguientes criterio:

La turbiedad de las aguas estuarias deberá ser considerada de acuerdo a los siguientes límites:

a) Condición natural más 5%, si la turbiedad natural varía entre 0 y 50;

b) Condición natural más 10%, si la turbiedad natural varía entre 50 y 100; y,

c) Condición natural más 20%, si la turbiedad natural es mayor que 100

Debe haber ausencia de sustancias artificiales que produzcan cambios en color, olor y sabor del agua del cuerpo receptor, de modo que no perjudiquen a la flora y fauna acuáticas y que tampoco impidan el aprovechamiento óptimo del cuerpo receptor.

En las aguas estuarinas debe haber ausencia de desechos susceptibles de sedimentarse, que puedan producir consumo de oxígeno, opacidad o interferencia en la respiración o nutrición de los organismos bentónicos.

En las aguas estuarinas los nutrientes no deben existir en cantidades tales que puedan causar hiperfertilización del agua.

Art. 26º.- Corresponde al IEOS, INERHI, DRB MER la realización de los bioensayos que permitan establecer los valores de CL 96/50 de los parámetros contemplados en el artículo anterior, así como

BEST AVAILABLE COPY

FIDEL CARRERO ALAVA
INGENIERO CIVIL
REG. PROF. [illegible]

establecer los límites de coliformes fecales para acuacultura y los valores para temperaturas según las diversas situaciones.

Art. 27º.- Para el uso industrial, se deberán observar los diferentes requisitos de calidad correspondientes a los respectivos procesos.

Art. 28º— En los casos en los que se concedan derechos de aprovechamiento de aguas con fines múltiples, los criterios de calidad para el uso de aguas, corresponderán a los valores más restrictivos de cada referencia.

TITULO IV

CAPITULO I

De las Descargas de los Residuos Líquidos

Art. 29º.- Se prohíbe toda descarga de residuos líquidos a las vías públicas, canales de riego y drenaje o sistemas de recolección de aguas lluvias y acuíferos, de conformidad con lo dispuesto en el Código de la Salud, la Ley de Aguas y su Reglamento y la Ley para la Prevención y Control de la Contaminación Ambiental y el presente Reglamento.

Art. 30º— Las aguas provenientes de la explotación petrolífera y de gas natural, podrán ser reinyectadas previo su tratamiento.

Art. 31º— Se prohíbe la utilización de aguas naturales de las redes públicas o privadas y las de aguas lluvias, con el propósito de diluir los efluentes líquidos no tratados.

Art. 32º— El uso de aguas servidas para riego será reglamentado por el INERHI.

Art. 33º— Se prohíbe la infiltración de efluentes industriales no tratados.

Art. 34º— El IEOS fijará en cada caso las normas que deben cumplir las descargas a un cuerpo de agua o a un alcantarillado, previamente a la instalación, modificación, ampliación de una fuente contaminante, o después de un plazo de cumplimiento por parte de cualquier usuario, con sujeción a las disposiciones de este Reglamento y las demás vigentes sobre la materia.

Art. 35º— Cuando se trate de normas específicas de descargas para la protección de los recursos naturales, éstas deberán ser fijadas por el organismo competente previa consulta a la Comisión Técnica del Recurso respectivo.

Art. 36º— Las normas para descargas serán fijadas teniendo en cuenta los criterios de calidad establecidos para el uso o los usos asignados a las aguas.

En los tramos en donde se asignen usos múltiples, las normas para descargas se establecerán considerando los valores más restrictivos de cada uno de los parámetros fijados para cada uso.

El muestreo para el control de la calidad se hará por fuera de la zona de mezcla, la cual será determinada para cada situación específica por el IEOS, INERHI o DIGMER.

Art. 37º— Para el control del cumplimiento de las normas de descargas por parte de cada usuario, se deberá tener en cuenta que cuando la captación y la descarga se realicen en un mismo cuerpo de agua, en las mediciones se descontarán las cargas de los contaminantes existentes en el punto de captación.

Art. 38º— Para el caso de industrias que capten y descarguen en el mismo cuerpo receptor, la descarga se hará aguas arriba de la captación.

Art. 39º— Los usuarios que amplíen o modifiquen su producción, serán considerados como usuarios nuevos con respecto al control de las descargas que correspondan al grado de ampliación.

Art. 40º— Los responsables de todo sistema de alcantarillado deberán dar cumplimiento a las normas de descargas contenidas en este Reglamento.

Art. 41º— Los sedimentos, lodos y sustancias sólidas provenientes de sistemas de potabilización de aguas y de tratamiento de desechos y otras tales como cenizas, cachaza, bagazo y similares, no deberán disponerse en cuerpos de aguas superficiales, subterráneas, marinas, estuarinas o sistemas de alcantarillado; y para su disposición deberá cumplirse con las normas legales referentes a los residuos sólidos.

Art. 42.-- Para efectos del control de la contaminación del agua por la aplicación de agroquímicos, se tendrá en cuenta:

a) Se prohíbe la aplicación manual de agroquímicos dentro de una franja de tres (3) metros, y la aplicación aérea de los mismos dentro de una franja de treinta (30) metros, medidas en ambos casos desde las orillas de todo cuerpo de agua;

b) La aplicación de agroquímicos en cultivos que requieran áreas anegadas artificialmente, requerirá informe previo del Ministerio de Agricultura y Ganadería.

Además de las disposiciones contenidas en el presente Reglamento, se deberán cumplir las demás de carácter legal y reglamentario sobre la materia.

CAPITULO II

De las Normas de Descargas

Art. 43.— Toda descarga a un cuerpo de agua deberá cumplir, por lo menos, con las siguientes normas:

BEST AVAILABLE COPY

PARAMETROS	EXPRESADO COMO	VALOR MAXIMO PERMISIBLE
Potencial de Hidrógeno	pH	5 — 9
Temperatura	°C	< 35
Material flotante		Ausencia
Grasas y aceites		Ausencia
Sólidos suspendidos, domésticos o industriales		Remoción > 80% en carga
Demanda bioquímica de Oxígeno para desechos domésticos o industriales	DBO_5	Remoción > 80% en carga

Art. 41.— Toda descarga a un alcantarillado público deberá cumplir, por lo menos, con las siguientes normas:

PARAMETRO	EXPRESADO COMO	UNIDAD	LIMITE MAXIMO PERMISIBLE
Potencial de Hidrógeno	pH		5 — 9
Temperatura		°C	< 40
Acidos o bases que puedan causar contaminación; sustancias explosivas o inflamables			Ausencia
Sólidos sedimentables		ml/l	10
Sustancias solubles en hexano		mg/l	50
Sólidos suspendidos			Remoción > 80% en carga
Demanda bioquímica de Oxígeno	DBO_5		Remoción > 80% en carga
Caudal máximo	1,5 veces el caudal horario del sistema alcantarillado	promedio horario de alcantarillado	

Art. 45.— Las concentraciones para el control de la carga de las siguientes sustancias de interés sanitario, son:

SUSTANCIA	Expresada Como	Unidad	Concentración
Arsénico	As	mg/l	0,1
Bario	Ba	mg/l	5,0
Cadmio	Cd	mg/l	0,02
Cobre	Cu	mg/l	1,0
Cromo	Cr^{+6}	mg/l	0,5
Compuestos fenólicos	Fenol	mg/l	0,2
Mercurio	Hg	mg/l	0,01
Niquel	Ni	mg/l	2,0
Plata	Ag	mg/l	0,5
Plomo	Pb	mg/l	0,5
Selenio	Se	mg/l	0,5
Cianuro	CN^-	mg/l	1,0
Difenil policlorados	Concentración de agente activo	mg/l	No detectable
Mercurio orgánico	Hg	mg/l	No detectable
Tricloroetileno	Tricloroetileno	mg/l	1,0
Cloroformo	Extracto carbón cloroformo (ECC)	mg/l	0,1
Tetracloruro de carbono	Tetracloruro de carbono	mg/l	1,0
Dicloroetileno	Dicloroetileno	mg/l	1,0
Sulfuro de carbono	Sulfuro de carbono	mg/l	1,0
Otros compuestos organo-clorados (cada tipo)	Concentración de agente activo	mg/l	0,05
Compuestos organofosforados (cada tipo)	Concentración de agente activo	mg/l	0,1

BEST AVAILABLE COPY

Carbonatos	mg/l	0,1
Hidrocarburos	mg/l	20,0
Cloro activo	mg/l	0,5

Cuando los usuarios, aún cumpliendo con las normas de descarga, produzcan concentraciones en el cuerpo receptor que excedan los criterios de calidad par el uso o los usos asignados al agua, el IEOS, INERHI y DIGMER podrán exigirles valores más restrictivos en la descarga.

Art. 46.— La carga de control de una descarga que contenga las sustancias de que trata el artículo anterior, se calculará mediante la aplicación de las siguientes ecuaciones:

A = 0,0864 x Q x CDC
B = 0,0864 x Q x CV

En la cual es:

A = Carga de control, kg/d
Q = Caudal promedio de la descarga, l/s

B= Carga máxima en el efluente, kg/d) (al 10% de significación estadística)
CDC= Concentración de control, mg/l
CV= Concentración en el efluente, mg/l
0,0864= Factor de conversión

La carga máxima permisible (CMP) en el efluente será el menor de los valores entre A y B.

Art. 47.— Cuando la carga real en la descarga sea mayor que la carga máxima permisible, aquella se deberá reducir en condiciones que no sobrepase la CMP.

Art. 48.— Cuando el caudal promedio de la descarga se reduzca y por consiguiente la concentración de cualesquiera de las sustancias previstas en el Art. 45 se aumente, la CMP será la fijada en el Art. 46 de este Reglamento.

Art. 49.— Las industrias deberán disponer de sitios adecuados para caracterización y aforo de sus efluentes y proporcionarán todas las facilidades para que el personal técnico encargado del control, pueda efectuar su trabajo de la mejor forma posible.

Art. 50.— De acuerdo con su caracterización, toda descarga puntual o no puntual, además de las disposiciones de este Reglamento deberá cumplir con las normas de descarga que establezca el IEOS.

Art. 51.— Los residuos líquidos provenientes de hospitales, lavanderías y laboratorios industriales, camales, así como los provenientes de la preparación y utilización de agroquímicos, parasicidas y similares, deberán ser sometidos a un tratamiento adecuado, de acuerdo con las disposiciones de este Reglamento y aquellas que con fundamento en la Ley establezca el IEOS.

Art. 52.— El IEOS y la Comisión Ecuatoriana de Energía Atómica (CEEA) establecerán las normas que deberán cumplir las descargas de residuos líquidos radioactivos.

Art. 53.— Toda área de desarrollo urbanístico, turístico o industrial que no contribuya a sistema de alcantarillado público, deberá contar con instalaciones de recolección y tratamiento de residuos líquidos, conforme a las normas específicas que para cada caso señale el IEOS.

Art. 54.— Se prohibe la descarga de residuos líquidos no tratados, provenientes de embarcaciones, buques, naves u otros medios de transporte marítimo, fluvial o lacustre, en aguas superficiales dulces, marinas y estuarinas, en concordancia con las disposiciones del Código de Policía Marítima y los convenios internacionales establecidos.

La DIGMER fijará las normas de descarga para el caso contemplado en este artículo, teniendo en cuenta lo establecido en este Reglamento.

Art. 55.— Los puertos deberán contar con un sistema de recepción y manejo para los residuos líquidos provenientes de embarcaciones, buques, naves y otros medios de transporte. Dichos sistemas deberán ajustarse a las normas de descarga.

Art. 56.— Las disposiciones de este Reglamento también se aplicarán a:

a) Las explotaciones y explotaciones petroleras o de gas natural;
b) Plantas aviolas;
c) Plantas petroleras; y,
d) Los establos y granjas.

Art. 57.— Se prohibe todo tipo de descarga en:

a) Las cabeceras de las fuentes de agua;
b) Aguas arriba de la captación para agua potable de empresas o juntas administradoras, en la extensión que determinará el INERHI; y,
c) Aquellos cuerpos de agua que el IEOS, INERHI y DIGMER declaren total o parcialmente protegidos.

Art. 58.— El IEOS establecerá el sitio de toma de muestras para la evaluación de las concentraciones de las sustancias de interés sanitario en las descargas.

Art. 59.— Se prohibe el lavado de vehículos de transporte terrestre y aeronaves de fumigación en las orillas y en los cuerpos de agua, así como el de aplicadores manuales y aéreos de agroquímicos y otras sustancias tóxicas y sus envases, recipientes o empaques.

Art. 60.— Se prohibe la descarga de residuos líquidos sin tratar, provenientes del lavado de vehículos aéreos y terrestres, así como el de aplicadores manuales y aéreos, recipientes, equipos y envases que contengan o hayan contenido agroquímicos u otras sustancias tóxicas.

Art. 61.— Los usuarios que exploten, explotan, refinan, transforman, procesan, transportan o almacenen hidrocarburos o sustancias nocivas para la salud

BEST AVAILABLE COPY

y para los recursos bioacuáticos, deberán contar y aplicar un plan de contingencia para la prevención y control de derrames, el cual deberá ser aprobado por el organismo de control competente.

CAPITULO II

De los Registros de las Descargas

Art. 62.— Las personas naturales o jurídicas que sean titulares de concesiones de agua y eriglbien descargas de aguas residuales domésticas o industriales, deberán registrar tales descargas en las Jefaturas Provinciales del IEOS.

Art. 63.— El plazo para el registro de las descargas de aguas residuales provenientes de uso doméstico o industrial, vertidas a sistemas de alcantarillado o cauces naturales, será de cuatro (4) meses para descargas existentes y tres (3) meses para descargas futuras, contados a partir de la fecha de expedición de este Reglamento.

CAPITULO III

De la obtención de los permisos de descarga y de los planes de cumplimiento para usuarios

Art. 64.— Las personas naturales o jurídicas que realizan descargas de aguas residuales, tienen la obligación de presentar al IEOS, INERHI y DIGMER, según el caso, la caracterización de tales residuos líquidos de acuerdo con los parámetros, frecuencia y demás aspectos establecidos por dichos organismos en el plazo de dos meses contados, a partir de la fecha de expedición de este Reglamento; así como también un estudio de impacto ambiental para las situaciones previstas en el Art. 91 de este Reglamento, el mismo que deberá ser aprobado por uno de los tres organismos citados en este artículo.

Cada trimestre, el usuario deberá actualizar la caracterización de la descarga, la cual estará sujeta a verificación.

La caracterización de las descargas podrá ser realizada por el usuario o por profesionales y laboratorios calificados.

En base a la información proveniente del registro y de caracterización exigida al usuario, la cual deberá presentarse por duplicado y previa inspección técnica, el IEOS en coordinación con el INERHI y DIGMER determinarán si es procedente otorgar el permiso definitivo de descarga o si aún sea necesario llevar a cabo los planes de cumplimiento.

Art. 65.— En caso de no ser procedente el otorgamiento del permiso definitivo el IEOS en coordinación con el INERHI o la DIGMER, según el caso, exigirá a cualquier usuario, dentro del lapso que se señale, la presentación de planes de cumplimiento a que se refiere el presente capítulo.

En la resolución mediante la cual se haga la exigencia a que se refiere el presente artículo, se deberán fijar las normas de descarga que deben cumplirse, así como los plazos para presentar la primera etapa del plan de cumplimiento.

Art. 66.— En los planes de cumplimiento se exigirá, por lo menos el siguiente desarrollo:

Primera etapa: Elaboración del programa de ingeniería y cronograma de trabajo, presentación de acuerdo con los procedimientos establecidos por los organismos competentes.

Segunda etapa: Ejecución de las obras de acuerdo con el cronograma presentado y aprobado por los organismos competentes.

Tercera etapa: Verificación del cumplimiento de las normas de descarga.

Art. 67.— Los plazos que podrán concederse para el desarrollo de planes de cumplimiento, para cada una de las etapas, son los siguientes:

Primera etapa: Hasta nueve (9) meses.
Segunda etapa: Hasta doce (12) meses.
Tercera etapa: Hasta seis (6) meses.

Art. 68.— La información y documentación mínimas indispensables para que el IEOS en coordinación con el INERHI y DIGMER, autorice el desarrollo de la primera etapa de un plan de cumplimiento comprenderá:

a) Nombre o razón social de los interesados;

b) Ubicación de las descargas;

c) Número de puntos de descarga de los residuos líquidos;

d) Sistemas de control existentes, su ubicación y eficiencia de diseño;

e) Procesos de producción. Flujograma adjunto con sus puntos de descarga;

f) Producción actual, proyectos de expansión y proyecciones de producción a cinco (5) años;

g) Materias primas y otros suministros utilizados;

h) Cuerpos receptores de las descargas; y,

i) Concesiones otorgadas o identificación de la cuenta en la red de agua potable correspondiente.

Se tomará las medidas indispensables para que se mantenga el carácter confidencial de la información solicitada.

Art. 69.— En función de las etapas de los planes de cumplimiento, el IEOS podrá otorgar los siguientes permisos de descarga:

a) Permiso provisional; y,

b) Permiso definitivo.

El IEOS notificará a los organismos competentes sobre el otorgamiento de tales permisos.

Art. 70.— Una vez aprobada la primera etapa de un plan de cumplimiento, el IEOS otorgará

BEST AVAILABLE COPY

el permiso provisional de descarga, el cual estará vigente durante el tiempo señalado para el desarrollo de las siguientes etapas.

El permiso provisional de descarga podrá ser suspendido en cualquier tiempo, si no se cumplen las características señaladas para el desarrollo de las distintas etapas.

Art. 71.— Cuando los usuarios no desarrollen los planes de cumplimiento en los términos y bajo las condiciones que los caracterizan, el IEOS, INERHI y DIGMER podrán imponer las sanciones legales a que haya lugar.

Art. 72.— Con el objeto de vigilar y verificar el normal desarrollo de los planes de cumplimiento y operación de sistemas de control, así como ajustes, según el caso, el IEOS, INERHI y DIGMER efectuarán inspecciones periódicas a las empresas o lugares que considere convenientes. La oposición por parte de los usuarios, a tales inspecciones, dará lugar a la aplicación de las sanciones legales pertinentes.

Art. 73 — Los usuarios que no dispongan de área apropiada para la construcción de plantas de tratamiento de los residuos líquidos y que no puedan cumplir con las normas de descarga, deberán reubicar sus instalaciones, salvo que un estudio de impacto ambiental aprobado por el IEOS, INERHI y DIGMER, con el financiamiento del usuario demuestre que la reubicación no es indispensable por cuanto la actividad que se realiza no representa riesgo para la salud humana y los recursos naturales.

Art. 74.— Las empresas que recolectan, transporten y dispongan residuos líquidos provenientes de terceros, deberán cumplir con las normas de descarga y obtener el permiso correspondiente. El productor de los residuos líquidos no queda eximido de la presente disposición y deberá responder conjunta y solidariamente con las empresas que efectúen las acciones referidas.

El IEOS fijará al usuario, en cada caso, los requisitos y condiciones necesarias para la obtención del respectivo permiso de descarga a que hace referencia este artículo.

Art. 75.— En las providencias mediante las cuales el IEOS otorgue los permisos definitivos o provisionales de descarga, deberá advertirse claramente que los usuarios no podrán hacer uso de ellas, sin haber obtenido antes el permiso sanitario de funcionamiento expedido por el Ministerio de Salud.

Art. 76.— Cuando se presente modificaciones sustanciales de las condiciones bajo las cuales se iniciaron los trámites para obtener el permiso de descarga o variaciones en la información suministrada, el usuario deberá dar aviso de inmediato y por escrito al IEOS, incluyendo los planos y diagramas correspondientes.

Art. 77 — Toda modificación ya sea en el proceso de producción o en el sistema de tratamiento por parte de un usuario, que incida sobre la descarga deberá ser sometida a previa aprobación del IEOS.

Art. 78.— Las solicitudes para renovación o prórroga del permiso de descarga, deberán ser presentadas ante el IEOS dentro del primer trimestre del último año de vigencia. La tramitación correspondiente se adelantará antes de que se produzca el vencimiento del permiso respectivo.

Dentro de los treinta (30) días siguientes a la ejecutoria de la resolución, mediante la cual se renueve o prorrogue un permiso de descarga, el IEOS procederá a remitir al Ministerio de Salud, la documentación pertinente, a fin de que se tramite la renovación o prórroga del permiso sanitario de funcionamiento a que haya lugar.

Art. 79.— Con sesenta (60) días, por lo menos, de anticipación a la fecha en que expire la vigencia de un permiso provisional de descarga el usuario deberá tramitar ante el IEOS el permiso definitivo de descarga.

Dentro de los quince (15) días siguientes a la ejecutoria de la resolución mediante la cual se otorgue el permiso definitivo, el IEOS procederá a remitir al Ministerio de Salud la documentación pertinente, a fin de que se tramite el permiso sanitario de funcionamiento.

Art. 80.— Los siguientes usuarios, entre otros, también deberán obtener los permisos de descarga y permisos sanitarios de funcionamiento correspondientes:

a) Todas las Municipalidades;

b) Los responsables de descargas líquidas no puntuales;

c) Los responsables de descargas líquidas provenientes del lavado de instalaciones, naves aéreas de fumigación, lavaderos y lubricadoras automotrices y estaciones de expendio de combustibles;

d) Los responsables de descargas líquidas provenientes de sitios de disposición final de residuos sólidos;

e) Los responsables de descargas líquidas provenientes de puertos aéreos, marítimos, fluviales y lacustres, así como de clubes náuticos;

f) Los responsables de descargas líquidas provenientes de cuarteles y bases de las fuerzas militares que no estén conectadas a la red de alcantarillado público;

g) Los responsables de descargas líquidas provenientes de almacenamiento de materias primas; y,

h) Las personas naturales o jurídicas de derecho público o privado, que recolecten, transporten, traten o dispongan residuos líquidos provenientes de terceros.

Art. 81.— En las resoluciones mediante las cuales el IEOS otorgue permisos provisionales de descarga a usuarios nuevos o existentes que de-

BEST AVAILABLE COPY

sarrollen ampliaciones o modificaciones en los términos de este Reglamento, deberá advertirse claramente que los usuarios no podrán hacer uso de ellos sin haber obtenido antes el permiso sanitario de funcionamiento, expedido por el Ministerio de Salud.

Art. 82.— Para los casos de modificaciones o ampliaciones efectuadas en las descargas por un usuario existente, éstas se harán constar en los respectivos permisos.

Art. 83.— La vigencia del permiso provisional de descarga abarcará el período necesario para ejecutar la modificación o ampliación correspondiente.

Art. 84.— El permiso definitivo de descarga tendrá una vigencia de tres (3) años.

CAPITULO IV

De la modificación de normas de descarga y criterios de calidad

Art. 85.— Las normas de descarga y los criterios de calidad señalados en este Reglamento, constituyen las disposiciones básicas para los efectos de control de las descargas y de asignación de usos del recurso agua. El IEOS, INERHI y la DIGMER podrán proponer la modificación, restricción o ampliación de las normas de descarga y criterios de calidad, de conformidad con el literal c) de la Ley para la Prevención y Control de la Contaminación Ambiental, previo al estudio técnico justificativo pertinente.

Art. 86.— Cuando para conjurar situaciones de alto riesgo para la salud, sea necesario modificar, incluir, ampliar o restringir las normas de descarga o los criterios de calidad de este Reglamento, el Ministerio de Salud podrá resolver lo pertinente mediante acuerdo, previa consulta con carácter urgente al IEOS, INERHI y DIGMER.

TITULO V

CAPITULO UNICO

De las tasas

Art. 87.- La utilización directa o indirecta de los ríos, arroyos, lagos y aguas subterráneas para introducir en ellos efluentes tratados de cualquier origen, se sujetará al pago de tasas, las que serán pagados semestralmente en los términos de este Reglamento.

Art. 88.- Los usuarios deberán informar previamente al IEOS, INERHI o DIGMER, los períodos en los que no harán descargas.

Art. 89.— La tasa ordinaria (TO) se calculará mediante la aplicación de las siguientes ecuaciones:

$$TO = CC \times SM_1 + TOX \times SM_2$$

$$CC = \frac{2\,DBO_5 + DOO + SS}{3}$$

$$SM_1 = A \times SMD$$

$$SM_2 = B \times SMD \times P$$

En las que:

CC = Carga combinada, en kg/d

TO = Tasa retributiva ordinaria diaria, en sucres

DBO_5 = Demanda bioquímica de oxígeno a cinco (5) días, en kg/d

DQO = Demanda química de oxígeno, en kg/d

SS = Sólidos suspendidos, en kg/d

TOX = Sumatoria de sustancias de interés sanitario, en kg/d

SM1 = Factor que permite expresar el costo del programa de control por unidad de carga combinada, en sucres/kg.

SM3 = Factor que permite expresar el costo del programa de control de las sustancias de interés sanitario, en sucres/kg.

SMD = Salario mínimo diario vigente en la fecha de evaluación.

P = Factor que prevé la acumulación de sustancias de interés sanitario en el recurso. Se considera igual a 20.

$$A = \frac{CACC}{TCC \times 365 \times SMD}, \text{ d/kg}$$

$$B = \frac{CATOX}{TTOX \times 365\ SMD}$$

CACC = Costo administrativo y de investigación del programa de control de los parámetros de la carga combinada, en sucres/año.

TCC = Total de carga combinada vertida al recurso dentro del área de jurisdicción, en kg/año, descontando la carga que existe en el punto de captación del recurso, siempre y cuando la descarga ocurra en el mismo cuerpo de agua.

BEST AVAILABLE COPY

CATOX = Costo administrativo y de investigación del programa de control de sustancias de interés sanitario, en sucres/año.

TTOX = Total de sustancias de interés sanitario descargadas al recurso dentro del área de jurisdicción en kg/año, descontando la carga existente en el punto de captación del recurso, siempre y cuando la descarga ocurra en el mismo cuerpo de agua.

SMD = Salario mínimo diario vigente en la fecha de evaluación.

Para la aplicación de las ecuaciones se tomará como base la caracterización promedio de la descarga en el semestre inmediatamente anterior, teniendo en cuenta los períodos en que no se produjo, siempre y cuando haya habido notificación previa por parte del usuario.

Art. 90 — En ningún caso el pago de la tasa retributiva exonera a los usuarios del cumplimiento de las obligaciones relativas a las normas de descarga, ni de la aplicación de las medidas preventivas, de seguridad o de las sanciones a que haya lugar, de conformidad con este Reglamento.

Art. 91 — La tasa retributiva deberá cancelarse en el trimestre siguiente a la fecha de ejecutoria de la resolución que la establece. En caso contrario, se aplicarán las sanciones a que haya lugar.

Art. 92.— EL IEOS, el INERHI y la DIGMER recaudarán el producto de las tasas retributivas, el mismo que deberá ser depositado en una cuenta especial de cada institución, el cual servirá para financiar los programas de control.

TITULO VI

CAPITULO I

De los Estudios de Impacto Ambiental

Art. 93.— El IEOS, INERHI y DIGMER, según el caso, exigirán a las personas naturales o jurídicas responsables de las actividades indicadas en el siguiente artículo, la presentación de un estudio de impacto ambiental, cuando ellas, puedan causar efectos nocivos para la salud o sean susceptibles de producir deterioro ambiental. La aprobación del estudio de impacto ambiental es requisito previo el otorgamiento de cualquier permiso de descarga.

Art. 94.— Se exigirá la presentación de un estudio de impacto ambiental, en las siguientes situaciones:

a) Cuando las descargas contengan sustancias de interés sanitario y presenten alto riesgo para la salud humana;

b) En proyectos de generación de energía y embalses de uso múltiple;

c) En complejos de exploración y explotación de los recursos naturales no renovables;

d) En proyecto de trasvase de aguas;

e) En los proyectos de terminales aéreos, marítimos y fluviales;

f) En obras viales que impliquen grandes movimientos de tierra;

g) En exploraciones y explotaciones de cauces y de suelos y subsuelos marinos;

h) En nuevos asentamientos humanos y parques industriales; y

i) En proyectos de explotación forestal.

Art. 95.— El estudio de impacto ambiental deberá contener como mínimo los siguientes puntos:

a) Descripción del proyecto;

b) Información sobre las características reales del recurso;

c) Información detallada de las actividades del proyecto;

d) Predicción de las alteraciones que se ocasionarían sobre el recurso;

e) Medidas correctivas que se adoptarán para minimizar el impacto.

f) Manejo de situaciones de emergencia;

g) Aspectos físicos y de carácter económico y social que sean consecuencia de la actividad

h) Conclusiones y recomendaciones.

El IEOS, INERHI y DIGMER podrán establecer requisitos adicionales derivados de las características del proyecto.

CAPITULO II

De los Métodos de Análisis y de la Toma de Muestras

Art. 96. La toma de muestras y los análisis de aguas deberán hacerse en base a las normas del INEN y a la falta de éstas, se regirán a lo establecido en los Métodos Estándar para el Examen de Aguas y Aguas Servidas preparados por la APHA, AWWA y WPCF de los Estados Unidos de América.

Art. 97.— Las muestras de agua que sirvan para determinar la calidad del recurso o para verificar el cumplimiento de las normas de descargas por parte del usuario, deberán ser tomadas por fuera de la zona de mezcla y de forma que sean representativas.

TITULO VI

CAPITULO I

De la Vigilancia y el Control

Art. 98.— El IEOS, INERHI y DIGMER ejercerán la vigilancia y el control general del aprovechamiento

BEST AVAILABLE COPY

y tomarán las medidas de prevención y correctivas para dar cumplimiento a las disposiciones de este Reglamento. Los citados organismos podrán solicitar la colaboración de otras entidades públicas o privadas para el control del uso del recurso agua.

Art. 99.— Las instalaciones de los usuarios podrán ser visitadas en cualquier momento por parte de funcionarios del IEOS, INERHI o DIGMER, previamente identificados para tal propósito, a fin de tomar muestras de sus descargas e inspeccionar las obras o sistemas de captación y de control de descargas.

Art. 100.— Cuando el caso lo amerite el IEOS, INERHI o DIGMER exigirán a los usuarios caracterizar sus descargas y reportar los resultados a la entidad solicitante, la que deberá especificar los parámetros a medir, la frecuencia y métodos de muestreo y análisis.

Art. 101.— A los usuarios cuyas descargas presenten riesgos para la salud y a los usuarios que almacenen, procesen o transporten hidrocarburos u otras sustancias peligrosas para la salud o para los recursos naturales renovables, el Ministerio de Salud, IEOS, INERHI o DIGMER les exigirán la presentación y desarrollo de un plan de contingencias.

Art. 102.— Los usuarios cuyas descargas lleguen a una planta de tratamiento de residuos líquidos, que sea utilizada en común deberán dar aviso a la entidad encargada de la operación de la planta, cuando con una descarga ocasional o accidental puedan perjudicar a su operación.

Art. 103.— Todo usuario deberá dar aviso al IEOS, INERHI y DIGMER cuando se presenten las siguientes situaciones:

a) Necesidad de parar en forma parcial o total un sistema de control de descargas, para el mantenimiento rutinario periódico que dure más de veinticuatro (24) horas;

b) Fallas en los sitemas de control de descarga cuya reparación requiera más de veinticuatro (24) horas;

c) Emergencia o accidentes que impliquen cambios sustanciales en la calidad o cantidad de la descarga; y,

d) Cuando las descargas contengan sustancias consideradas de interés sanitario.

Art. 104.— Cuando en un cuerpo de agua se produzcan descargas accidentales, por fuerza mayor o caso fortuito y que originen situaciones de emergencia, el organismo de control competente exigirá que el usuario causante realice las acciones pertinentes para controlar tales situaciones y solicitará a la autoridad respectiva la imposición de sanciones cuando haya lugar.

Art. 105.— Cuando el IEOS, INERHI y DIGMER realicen un muestreo para verificar la calidad de una descarga, deberán informar sobre los resultados obtenidos al usuario respectivo, conjuntamente con las recomendaciones a que haya lugar.

Art. 106.— Para comprobar que el usuario cumple con las normas de descarga, coordinadamente el IEOS, INERHI y DIGMER realizarán controles de los siguientes aspectos:

a) Caracterización de las descargas;

b) Evaluación de la eficiencia de la planta de tratamiento de residuos líquidos.

Art. 107.— Cuando mediante los controles a que se refiere el artículo anterior se constate que un usuario no cumple con las normas de descarga que le han sido fijadas, se procederá de la siguiente manera:

a) Si el incumplimiento obedece a fallas en el diseño o en el manejo u operación de los sistemas de tratamiento, el permiso de descarga se podrá prorrogar por el tiempo que según estudio técnico requieran los ajustes.

b) Cuando el incumplimiento no aparezca plenamente justificado, la prórroga a que se refiere el presente artículo, no excluye la aplicación de las sanciones a que haya lugar.

Art. 108.— El Ministerio de Salud Pública a través del Instituto Ecuatoriano de Obras Sanitarias (IEOS); el Ministerio de Agricultura y Ganadería a través del Instituto de Recursos Hidráulicos (INERHI) y el Ministerio de Defensa Nacional por intermedio de la Dirección General de Marina Mercante y del Litoral (DIGMER), en lo no previsto por este Reglamento dictarán las normas técnicas que deberán ser cumplidas por las personas naturales y/o jurídicas con carácter público o privado, cuyas actividades generen contaminación de las aguas.

CAPITULO II

De las medidas de orientación, educación y promoción

Art. 109.— Los Ministerios, las Municipalidades y otras Instituciones Públicas o Privadas, dentro de sus correspondientes ámbitos de competencia, elaborarán y pondrán en práctica los planes, campañas y otras actividades tendientes a la educación y difusión de lo que es el problema de la contaminación de las aguas significa, sus consecuencias y, en general, los medios para prevenirla y controlarla.

Art. 110.— El Ministerio de Educación, Cultura y Deportes, incluirá en sus programas educativos la enseñanza obligatoria de los aspectos elementales del origen y prevención de la contaminación de las aguas.

Art. 111.— Las Universidades y Escuelas Politécnicas y el Consejo Nacional de Ciencia y Tecnología (CONACYT), promoverán y auspiciarán la investigación científica y tecnológica relacionada con la prevención de la contaminación de las aguas y la forma de controlarla, incluyendo dentro de sus programas de estudio las prácticas y cursos correspondientes, así como la difusión en tesis, revistas y otros medios, de las recomendaciones a que haya lugar.

BEST AVAILABLE COPY

TITULO VII

CAPITULO I

De las sanciones

Art. 112 — El Ministerio de Salud Pública, a través de las Comisarías de Salud de las Direcciones Provinciales de Salud, previo informe técnico del IEOS, está facultado para establecer e imponer sanciones a las infracciones que se produjeren, de conformidad con lo establecido en los artículos 25, literal c) y 26 de la Ley de Prevención y Control de la Contaminación Ambiental y su Reglamento General, sin perjuicio de la aplicación de sanciones establecidas en otras leyes y reglamentos, evitándose en todo caso la duplicación de sanciones por la misma infracción.

Se establecerán sanciones que puedan llegar incluso a la clausura temporal o definitiva de fábricas, establecimientos o fuentes productoras de contaminación de las aguas, que con su actividad violen las disposiciones de este Reglamento, hasta tanto se adopten las medidas para adecuarse a ellas.

Art. 113.— Contra las resoluciones que se dicten con motivo de la aplicación de este Reglamento, se concederán los recursos de reconsideración y apelación, con sujeción al trámite establecido en el Código de la Salud, Ley de Aguas y Reglamento y el Código de Policía Marítima.

CAPITULO II

De la acción popular

Art. 114 — Se concede acción popular para denunciar ante la autoridad competente todo hecho que contamine las aguas, en los términos de la Ley de Prevención y Control de la Contaminación Ambiental y este Reglamento.

Art. 115.— La acción popular para denunciar la existencia de alguna de las fuentes de contaminación a que se refiere este Reglamento, se ejercitará por cualquier persona o entidad ante el Ministerio de Salud Pública o ante las direcciones provinciales de salud y ante el IEOS, INERHI o DIGMER, precisando las razones de la queja y señalando los datos necesarios que permitan localizar el nombre y domicilio del denunciante. Estas denuncias serán objeto del estudio técnico correspondiente por parte del IEOS.

El presente Reglamento entrará en vigencia desde la fecha de publicación en el Registro Oficial.

Comuníquese.— En Quito, a 18 de mayo de 1989.

f.) Dr. Rodrigo Guerrero, Ministro de Salud, Encargado.

La presente es fiel copia del original.— Lo certifico en Quito, a 29 de mayo de 1989.

f.) Lcdo. Gonzalo Falconí, Secretario General.

Nº 0036

LA SUBSECRETARIA REGIONAL DE FINANZAS Y CREDITO PUBLICO DEL LITORAL,

Considerando:

Que, mediante Nº BID/ESPOL II 240-89 de 7 de marzo de 1989 suscrito por el Ingeniero Galo Botancourt Sánchez, Director Ejecutivo, a nombre y en representación de la Escuela Superior Politécnica del Litoral, Unidad Ejecutora Proyecto BID—ESPOL II, elevó a esta Subsecretaría una solicitud tendiente a obtener el correspondiente Acuerdo de Liberación Definitivo a importaciones realizadas.

Y, de conformidad con el Art. 40, numeral 4to de la Ley Orgánica de Aduanas, el Decreto Legislativo 88, publicado en el Registro Oficial Nº 211 de mayo 14 de 1982, el Decreto Supremo 1038-A, publicado en el Registro Oficial Nº 400 de agosto 16 de 1977, el Decreto Legislativo 136, publicado en el Registro Oficial Nº 180 de junio 8 de 1963 y el Acuerdo Ministerial Nº 335 de junio 2 de 1987, publicado en el Registro Oficial Nº 03 de junio 9 de 1987.

Acuerda:

Autorizar a la Administración de Aduanas del I Distrito — Guayaquil despache libre del pago del 05% de los Derechos Arancelarios 1 (Un) cartón conteniendo 1 (Un) congelador de pulpas marca Dole de seis estaciones completo con sus respectivos accesorios con un peso bruto total de 1.315,13 (Un mil trescientos quince 43/100 kilos) y un valor C&F de US $ 18.908,00 (Diez y ocho mil novecientos 00/100 dólares), al amparo del Permiso de Importación Nº 02-8-0003 de 4 de mayo de 1981, Autorización Ministerial Nº 153 de 6 de marzo de 1988 concedida por esta Subsecretaría Región I, llegados en el Vapor Genevieve Lykes bajo Registro Aduanero Nº 1105 de 19 de diciembre de 1988. Importación consignada a Escuela Superior Politécnica del Litoral, Unidad Ejecutora del Proyecto BID/ESPOL II.

Comuníquese — Dado en Guayaquil, a 28 de marzo de 1989.

f.) Subsecretario Regional de Finanzas y Crédito Público del Litoral.

Certifico: Es igual a su original.

f.) Ing. Com. Dalia Rosero de Ortiz, Director Técnico Regional.

BEST AVAILABLE COPY

132

Appendix E. Quito Law

Ordenanza Nº 2965

Visto el Oficio 1185 enviado por el señor Director de Higiene de 13 de julio de 1992; y,

CONSIDERANDO:

QUE, debido a inconvenientes de origen tècnico y logistico es necesario considerar la reforma a la disposiciòn transitoria, de la Ordenanza que establece la Prevenciòn y Control de la Contaminaciòn producida por las descargas liquidas industriales y las emisiones hacia la atmòsfera.

En uso de las atribuciones que le confiere la Ley,

E X P I D E:

LA SIGUIENTE ORDENANZA QUE REFORMA LA PRIMERA DISPOSICION TRANSITORIA DE LA NO. 2910 DE LA PREVENCION Y CONTROL DE LA CONTAMINACION PRODUCIDA POR LAS DESCARGAS LIQUIDAS INDUSTRIALES Y LAS EMISIONES HACIA LA ATMOSFERA.

Art. 1 Sustituyese la disposiciòn transitoria Primera en los siguientes tèrminos:

A partir de la fecha de vigencia de esta Ordenanza las Industrias y todas las actividades sometidas a las disposiciones de la presente Ordenanza presentaràn los registros y programas de instalaciòn de sistemas de tratamiento de agua residuales y controles de emisiones a la Atmòsfera , hasta el 29 de septiembre de 1992 y los planes de cumplimiento hasta el 29 de junio de 1993, a la Direcciòn de Municipal de Higiene y Medio Ambiente para su aprobaciòn.

Ordenanza Nº 2910

EL I. CONCEJO MUNICIPAL DE QUITO

Visto el Informe No. IC-92-04, de 8 de enero de 1992, de la Comisión de Higiene; y,

CONSIDERANDO:

Que, la contaminación ambiental ha tomado características de alta peligrosidad para la salud y bienestar de los habitantes del Cantón;

Que, según el Art. 164 lit j) de la Ley de Régimen Municipal, al Municipio le compete velar por el fiel cumplimiento de las normas legales sobre Saneamiento Ambiental; y,

Que, de acuerdo a lo previsto por el num. 14 del Art. 64 de la misma Ley, le compete al Concejo aprobar las especificaciones y normas a que debe sujetarse el uso de los servicios de alcantarillado y más servicios a cargo del Municipio;

En uso de las atribuciones que le confiere la Ley,

E X P I D E:

LA SIGUIENTE ORDENANZA PARA LA PREVENCION Y CONTROL DE LA CONTAMINACION PRODUCIDA POR LAS DESCARGAS LIQUIDAS INDUSTRIALES Y LAS EMISIONES HACIA LA ATMOSFERA

Art. 1 Las normas de esta Ordenanza, se aplicarán:

BEST AVAILABLE COPY

a) A las personas naturales o jurídicas cuyas actividades industriales o comerciales produzcan u originen descargas líquidas a la red pública de alcantarillado o a los cursos de agua; y,

b) A las personas naturales o jurídicas cuyas actividades produzcan emisiones de partículas o gases contaminantes a la atmósfera producidas por fuentes fijas o móviles.

Art. 2 Todo establecimiento comercial e industrial que se encuentre en cualquiera de los casos previstos en el Art. anterior, solicitará la autorización de funcionamiento, según lo previsto por el Art. 15, num. 8 de la Ley de Régimen Municipal.

La Municipalidad verificará anualmente el cumplimiento de los requisitos xigidos en esta Ordenanza. Para esta verificación la Dirección Municipal de Higiene y Medio Ambiente constatará el cumplimiento de las normas de esta Ordenanza y de las demás vigentes sobre prevención y control de la contaminación y expedirá el certificado de control de la calidad ambiental.

Art. 3 Toda descarga líquida proveniente de actividades industriales o comerciales, deberá ser vertida en la red pública de alcantarillado.

Solamente si fuere imposible el acceso a la red pública y previa autorización de la Dirección Municipal de Higiene y Medio Ambiente, las descargas líquidas podrán ser vertidas a los cursos de agua.

BEST AVAILABLE COPY

Art. 4 Toda descarga liquida proveniente de actividades industriales o comerciales antes de ser vertida a la red de alcantarillado, o a los cursos de agua, si fuere del caso, deberà ser tratada hasta que se sujete a las especificaciones minimas establecidas por la autoridad competente.

Prohibese la descarga de residuos liquidos que no cumplan con las especificaciones establecidas por la autoridad competente.

Art. 5 Cuando las descargas liquidas que se viertan en las redes de alcantarillado o en los cursos de agua, si fuere del caso, superen durante dos periodos mensuales de medición continua el ciento por ciento del nivel màximo permitido, se suspenderà el permiso de funcionamiento, hasta que se compruebe que se han introducido los correctivos para que los residuos sean tratados y cumplan las especificaciones establecidas por la autoridad competente.

Art. 6 En caso de reincidencia, la Dirección Municipal de Higiene y Medio Ambiente podrà ordenar la reubicación del establecimiento comercial o industrial.

Art. 7 Cuando los niveles de contaminación atmosfèrica detectados por el sistema de la red Municipal del Monitoreo de Calidad del Aire o por otros medios tècnicos, determinen indices superiores al ciento por ciento del nivel màximo de la norma a causa de fuentes mòviles, la Dirección Municipal de Higiene y Medio Ambiente procederà a restringir, dentro del limite urbano, el uso de vias para el tránsito de vehiculos durante los horarios

BEST AVAILABLE COPY

establecidos según las necesidades tècnicas determinadas por la misma Direcciòn.

Art. 8 El Municipio establecerà sistemas de medición y mantendrà controles de los niveles de contaminaciòn atmosfèrica causada por fuentes fijas artificiales con excepciòn de las chimeneas de uso domèstico, segùn las normas de calidad del aire establecidas por la autoridad competente.

Art. 9 Cuando los niveles de contaminaciòn por partículas o emisiones gaseosas superen el ciento por ciento de la norma de emisiòn adoptada durante dos periodos mensuales consecutivos de medición, se suspenderà el permiso de funcionamiento, hasta que se compruebe que se han introducido los correctivos tècnicos necesarios para asegurar que las emisiones a la atmòsfera estèn dentro de los niveles permitidos.

En caso de reincidencia, la Direcciòn Municipal de Higiene y Medio Ambiente podrà ordenar la reubicaciòn del establecimiento o establecimientos industriales o comerciales.

Art. 10 La Direcciòn Municipal de Higiene y Medio Ambiente divulgarà periòdicamente por medios masivos los indices de contaminaciòn registrados en el Cantòn Quito, dando sugerencias a la poblaciòn sobre las precauciones que deberà tomar para el cuidado de la salud. Asi mismo divulgarà otras medidas destinadas al control ecològico.

Art. 11 A màs de las facultades y atribuciones previstas en esta Ordenanza, la Dirección Municipal de Higiene y Medio Ambiente ejercerà las que le correspondan a la Administración Municipal en lo relativo a la prevención y control de la contaminación ambiental según lo previsto en las normas vigentes y en virtud de la delegación hecha conforme a la ley por las autoridades de salud.

DISPOSICIONES TRANSITORIAS

PRIMERA.- A partir de la fecha de vigencia de esta Ordenanza, las industrias y todas las actividades sometidas a las disposiciones de la presente ordenanza, en el plazo de seis meses presentaràn el programa y plan de instalación de sistemas de tratamiento de agua residuales y controles de emisiones a la atmòsfera a la Dirección Municipal de Higiene y Medio Ambiente, para su aprobación . Esta Dirección fijarà los plazos de instalación según la clasificación establecida en el Reglamento. En ningùn caso este plazo serà mayor de un año.

SEGUNDA.- El Alcalde de la ciudad de Quito, en el plazo de treinta dias, a partir de la aprobación de la presente Ordenanza dictarà el Reglamento de aplicación.

DADA, en la Sala de Sesiones del I. Concejo Municipal de Quito, el 27 de enero de 1992.

6

Ordenanza Nº 2010

EL I. CONCEJO MUNICIPAL DE QUITO

Alfonso Laso Bermeo
VICEPRESIDENTE DEL
I. CONCEJO

Lcdo. Gustavo Saltos Saltos
SECRETARIO GENERAL DEL
I. CONCEJO

CERTIFICADO DE DISCUSION:

El infrascrito Secretario General del I. Concejo Municipal de Quito, certifica que la presente Ordenanza fue discutida y aprobada en sesiones de 13 y 27 de enero de 1992.

Lcdo. Gustavo Saltos Saltos
SECRETARIO GENERAL DEL I. CONCEJO

ALCALDIA DEL CANTON.- Quito, 29 de enero de 1992.

E J E C U T E S E :

Rodrigo Paz Delgado
ALCALDE DE
SAN FRANCISCO DE QUITO

Lcdo. Gustavo Saltos Saltos
SECRETARIO GENERAL DEL
I. CONCEJO

MSI.

ES FIEL COPIA DEL ORIGINAL
LO CERTIFICO

EL SECRETARIO GENERAL

BEST AVAILABLE COPY

Rodrigo Paz Delgado, Alcalde de San Francisco de Quito, en uso de sus atribuciones legales y en cumplimiento de la Segunda Disposición Transitoria de la Ordenanza 2910 del 27 de enero de 1992.

EXPIDE

EL REGLAMENTO DE APLICACION DE LA ORDENANZA NO.2910 PARA LA PREVENCION Y CONTROL DE LA CONTAMINACION PRODUCIDA POR LAS DESCARGAS LIQUIDAS INDUSTRIALES Y LAS EMISIONES HACIA LA ATMOSFERA.

CAPITULO I - DE LAS DEFINICIONES

Art.1.- Para la aplicación e interpretación de este Reglamento, se tendrán en cuenta las siguientes definiciones:

CARACTERIZACION DE DESCARGAS CONTAMINANTES, procedimiento sistemático por el cual se establece el rango de variación en la descarga de contaminantes líquidos y gaseosos (concentración y caudal) y la magnitud de los valores más persistentes y representativos.

CERTIFICADO DE CONTROL DE CALIDAD AMBIENTAL, documento que otorga la Dirección Municipal de Higiene y Medio Ambiente como constancia del cumplimiento de las disposiciones de la Ordenanza 2910 y de este Reglamento.

CONDICIONES DE DESCARGA, ver Normas de Calidad.

EMISION, lanzamiento de materiales al aire, ya sea por un foco localizado (emisión primaria) o como resultado de reacciones fotoquímicas o cadena de reacciones iniciadas por un proceso fotoquímico (emisión secundaria).

ESTABLECIMIENTO, las plantas industriales y los locales de comercio o de prestación de servicios que generen residuos sólidos, gases

BEST AVAILABLE COPY

y aguas residuales capaces de contaminar el suelo y la atmósfera y los cuerpos de agua; o que utilicen sustancias tóxicas, hidrocarburos o sus derivados y otros compuestos químicos capaces de causar daño a las instalaciones de alcantarillado público o que sean peligrosos para la salud humana. Se incluyen las mecánicas y vulcanizadoras. Las obligaciones impuestas al establecimiento, se entienden atribuidas a su propietario.

FUENTE FIJA DE CONTAMINACION DEL AIRE, aquella que emite o es susceptible de producir contaminación del aire en un lugar fijo o inamovible.

FUENTE MOVIL DE CONTAMINACION DEL AIRE, aquella que habilitada para desplazarse pueda generar o emitir contaminantes.

HOJA DE SEGURIDAD DE PRODUCTOS QUIMICOS, documento en el cual está consignada información sobre la composición química, aspectos toxicológicos, normas de seguridad para el manejo e impacto ambiental de los productos utilizados en procesos.

IMPACTO AMBIENTAL, efecto de una acción natural o proyectada por el hombre sobre los recursos naturales, las condiciones económicas, sociales y culturales.

INFORME DE INSPECCION, documento en el cual se hace constar, en forma detallada, los resultados del examen a un Establecimiento a base de observaciones en el sitio, constatación de la existencia y veracidad de registros, evaluación del proceso de tratamiento de desechos y de medición de contaminantes ambientales.

INMISION, concentración de contaminantes en la atmósfera a nivel del suelo o de cualquier receptor (vegetación, edificios), de manera temporal o permanente.

142

BEST AVAILABLE COPY

NORMAS DE CALIDAD, valores referenciales establecidos por la autoridad competente que señala la concentración máxima o el rango permisible de variación para los parámetros de calidad de los bienes de uso público (aire, agua) o de las descargas de aguas residuales o gases.

PLAN DE CUMPLIMIENTO, programa mediante el cual se indican las acciones a seguir y los plazos necesarios para asegurar que (~~las fuentes de contaminación ambiental~~ los establecimientos) puedan cumplir con las normas de calidad requeridas para las descargas de aguas residuales o gases.

REGISTRO, documento en el que constan datos básicos de identificación, localización o mediciones de contaminantes del Establecimiento, para fines de control posterior.

REPRESENTANTE LEGAL, persona natural que ejerce la representación legal de una persona jurídica.

REVOCATORIA DEL CERTIFICADO DE CONTROL DE CALIDAD AMBIENTAL, es la pérdida de vigencia del Certificado que da lugar a que el establecimiento deje de funcionar, sin que pueda reabrirse durante el tiempo de tres meses y, una vez transcurrido este tiempo, solamente si se han adoptado los correctivos y medidas que aseguren el cumplimiento de las normas.

SISTEMA DE CONTROL, conjunto de obras, equipos o instalaciones efectuadas con el fin de garantizar que las descargas de aguas residuales y de gases cumplan con las Normas de Calidad establecidas por la autoridad competente.

BEST AVAILABLE COPY

SUSPENSION DEL CERTIFICADO DE CONTROL DE CALIDAD AMBIENTAL, el retiro temporal de la autorización para operar, por lapsos no inferiores a dos días ni superiores a ocho, según la gravedad de la infracción.

CAPITULO II - AMBITO DE APLICACION

Art.2.- El presente reglamento establece las normas y procedimientos para la aplicación de la ordenanza 2910 sobre el control de la contaminación ambiental ocasionada por las descargas de aguas residuales hacia cuerpos de agua o al alcantarillado y la emisión de gases hacia la atmósfera a partir de fuentes fijas o móviles de contaminación del aire.

Art.3.- Las regulaciones de la Ordenanza No.2910 y de este Reglamento rigen para:

1) Los establecimientos industriales, comerciales y de servicios ubicados dentro del Cantón;

2) Las fuentes móviles de contaminación del aire.

CAPITULO III - DEL REGISTRO DE ESTABLECIMIENTOS

Art.4.- Ningún establecimiento de los comprendidos en el artículo 3 de la Ordenanza 2910 podrá funcionar sin haber sido registrado en la Dirección Municipal de Higiene y Medio Ambiente del I.Municipio de Quito.

Para obtener su inscripción en el Registro, el establecimiento deberá presentar la siguiente información:

1) Nombre o razón social y domicilio del propietario.

2) Número del Registro Unico de Contribuyentes.

BEST AVAILABLE COPY

3) Nombre del representante legal, si se trata de personas jurídicas;

4) Descripciòn con diagramas de flujo de los procesos de producciòn, indicando los puntos de descarga de aguas residuales o gases a la atmòsfera.

5) Diàmetro de las alcantarillas ubicadas dentro del predio y su material constitutivo.

6) Altura, diàmetro y material constitutivo de chimeneas o ductos.

7) Gènero del producto o productos finales.

8) Hojas de seguridad de productos quìmicos utilizados en procesos.

9) Desechos generados

10) Clases de combustibles utilizados.

Cualquier cambio de caràcter tècnico deberà ser notificado a la Direcciòn.

Art.5.- Los establecimientos obligados al registro lo obtendràn:

1) Si se trata de establecimientos nuevos para cuya instalaciòn se requiere de aprobaciòn de planos, al momento de presentar dichos planos para que sean aprobados;

2) Los demàs establecimientos nuevos, dentro de los primeros 30 dias de funcionamiento;

3) Los establecimientos existentes, en el plazo de sesenta (60) dias contados a partir de la promulgaciòn de este Reglamento.

BEST AVAILABLE COPY

CAPITULO IV - DEL CERTIFICADO DE CONTROL DE LA CALIDAD AMBIENTAL

Art.6.- Sin perjuicio de los demàs que se exijan por otras disposiciones vigentes, ningùn establecimiento de los comprendidos en el articulo 3 de la Ordenanza 2910, podrà funcionar si no cuenta con el Certificado de Control de Calidad Ambiental expedido por la Direcciòn.

Este certificado surtirà los efectos del permiso de funcionamiento a que se refiere el articulo 15 numeral 8 de la Ley de Règimen Municipal.

El certificado se entenderà vigente mientras el establecimiento mantenga condiciones de calidad en las descargas de aguas residuales o emisiones a la atmòsfera, dentr de los limites permitidos por las normas vigentes recogidas en los Anexos a este Reglamento.

Art.7.- Para obtener el Certificado a que se refiere el articulo anterior, los establecimientos nuevos deberàn:

1) Haber obtenido su Inscripciòn en el Registro;

2) Informar por escrito a la Direcciòn sobre las obras, instalaciones de prevenciòn y control con las que contaràn para el cumplimiento de las normas.

Cuando, por la naturaleza de la actividad a la que se dedicarà el establecimiento, o por las caracteristicas de la zonificaciòn urbana o las condiciones meteorològicas locales, la Direcciòn Municipal de Higiene y Medio Ambiente lo crea necesario, podrà exigir que, como requisito previo al otorgamiento del certificado, el establecimiento deba contratar a su costa y presentar un estudio de impacto ambiental, de acuerdo a las especificaciones que la Direcciòn establezca.

BEST AVAILABLE COPY

Art.8.- Para la obtención de este certificado, los Establecimientos existentes que deban ejecutar un plan de cumplimiento, se sujetarán a lo dispuesto en el Capítulo VIII.

Art.9.- La Dirección podrá en cualquier tiempo verificar el cumplimiento de las normas de descarga de aguas residuales o emisiones a la atmósfera, sujetándose a las normas de este Reglamento.

CAPITULO V - DE LAS NORMAS DE DESCARGA DE AGUAS RESIDUALES Y DE EMISION DE GASES CONTAMINANTES

Art.10.-Las descargas de aguas residuales provenientes de establecimientos industriales, comerciales o de servicios, hacia las redes de alcantarillado o a los cuerpos de agua, deberán cumplir con las normas de calidad establecidos por la autoridad competente, que constan en el Anexo 1 de este Reglamento.

Art.11.-La calidad del aire en las inmediaciones de áreas residenciales, comerciales e industriales, deberá sujetarse a las Normas establecidas por la autoridad competente y que constan en el Anexo 2 de este Reglamento.

Art.12.-Si el I. Municipio de Quito, a través de la Dirección Municipal de Higiene y Medio Ambiente, en ejercicio de facultades delegadas por los organismos competentes, emitiere resoluciones que modifiquen las Normas de Calidad a que se refierenlos artículos anteriores, el contenido de dichas resoluciones se integrará como anexo al presente Reglamento y deberá ser observado por los establecimientos que fueren del caso.

BEST AVAILABLE COPY

CAPITULO VI - DEL CONTROL DE LA CONTAMINACION POR FUENTES MOVILES DE CONTAMINACION DEL AIRE

Art.13.-Si las concentraciones de inmisión de contaminantes atmosféricos superan los límites máximos admisibles establecidos por la autoridad competente, la Dirección Municipal de Higiene y Medio Ambiente podrá, mediante resolución, restringir el tránsito de automotores en las vías y con los horarios que para cada caso se establezcan.

CAPITULO VII - OBLIGACIONES ESPECIALES

Art.14.-Todo establecimiento está obligado a:

1) Permitir que se realicen las constataciones necesarias para el aforo y muestreo de los efluentes líquidos industriales;

2) Disponer de plataformas para el muestreo de gases en las fuentes fijas de combustión y sus estructuras de acceso;

3) Mantener un Registro de las mediciones de contaminantes que efectúe.

Art.15.-Sin perjuicio de la instalación de sistemas depuradores, la altura de las chimeneas o ductos utilizados como medios para la emisión de gases o partículas contaminantes hacia la atmósfera, deberá ser la mayor de las siguientes alternativas:

1) Superior en un 30% a la altura promedio de los edificios circundantes, en un radio de quinientos metros.

2) Una altura mínima de veinticinco (25) metros.

Si los niveles de contaminación en casos determinados alcanzaren características de especial gravedad, la Dirección Municipal de Higiene y Medio Ambiente podrá exigir el diseño y construcción de chimeneas de mayor altura.

BEST AVAILABLE COPY

Art.16.-En caso de falla de los sistemas de depuración, el Establecimiento dará aviso de su paralización circunstancial o definitiva para que la Dirección determine lo procedente. Si durante una inspección se comprobare que esta situación no ha sido informada oportunamente, se suspenderá el certificado de control de calidad ambiental.

CAPITULO VIII - DE LOS PLANOS DE CUMPLIMIENTO

Art.17.-Los establecimientos existentes cuyas descargas de aguas residuales o medios para la emisión de gases, no cumplan con las normas establecidas en este Reglamento, están obligados a presentar a la Dirección Municipal de Higiene y Medio Ambient el Plan de Cumplimiento en un plazo máximo de seis (6) meses a partir de la fecha de expedición de la Ordenanza 2910.

Art.18.-Para el cumplimiento de la obligación a que se refiere el artículo anterior, el establecimiento presentará, en el formulario que la Dirección suministre para el efecto, los siguientes detalles del Plan:

1) Caracterización de las descargas de aguas residuales o emisiones de gases,

2) Descripción general de los sistemas de control a instalarse, con cronograma de las actividades necesarias para el efecto.

3) Proposición del plazo adecuado para la ejecución del plan.

Art.19.-La Dirección Municipal de Higiene y Medio Ambiente estudiará el plan presentado y podrá corregir el plazo propuesto, si lo considerare excesivo.

BEST AVAILABLE COPY

En ningún caso, el plazo para la ejecución del plan de cumplimiento podrá exceder de 12 meses, contados a partir de su aprobación.

Art.20.-Al término del plazo concedido para la ejecución del Plan, la Dirección verificará su cumplimiento y el de las normas de descarga, pudiendo requerir del Establecimiento la presentación y ejecución de un Plan Emergente Correctivo, en caso necesario. Sin embargo, aún antes del fenecimiento del plazo, si se produjeren variaciones en los niveles de contaminación que entrañen especial peligro, la Dirección podrá exigir que se adopten medidas emergentes.

CAPITULO IX - DEL CONTROL E INSPECCI N

Art.21.-Con el objeto de verificar el cumplimiento de las Normas establecidas en la Ordenanza 2910 y en este Reglamento, los funcionarios autorizados de la Dirección Municipal de Higiene y Medio Ambiente podrán ingresar al Establecimiento previa notificación por escrito firmada por el Director Municipal de Higiene y Medio Ambiente.

Art.22.-Durante la inspección, el funcionario autorizado podrá solicitar la siguiente información:

1) Datos mensuales de consumos de aguas (potable, pozo, tanquero), energía eléctrica y combustibles utilizados,

2) Especificaciones técnicas de las fuentes de combustión (calderos, hornos, incineradores, generadores) y el mantenimiento preventivo o correctivo proporcionado a cada una,

3) Resultados de aforos y de análisis físico-químico bacteriológico de las aguas residuales,

BEST AVAILABLE COPY

4) Resultados de análisis de emisiones gaseosas.

Art.23.-La Dirección comunicará los resultados de la inspección al Establecimiento, indicando las novedades registradas, los resultados de análisis de contaminantes y, si fuere del caso, las medidas correctivas que deban adoptarse.

Art.24.-El Establecimiento, en el plazo de seis días podrá formular observaciones al informe, mediante exposición escrita a la cual acompañará las pruebas o demostraciones necesarias para sustentar sus observaciones.

Art.25.-La Dirección Municipal de Higiene y Medio Ambiente se pronunciará sobre las observaciones, para lo cual podrá disponer de oficio la práctica de las pruebas o constataciones que juzgue necesarias.

Art.26.-Si del informe de inspección resultare que hay fundamento para la aplicación de sanciones, la Dirección remitirá los antecedentes al Comisario Municipal, para que inicie el correspondiente procedimiento.

Art.27.-Todos los análisis de muestras de contaminantes los efectuará el Departamento de Laboratorios de la Dirección Municipal de Higiene y Medio Ambiente. El establecimiento podrá hacer analizar alícuotas de las mismas muestras en un laboratorio independiente, cuyos resultados tendrán carácter referencial.

CAPITULO X - DE LAS SANCIONES

Art.28.-Se sancionarán con la suspensión del Certificado de Control de Calidad Ambiental, las infracciones siguientes:

1) La inobservancia de los límites máximos permisibles de contaminantes ambientales,

BEGTAV TAB

2) Ofrecer resistencia u obstaculizar la práctica de una inspección.

3) No dar aviso oportuno sobre la paralización circunstancial o definitiva de los sistemas de depuración de las descargas de aguas residuales o gases y partículas contaminantes.

Art.29.-Se sancionarán con (la revocatoria ~~el retiro definitivo~~) del certificado de control de la calidad ambiental, las infracciones siguientes:

1) Haber sido objeto de sanción por inobservancia de los límites máximos permisibles de contaminantes ambientales en dos ocasiones anteriores,

2) La reincidencia en las infracciones a que se refieren los numerales 2 y 3 del artículo anterior.

Art.30.-Podrá disponerse la reubicación del establecimiento en los siguientes casos:

1) Si por no disponer de área apropiada para la construcción de plantas de tratamiento de los residuos líquidos, está imposibilitado de cumplir las normas sobre descargas de aguas residuales,

2) Si luego de la revocatoria del certificado de control de calidad ambiental, los correctivos adoptados resultaren insuficientes para cumplir con las normas sobre descargas líquidas o emisiones a la atmósfera.

Art.31.-Los comisarios municipales procederán al cierre de los establecimientos que no hubieren obtenido el registro en la Dirección o el certificado de control de calidad ambiental.

BEST AVAILABLE COPY

DADA, en el Despacho de Alcaldía, a los 27 días del mes de febrero de 1992.

Rodrigo Paz Delgado
ALCALDE DE SAN FRANCISCO DE QUITO

MP.

BEST AVAILABLE COPY

ANEXO NO.1

NORMAS DE DESCARGA DE AGUAS RESIDUALES

PARAMETRO	EXPRESADO COMO	UNIDAD	LIMITE MAXIMO PERMISIBLE	
			CUERPOS DE AGUA	ALCANTARILLADO PUBLICO
Potencial Hidrógeno,	pH		5 - 9	5 - 9
Temperatura,		'C	<35	<40
Ácidos o bases que puedan causar contaminación, sustancias explosivas o inflamables,				Ausencia
Grasas y aceites,			Ausencia	
Sólidos sedimentables		ml/l		10
Sólidos suspendidos		mg/l	Remoción> 80 % en carga	
Sustancias solubles en hexano		mg/l		30
Demanda Bioquímica de Oxígeno	DBO3	mg/l	Remoción> 80 % en carga	
Caudal máximo			1.5 veces el caudal promedio horario del sistema de alcantarillado.	

CONCENTRACIONES PARA EL CONTROL DE SUSTANCIAS DE INTERES SANITARIO

SUSTANCIA	EXPRESADA COMO	CONCENTRACION (mg/l)
Arsénico,	As	0.1
Bario,	Ba	5.0
Cadmio	Cd	0.02
Cobre	Cu	1.0
Cromo	Cr	0.5
Compuestos fenólicos,	Fenol	0.2
Mercurio	Hg	0.01
Níquel	Ni	2.0
Plata	Ag	0.5
Plomo	Pb	0.5
Selenio	Se	0.5

BEST AVAILABLE COPY

uros	CN	1.0
·nil	Concentración	No detectable
clorados,	agente activo	
ulo orgánico	Hg	No detectable
:tiloro tileno	Tricloroetileno	1.0
oforo	Extracto carbón	0.1
	Cloroformo	
·cloruro de	Tetracloruro	1.0
·ono	de carbono	
oroetileno	Dicloroetileno	1.0
uro de carbono	Sulfuro de carbono	1.0
uestos organo-	Concentración	0.05
ados (cada	agente activo	
)		
uesto organo-	Concentración	0.1
orados (cada	agente activo	
)		
·nitros		0.1
bonilmos		20.0
o activo		0.5

FE: Reglamento para la prevención y control de la contaminación ental, en lo relativo al recurso agua.- Acuerdo Ministerial 2144, 29 de 1989, Ministerio de Salud Pública. - Registro Oficial 204, 5 1989.

BEST AVAILABLE COPY

ANEXO NO.2

NORMAS DE CALIDAD DEL AIRE

PARTICULAS SEDIMENTABLES: La máxima concentración de una muestra recolectada en forma continua durante treinta (30) días, es de un (1) miligramo por centímetro cuadrado (1 mg/cm2 x 30 d).

PARTICULAS TOTALES EN SUSPENSION: El promedio geométrico de los resultados de todas las muestras diarias recolectadas en forma continua durante veinte y cuatro (24) horas, en un intervalo de doce (12) meses, no deberá exceder de ochenta (80) microgramos por metro cúbico (80 Mg/m3).

La máxima concentración de una muestra recolectada en forma continua durante veinte y cuatro (24) horas que se puede sobrepasar por una sola vez en un periodo de doce (12) meses, es de doscientos cincuenta (250) microgramos por metro cúbico (250 Mg/m3).

DIOXIDO DE AZUFRE (SO-): El promedio aritmético de los resultados de todas las muestras diarias recolectadas en forma continua durante veinte y cuatro (24) horas, en un intervalo de doce (12) meses, no deberá exceder de ochenta (80) microgramos por metro cúbico (80 Mg/m3).

La máxima concentración de una muestra recolectada en forma continua durante veinte y cuatro (24) horas que se puede sobrepasar por una sola vez en un periodo de doce (12) meses, es de cuatrocientos (400) microgramos por metro cúbico (400 Mg/m3).

La máxima concentración de una muestra recolectada en forma continua durante tres (3) horas que se puede sobrepasar, por una sola vez en un periodo de doce (12) meses, es de un mil quinientos (1500) microgramos por metro cúbico (1500 Mg/m3).

BEST AVAILABLE COPY

MONOXIDO DE CARBONO (CO): La máxima concentración de una muestra recolectada en forma continua durante ocho (8) horas (como promedio móvil), es de diez (10) miligramos por metro cúbico (10 mg/m3).

La máxima concentración de una muestra recolectada en forma continua durante una (1) hora, es de cuarenta (40) microgramos por metro cúbico (40 Mg/m3).

OXIDANTES FOTOQUIMICOS EXPRESADOS COMO OZONO (O-): La máxima concentración de una muestra tomada en forma continua durante una (1) hora que se puede sobrepasar, por una sola vez en un periodo de doce (12) meses, es de doscientos (200) microgramos por metro cúbico (200 Mg/m3).

OXIDOS DE NITROGENO (EXPRESADOS COMO DIOXIDO DE NITROGENO NO-): El promedio aritmético de los resultados de todas las muestras diarias recolectadas en forma continua durante veinte y cuatro (24) horas, en un intervalo de doce (12) meses, no deberá exceder los cien (100) microgramos por metro cúbico (100 Mg/m3).

PLOMO: El promedio aritmético de los resul ados de todas las muestras diarias recolectadas er forma continua durante veinte y cuatro (24) horas, en un intervalo de tres (3) meses, no deberá exceder los uno y medio (1.5) microgramos por metro cúbico (1.5 Mg/m3).

CORRECCION POR LAS CONDICIONES DE LA LOCALIDAD: Las normas de calidad del aire señaladas, representan condiciones medidas teniendo como condiciones de referencia 25 °C y 760 mm Hg, y deberán corregirse de acuerdo a las condiciones de la localidad utilizando la siguiente ecuación:

MC = MO x (760 mm Hg/Pbl mm Hg) x (273 °K + t °C)/ 298 °K

en donde MC	Medición corregida,
MO	Medición observada,
Pbl	Presión barométrica local (mm Hg)
t °C	Temperatura local en grados centígrados

BLE COPY

Appendix F. Algae

Anabaena is a blue-green algae that produce an odor of mildew or grass. It decomposes with septic odor and occurs in large numbers in waters that receive organic residues. Some of the species are toxic.

Ceratium is a multi-colored species which is an indicator of septic odor when it is in large numbers. It produces a fish odor and a bitter taste in the water.

Chlamydomonas are also a multi-colored species which in general only live in waters that contain certain organic components including nitrogen . They are also frequently seen in oxidation lagoons.

Chlorella is a green algae that lives in waters polluted with organic materials. They are also present in waters that are very high in mineral salts, they act as indicators of seawater, and produce a mildew odor when in large numbers.

Chlorococcum is a green algae that lives in waters of high salinity. They resist pollution and maintain themselves in the distribution nets of the surrounding waters without light.

Chlorogonum is a multi-colored algae that lives in polluted waters.

Cyclotella is an algae, some of which species live in clean water, and some of which species live in

polluted water. The polluted variety is found especially in the waters where phenol is present, which could be in the residues from pharmaceutical, plastic or disinfectant companies. This algae produces a flavor and odor of geraniums or fish.

Euglena is a multi-colored algae found frequently in polluted waters where there are organic compounds, though there are species that are in clean water only. They produce odors and flavors of fish in the water, though some varieties have a sweet taste.

Gymnodinium is another multi-colored algae which is frequently blooming. Certain species occur during the phenomena of red tide.

Microcystis is blue-green algae that produces turbidity. It corrodes concrete walls or columns and can pass through the distribution water systems. It produces odors of grass and have a sweet flavor. Some species are toxic, but most are damaging because of the turbidity that it produces.

Navicula is an algae that has types that can live only in clean waters and also has types which resist the industrial phenol drainage from the paper or oil industries. There are also species that are indicators of hydrogen sulfide and species which live in high salinity waters.

Nitzchia is another algae that has species that

live in clean water and other ones that live in industrial waste water. It can survive in water that contains copper, hydrogen sulfide, chlorides or phenol.

Oscillatoria is green-blue algae that at times produces red flowers. It produces an odor of grass and indicates numerous things including thermic pollution, salinity and residue from paper companies.

Peridinium is multi-colored algae that emits an odor in small numbers similar to that of pickles, but in large numbers produces an odor of fish.

Phacus is a blue-green algae that lives in polluted waters with a lot of organic materials and exists in lagoons. Some species indicate clear water.

Scenedesmus is green algae that lives in waters high in salt minerals. Others live in polluted waters and in waters with residues containing copper. They produce an odor and flavor of grass.

Stephanodiscus produces an odor of geraniums or of fish, and they obstruct filters.

Tetraedron is a green algae that lives in polluted waters where there is domestic organic residues.

Volvox is a multi-colored algae that combines with chlorine to produce a strong odor of fish.

Zygnema is a green algae that obstructs filters because it lives on the surface of the water.

VIII. References

American Society for Testing and Materials. Manual on Water, Third Edition. Maryland: ASTM, 1969.

Aspiazu de Paez, Patricia and Milton Luna Tamayo. Aula, Curso de Orientacion Escolar, Geografia E Historia Del Ecuador. Spain: Cultural, S. A., 1993.

Camp, Thomas R., and Robert C. Meserve. Water and its Impurities. Pennsylvania. Dowden, Hutchinsen & Ross, 1974.

Coloma, Cesar. Rapid Evaluation of the Liquid Contaminants from Industrial Sources. Graduating Project, ESPOL, 1993.

Corrales, Gerardo, and Francisco Pesantes. Department de Prevencion y Control de Contaminacion. Guayaquil, 27-28 de Junio de 1990.

Davis, Mackenzie L., and David A. Cornwell. Introduction to Environmental Engineering. New York. McGraw-Hill, 1991.

Encyclopedia Americana.

Encyclopedia Britannica.

Jackson, Tim. Clean Production: Strategies. Boca Raton. Lewis, 1993.

Klein, Louis. River Pollution - Causes and Effects. London. Butterworth, 1962.

Klein, Louis. River Pollution I. Chemical Anaylsis. London. Butterworth, 1959.

Marchan, Cornelio, and Alexander Schubert. Ecuador Siglo XXI - Estrategia de Desarrollo Economico y Social. Quito, Ecuador, Proyecto Conade/GTZ, 1992.

Martz, John D. Politics and Petroleum in Ecuador. New Brunswick, NJ. Transaction Books, 1987.

Metcalf & Eddy, Inc. Wastewater Engineering: Treatment, Disposal, Reuse. New York: McGraw-Hill, 1972.

Morton, Stephen D. Water Pollution - Causes and Cures. Stevens Point, Wisconsin, Worzalla Publishing, 1976.

Nebel, Bernard J., and Richard T. Wright. Environmental Science . . . The Way the World Works. Prentice Hall, 1993.

Nybakken, James W. Marine Biology, an Ecological Approach. 2nd ed. New York. Harper & Row, 1988.

PCGlobe. Computer Software.

Scientific Committee on Problems of the Environment, SCOPE. Environmental Impact Assessment, Principles and Procedures. R. E. Munn Ed. Toronto, 1975.