Advisor of Record Initials: L.E.S

Project Number: 1391 41

Pollution and Waste Disposal in Trinidad

An Interactive Qualifying Project Report
Submitted to the faculty of
Worcester Polytechnic Institute
In partial fulfillment of the requirements for the
Degree of Bachelor of Science
by

Kristian Bleasdell

Approved :

Professor Lance E. Schachterle, Co-Advisor

Professor Suzanne L. Weekes, Co-Advisor

Acknowledgements

Trinidad

Dr. Dyer Narinesingh, Ph.D.

Mr. Jason Bleasdell

Mr. Raul Bermudez

Ms. Gloria Balbos

Ms. Sherrianne Bachew

Massachusetts, USA

Professor Suzanne Weekes

Professor Lance Schachterle

Mr. Clarence Plant

Mrs. Pamela Bleasdell

A special thanks to all the people that helped me during the course of my project in Trinidad.

Table of Contents

Introduction

Introduction:

According to the September 14th, 1998 issue of the New York Times, Trinidad and Tobago is quickly emerging as an "Economic tiger in a sea of pussy cats." The reason for this statement is because of the substantial rise in the nation's economy compared to the rest of the islands in the Caribbean. This is due to the fact that the country has begun to lessen its concentration on the oil industry, which has been the basis of the island's economy, and is focusing more on the business of natural gas production. Its ample supply of this natural resource has proven to be more profitable than the government ever thought. As a result, companies such as PCS Nitrogen Gas, Atlantic L. N. G. Company of Trinidad and Tobago and others from Canada, Germany, India and Norway are all flocking to the island eager to get a piece of the pie. At the same time, the Caribbean islands of Trinidad and Tobago are undergoing a serious technological change. This change has fostered the growth of new business and industry. Now, more than ever before, the nation is becoming an industrial giant in the Caribbean.

In certain parts of the island large areas are predominantly factory oriented such as Point Lisas which is located in central Trinidad. As a result of these factories' processes there is a release of byproducts into the environment. These byproducts include sulfur dioxide (SO2), nitrogen oxides (N0x), sludge produced by the chemical, petroleum, and beverage industry, and solid waste material from the pharmaceutical, fertilizer, and food product industries. If they are not properly disposed of or contained these materials can be hazardous to plant, animal, and aquatic life. The question is how are the companies, the government, and the people dealing with the problem of finding proper prevention and disposal techniques? Are the companies using the best technology available, which would greatly reduce the amount of pollutants that are released into the environment? Are there laws that govern against wrongful pollution, both locally and internationally? Are the people on the twin island nation aware of what is going on around them and have they been educated about the problem? These are the questions that this project intended to answer.

The purpose of this project was not to solve the problem of pollution in Trinidad. It was to explore the current techniques that are being used to deal with the waste matter. Trinidad is projected to be, by the year 2000, the leading exporter of ammonia and methanol, not only in the Caribbean, but also in the world. In my project I examined how different companies are handling the byproducts that are the result of their work. I also made some minor comparisons between the techniques used by the local industry to those used by the United States to deal with pollution. I examined the techniques and equipment used to control and dispose of the waste produced in industry.

My intent was to observe the different methods used to combat the problems of waste pollution in Trinidad. However, I discovered the lack of use of any pollution prevention technology at all. An independent researcher, who wishes to remain anonymous, once commented to me that only five percent of all industry in Trinidad today actually have pollution prevention and disposal programs. The businesses in Trinidad and Tobago (T&T) are either not yet ready to commit to such costly ventures or are waiting on the government and its environmental agency, the EMA (Environmental Management Authority), to set specific standards and guidelines. Those companies that are environmentally friendly are so for several reasons. First, if they have loans from the World Bank they must abide by World Bank regulations or risk loosing their financing. Secondly, if they are leasing their land, companies are required to abide by the pollution guidelines set by their landlord. This includes all the businesses at Point Lisas. Thirdly, some corporations choose to be more environmentally aware for the sake of their public reputation. Businesses that rely on favorable public opinion tend to initiate environmental programs at all their factories to avoid looking bad in the eyes of their customers. The fact is Trinidad and Tobago is a developing country and does have the capability of becoming an environmentally conscious nation in the future. What seemed to be needed was a stronger environmental plan and a commitment to its enforcement. I came to the realization that such improvements are costly and it will take some time and government incentives before all the companies are able to perform these tasks.

In this report I explain in further detail the topics that I have mentioned. During my seven-week stay in Trinidad I was able to gather this information by speaking with

company representatives, by doing research at the EMA library, and by talking with the people. However, this was not an easy job to accomplish. Some companies were extremely suspicious of my motives. They did not believe that I was merely on a fact-finding mission. As a result appointments were constantly cancelled or refused, but due to persistence I was able to meet with some of them and gain access to the necessary information.

This project was difficult to complete, but worthwhile. I got a chance to help improve a community, a country, and a people that I love and who love me. I spent the first eleven years of my life in Trinidad. This island is a part of me, of who I am. I am happy that I got a chance to give back to them. This was the first time that anyone from Worcester Polytechnic Institute has tried to research this particular subject matter in the Caribbean. My work should be the foundation from which other students and researchers, who also wish to pursue this area of study, can build on.

Abstract:

The steady rise of new industry and business on the island of Trinidad has created new jobs and strengthened the nation's economy. However, with the increase of industry there has been a steady increase of pollutants released into the environment. Through my research I discovered what was and was not being done to deal with these pollutants by speaking with company representatives, environmental experts, and the people that lived on the island. I observed that only a few companies were being environmentally conscious, while others are waiting on the government to set and enforce standards.

Literature Review

Literature Review

In the Literature Review I have included Interactive Qualifying Projects (IQP) and Major Qualifying Projects (MQP) done by WPI students which helped to further educate me on some environmental terminology and current issues. I have also included information on some of companies and organizations that I met with during my stay on the island. I have also listed the necessary skills and classes I used to accomplish the goals of this project. This section enables the reader to find additional material on the subject and examine what others have done in this particular field. It also provides specifics on some of the organizations that deal with the environment, which I examined in my work.

IQP & MQP work

These are Interactive and Major Qualifying Projects done by WPI students which contain useful information on waste material and its treatment. Below are the abstracts taken from the students' reports.

95D037I Title: Waste Management **Subject: Waste Disposal**
Advisor: Wyslouzil, B. E.

This report critically examines the current waste management situation. By establishing historical references, the extent of the current "crisis" is first placed into context. Technological advances are then illustrated, leaving open the key question of why these improvements are not more readily welcomed. An ongoing landfill sighting conflict has served as a model for this research and first hand observations of this process are supported by a telephone survey.

96D003I Title: Industrial impact on the Machangra River Subject: Industrial Waste
Location: Ecuador Advisor: Rollings, J. E.

The purpose of this project was to study the environmental impacts of five specific companies on the Machangra River and the people who utilize it. This was accomplished through the aid of the Direccion de Medio Ambiente, the environmental division of the Municipality of Quito. Research was performed to establish relationships between human health and industrial contaminants. The majority of these companies were found to have adversely affected the Machangra River's health and that of the people within its basin.

96D0531 Title: Cooperative WMS. Bangladesh Subject: Waste Treatment Advisor: Heaton, G. R.

This project explores the application of collaborative pollution control to the fledging pharmaceutical industry of Bangladesh. In this system, companies in both public and private sectors would jointly create and maintain a communal waste treatment plant. The background reseach consisted of an analysis of the pharmaceutical market and the national policies towards this industry and its environmental impact. A waste processing plant design, encompassing feasibility, implementation, and the economics was proposed, consisting of an incinerator, a bioreactor, a scrubber, and a holding tank. In conclusion, the study suggests that the communal treatment plant could be successful in Bangladesh provided there is adequate training and industrial initiative.

96D0041 Title: Pollution Cont. & Correction Through Industrial Eco-efficiency Subject: Industrial Waste Location: Ecuador Advisor: Rollings, J. E.

This report, prepared for Escuela Superior Politecnica del Litoral, contained a societal and technological interactive study. Technical reports indicated Estero Salado and Guayas River contamination. Data suggested solutions should involve industrial changes. The objective was to link pollution contribution with industrial operation mentality trends. Interview investigations denoted pollution as a resultant of scant environmental regulation awareness and enforcement. This project proposed a coupling of manufacturing efficiency and profit maximization with environmental concern. Recommendations included industrial education and environmental law enforcement.

Company Information

The following are companies and/or organizations that specialize in either waste disposal, and/or waste regulation, or that make environmental assessments. We will look towards them to find information on waste materials, disposal laws, pollution penalties, and waste management techniques.

1) Environmental Management Authority (EMA)

The EMA is a statutory body established by the government of Trinidad and Tobago to address the country's environmental problems. The EMA was established in June 1995 under the Environmental Management Act, No. 3 of 1995

(Further information on this organization can be found in the EMA section of this report.)

Contact Information: 2nd Floor, The Mutual Centre
16 Queen's Park West
Port of Spain, Trinidad, W.I.
Phone: (868) 628 – 8042
Fax: (868) 628 – 9122
E-mail: ema@carib-link.net

2) Waste Disposals Limited (WDL)

The WDL has been in the business of providing integrated waste management services to domestic, municipal, commercial and industrial clients for over eighteen years. The focus of its activities has been the collection, haulage, treatment and disposal of various categories of liquid, solid and hazardous wastes. The Company pioneered the use of modern containerized waste collection equipment and continues to be the industrial leader, by introducing new containerized systems and approaches to waste handling in Trinidad and Tobago and the Eastern Caribbean.

Contact Information: 9 Concessions Road,
Sea Lots, Port of Spain,
Trinidad and Tobago, West Indies
Phone: (868) 625-6746 / 5546-7,
Fax: (868) 625-6747,
E-mail: waste@trinidad.net

3) Rapid Environmental Assessments Limited (REAL)

Since the company was incorporated in 1992, it has provided specialized consultancy services, undertaken baseline studies and assessment for projects involving road design and construction, land reclamation and port development, oil spill contingency planning, petrochemical and other process operations, and environmental training of planners for development control. Their principal and associate staff has had prior project experience throughout all the CARICOM islands.

Contact Information: 74 Ana Street Woodbrook,
Port of Spain, Trinidad, West Indies
Tel: (868) 622-4722
Fax: (868) 622-8809

4) The Institute of Marine Affairs (IMA)

The IMA was established in 1976. The Institute collects, analyzes and distributes data relating to the economic, technological, environmental, social and legal development in marine affairs generally. This institute is primarily a research facility. This organization does not monitor Trinidad's oceans and waterways on fulltime basis. They are contacted by the EMA to perform assessments and analysis on areas specified by the EMA. The IMA also does private environmental assessments for companies such as the businesses at the Point Lisas estates

Contact Information: PO Box 3160
Carenage Post Office
Trinidad and Tobago
Tel: (809)-634-4291/4
Fax: (809)-634-4433

5) Point Lisas Industrial Port Development Corporation Limited (PLIPDECO)

Point Lisas Industrial Port Development Corporation Limited is the only multi purpose industrial port and industrial estate of Trinidad and Tobago. They provide top quality industrial port and real estate management services with direct access to management. They are the landlords of the Point Lisas Industrial Estate. All companies who desire to build at this location must lease the land from PLIPDECO.

Contact Information: PLIPDECO House
Orinoco Drive, Point Lisas Industrial Estate
Point Lisas, Trinidad and Tobago
Tel: (868)636 2201/1888

Studies and Techniques

The following are the skills used to successfully complete this project:

1) The ability to research and compile data
2) Communication with companies/organizations and their engineers, asking the right questions and understanding the response
3) Basic comprehension of technical terms
4) Knowledge and access to laws (EPA, International, Local)
5) Knowledge of the island and its companies
6) Knowledge of what types of waste are being produced

I took classes that aided me during my Interactive Qualifying Project. They included:

1) SS2311 Legal Laws of the Environment – In this course we studied environmental law in the United States and touched on some international issues as well. I learned about environmental treaties between different countries. I also studied environmental cases that had been brought before the US judicial system. This class helped me to better understand legislation, which was a useful tool during my research.

2) CE3059 Environmental Engineering – Through this course I learned a lot about waste disposal, water treatment, and pollutants. I studied the basic techniques used to deal with pollution and the handling of waste material. This knowledge was essential during my research because it enabled me to fully understand both the terminology used and the methods described by company representatives.

Background on the E.M.A.

The Environmental Management Authority

In 1992, representatives from the government of Trinidad and Tobago attended the Earth Summit in Rio de Janeiro. This gathering was put together by the United Nations Conference on Environmental and Development (UNCED) to discuss world wide sustainable development*. At this meeting Trinidad and Tobago announced its intention to foster and encourage an ecologically sustainable development on its islands. To this end, the Environmental Management Act, No.3 of 1995 was enacted and the Environmental Management Authority was established on June 5th of that Year. The Environmental Management Act is legislation with the goal of ensuring the protection, conservation, enhancement, and wise use of the land of Trinidad and Tobago. It also provides the Environmental Management Authority with an Environmental Trust Fund and an Environmental Commission. To give effect to the many provisions of the Act, subsidiary legislation was and is required.

The EMA is a statutory body governed by a Board of Directors consisting of a Chairman and nine persons appointed by the President of the country and drawn from the 11 disciplines and groups specified in the Act. The Board reports to the Ministry of Planning and Development, which is responsible to Parliament for environmental matters. The EMA has a staff complement of 27. This includes nine technical staff with training and experience in the environmental management.

The EMA staff is organized into six units:

- CEO's Office
- Finance and Administration
- Information and Communications
- Planning and Conservation
- Pollution Prevention and Control
- Legal and Enforcement

(*Sustainable Development – increasing the standards of living without destroying the environment.)

The reason for the Environmental Management Act and the establishment of the EMA is reasonably clear. The national population of 1.2 million, growing annually at a rate of 1.0%, has placed a high demand for goods and services on this relatively small twin island state. This demand has led to significant impacts on the water, land, air, and natural resources of the country.

Resource exploitation in the past has been characterized by the search for short-term economic gain with little attention paid to the environment. As a result of the use of land for unplanned settlements, indiscriminate quarrying activities, undesirable agricultural practices and excessive logging, several problems have arisen and persist in various parts of the country. Land based activities have also contributed to the impairment and loss of beaches, mangroves, coral reefs, fisheries, and wildlife.

Over the past twenty years, investments in the protection, conservation and enhancement of the environment of Trinidad and Tobago were somewhat limited and uncoordinated. This resulted in a patchwork of approximately more than 40 pieces of legislation addressing some aspects of environmental management and some 28 government agencies involved in carrying out various functions and activities related to environment management. The result was a lack of institutional and legal focus for these problems. For these reasons the government of the Republic of Trinidad and Tobago established the EMA. The following are the functions of the EMA as described in the Environmental Management Act:

- Develop and implement policies and programs for the effective management and wise use of the environment, consistent with the objectives of the Act.
- Make recommendations for a National Environmental Policy.
- Coordinate environmental management functions performed by persons in Trinidad and Tobago.
- Make recommendations for the rationalization for all government entities performing environmental functions.
- Promote educational and public awareness programs on the environment.
- Develop and establish national environmental standards and criteria.

- Monitor compliance with the standards, criteria, and programs relating to the environment
- Take all appropriate actions for the prevention and control of pollution and conservation of the environment.
- Establish and coordinate institutional linkages, locally, regionally, and internationally.

In 1997, the EMA's work-plan focused on the development of:

- A National Environmental Plan and National Environmental Action and Management Plans.
- The drafting of subsidiary legislation to address Sensitive Areas and Sensitive Species, a Certificate of Environmental Clearance, a component of which includes the Environmental Impact Assessment process, and the designation of hazardous substances and the procedures for handling.

(Guidelines for the establishment of Solid Waste Management Legislation can be found in the Appendix)

- Implementation of a comprehensive environmental education and awareness plan.
- The production of a State Environmental Report.
- A National Environmental Information System.

Criticisms of the Environmental Management Authority:

The following is my assessment of how well the Environmental Management Authority has accomplished the previously mentioned tasks and functions outlined in the Environmental Management Act.

Although the EMA's job is to create, administer, and enforce environmental laws in Trinidad and Tobago, according to what I have been told by companies, independent observers, and have witnessed for myself they have not accomplished their designated tasks. According to sources within the government a "National Environmental Plan and National Environmental Action and Management Plans" are still in the preliminary stages and could be complete some time soon if the proper effort is put into the job. The goal of a "National Environmental Policy" is far from being reached due to the lack of drive in the organization. Perhaps this is also due to the fact that they are severely under staffed. Whatever the reason this is a problem that needs to be remedied.

The EMA has done some work in the area of educational and public awareness programs on the environment. They promote themselves on the local television, radio, and billboards. They also have a bulletin in which they discuss some of the current environmental issues. However, this bulletin along with other pamphlets can only be seen at EMA headquarters. They are not properly distributed throughout the island to increase awareness.

The EMA has made some headway in drafting laws to deal with sensitive areas and sensitive species. They require companies to submit a Certificate of Environmental Clearance
before building. The EMA has gotten "Towne &Country Planning", the local distributors of construction permits, to require businesses to get an Environmental Impact Assessment before they are given permission to build. It is also working with biologists help preserve

the bio-diversity of the island. They attempt to preserve and protect as many of the island's unique species as possible.

From what I have observed, the EMA's implementation of a comprehensive environmental education and awareness plan is far from comprehensive. They have not introduced themselves into the school systems. Institutions of higher learning are not targeted enough. They do hold some workshops, but the majority of the participants are already environmentally educated. The EMA needs to find a way to capture a wider audience and become more of a friend to the local, everyday people. Right now they are seen as an unapproachable government organization that holds seminars and workshops for professionals and big business representatives.

The Pollution Prevention and Control Unit of the EMA:

The Environmental Management Authority (EMA) has the mandate to develop and implement programs for the management of water, air, noise and waste pollution. The Pollution Prevention and Control (PP&C) Unit was created for this reason. The Unit assists industries in engaging in voluntary environmental management programs. As a form of pollution control, subsidiary legislation is currently being developed as well as standards at source of generation. In addition the PP&C deals with the investigation and resolution of complaints.

One of the projects conducted by the PP&C in 1997 was a Pollutant Inventory Study. The objective of this study was to conduct a detailed assessment of existing significant sources of pollutants in industrial, agricultural, and other sectors of economic activity in Trinidad and Tobago. The study also should have provided the baseline information for future environmental impact assessment.

An essential part of the pollution control is the reduction of pollution at its source. This requires the development of pollutant standards at the source of generation, making these standards compulsory and enforcing them. In 1997, the EMA established limits for water effluents emitted by all industrial processes (excluding domestic wastewater treatment plants) and established monitoring and reporting requirements for industry. These requirements are specified in the rules under the Environmental Management Act. If a specific group is reported to the EMA, it is the job of the PP&C to investigate and assess if there has been any wrongdoing and at what level.

Opinion on Pollution Prevention and Control Unit:

Whether the pollutant standards are enforced by the PP&C and the EMA is unclear. Since the EMA is so understaffed, one can not see how they can monitor all companies. They do request the help of the Institute of Marine Affairs (IMA), an independent testing group that is contracted by businesses, to test pollution levels at specific locations in the oceans. However this is only done when a problem is reported. Also most of the pollution monitoring of the industries is done by PLIPDECO, the landlords of Point Lisas Estates.

My intention was to have a meeting with the EMA's Technical Coordinator and member of the PP&C, Glenn Goddard, in order to gain more information about the PP&C and their Pollutant Inventory Study. However, all of my scheduled appointments with him were cancelled, usually at the last moment, and I was told that his secretary would be in touch, but there was no further correspondence. All the information that I found concerning the EMA and the PP&C was gained primarily from their library. I was allowed access because I knew someone that knew someone. My constant attempts to speak with an informed representative of the organization were always met with postponements and cancellations. It brought me to the conclusion that this was the standard process when dealing with persons seeking real data instead of the customary public relations information. I now understood how the public and some of the responsible businesses could become frustrated when dealing with the PP&C and EMA.

Data Gathering Procedure

Data Gathering Procedure:

In this particular section of my report, I describe the way I went about collecting the necessary data that I used for my IQP. During this process I met with several barriers that attempted to prevent me from finding out the necessary information. Company representatives often delayed meetings and computer access was sometimes also limited. However, I persisted and was able to gain the information either directly from the company, its library, or through sources who requested that their anonymity be maintained.

The work done in order to complete my Interactive Qualifying Project all centered around researching, gathering, and compiling data. When I arrived at my project site, The University of the West Indies at Trinidad, I ensured that I had access to all the requested equipment (computers, library, etc.). During the following weeks, I went to various factories, corporations, governmental offices, environmental associations, and waste management companies and talked (or attempted to talk) with their respective representatives. I spoke to corporations and their factories about the types of waste that are being produced as a direct result of their processes. We discussed the methods and equipment that are currently being used to deal with such pollution problems and whether there were any guidelines, regulations, or laws that had to be followed. I visited the Chamber of Commerce where I researched data on companies that were on the island. I also went to the Tourism Board to gain information on beach conditions and the status of other recreational sites.

After I gathered all the data, I proceeded to submit five pages of work to my advisors each week. They looked over my work, told me what needed improvement, and places I could go to get help. In the final two weeks of my stay in Trinidad, I wrote my project report containing all the information I have found and my conclusions.

Interviews with Companies

In this section the results of the interviews with company representatives are stated. I spoke with Human Relations personnel, Environmental Officers, Operations Directors, and high ranking company employees from five different groups. They provided me with some answers to the question of waste disposal and prevention at their places of business. The company representatives told me how their employers were dealing with the problem of pollution. Although some claimed that they had to wait on guidelines from the EMA, others had already initiated an environmental program at their factories or were in the process of creating treatment facilities. It was clear that the companies who had substantially larger budgets (wealth comparison is on a global scale) were more able to build treatment facilities or had incorporated pollution prevention equipment into their processes. There were other companies that argued that this type of activity was a costly venture and could not commit such a large part of their capital unless it was a requirement of the law. The truth is that most companies on the island can not afford to have top of the line environmentally friendly equipment and still stay competitive. The only solution depends heavily on the government providing financial incentives that would ease costs. Only through this method would a majority of the businesses on the island be more able to deal with their pollution problems.

Interview with Caroni (1975) Limited.

This interview took place on Tuesday 2nd February, 1999. I spoke with Caroni Ltd. Human Relations representative Mr. Selwyn Bhajan. This interview was recorded. Some information was also taken from a brochure that was given to me by Mr. Bhajan.

What are the principal products that Caroni Ltd produces?

ANSWER: Caroni Ltd. mostly manufactures sugar, both refined and raw from the fields. It produces prepares beef, lamb, fish and dairy products. It also produces rice, molasses, and its second largest business, rum.

What are the major wastes that are the result of producing these products?

ANSWER: The major wastes are broken down into groups, depending on which area of Caroni Ltd. you are referring to:

- Fisheries – No real waste is produced. All byproducts are biodegradable.
- Rice – There is no waste from the actual harvesting; however pesticides are used during their growth to protect them from insects. These pesticides are currently harmful and do threaten the island's bio-diversity.
- Rum – This is the area in which there is the most waste material. The effluence that is produced is a direct result of the rum refinement process. Before their waste treatment facility Caroni Ltd was a major contributor to the waste that is being dumped into the Caroni River.
- Sugar – Caroni Limited's biggest pollution problem is in the sugar industry. The sugarcane that is harvested from the fields is burned in the refinement process; as a result there is a large amount of ash that is released into the atmosphere. This ash is responsible for the black smoke that is bellowed from the factory's smoke stacks and pollutes the island.

Is the Bagasse from the sugarcane considered a waste product?

ANSWER: No, the bagasse that is a result of processing the sugarcane is considered a byproduct. It is now mixed with other ingredients to make a rich manure. Farmers are allowed to come to the factory and get as much as they want for free.

(Note: Bagasse is the hard shell like skin that covers the sugar cane. It is entirely biodegradable.)

What exactly is Caroni Ltd. doing to deal with their pollution problem?

ANSWER: There are three major areas which we are currently working on:

- Toxic Pesticides – Work is being done in the field at the Caroni Research Station. This department is located at Wasterloo Road, Carapichaima, and conducts research

on crops and agricultural problems of interest to the Company. We are currently developing a pesticide that is totally biological and is a natural predator of the pests. This agent is called Matarhizium anisopliae.

- Rum Effluence – The EMA is working with the company to develop a treatment facility that will filter the waste and make it more environmentally friendly.
- Ash – We have introduced filtering equipment called Wet Scrubbers. They have drastically reduced the amount of ash that is released into the atmosphere to the point of almost non-existence. The company is also working on changing over to a new technique in which the cane is not burned in the refinement process. This method is used in South Africa and Australia with great success.

When did Caroni Ltd. start doing environmental work? What prompted them to start?

ANSWER: We have always tried to be sensitive to the environment, but the Environmental Bill of 1994 (Actually the Environmental Act of 1995) forced the company to really start to put their business in order. This was the first bill of this nature. It is the most comprehensive of its time.

Are there any outside groups that are helping you to solve the problems of pollution, consultants, etc.?

ANSWER: The Environmental Management Authority has been consulting with Caroni Ltd. for some time. They have been helping to develop many new ways of waste management and pollution control.

What do you think of the EMA's work?

ANSWER: The EMA has been of great assistance. They will be setting guidelines that we plan to surpass.

Is your company's waste shipped to any other locations, locally or internationally?
ANSWER: No, we handle all our own waste.

Where do you see Caroni Ltd. in the next 10 years regarding how it will be dealing with the problems of environmental pollution?

ANSWER: Long before the ten-year period we would have mastered the work with the Wet Scrubbers. We would have eliminated the burning process of sugar refinement. All our pesticides will be biological. The major flow of effluence that comes from the rum industry will be seriously reduced. Also the Environmental Management Authority will create more comprehensive laws and guideline which will force companies to create even better technology.

(Caroni Ltd. is trying to be a responsible business, but like most companies they are waiting on the EMA to set definite regulations. They are doing some positive work by installing the Wet Scrubbers and making attempts at recycling where ever possible.)

Meeting with representatives of Coca Cola Company:

Representative of Coca-Cola: Mr. Awai, Operations Director, Caribbean Bottlers Trinidad & Tobago (formerly Canning's Soft Drinks), Trinidad, West Indies.

Coca-Cola, an American corporation, took over Canning's Soft Drinks two years ago in 1997. Before this time most of the same types of environmentally conscious actions, as stated below, did take place except for the processes dealing with the disposal of wastewater and types of cleaning chemicals used.

The major products of this company are soft drink beverages, which include Coke, Sprite, etc.

The major wastes that are produced, as a result of Coca-Cola's many processes are:

- Plastic and Cardboard – from bottling and packaging
- Metal crowns – bottle covers
- Glass – bottles and containers
- Syrup – the mixture that is the basis for all their beverages before carbonated water is added. It becomes a waste product when there is excess or if a batch is made incorrectly.
- Cleaning Chemicals – Caustic, Different types of alkaline solutions

These types of waste are treated as follows:

a) The plastic, the glass, and the cardboard are collected by an outside contractor who sells these materials to foreign recycling plants (Locally there are no major recycling facilities).
b) The metal crowns that are used to cap Coca-Cola's glass bottled beverages are also recycled and reused.

c) Currently the excess and poorly made syrup is not properly disposed. However, because Coca-Cola is an international company it has to abide by certain rules that are requirements of money-lending banks and US regulations since it is a US based company. They adhere to these rules both for financial reasons and for good public relations. As a result within 6 months, starting from February '99, they would have set up a Process Wastewater Pretreatment Facility at Caribbean Bottlers. This Process Wastewater Treatment Facility will include: screening; oil and grease removal; a two–stage biological treatment system; chlorination and dechlorination filtration system; sludge dewatering equipment and a control building. After the wastewater has gone through these processes it will be re-circulated throughout the plant, but it will not be used in the beverage making process nor will it replace fresh drinking water. It will be used in restroom toilets and in the cleaning of machinery. There will also be a large pond where the "regenerated" water, as it is referred to, will flow. In this pond the will be an array of fish and other aquatic life, thus providing proof of the water's purity and the success of their new facility. It will take six months for this facility to be completely constructed. However before that plans had to be drawn up. Each facility is different. They are designed specifically for the plant and region. Thus it takes some time before one can be built. Considering all of this the Coca-Cola company could not have done this project any sooner.

d) The company tries to use only biodegradable cleaning chemicals wherever possible. In the cases where this is not yet possible, machinery cleaning, the chemicals are disposed of by an independent contractor, Solid Waste Management Company Limited (SWMCOL).

The Coca-Cola Corporation has been working with the Environmental Management Authority in setting up its new facilities. However, its international standards have already surpassed those proposed by the EMA. The Coca Cola Corporation has sent to Trinidad its own environmental consultants whose job it is to train the people at the Caribbean Bottlers branch of Coca-Cola. Most international

companies that rely heavily on public opinion tend to do their best to deal with the waste problem because bad publicity could drastically reduce sales. Also international companies that depend on loans especially from the World Bank must abide by certain regulations. These are called the World Bank guidelines, which are attached to this report.

Description of Major Units of Coca Cola's Waste Water Treatment Plant

- Oil & Grease Separator
- Raw Wastewater Pump Station
- Equalization Tank
- Flow Control Weir Box – Forward Flow
- Flow Control Weir Box – Sludge Recycle
- Roughing Filter
- Aeration Tank
- Clarifier
- Chlorine Contact Chamber
- 2 Pressure Filters
- Effluent Fish Pond
- Monitoring Station – Effluent
- Aerobic Digester

Interview with Carib Brewery

This interview took place at Carib Brewery. I spoke with Mr. Che Risbrooke, an environmental technician at the company.

What are the principal products of Carib Brewery?
ANSWER:

- Lager - Carib Beer, Stag Beer, Heineken
- Stout - Guinness
- Other - Malta, Ginseng-Up

What are the major wastes that are the results of the Brewing process?
ANSWER:

- Packaging - Kostic and other cleaning chemicals that constantly flow throughout the plant.
- Brewing - Spent yeast, spent grain, traces of effluence during filtration. Utility regenerated wastewater.
- Solid waste - Kiselgul, which is the filtrate for the beer and spent oil. This waste is handled by the Solid Waste Management Company Ltd. (SWMCOL)
- Cardboard Packaging - This is recycled and is done by a private contractor.
- Bottles - This is also recycled by a private contractor.

Currently all waste that is not handled by SWMCOL runs directly into the drainage system.

Are you working with the EMA? Are there any guidelines to follow?
ANSWER: Yes, we are working with the EMA and there are some guidelines, but they are not final. In my opinion, the EMA is not really effective, since no deadlines or definite standards are imposed on us. At this time we are fearful to go ahead with any new technology, since this is a capital project and is very costly. However we are doing a

feasibility study with other companies in the area with similar interests to build a new wastewater treatment plant.

What exactly is your company doing to dealing with your waste?
ANSWER: The spent grain is mixed together with other ingredients and sold together as animal feed. This eliminates it from going into the waterway. The filter aid is disposed of by Solid Waste Management Company Limited (SWMCOL). Carib minimizes its water flow through recovered water and water conservation exercise programs. Its main concern is the spent yeast from the brewing process. It is a high load; it is high in POD and DOD (Note: These are chemicals that are produced as a result of the brewing process. They can be harmful if they enter the water supply). Carib plans to neutralize the water before it goes into the waterways, water that has alkaline and acids, which is harmful to some aquatic life.

Do you ship your waste?
ANSWER: All of the brewery's solid waste is handled by Solid Waste Company Limited.

Where do you see Carib Breweries in the next ten years as far as dealing with the problems of the waste materials?
ANSWER: Within the next two years the company should have its own waste water treatment plant fully functional and surpassing EMA guidelines (once they are set into place). Carib Brewery plans on being a model that other companies should follow in terms of environmentally friendly products. However all this work can only be accomplished in stages because it would cost too much to do it all at once (capital project – a project that requires a large investment of money).

Note:

I attempted to speak with representatives from Solid Waste Company Limited because they handle most of the island's waste, but through some reason or the other they were never available. I was told to check their web site for information. When I did visit their homepage it was very limited and basically just gave me some company

background. Their main method of disposal is the landfill process. However they do not line the landfill area with any sort of protective coating before trash is dumped. I was told this by a representative from Waste Disposals Limited (WDL), a company which does exactly the same type of waste disposal work as SWMCOL. WDL also transports some waste material to the SWMCOL landfill site, which is located off the Beetham Highway near Port of Spain. The only method of protection used for hazardous waste is very basic. The waste is encapsulated in concrete and then buried in the ground. Both companies were hesitant to give me any further information. WDL did agree to speak with me. I was supposed to speak with Mr. Allan Huggins who was not there when I arrived at the designated time. Instead I spoke to a Public Relations man that could not give me the real facts.

Meeting with PCS Nitrogen Gas

On Tuesday, February 9th 1999 I met with Mr. Ian Welsh of PCS Nitrogen Gas. We did not have much time for the interview since he was a very busy man. However, During a brief tour of their facility I was able to gain the necessary information by taking notes as he spoke and from company materials, which he gave to me.

As we are aware Nitrogen Gas is one of the cleanest form of gas, however in the manufacturing process of this gas there is still some waste.

Waste:

- Carbon Dioxide (CO2)

CO2 is used as a raw material to produce urea. Also CO2 is sold to the Methanol Plants to enhance their products. However, there is some surplus, which is released into the atmosphere.

- Catalysts

Catalysts are used in the manufacturing process. It is a material that reacts with another to produce a given product, in this case nitrogen gas. The average life span of any given catalyst is five years. Some of the different types of catalyst that are used in this process are Cobalt/Molybdenum, Zinc Oxide, Nickel, and Iron. After their life span is over the catalyst is shipped back to the manufacturer in the same containers that the replacement catalyst arrive in. The manufacturers then proceed to remove any salvageable precious metals from the catalysts then dispose of the waste material in landfills.

PCS Nitrogen Gas was formerly known as the Arcadian Corporation, a corporation that was American owned. It is now fully owned by a Canadian Corporation. PCS Nitrogen Gas follows the Canadian Ocean guidelines in dealing with their waste.

They do not interact with the EMA since they are mainly financed by the World Bank and must adhere to World Bank Standards. They also follow the UNEP (United Nations Environmental Policy) laws since this is a condition of their loans. PCS Nitrogen Gas is one of the few companies who have actually started educating the people and making them aware of the danger of their waste. They invite the schools and the communities to seminars at the plant. They have orientation classes for their employees and have a keen sense of community awareness. PCS Nitrogen Gas has set a standard of excellence in environmental awareness which all companies should follow.

Additional information on processes that take place at PCS Nitrogen Gas can be found in the appendix of this report.

Petrotrin:

This information was gained by speaking with an employee of Petrotrin who desired to remain anonymous. The data was gathered by taking notes as the person spoke an from an information packet on Petrotrin which was given to me by the employee.

Petrotrin is an integrated oil company involved in the exploration and production of crude oil reserves onshore and offshore Trinidad and Tobago. It operates a hydro-cracking refinery which supplies products to the local market via a state owned distributor (National Petroleum Marketing Company). It also has an international market supplying its products to the Caribbean, Latin America, the US and Western Europe. The Company augments indigenous crude supplies of approximately 70,000 barrels per day (bpd), and imports another 70,000 bpd from various suppliers such as Ecopetrol (Columbia), Repsol (Spain), PdVSA (Venezuela), and others. Petrotrin maintains a refining capacity from 90,000 bpd to 140,000 bpd. Since 1994, when the company initiated its Externally Financed Drilling concept, it has produced over 1 million barrels of oil and added 5 million barrels to Petrotrin's reserves. This company is funded by loans from the World Bank and, as a result, has to follow the World Bank guidelines. The following are the steps that Petrotrin has taken to ensure environmental safety and to adhere to the World Bank guidelines:

Internal Measures:

Petrotrin has initiated a number of environmental management programs over the past couple of years. Part of the impetus for this initiative is the legislative developments from EMA, concerning the environment. The company created an Environmental Management System to improve environmental conditions such as the preservation of estuarine and coastline conditions, the prevention of contamination of agricultural lands and the improvement of the air quality in all areas of the company's operations. A separate division of Petrotrin was set up to:

a) Monitor the program.
b) Identify areas of major concern on an on-going basis for timely and cost effective resolutions to pollution related problems

c) Develop and administer programs to educate the public and eliminate problems at their source.

Petrotrin's External Measures:

In June 1996, Petrotrin contracted Ecopetrol of Columbia to design and build a facility to treat and dispose of oily solid wastes (a byproduct of refinery operations). In the process, the company has benefited from the technology transfer. Petrotrin has entered into a contract with Techint of Argentina to improve the Liquid Effluent Quality. This project is expected to reduce the volume of contaminated cooling water by about 70% of the amount being handled at the present. Since the facilities will not allow the great variation in flow rates associated with unpredictable weather conditions there will be minimal contamination of storm run-offs. Petrotrin is also part of an action plan with Venezuela and has been involved in two simulation exercises for major spill clean-ups.

PLIPDECO

(Point Lisas Industrial Port Development Corporation Ltd.)

Point Lisas Industrial Port Development Corporation Limited (PLIPDECO)

This information was obtained during a short interview with Mr. Deenesh Persad, the Environmental Officer for Point Lisas Industrial Port Development Corporation Limited (PLIPDECO). PLIPDECO is the actual owner of all the land on the Point Lisas Industrial Estate, located on the west coast of central Trinidad. With its abundant supply of natural gas and well established infrastructure, this unique estate offers unrivalled facilities for industrial clients. The estate contains approximately 80 tenants comprising a mix of world-class petrochemical and steel plants; medium sized manufacturers and smaller service companies providing a range of support facilities. Currently, the estate is expanding to accommodate new clients. They lease out the land to various companies. The leases span from 33 years to 99 years.

In order to get a lease to build on this estate the Corporation states that the prospective company must meet certain requirements. They must be evaluated by the environmental officers of PLIPDECO and receive an environmental clearance permit. Just recently Towne & Country Planning (Trinidad and Tobago's bureau for building permits) began requiring an Environmental Impact Statement (EIS) from companies before they are given permission to construct a factory or plant. If a company is found to be unsafe to the environment they are denied a lease. An independent contractor must do the Environmental Impact Statement. Businesses can not do their own EIS. Companies that are usually hired to do this job in Trinidad are REAL (Rapid Environmental Assessments Limited), the EMA, and also the Institute of Marine Affairs (IMA). Employees of PLIPDECO sit on the Towne & Country board which approve these permits. Thus they do have a large say in who builds and where they build on the island. Since there are no required guidelines on emissions or effluence on the island (all guidelines on these subject are currently voluntary), PLIDECO asks that companies abide by the World Bank guidelines. To ensure that businesses are obeying these regulations they have reserved their right to unauthorized inspections and spot checks. They require tenants to submit environmental reports several times a year.

PLIPDECO's statement on safety and the environment:

"A safe and secure environment has always been an integral part of PLIPDECO's development plans. We are cognizant of the fact that industrial safety must be part of the equation in our bid to become the leading industrial port and estate in the Caribbean and Latin American region."

Environmentalists

In this part of my project report, I indicate the various independent environmentalist groups that are currently working in Trinidad and Tobago. These organizations are trying to preserve the natural beauty of Trinidad and Tobago, and to save the exotic plant, animal, and aquatic life that has been endangered by industrial growth. I spoke with a representative from one organization and he gave me his candid opinion on what he believed was really happening. These types of groups play a particularly important role in the environment. They are the voice of the people. They help to educate the people. The public might not be aware of what is going on in their own environment. Environmentalists make it their mission to give this knowledge to us.

Environment Tobago

Mr. Kamau Akelle, an environmentalist working with *Environment TOBAGO*, spoke to me about Trinidad and Tobago's current environmental situation. Our conversation took place over the telephone since he was in Tobago and I was in Trinidad.

Environment TOBAGO is an environmentalist organization based on Trinidad's sister island Tobago. Its goal is to conserve Tobago's natural and living resources and to advance the knowledge and understanding of such resources, their wise and sustainable use, and their essential relationship to human health and the quality of life.

Mr. Akelle and I had a rather lengthy discussion over the telephone. Our conversation was quite important since this was the one of the few environmentalist organization of its kind in either Trinidad or Tobago.

I asked him his opinions on the state of the environment of Trinidad and Tobago and what his organization sees as the major environmental problems. We discussed the waste problems that have occurred during and from the industrialization of Trinidad. He said that the sources of these wastes center around the Point Lisas industrial area and the oil industry, which they feel, are responsible for the degradation of the island's waters and the aquatic life that inhabits it.

In my course of studies of the Point Lisas area, I found that several companies use the seawater to cool down their power plants and once this has been done the water is returned to the ocean at a much higher temperature. Although there are regulations which state that the water should not exceed the temperature of 32 degrees Celsius, which is about 90 degrees Fahrenheit, the delicate plant and other aquatic life are still affected. The balance is disrupted when these species, which serve as nourishment for other life such as fish, begin to die out. Thus an entire cycle of undersea life is affected and possibly destroyed.

Environment Tobago has also noted that the other environmental problems facing the island are the sewerage pollution, the improper disposal of grease pits from the

restaurants and the littering of the streets and beaches. The standards concerning the construction of sewerage pits are not enforced.

Mr. Akelle believes that to stop these types of activities specific standards should be set. Companies should be monitored not only by PLIPDECO (Point Lisas Industrial Port Development Corporation Ltd.), but also by the EMA. Strict and costly penalties should be placed on violators of regulations. Most importantly the public should be educated.

It is important to note that Environment TOBAGO is a new organization and at this point in time their major concentration is on domestic pollution such as littering and garbage disposal. They are not yet fully equipped or staffed to deal with the problems of industrial pollution. They have just begun to take the first steps towards protecting and conserving the environment, steps that will help them and us to save these islands.

Other Environmentalist Groups on the island of Trinidad.

The Point-a-Pierre Wild Fowl Trust

The Point-a-Pierre Wild Fowl Trust continues research on the breeding and translocation of many wildfowl species. To date, the Trust has been extremely successful in breeding the Blue and Gold Macaw as well as five species of waterfowl.

Environmental education is also a main priority for the Trust. Holy Name Convent in Port of Spain has been one of the schools that has benefited from its education program. The school was very successful in an international science competition on "Wetlands and Endangered Species in Wetlands" and was assisted by the Trust with research material and hands-on information with visits to the Nariva and Caroni Swamps.

Toco Foundation

The Toco Foundation recently launched the four products of its eco-tourism project – Galera, Sans Souci Bay, Balandra Wetfoot and the Simon Kayay Rock Formation. They have also set up nature trails and have trained tour guides, lifeguards, and litter wardens to ensure that environmental standards are maintained in this area.

Asa Wright Nature Centre

The mission of the Asa Wright Nature Centre is to preserve the Arima Valley in its natural state, for the protection of wildlife and the enjoyment of all persons. The 31-year-old Centre was recently presented with the 1998 Eco-Tourism Award by Islands Magazine. In addition, the Centre conducts ongoing environmental education programs all over the island.

Latest Technology

The following are the latest technologies used by the United States to deal with the problems of waste treatment and disposal. It is important to compare what they are doing in the US because the majority of the world considers this country, to have the most stringent environmental laws and policy. Thus the techniques developed and/or used here would be the measuring stick which all others can compare themselves to. However it is important to note that in some countries the companies are not as wealthy (on a global scale) as the US companies and may not be able to afford such equipment. For this reason developing nations such as Trinidad can not yet reach this level of waste treatment and disposal. Perhaps with time this can be accomplished.

Latest Technologies:

Wastewater Treatment:

The BRM Membrane Bioreactor created by Inflico Degremont, Inc. (This information was taken directly from the Inflico Degremont, Inc. website: www.infilcodegremont.com.)

The BRM is an innovative wastewater treatment (WWT) technology based on proven processes of activated sludge biological treatment and membrane separation. The BRM system, developed by Degremont and Suez-Lyonnaise des Eaux, has already been implemented in several full-scale industrial applications. The synergistic combination of enhanced biological treatment and crossflow membrane filtration produces a treated effluent quality, which is not merely excellent but is also consistent. This provides industrial facilities with the opportunity to recycle or reuse part of the treated effluent, thereby reducing costs for fresh water and water treatment on one hand, and of wastewater discharge, on the other.

A specific description of how the BRM system works can be found in the appendix.

High Temperature Fluidized Bed Incineration:
(Information obtained from the Department of Energy website)

This proven technology, now in use worldwide, addresses and solves two of the most perplexing waste management problems facing municipalities today:

- How to reduce wastewater treatment sludge volume efficiently, economically, and safely.

- How to eliminate the environmental hazards of conventional incineration, including air pollution.

A specific description of the High Fluidized Bed Incineration process can be found in the appendix.

My Suggestions

In this chapter of my report, I explain what I have done to help solve the problems of pollution and waste disposal in Trinidad. I tried to raise public awareness. It was difficult to find an effective method of reaching the companies as well as the people. The key factor, which enabled me to gather students together, was my friendship with student leaders of the University and a good faculty advisor, Dr. Dyer Narinesingh. They told me where to go and with whom to speak. I think that the problem in Trinidad can be solved if the people of the island come together and demand that environmental standards and regulations be set.

My Solutions:

I gave the companies that I met with my personal assessments and opinions about the pollution problem. Hopefully, they truly listened to my advice because it was an informed one. I told them that the most important role of companies should be to educate the people and let them know what they are doing and what dangers are out there. They can have Environmental Awareness Seminars that are open to the public, advertise on television and radio, have a representative from their company visit schools. I myself tried to do this. I visited a neighborhood elementary school and sat down and really talked with the students there. They were completely unaware of what was going on in their country. Their knowledge of pollution was very limited. They thought that the biggest problem they had was littering. I made it my job to let them know what was going on. I also was able to set up an impromptu discussion group, before I returned to WPI, with students from the University of the West Indies. They knew of the problem, but they were unaware of the magnitude to which it has reached. I believe that this meeting was an important step in starting a student based environmental organization.

UWI Student discussion

Number of students attended: 20

Topics discussed:

- *Waste disposal*
    1. Landfill techniques

2. Waste water treatment
3. Dumping in the oceans

- *Car Emissions*
    1. Inspections
    2. Cost of better cars
    3. Laws

- *Environmental Management Authority*
    1. Effectiveness
    2. Leadership
    3. Response to Environmental Emergencies
    4. The Ability of the EMA
    5. Why was the EMA formed

- *The Students' Role in Environmental Awareness*
    1. Responsibility of the Educated to Educate
    2. Career Choices
    3. What can the student do

I do not believe that the EMA is very effective at this point in time. In my effort to be a liaison between the EMA and several companies on the island, such as Carib Brewery, I always got the same response. Companies were not willing to do any large-scale environmental overhaul until the EMA set definite guidelines and deadlines. I understand the EMA is short staffed and this may be the problem. I believe that they need to be more disciplined and make decisions. Maybe they need to recruit more experience staff or have an outside group such as the EPA of the United States trains them.

Trinidad and Tobago does not have a recycling program, except for the recycling of bottles. I suggested to the EMA and to the people at Waste Disposals Limited who, along with Solid Waste Management Company, are responsible for most, if not all, the

domestic waste on the island, that they start a variety of recycling programs. Their programs should offer cash incentives to the participating public and make it a requirement for companies.

I also spoke to several companies about WPI's Major Qualifying Projects. Perhaps their factories and plants could become new sites where future Environmental Engineers can help these companies to actually design and construct some technology to assist them in saving the environment.

In my discussions with other students and the general public I noticed that they lacked the necessary motivation to go out and do something to help. As a result I felt the need to try and give them that drive. Those that I spoke with really seemed to understand the urgency and the need for action. However, I couldn't speak to everybody. I had to broaden my audience so I wrote and article and submitted it to be published in the University paper, which has a surprising large circulation both on the island, and the other islands on which there are UWI campuses. The article was approved and was published. Attached is a copy of the article that I wrote. I really hope that it makes a difference.

A copy of my article which was printed in the University of the West Indies newspaper is on the next page.

The first step to saving our future

By anonymous

First of all I would like to say that I'm no writer. It's ~~not my~~ way. I will not attempt to dazzle you with rhetoric or move your hearts with rhyming words. The purpose of this article is to enlighten your mind, to cause a reaction to what you read. Why, you might ask is this any of your business? Why am I in your paper, intruding on your life? Because this is not only about me. It is about us, our life, our home, our future.

In the past, Trinidad and Tobago has been hardly noticeable on the world scale. We were seen, if at all, as a small spec that floated off the coast of Venezuela. In the older maps we don't even exist. These days, however, that spec has grown by leaps and bounds. We are no longer dismissed as some third-world country that is best known only for inventing steelpan. We are an industrial nation. The world has begun to sit up and take notice. The New York Times recently referred to the Republic of Trinidad and Tobago as "An Economic Tiger in a Sea of Pussy Cats". The reason for this title is obvious. By the year 2000 it is estimated that our nation will become the leading exporter, in the world, of methanol and ammonia.

Countries from all corners of the earth have come, eager to help process our abundant supply of natural gas, eager for a piece of the pie. They bring in foreign dollars, construct massive plants and factories, offer new technology, and create thousand of new jobs. Also as a result, local business begins to prosper and grow. All this we have achieve, but at what cost. For all that we get, what do we lose? What is the price that we will have to pay?

Our islands are paying that costly price. Daily the oceans and the rivers are made home to gallons of waste material. Roads are battered and destroyed by heavy-duty, diesel trucks whose dark emissions of carbon monoxide blacken our skies and burn our lungs. Communities are disrupted by noise pollution and their homes stained with ash from nearby smoke-stacks. Fishermen reel in half empty nets, which use to be abundant with fish. The fish have migrated to locations where the plant life has not been damaged by unclean or overheated waters.

Companies need to be more responsible, not only foreign ones, but domestic as well. The intention of this article is to hold all polluters accountable. Corporations that have taken loans from the World Bank must abide by the World Bank environmental guidelines or else they won't get their money. However, what about the companies that don't have these loans? What are their incentives to be environmentally cautious? What standards must they meet? Often when I have asked these very same questions I was told to check the EMA, the Environmental Management Authority. So I did. I went to their library and did some research. I also tried to meet with several key figures at the organization. When the days of my scheduled appointments came I was left waiting...waiting...waiting.... and then told that they were not coming. The

truth is everybody is waiting on then to set the standards and time deadlines for when they must be met. And from what I saw it could be awhile before anything is really done. You see we the people are not doing anything. There is no pressure on the EMA to get this job completed. Companies are surely not going to do this. The fact is they are happy with the way things are. The longer they do not have to spend money to treat and dispose of their waste, the better is for them. Their profits are safe. It is up to us to apply that pressure and now.

You might ask, what can I do? How can you expect me to play a role in something so big? How can I change a system where corruption seems to fester and grow? The answers lie within us. We must use the skills that we have learned in schools and in universities. We should start environmentalist groups, publicize, get the word out. I recently asked a fairly popular UWI student if there were any such groups on campus. She said that there were none, at least none that she had heard of. If there isn't one, form one, and if there is we need them to step forward. If you are not into the group thing then write, express yourself, inspire and educate others, just speak out.

We are trying to save our land, preserve it not only for ourselves, but for the future generations that will spring from us. We are the future leaders and lawmakers of this nation. We are the lucky ones that have had a chance to be educated. It is our responsibility to see that this land, our home is not destroyed. The time is now. We must act. Someone once told me that " A journey of a thousand miles begins with one step". That first step is yours to take. PEACE.....

Conclusion

Conclusion:

According to the World Bank group, if development is to become sustainable, human behavior must change. Corporations, consumers, and the public agencies all need to switch away from activities that degrade the environment and invest instead in activities that conserve ecosystems for the future. If the Republic of Trinidad and Tobago is to survive both as an island paradise and as an industrial nation, the corporations, consumers, and public agencies that exist on these islands must come to this realization.

The intent of my project was " to explore the current techniques that are being used to deal with the waste matter on the islands of Trinidad and Tobago." I was a little surprised at what I found. Pollution has become a major problem in Trinidad due to the rise of industry over the past couple of years. However, the Environmental Act was passed through legislation in 1995 and an agency, the Environmental Management Authority (EMA), the only government regulated environmental agency in Trinidad, was set up in June of that year. Their function is to establish guidelines and standards for companies, to monitor, and to see that these regulations are upheld. Unfortunately, throughout my observations and in my conversations with other companies, I found that the EMA is very ineffective. Companies are waiting on the rules from the EMA. As a representative from Carib Brewery pointed out, these are *capital projects* which can be very costly and they are not willing to take the risk and go ahead on a project, only to find out that their plans are rejected by the EMA. There are almost seventeen hundred companies in Trinidad and Tobago and approximately five percent have actually begun to set up systems to deal with their waste. Pressure must be applied to the EMA to be more disciplined and make decisions or else the companies will become more complacent.

The main industrial area of Trinidad and Tobago is Point Lisas; this is referred to as "Little Texas" since it is the largest concentration of industries in one area, second only to Texas. Most of the industries such as Trintogas, PCS Nitrogen Gas, Caribbean Methanol, etc. are located here and are funded by the World Bank. There is no requirement by the bank, however, to perform any monitoring or to have someone that reports to them. The guidelines are ones that are utilized in areas where there are no prevailing or set laws concerning that particular type of pollution and its regulation. It is

up to the institution, in the case of Point Lisas, the landlords of the estate, Point Lisas Industrial Development Corporation Ltd. (PLIPDECO), or the government to implement and monitor. The Bank, in lending monies, requires proof from the borrowers that its guidelines in the least will be met and maintained throughout the life of the project. PLIPDECO requires its tenants to monitor all their pollutants since plant specific guidelines are inserted as sub clauses in the lease agreements. They also perform independent monitoring to verify what is reported. Failure by a tenant to correct non-compliance with the guidelines will result in PLIPDECO doing so at the cost of the tenant. With respect to the World Bank, there are draw-downs (checks from the bank that are based on a company's loan) on the funds, and these are only made after the required work is completed. A good example is the loan from the World Bank to Petrotrin, one of the largest oil companies in Trinidad. One of the conditions of their loan stated that Petrotrin should clean up the Point-a-Pierre River. The residue and waste from the refinery was being drained into the river, causing a foul stench and sludge. After the first draw-down on the funds, Petrotrin was found in default of completing this task and the loan was stopped until the river was cleaned.

All the solid waste in Trinidad is dumped and used as landfill. There is currently no processing system to get rid of this waste. One representative from Waste Disposal Limited said that even the hazardous waste is not processed. Instead it is encapsulated in concrete and then buried. As a result of these types of activities swamp areas are being destroyed. These areas are homes to certain types of aquatic life such as mollusks, crabs, and the local cascadura fish. They are also nesting places from certain species of birds, which are being disturbed by man's sudden invasion, such as Trinidad and Tobago's national bird the Scarlet Ibis. Other birds that migrate and return at certain times of the year are now becoming extinct in Trinidad.

There is very little environmental awareness in Trinidad. No matter what legislation is passed, if the people are not educated as to what problems can be caused by throwing garbage from their cars, dumping waste into drains and rivers, the island will suffer. The EMA publishes handouts, which are very informative, but they are not distributed to the public or the schools. They handouts would be more effective if they are made part of schools' curriculum.

It is not economically feasible for Trinidad and Tobago to abide by all the environmental laws and legislation such as those created in the United States. This can cripple a small nation. For example, car emissions that are bad are mainly from cars owned by the poor or middle class who depend on their cars either as transportation or as a source of income (taxis). They can not afford to buy better cars or fix theirs and without out their automobiles their livelihoods would be in serious jeopardy. Technology in the area of environment is sorely lacking in Trinidad. These are capital projects and as mentioned before they are very costly. In these cases companies look towards the government to provide incentives which would reduce cost. An example of a monetary incentive would be a percentage tax reduction for businesses with pollution control programs. Companies are more willing to develop and introduce new technology when they are made more affordable.

I believe that once the people of Trinidad and Tobago are fully educated and made aware of the environmental problems facing them and the danger to future generations, not only domestically, but globally, they will have no other choice but to act. With time and the expansion of industry, technology will become available and affordable which will help to ease the process of transition to a more environmentally friendly society.

Budget

The Trinidad Interactive Qualifying Project
Budget

Time Period: Jan. 3rd, 1999 to March 15th, 1999

Transportation:		
	Air Fare (British West Indian Airlines)	$800.00 (round trip)
	Local	$700.00
Room and Board:		
	Housing:	$400.00 (2 ½ months)
Includes:	Electric	
	Gas	
	Water	
	Food	$300.00
Tuition:		$00.00
Supplies and Equipment:		
	Camcorder	$00.00
	Lap Top	$00.00
	Tape Recorder	$00.00
	Stationary (Paper/Postage)	$150.00
	Copies @ $0.10 per copy	$120.00
Communications:		
	Telephone	$85.75
	Faxes	$100.00
Total:		$2,655.75

Bibliography

Bibliography:

J. T. O'Connor's IQP Guidelines (WPI Project Center)

M. Gennert's Project Guidelines (WPI Project Center)

Guidelines on "Team Dynamics" and "Economics Analysis" (Project Center)

Environmental Law for Non-Lawyers (Second Edition)
David B. Firestone, Frank C. Reed, SoRo Press, 1993

Environmental and Developmental Education at the University of the West Indies, H. O. Phelps, West Indian Journal of Engineering, WI, vol. 16, n2, 1994

Environmental Abstracts Annual, Bowker A&I Pub., NJ, vol. 1, 1994

State Environmental Reporter (Mass.), The Bureau of National Affairs, Inc., Washington D. C., 1994

Environmental Reporter Cases, The Bureau of National Affairs, Inc., Washington D. C., vol.26, n1, 1995

95D037I Title: Waste Management Subject: Waste Disposal
Advisor: Wyslouzil, B. E.

96D003I Title: Industrial Impact on the Machangara River Subject: Industrial Waste
Location: Ecuador Advisor: Rollings, J. E.

96D053I Title: Cooperative WMS. Bangladesh Subject: Waste Treatment
Advisor: Heaton, G. R.

96D004I Title: Pollution Cont. & Correction Through Industrial Eco-efficiency
Subject: Industrial Waste Location: Ecuador Advisor: Rollings, J. E.

Bibliography continued (websites):

Trinidad and Tobago Chamber of Commerce
http://www.trinidad.net/cjambers/ttcic/businessdir.html

UWI Center of Environmental Development (UWICED)
http://www.uwimona.edu.jm/cesd/jamaice/uwiced/uwiced.html

U.S. Department of Energy (Waste Treatment)
http://www.em.doe.gov/

Addison County Solid Waste Management District
http://www.wmsym.org/

Waste Disposals Ltd.
http://www.wastedisposalsltd.com

Rapid Environmental Assessments Limited. (REAL)
http://www.opus.co.tt/real/index.html

The Caribbean Reporters Network (CERN)
http://www.webgate.poptel.org.uk/zadie/

NTTC Environmental
http://www.nttc.edu/environmental.html

Infilco Degremont, Inc (Wastewater Treatment)
http://www.inflicodegremont.com

Department Of Energy (DOE)
http://www.em.doe.gov

Appendix

The Basel Convention

The Environmental Management Authority (EMA), as a focal point for Trinidad and Tobago (T&T) was invited to the Basel Convention (BC) by the Secretariat of the Basel Convention (SBC). The conventions full title was The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. Its purpose, which if not clear by the title alone, was to control, limit, and prevent generators of hazardous waste form transporting this material to other international locations. The first convention of this sort took place in 1989 in Basel, Switzerland. The EMA was invited to the conference in 1997. By this time the Basel Convention had 111 States, not including the United States, and European Communities as parties. The rapid growth of membership to this group demonstrated the increasing interest in this important part of environment and health protection.

The Trinidad and Tobago delegation consisted of Glenn Goddard, Technical Coordinator, EMA and Ms. Lauren Boodoo, Trinidad and Tobago Permanent Mission, Geneva.

The Key Objectives of the Basel Convention

- To reduce transboundary movements of hazardous wastes and other wastes, subject to the Basel Convention, to minimum, consistent with environmentally sound management.
- To dispose of the hazardous wastes and other wastes generated, as close as possible to their source of generation.
- To minimize the generation of hazardous wastes in terms of quantity and hazardousness.
- To ensure strict control over the movements of hazardous wastes across borders, as well as the prevention of illegal traffic.

- To prohibit shipments of hazardous wastes to countries lacking the legal, administrative and technical capacity to manage and dispose of them in an environmentally sound manner.
- To assist developing countries and countries with economies in transition in environmentally sound management of hazardous wastes they generate.

The Basel Convention (BC) is the broadest and most significant international treaty on hazardous waste presently in effect. It is the first and foremost global legal instrument regulating the transboundary movement of waste and its disposal. The administrative functions of the BC are performed by the SBC, which is located in Geneva, Switzerland. Its activities are funded by contributions by member countries, which is based on a UN scale of assessments. Trinidad and Tobago is a party to the convention, but is not yet required to make contributions to the Trust Fund.

In an EMA report written by Mr. Glenn Goddard on the Basel Convention he writes that Trinidad and Tobago has ratified the BC, but has taken few steps to internalize it requirements. Transboundary movements of waste for recycling or disposal (import and export) are only allowed between parties to the Convention and even then only through strict rules of import, transit, and export. If these types of movements are to occur between party and a non-party (not a BC member), a separate agreement must be drawn up between the two. This agreement must be in accordance with the requirements of the Basel Convention. Trinidad and Tobago, a BC member, has been transporting waste to the United States, Venezuela, and perhaps other countries that are not members of the Basel Convention. None of these movements have been subject to the requirements of the BC. This movement was illegal and could have cost Trinidad and Tobago its membership in the BC.

Preliminary indications are that companies in Trinidad and Tobago export used batteries to Venezuela and spent catalyst to the United States. Trinidad and Tobago has also imported waste lead from Jamaica. Basel regulates all of these types of waste, but since the U.S., Venezuela, and Jamaica are not currently parties to the Convention they are not monitored.

In order to cease these illegal activities and to take advantage of the Basel Convention, Glenn Goddard of the Environmental Management authority wrote in a 1997 paper on the Basel Convention (reference number-EMA 828) the following requirements:

The EMA should immediately-

1. Meet with Customs officials to inform them of the requirements of the Basel Convention and determine the necessity for training to fulfil their role as the first point of intervention for hazardous waste movement.
2. Inform the business sector of the convention, through direct contact, have a liaison with industry associates and through newspaper articles, and solicit from their requirements for current and proposed transboundary movements.
3. Meet with the Ministry of Foreign Affairs (MFA) to develop bilateral or regional agreements on transboundary movement on hazardous waste with the US, Venezuela, etc. in accordance with (2.) above.
4. By writing to the SBC, the EMA should appoint itself as the competent authority for the Convention for Trinidad and Tobago.

In the short term the EMA should-

1. Report to the SBC on activities for 1994 to current.
2. Implement hazardous waste import/export laws for Trinidad and Tobago – a draft has been developed by the SBC.
3. Arrange meetings with the following agencies to determine Trinidad and Tobago's position on the issues to be discussed at the next meeting, Conference of Parties (COP IV):

- Ministry of Foreign Affairs
- Ministry of Planning and Development
- CARIRI
- Chief State Solicitor
- Trinidad and Tobago Manufacturers Association

- Customs and Excise
- Pesticides and Excise

The Basel Convention provides an excellent opportunity for Trinidad and Tobago (T&T) implement hazardous waste management programs and legislation. The government of T&T has, by ratifying the Convention, already agreed to its development of legislation, pollutant inventories, and regional environmental information systems. This support should develop if the nation continues to participate in the meetings of the Convention and show some initiative such as performing some if not all of the tasks that Mr. Goddard has outlined in his paper (EMA 828) and I have listed above.

Guidelines for the Establishment of Solid Waste Management Legislation:

The guidelines for the establishment of solid waste management are taken from Planning and Stanley Associates Trinidad and Tobago Solid Waste Study, which was done in 1979. Below is an excerpt taken from that study. It shows the birth of the idea of the EMA all the way in '79, and the laws that it should govern. These guidelines are what the EMA are trying to implement today in 1999.

" The ultimate goal of the legislative program should be to produce a comprehensive set of regulations dealing exclusively with waste management. These regulations could be administered by an existing government ministry or possibly a newly formed authority, but in any case would require competent expertise in the fields of environmental science and pollution control. In its most abbreviated form, such a regulation, in conjunction with its enabling statue, should have provision for the following eleven distinct functions: (1.) Application, (2.) Prohibition, (3.) Approval, (4.) Standards, (5.) Research, (6.) Monitoring, (7.) Control Order, (8.) Expropriation, (9.) Appeal, (10.) Regulation, (11.) Enforcement and Penalties."

Explanations of each of these functions can be found on the next page.

1. ***Application Function***

This function is to set out where, what and to whom the legislation applies, i.e., the geographical and demo-graphical application of the regulations. This function also includes the power to require the provisions or setting up waste management facilities by any person, corporation, or local authority for the sue of people or businesses in the area. (Application and approval by the EMA would still be required.).

2. ***Prohibition Function***

This function is the basis of the legislation and must be clearly and rigorously set out. Power is necessary to prohibit the disposal of waste by any person at any location other than that at an approved waste management facility. Also there must be a prohibition of the construction or operation of a waste management facility without the approval of the EMA.

3. ***Approval Functions***

Given that the prohibition function prevents the construction, use or operation of unapproved waste management facilities, the approval function sets out the framework in which application are received, assessed and processed. The requirements for the application such as scale of plans, detail of reports, qualifications of persons preparing plans and application fee structures is included.

A useful power, which can be included under this function, is that of requiring environmental impact assessments by applicants who wish to develop facilities in sensitive areas. The impact assessment process has been well documented by the United States' EPA and other agencies who have had several years of working experiences. Such an assessment process for Trinidad and Tobago would be a positive step in environmental legislation.

4. ***Standards Function***

In order to allow full environmental protection and at the same time give planners and designers guidelines to which plants or facilities can be built, it is necessary to establish limits on contaminants which can be released into the environment (air, water, and soil) by any facility. These are known as effluent standards and are usually based on plant throughput, concentration, or absolute quantities of contaminants per unit of time. With waste management facilities, the only contaminants of usual concern would be leachate to groundwater or surface water, CO2 + methane gas to the atmosphere and air pollution from burning and blowing waste.

5. ***Research and Study Function***

The EMA should have the power to conduct research and engage in studies, consult with experts, and publish findings on the general topic of waste management including, but not limited to waste generation, storage, collection transfer, transportation, processing, disposal, recycling, health implications, environmental impact, economies, social and psychological aspects.

6. ***Monitoring and Data Collection Function***

The authority should have the power to require operational data and records to be submitted as a condition of a facility approval, at time intervals to be specified by the EMA. There should be right of entry for employees of the EMA to inspect waste management facilities and take samples for analysis. Inspectors should have protection from harassment and litigation providing entry and inspectors are done without malace and in good faith. Court orders for forced entry is available if required.

7. Control Order Function

Experience has shown that normal remedies through the courts for environmental legislation violations are both tedious and non-productive. This is due in part to the difficulty in drafting prohibitions that are specific enough to be prosecuted under the normal rules of evidence and in part due to the attitudes of some courts that environmental legislation is somehow frivolous. This difficulty is compounded when the violation involves a local government. Courts have historically taken a dim view of senior governments prosecuting in effect "their own children". Therefore it has been shown that rather than resorting to court action to remedy an environmental problem, it is more effective to empower, by legislation, the issuance of control orders by the authority (EMA) which require specific acts of compliance by a person, corporation or local government. With regard to waste management facilities these acts include:

- Controlling the type and quantity of waste coming into the facility for processing.
- Following handling procedures for various types of contaminants or wastes as specified by the EMA.
- Following operational, clean up or disposal procedures as specified by the EMA.
- Improve, repair, enlarge, operate or modify a waste management facility in accordance with the approval function.
- Extinguish fires burning at waste management facilities.

8. Expropriation Function

It may be necessary to expropriate or seize private land for the purposes of establishing or expanding waste management facilities. Therefore this function is included in the legislation. As well as a provision for the ownership of land by regional authorities or agencies is addressed.

9. *Appeal Function*

It may be necessary because of political or legal restraints to allow appeals to the courts of both the control order and the expropriation order. If this is done, the control order will not be stayed pending an appeal.

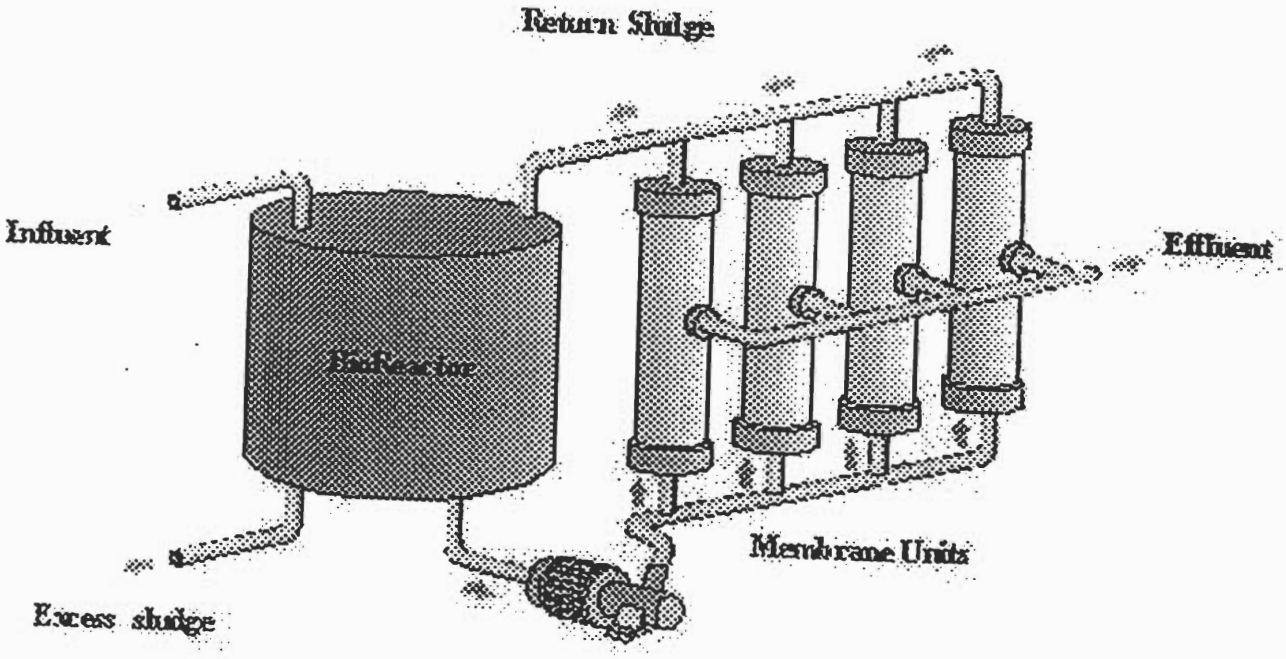
10. *Regulation Function*

This would be the power to make regulations under the statue and should cover all possible areas where action is necessary or problems could arise. It would also establish standards of quality, composition, size or shape of any packaging to facilitate recycling or reuse of the packaging or to facilitate resource recovery.

11. *Enforcement and Penalties Function*

This function is standard for any legislation and requires no special adaptation for waste management. As mentioned previously, the main instrument for enforcement is not direct prosecution but the use of administrative control orders.

BRM Membrane Bioreactor System Diagram



BRM™ System Description:
(Information taken from www.inflicodegremont.com)

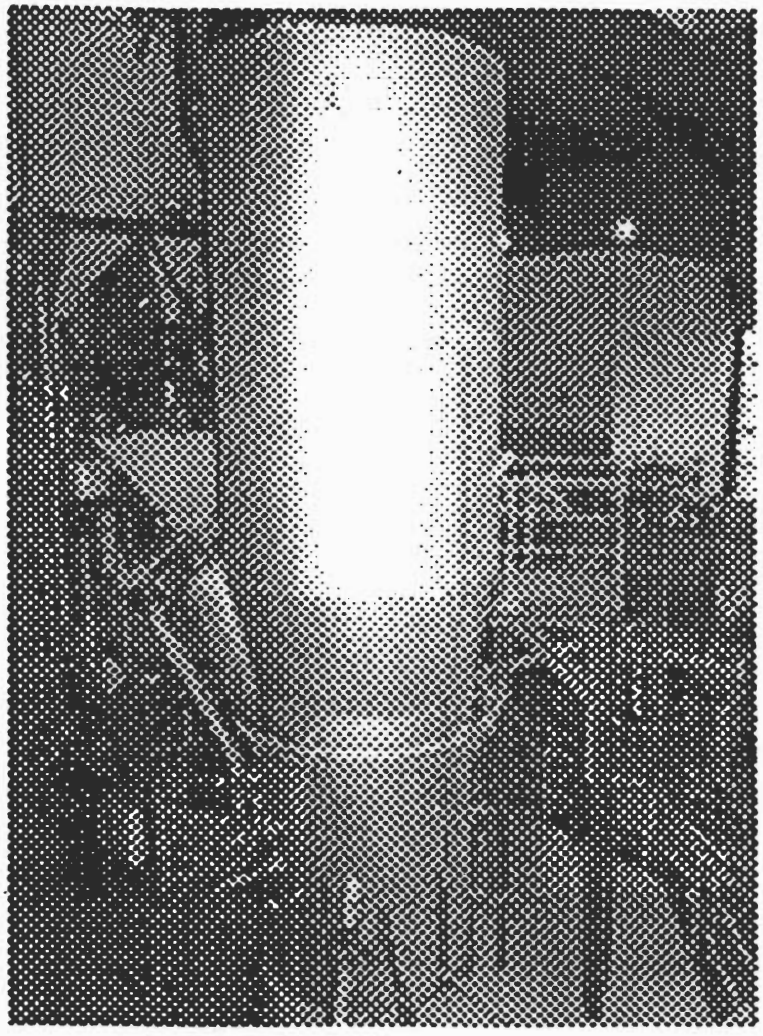
Screened influent enters the bioreactor, where it is oxidized to remove organic pollution as well as ammonia, if any. The mixed liquor from the bioreactor, at a SS concentration ranging from 10-30 g/L, is withdrawn and pumped through crossflow filtration membrane modules. The permeate from the membranes constitutes the treated effluent. The reject stream, consisting of concentrated biosolids, is returned to the bioreactor. Excess biosolids are wasted from the bioreactor or from the return line.

It may be noted that, due to the membranes acting as an absolute barrier to solids, it is possible to accurately maintain the desired sludge age in the system. Also, the micro- or ultrafiltration membranes used for separation are capable of separating suspended and colloidal solids, organic macromolecules, as well as microorganisms from treated effluent.

The BRM™ system is based on an external membrane configuration where the membrane units follow, and are situated outside, the bioreactor. This helps keep the two processes separate, avoiding interference and enabling individual process optimization. The complete separation of hydraulic and solids retention times (SRT) provides optimum control of biological reactions and greater reliability and flexibility in use (Beaubien, 1994). The BRM system typically uses high SRTs in the range of 60-100 days. The high SRT used helps in the development of slow-growing microorganisms, such as nitrifying bacteria, as well as providing complete biodegradation of difficult-to-degrade components as found in wastewaters from chemical/pharmaceutical industries, for example. Typical effluent from a BRM system has no SS, 0-5 ppm BOD and 30-50 ppm COD. Due to the high biomass concentration in the bioreactor (10,000-30,000 mg/L), the reactor can be much more compact compared to conventional activated sludge systems. Additionally, this allows the system to accept higher organic loads. Another major advantage of the BRM system is that the excess sludge production is lower than conventional systems. This has to do not only with the high SRTs used in the process, but also is a function of the shear forces imparted to the biomass as they move through the membrane units. Thus, while the BRM is an enhancement of the activated sludge system, it is quite different in space requirement and performance.

Application Areas of the BRM System:
The various advantages of the BRM system give it a unique application niche in the treatment of industrial wastewater. Typical WW characteristics where BRM becomes a viable technology are as follows:
Flow Rate: Up to 500,000 gpd, BOD: > 1,500 mg/l.
Industries where this technology has been successfully implemented include chemical, pharmaceutical and fine chemical, cosmetics, dairy, paper, landfill leachate, and food.

High Temperature Fluidized Bed Incinerator



A NIRO High Temperature Fluidized Bed:
(www.em.doe.gov)

A NIRO High Temperature Fluidized Bed (HTFB) incinerator consists of three basic zones: (1) a windbox, (2) a sand bed, and (3) a teardrop-shaped "freeboard" reactor chamber. The term "fluidized bed" refers to the violent "boiling" action of the sand itself, which occurs when air is blown through the sand bed from below. Combustion and fluidizing air enters the windbox and moves upward into the sand bed through a refractory arch and its array of special alloy tuyeres. Entering air is either ambient temperature (Cold Windbox design); preheated to 700° F (Warm Windbox design); or is preheated to 1200° F (Hot Windbox design). Dewatered sewage sludge and auxiliary fuel (if required) are introduced directly into the fluidized sand bed and are immediately combusted. The combustion gases and evaporated water flow upward into the teardrop-shaped freeboard area. This area serves to disengage the bed material and to provide efficient retention time to complete combustion. Exit gases leave the fluid bed and can be used to preheat the combustion and fluidizing air or can be recovered in a waste heat boiler. The particulate matter, inorganic ash and fine sand carryover is removed from the flue gas in the air pollution control system and goes to ash disposal. The air pollution control system is designed to meet the most stringent air pollution standards.

Common US Disposal Methods

How Is Waste Treated in the United States?
(Department of Energy website: www.em.doe.gov)

Treatment methods are selected based on the composition, quantity, and form of the waste material. Some waste treatment methods are prescribed by regulations and The Department of Energy (DOE) Orders; other treatment methods are being developed for specific wastes. Waste treatment methods being used today include solidification (e.g., calcining and vitrification) and volume reduction (e.g., incineration, compaction, and sizing).

Solidification :

Solidification processes such as calcining and vitrification can be used to treat non-solid radioactive waste. DOE processing plants take liquid waste or semi-solid sludge and convert it to a solid waste form that can be safely disposed in a geologic repository. For example, liquid waste can be solidified by a calcining process, such as that being used at DOE's New Waste Calcining Facility (NCWF) at the Idaho National Engineering Laboratory (INEL). NCWF uses evaporation to solidify liquid high-level waste generated during past spent nuclear fuel processing operations at INEL. The fluidized bed system is the heart of the calcining facility. Radioactive liquid waste droplets are sprayed into the calcining vessel where they solidify quickly on the hot fluidized beds. The end products are water vapor and small radioactive waste grains that are continuously withdrawn and transported through pipes to stainless steel bins for long-term storage pending disposal. These bins, which have a life span of hundreds of years, are encased in concrete vaults.

Vitrification is a solidification process that combines semi-liquid waste with glass, resulting in a stable glass form. In this process, highly radioactive liquid and sludge is mixed with glass particles and heated to very high temperatures to produce a molten glass. This molten glass is then poured into stainless steel canisters. When the mixture cools, it hardens into a stable glass that traps the radioactive elements and prevents them from moving through the air or water into the environment. DOE is currently operating vitrification plants at the Savannah River Site in South Carolina and the West Valley Demonstration Project in New York.

Solid Waste Reduction :

By reducing the volume of waste that requires disposal, DOE can use the existing storage and disposal sites for a longer period of time. Solid waste reduction includes treatment methods that reduce the volume of solid waste such as incineration, compaction, and sizing.

Incineration can be used to treat and destroy combustible materials in transuranic, low-level, and some mixed waste. DOE's high-efficiency incinerators are designed to control harmful effluents and comply with all environmental and regulatory laws. The resulting incinerator ash, which still contains many radioactive and heavy metals that were in the initial waste stream, is packaged and disposed of using much less space than the original waste volume would have required. Airborne effluents are carefully

processed and monitored for compliance with environmental regulations and permit conditions to ensure safety. Examples of DOE incinerators include the Toxic Substances Control Act Incinerator at Oak Ridge, Tennessee, which currently processes hazardous and mixed waste, and the Waste Experimental Reduction Facility Incinerator at INEL, which treats mixed waste. Both use extremely high temperatures to destroy the hazardous components of the waste.

Compaction is a means of reducing the volume of noncombustible waste by compressing it into a smaller, denser waste form. For example, the Waste Experimental Reduction Facility at INEL reduces the volume of low-level radioactive waste by a factor of 3 through processes such as crushing drums and shredding wastes.

In the *sizing* process, a plasma arc torch is used to cut large pieces of contaminated metals into smaller pieces that require less packaging space. Once the metal pieces have been reduced in size, they are stacked in containers, and buried as low-level waste at INEL.

Storing of Waste:

Low-level waste must be stored until it can be treated and/or disposed. The majority of DOE's solid low-level waste is disposed at selected sites using proven landfilling techniques. Some liquid, low-level waste is mixed with fly ash and poured into metal containers. Once the waste has hardened, the drums are placed in concrete vaults where they await final disposal. Solidified liquid low-level waste that cannot be disposed in existing facilities is stored in steel drums inside concrete vaults.

Hazardous waste is generally accumulated for a short time on site and subsequently sent to permitted commercial facilities for treatment and disposal. A very small portion is packaged in drums and either placed in permitted storage in buildings or on concrete pads awaiting the development of appropriate treatment facilities. Land disposal restrictions ensure that hazardous waste is stored and disposed of according to specific regulatory provisions. Hazardous waste accumulation and storage will diminish steadily as advanced minimization and treatment programs are established and implemented.

Transuranic (TRU) waste is contaminated with radioactive isotopes that have decay rates and concentrations exceeding specified levels. Because it will remain radioactive for thousands of years, TRU waste presents unique problems. DOE stores most TRU waste in a method that allows for easy retrieval. To protect the groundwater under storage areas, the waste is placed in containers and stacked on concrete pads. These containers are then enclosed in a protective vinyl cover and the area is backfilled with soil providing stable storage. The containers can be easily retrieved for future processing and disposal.

PCS Nitrogen Gas Processes

PCS Nitrogen Trinidad Limited is a subsidiary of Potash Corporation of Saskatchewan, Inc., the world's largest integrated fertilizer company. PCS produces potash, phosphate and nitrogen, nutrients which are vital for the growth of health crops, and for improving agricultural yields world-wide.

The Trinidad plant employs 420 persons, and accounts for 45 percent of total company nitrogen production.

AMMONIA

The Ammonia Complex consists of four ammonia units producing approximately 2 million short tons of ammonia annually. The utilities needed to run these units include three cooling towers, three ammonia storage tanks, steam, plant & instrument air support and the production of demineralized water for making steam.

Ammonia is a chemical with a variety of uses, its largest application being as a nitrogenous fertilizer. Under normal conditions of temperature and pressure, it is lighter than air, has a sharp, irritating odour and burns the eyes and skin. Ammonia is produced by the reaction of nitrogen and hydrogen at elevated temperatures and pressures in the presence of a catalyst. The three basic raw materials are air, natural gas and water.

The process of manufacturing anhydrous ammonia (NH_3) can be divided into eight basic steps:

1. **DESULPHURIZATION:** In this step, the natural gas feedstock is passed through a desulphurizer to remove any traces of sulphur, since this reduces the life of the catalyst in the downstream processes.

2. **PRIMARY REFORMING:** Here, steam (H_2O) is mixed with natural gas, heated and passed over a catalyst, to form mainly hydrogen (H_2), and carbon monoxide (CO) and carbon dioxide (CO_2). The catalyst promotes a reforming reaction through which the natural gas is converted into these components.

3. **SECONDARY REFORMING:** Air is added to the reformer in the necessary proportion to obtain a ratio of three parts hydrogen to one part nitrogen (N_2). The oxygen (O_2) reacts with un-reacted methane (CH_4) to form carbon monoxide, carbon dioxide and hydrogen.

4. **SHIFT CONVERSION:** Carbon monoxide formed in the primary and secondary reforming steps is further reacted with steam to produce hydrogen and carbon dioxide.

5. **CARBON DIOXIDE REMOVAL:** Carbon dioxide is removed from the gas stream by absorption in a solution known as monodiethanolamine (MDEA). It is then stripped from the MDEA and some is used as feedstock in the production of both urea and methanol. The MDEA is recycled.

6. **METHANATION:** The gas stream now consists primarily of hydrogen and nitrogen, plus small quantities of carbon oxides not removed in the two preceding steps. Since carbon oxides would poison the ammonia synthesis catalyst, it is necessary to adjust the concentration to lower than 20 parts per million (ppm). Carbon oxides are converted back to methane by reversing the steam reforming reaction. The gases are then compressed and sent to the ammonia synthesis reactor.

7. **AMMONIA SYNTHESIS:** The synthesis gas contains a 3:1 ratio of hydrogen to nitrogen. This gas is reacted over a catalyst (iron). The gas leaving the synthesis reactor contains only about 15% of ammonia. This is condensed to liquid ammonia in the refrigeration step.

8. **REFRIGERATION AND STORAGE:** The gases leaving the reactor are cooled to approximately -33.3° centigrade in order to liquefy the ammonia. The liquid ammonia is pumped to storage tanks where the temperature is maintained in order to keep it in a liquid state. The uncondensed, unreacted hydrogen and nitrogen are recycled to the synthesis reactor, where they join fresh incoming feed for ongoing reaction.

There are three insulated storage tanks, with a combined capacity of 110,000 short. From these tanks, liquid ammonia is pumped to the Savonetta Pier, where it is loaded into export tankers. The ammonia loading arm installed at the Savonetta Pier is rated at 1050 short tons per hour.

The utilities provide the services, facilities and supplies needed to operate the ammonia units: such as treated water for boilers, cooling water (fresh and salt), air (for the process, as well as instruments), steam, waste disposal and back-up electricity. One of these units, the Demineraliser, treats fresh water (provided by WASA) to remove all salts and produce demineralized water for steam generation. Fresh water is also used for cooling process equipment, and is itself cooled by sea water to reduce the use of fresh water. The sea water is in turn cooled in the Cooling Towers and recirculated.

About 18% of the ammonia produced is supplied to the Urea Plant as its major raw material, and the rest is exported to foreign markets, mainly in North America and Western Europe.

UREA

The Urea Plant has a capacity of 1875 tonnes a day of urea in granular form, suitable for both direct application and for blending with other solid fertilizers. The two main ingredients in the manufacture of urea - ammonia and carbon dioxide - are both supplied by the Ammonia Complex.

Urea is an organic chemical compound obtained from the high pressure synthesis of ammonia and carbon dioxide. It is a white, non-toxic, non-volatile, compound which is highly soluble in water, melts at 132.7° celsius, is very hygroscopic and can be handled manually. It is used mainly as a fertilizer which supplies 46.6% nitrogen by weight (the highest concentration of nitrogen available in a solid material). It is also used in many other ways: for example, as the chemical intermediate in the manufacture of resins, varnishes, glues and other adhesives; as a protein supplement for cattle feed; in toothpaste, plastics and fabric treatment.

The process of manufacturing granular urea can be divided into five steps:

1. **SYNTHESIS:** In this step, liquid ammonia and gaseous carbon dioxide in a ratio of 3.6 to 1 are fed to a Reactor, where they form ammonium carbamate, which decomposes to form urea and water. Since the reaction does not go to completion, the un-reacted carbon dioxide and ammonia are stripped off, condensed and recycled to the Reactor.

2. **MEDIUM PRESSURE PURIFICATION:** The urea solution leaving the high pressure synthesis system is expanded and heated and a further portion of the un-reacted ammonia together with carbon dioxide and water vapour is recovered and recycled to the Reactor (Synthesis).

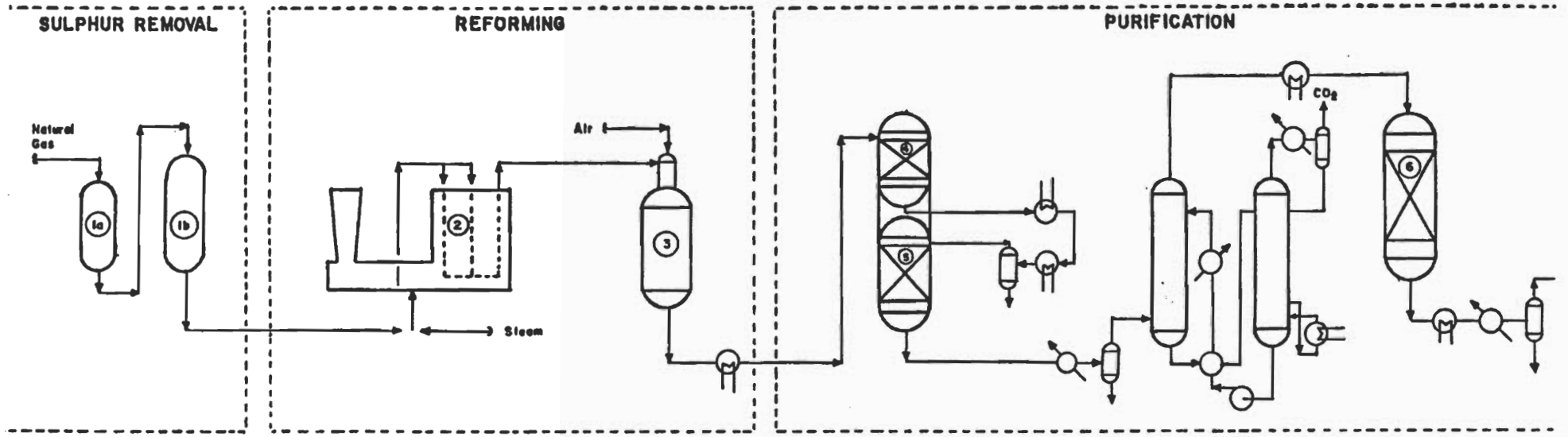
3. **LOW PRESSURE PURIFICATION:** The urea solution is again expanded and heated at a still lower pressure. A carbonate solution containing ammonia and carbon dioxide in water is recycled to the reactor via the medium pressure purification recovery system.

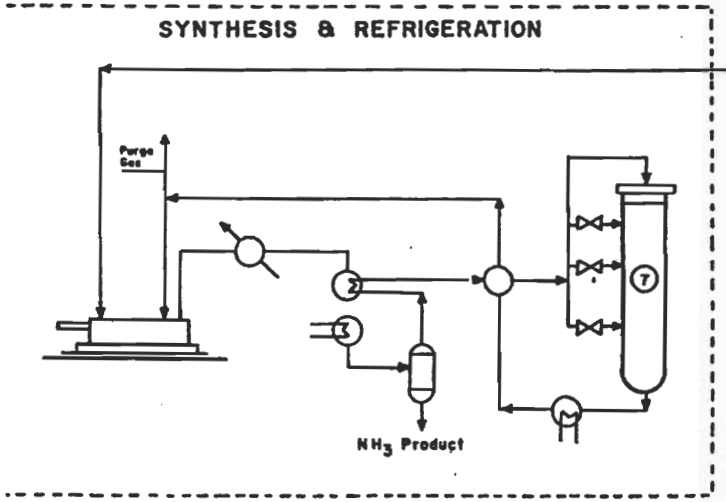
4. **EVAPORATION:** The urea solution is heated and flashed at vacuum pressure, to a molten 96% urea solution (urea melt), in a vacuum separator. The evaporated water is condensed and fed to the waste water treatment system, where traces of ammonia, carbon dioxide and urea are removed, leaving a condensate suitable for use in the steam generation system.

5. **GRANULATION:** In this final step, a small amount (0.5 percent) of urea formaldehyde is added to the urea melt. It acts as an anti-caking agent by helping to restrict the tendency of the urea granules to absorb moisture. The solution is then sprayed upwards into a bed of seed granules which is kept fluidized with warm air. Hot air is injected along with the molten urea, to atomize the urea melt into a fine spray. This spray accretes on the seed granules which then fall to the bottom of the bed and are moved along by the warm fluidizing air. The granules are then cooled and screened to ensure that they meet the market specifications. Undersize and crushed oversize granules are recycled to the granulator for use as seed granules.

The granular urea is then sent to the bulk warehouse (which has a capacity of 79,000 short tons, or 44 days production), where it is stored under controlled temperature and humidity. 90% is transported along conveyor belts to the pier, where it is loaded into the holds of dry cargo vessels at rates of up to 880 short tons per hour. The major markets are the United States, Canada and Latin America, but some sales are also made to India and China. The other 10% is bagged in 50 kilogram polyethylene sacks for sale to local and regional markets.

AMMONIA PROCESS FLOW DIAGRAM





		CATALYST	REACTIONS
1.	DESULPHURISERS:	1. COBALT/MOLYBDENUM 2. ZINC OXIDE	1(a) $S + H_2 \rightarrow H_2S$ 1(b) $H_2S + ZnO \rightarrow ZnS + H_2O$
2.	PRIMARY REFORMER:	NICKEL:	1. $CH_4 + H_2O \rightarrow CO + 3H_2$ 2. $CH_4 + 2H_2O \rightarrow CO_2 + 4H_2$
3.	SECONDARY REFORMER:	NICKEL:	$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
4.	HTS SHIFT CONVERTER:	IRON/CHROMIUM:	$CO + H_2O \rightarrow CO_2 + H_2$
5.	LTS SHIFT CONVERTER:	COPPER/ZINC:	$CO + H_2O \rightarrow CO_2 + H_2$
6.	METHANATOR:	NICKEL:	1. $CO + 3H_2 \rightarrow CH_4 + H_2O$ 2. $CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$
7.	AMMONIA CONVERTER:	IRON:	$N_2 + 3H_2 \rightarrow 2NH_3$

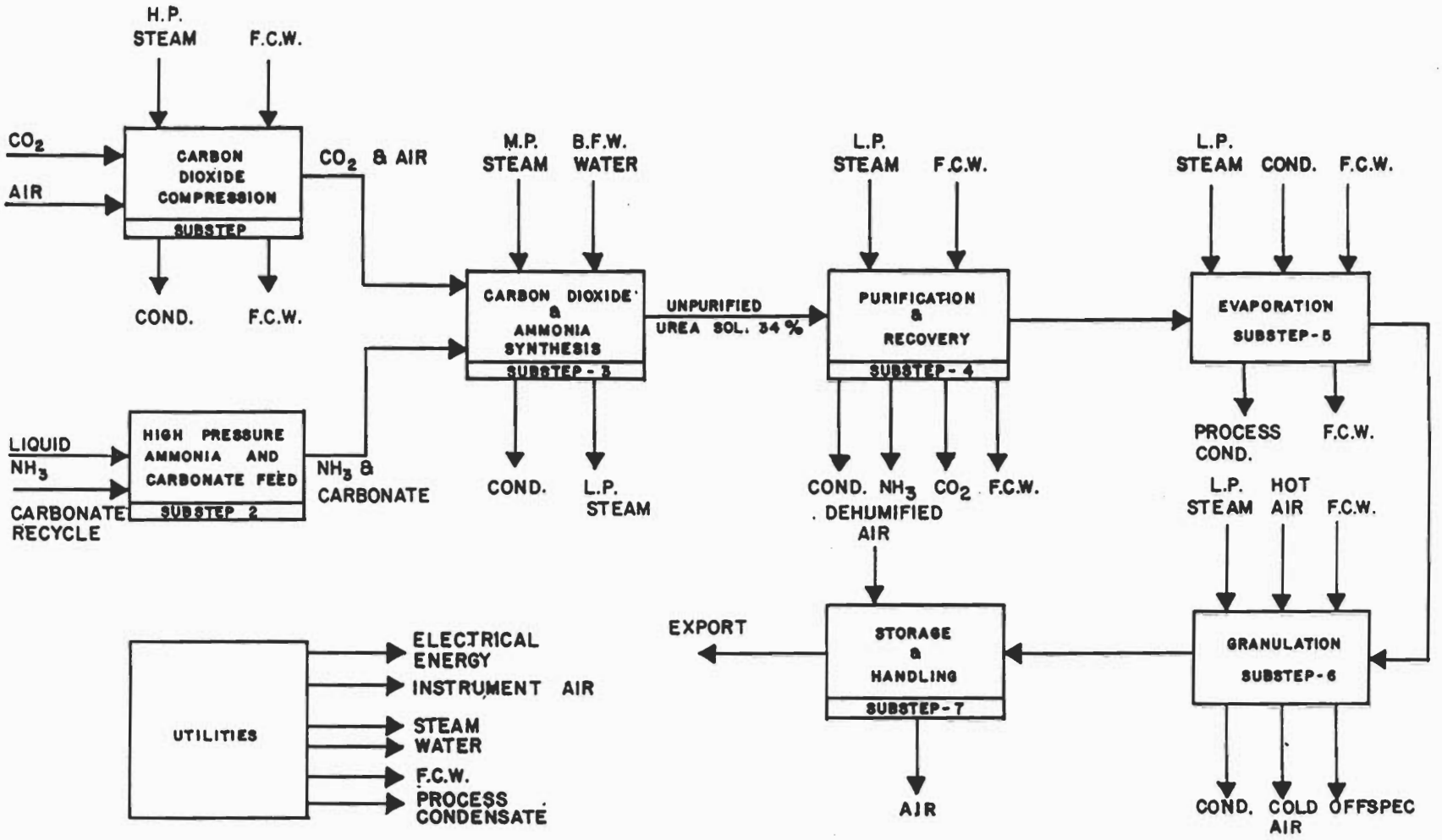


FIG. 1-1B FUNCTIONAL BLOCK DIAGRAM.

COUNTRY REPORT

ON

INCENTIVES AND BARRIERS

FOR RECYCLING:

TRINIDAD AND TOBAGO

by

Judy Daniel
Environmental Attorney

World Bank Guidelines

(This information was taken directly from the World Bank webpage: www.worldbank.org)