



**WASTEWATER TREATMENT: THE EXPERIENCES OF THE SCIENTIFIC  
RESEARCH COUNCIL IN JAMAICA**

**PPREPARED BY:**

**Julia Brown  
Manager, Process Development  
Scientific Research Council  
P.O. Box 350  
Hope Gardens, Kingston 6**

**DATE:**

**2003 October 23**

## **EXECUTIVE SUMMARY**

Jamaica, an island state in the Caribbean, is one of the special places in the world that heavily depends on its water resources to sustain the economic livelihood and social well being of its people. Agriculture for primary production and tourism are two of the main economic activities from which Jamaica earns most of its foreign exchange. Fishing from rivers, the Caribbean Sea and inland pond systems are other important means of livelihood for many of its residents, activities that directly impact the water resources of the country.

Among the implications of this great demand is the need to manage these resources in a sustainable, efficient and effective manner to ensure long-term availability for use.

There is also an urgent demand to support public and private industry compliance with local and international environmental standards

The availability of local water resources is threatened by environmental pollution caused by domestic, agricultural and industrial interference.

The Scientific Research Council (SRC) of Jamaica has over the ten years focused on providing appropriate technological and economic alternatives to the agricultural, municipal and industrial sectors, in order to avoid, reduce and treat wastewater. The SRC has completed pioneering research and development activities to adapt anaerobic technology to local conditions, in the treatment of wastewater in an environmentally friendly and cost effective manner. The process generates treated water for irrigation purposes or its return to water bodies without polluting them; organic fertilizer; and biogas, an alternative source of fuel, by allowing naturally occurring bacteria to break down solid waste, in a closed system. The process is energy generating and requires minimum operation and maintenance thus reducing operating and maintenance costs.

This paper will present experiences of the SRC in providing cost effective solutions to waste producers in Jamaica enabling delivery of “green” products and services to satisfy local and international environmental standards.

## 1.0 INTRODUCTION

In view of the economical situation existing in Jamaica and the necessity for pollution control, wastewater treatment technologies should be sustainable, cost effective and environmentally sound. These technologies should combine a high efficiency with simplicity in construction and operation and maximize the opportunities for efficient removal of pollutants.

In developing countries like Jamaica, there are many competing demands on the limited resources available for development. Waste management, although important for public health, generally gets a lower level of recognition than for example a safe and reliable water supply system. As will be shown in the following chapters, the need for quick solutions has become a priority.

The anaerobic technology is not new to Jamaica. This technology has been in use over two decades as the conventional *biogas plants* utilising animal manure. These plants are focused on generating energy for farm and household purposes. There have however been advances in the technology to what is now called the *Biodigester Septic Tank* (BST) for the on-site treatment of domestic sewage in single households and housing complexes and an anaerobic demonstration pond for the treatment of sugar wastewater as well as two Upflow Anaerobic Sludge Blanket (UASB) reactors for the treatment of food processing wastewater.

The SRC has over the years provided solutions in the avoidance and reduction as well as the treatment of wastewater to the following wastewater sectors.

### **Sectors**

- Sugar
- Municipal – Residential, commercial and Hotels
- Agro-processors (food processing)
- Farms
- Distillery
- Dairy

## 2.0 COST EFFECTIVE AND SUSTAINABLE WASTE MANAGEMENT SYSTEMS

A cost-effective system is one, which includes the following:

- Low capital cost
- Low operating cost
- Low maintenance cost
- Has a short payback period
- Offers useful byproduct/s

A sustainable waste management system is one, which is effective in meeting the demand of the present without affecting the future.

### 2.1 Why the need for Cost Effective and Sustainable Waste management Systems?

### 2.2 Present Scenario

The domestic sewage generated across the island is handled in the following ways:

**Central Sewerage System** -  $\approx$  30 % of the total sewage generated (this figure is due to the fact that the full capacity is not operational in Montego Bay, Ocho Rios and Negril). If total capacity is realized the figure will be about 40 %

**Pit Latrines** -  $\approx$  30 % of the population

**Soak-away** -  $\approx$  20 % of the population

**Septic Tank/Soak away** -  $\approx$  15 % of the population

**Other soil absorption system** -  $\approx$  1 % of the population

None of the present “Onsite” systems as well as most of the “offsite” system of sewage disposal does not provide much in the way of treatment so that most of the polluting load simply escapes into the surrounding ground or surface waters.

The following factors highlight the need to improve or substitute the present practices in the way of waste treatment and disposal:

- The impact of wastewater discharge on economically important natural resources and ecosystem
- The risk to health posed by inadequate handling and disposal of sewage
- Household sewage generated is causing serious pollution of surface and ground waters
- The present ‘on-site’ systems of sewage disposal do not provide much in way of treatment
- The extremely high cost of high tech systems (activated sludge, oxidation ditches etc.)
- The potential use of the generated byproducts

### **2.3 Solutions put forward by the Scientific Research Council**

The Scientific Research Council (SRC) along with the Ministry of Mining and Energy has since 1970 been involved in the use of the biodigester system for the digestion of animal waste and the subsequent production of biogas as a source of energy. The use of the technology has over the years been successfully anchored in Jamaica with the operation of over one hundred and fifty biodigester systems. Since 1993 and with the increased need for low cost on-site treatment alternatives the biodigester system has been expanded to the use of the BST. There has since been the construction of about ten units in single households and housing complexes. The performance of the BST has been very

successful with over 90 % removal in organic matter and solids. The SRC has also embarked on the implementation of the Upflow Anaerobic Sludge Blanket (UASB) reactor for the treatment of Agro-industrial wastewater.

The technology involved in the treatment of waste in the UASB, Biodigester and the BST and the Bio-latrine is the Anaerobic Process.

### 3.0 ANAEROBIC TECHNOLOGY

The anaerobic technology has been in existence for a very long time. According to McCarty (1981), it has existed as a technology for over one hundred years. Increasing energy prices and cost of operation and maintenance of aerobic treatment favoured the development of anaerobic treatment processes, since these processes do not require energy input and just little maintenance and attention (Schellinkhout et al., 1985). Anaerobic digestion processes occur in many places where organic material is available and redox potential is low (zero oxygen) as in the stomach of ruminants, in marshes, sediments of lakes and ditches, municipal landfills and also sewers (Alaerts et al., 1990).

For a long time these processes have been used for the stabilization of wastes and for the production of methane, a valuable source of energy (Alaerts et al., 1990). As stated by Votchen et al., (1987), it gradually evolved from an airtight cesspool and septic tank to a temperature controlled completely mixed digester and finally to a high rate reactor containing a large mass of highly active biomass.

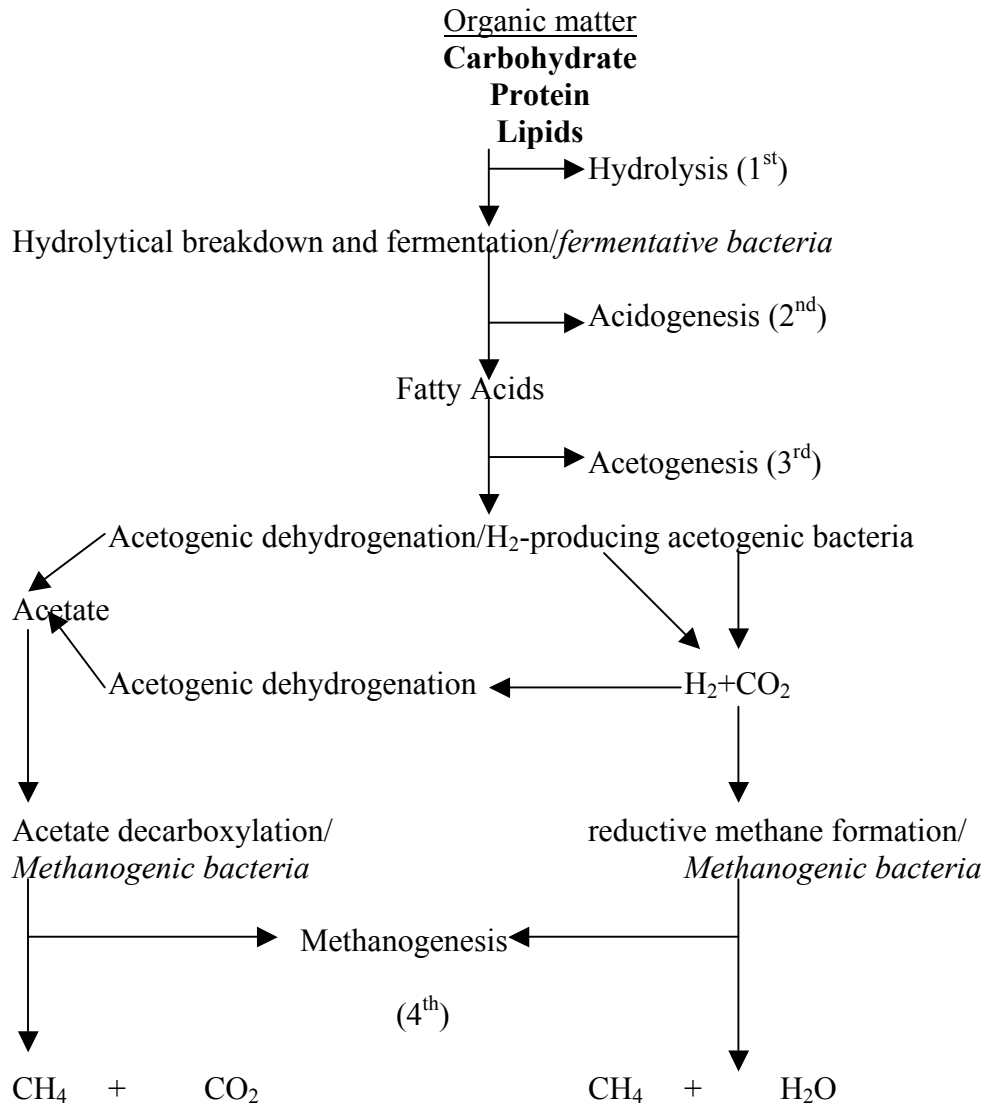
Anaerobic processes can be profitably applied for all types of waste of natural origin. Successful full-scale facilities have been constructed and operated for dilute wastewater such as municipal sewage and for very concentrated effluents such as rum stillage. Anaerobic treatment has been increasing rapidly in popularity worldwide (Lettinga et al., 1988) and as a result of its cost competitiveness has evolved into a mature technology for waste treatment (Pfeiter et al., 1986). However, with the present state of technological development and basic insight into the process, only a few of the presumed drawbacks remain, while all its principal benefits over conventional aerobic methods are still relevant (Lettinga, 1995, Lettinga et al., 1988, Lettinga, 1996)

### **3.1 Anaerobic Degradation**

The digestion process is done by putrefactive bacteria, which break down the organic material under airless conditions. This process is called “anaerobic digestion”.

The conversion processes in the anaerobic degradation are done by five major groups of bacteria:

1. fermentative bacteria;
2. hydrogen – producing acetogenic bacteria;
3. hydrogen consuming acetogenic bacteria;
4. carbon dioxide – reducing methanogens;
5. aceticlastic methanogens



**Fig. 1:** Anaerobic degradation Processes

Four different phases can be distinguished in the overall conversion process, these are Hydrolysis, Acidogenesis, Acetogenesis and Methanogenesis. The mechanisms of these different processes are as follows:

### **Hydrolysis**

First, complex polymeric materials such as polysaccharides, proteins and lipids (fats and grease) are hydrolysed by extracellular enzymes to soluble products of a size small enough to allow their transport across cell membrane.

### **Acidogenesis**

These relatively simple, soluble compounds are fermented or anaerobically oxidised to short – chain fatty acids, alcohol, carbon dioxide, hydrogen and ammonia.

### **Acetogenesis**

The short –chain fatty acids (other than acetate) are converted to acetate, hydrogen gas and carbon dioxide.

### **Methanogenesis**

Methanogenesis occurs from carbon dioxide reduction by hydrogen and from acetate to produce methane.

The biogas produced in anaerobic digestion consists mainly of methane (CH<sub>4</sub>, 60 – 70 %), carbon dioxide (CO<sub>2</sub>, 30 – 40 %), and traces of hydrogen sulphide (H<sub>2</sub>S, 0.5 – 1 %).

### 3.1.1. Advantages of anaerobic digestion

Table 1 provides a list of the advantages of anaerobic treatment

**Table 1:** *Advantages of Anaerobic Treatment*



One of the major reasons for the promotion of the anaerobic technology for the treatment of waste is the benefit it offers over the conventional treatment systems as outlined in Table 2.

**Table 2:** *Benefits of anaerobic treatment over conventional aerobic methods.*

- The method is simple in construction and operation, consequently inexpensive
- The method generally does not require electricity
- The method can be applied at very small and at very large scale, enabling a decentralised application
- Application of anaerobic wastewater treatment, when applied in decentralised mode will lead to very significant savings in the investment of sewerage systems.
- In the case of the BST there is no sludge development due to complete degradation

One of the major inhibition of the anaerobic process for the treatment of waste is the fact that the method cannot accomplish complete treatment, because not much is removed in terms of faecal coliform and nutrients and therefore as in aerobic process tertiary treatment is required.

## **4.0 SYSTEMS ADAPTED AND OPTIMIZED**

The system adapted and being propagated by the SRC for the use of waste management in Jamaica are as follows:

- The Biodigester
- The Biodigester Septic Tank
- The Upflow Anaerobic Sludge Blanket reactor
- The Bio-latrine

### **4.1 The Biodigester and the Biodigester Septic Tank**

#### **The Biodigester System**

The biodigester system is a concrete tank (see figure 1 below) which is located below the ground. The gas comes off at the top of the tank via pipelines, while the residual waste comes out automatically and flows into another tank (compensation tank). From this second tank the bio-fertilizer can be dried or sent as slurry directly to crops or to the soil. The liquid from the drying beds is sent to a polishing pond to clean the water for irrigation purposes.

The biodigester system can be used to treat the following types of organic waste:

- Dung from cattle, pigs, goats and other livestock
- Vegetable matter, Green plants and plant waste
- Agro-industrial waste and wastewater

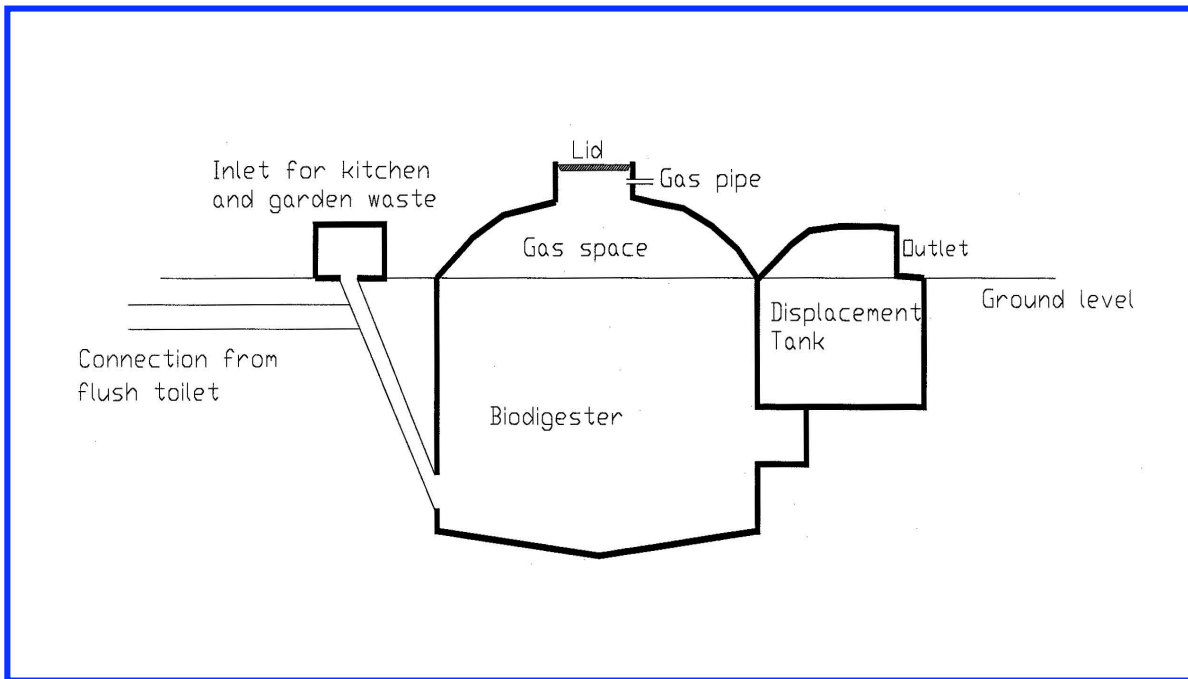
#### **The Biodigester Septic Tank (BST)**

The BST is an on-site sanitation unit, which provides for the disposal of toilet (black) wastewater as well as of (kitchen and bathroom) sullage (grey water). It should be

stressed that the BST is not an alternative or a replacement of the centralised treatment systems but for the present ineffective on-site methods of disposal such as soak-away pits.

The use of the BST has increased in importance due to the following reasons:

- ◇ The negative impact of wastewater discharges on economically important natural resources and ecosystems
- ◇ The risk to health (especially of young children) posed by inadequate handling and disposal of sewage.
- ◇ Household sewage generated is causing serious pollution of surface and ground waters and ultimately coastal water, with corresponding risks to quality.
- ◇ The present 'on-site' systems of sewage disposal do not provide much in the way of treatment – most of the polluting load simply escapes into surrounding ground and surface waters.
- ◇ The extremely high cost to operate and maintain high tech systems (activated sludge, oxidation ditches etc.)
- ◇ The use of the generated biogas, which can be, used as a replacement for liquid petroleum gas (LPG) and firewood hence reducing deforestation.
- ◇ The general need for low cost environmentally friendly alternatives.



*Figure 1. A schematic outline of a biodigester/BST*

## **4.2 Upflow Anaerobic Sludge Blanket Reactor**

The UASB is a high rate anaerobic system used for the treatment of different types of wastewater. The system was developed in the Netherlands in early seventies.

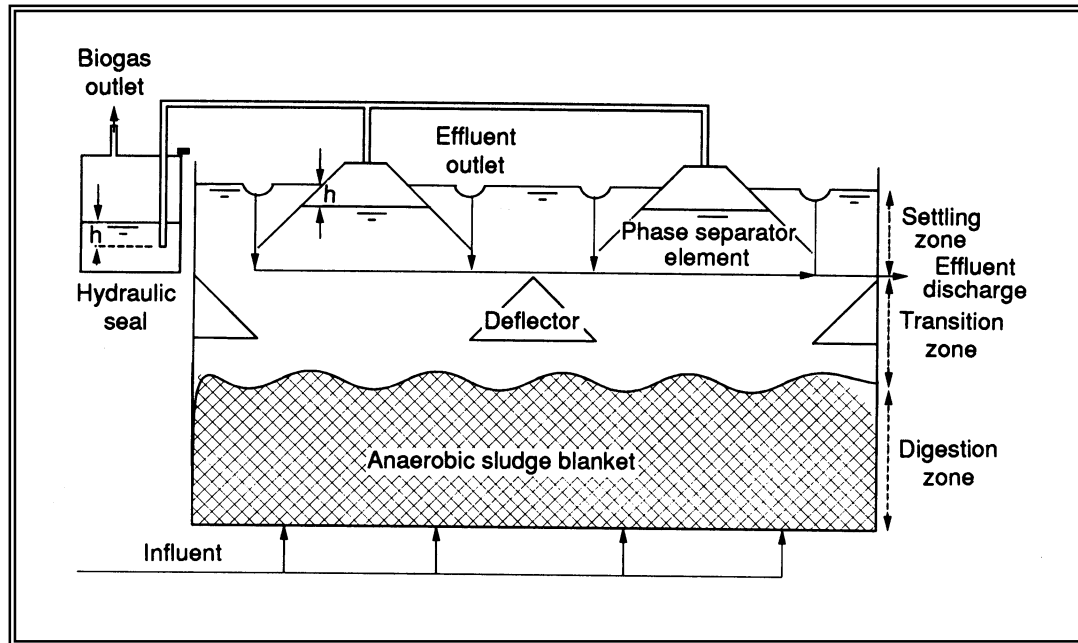
The UASB process is characterised by an active sludge blanket/bed at the bottom of the reactor that degrades the incoming wastewater. The bacteria may spontaneously agglomerate to form granules. These granules have good settling properties and are not susceptible to be washed from the system under practical conditions. Retention of active sludge, whether granular or flocculent within the UASB reactor enables good treatment at high organic loading rate. The maintenance of a high sludge concentration in the reactor is one of the most important conditions of a UASB process.

A schematic representation of the UASB reactor is shown below in figure 5. The most characteristic device of the UASB reactor is the phase separator. This device is placed at the top of the reactor and divides it into a lower part, the digestion zone, and an upper part, the settling zone. The presence of a settler on top of the digestion zone enables the system to maintain a large sludge mass in the reactor, while an effluent basically free of suspended solids is discharged. The biogas bubbles rise up to the liquid – gas interface under the phase separator. This interface may be at the same level as the water – air interface in the settler or at some lower level if a hydraulic seal pressurises the biogas. Sludge flocs with adhering gas bubbles may rise up to the interface in the gas collector, but will settle when the gas bubbles are released to the gas phase at the interface. Baffles, placed beneath the apertures of the gas collector units, operate as gas deflectors and prevent the biogas bubbles from entering the settling zone, where they create turbulence and consequently hinder the settling of sludge particles.

Some characteristics of the UASB that make it so popular and so widely used are listed below.

- High organic loading rates
- Short hydraulic retention time
- Low energy demand
- No need of support media
- Simple reactor construction
- Substantial full scale experience

**Figure 5:** Typical cross section of conventional UASB reactor showing sludge blanket/Bed and Gas - Liquid - Solids separation (van Haandel and Lettinga, 1994)



### 4.3 By-products of the Anaerobic Process

There are three major by-products of the anaerobic process - biogas, nutrient rich effluent and a stabilised sludge. However in the BST there are only two (biogas and effluent) since there is almost complete degradation of solid, as was previously stated, in a BST system.

#### 4.3.1 Biogas

Biogas is lighter than air and has an ignition temperature of approximately 700 °C compared to diesel oil 350 °C; petrol and propane of about 500 °C. The temperature of the flame is 870 °C.

Biogas consists of about 60 % methane (CH<sub>4</sub>) and 40 % carbon dioxide (CO<sub>2</sub>). It also contains small proportions of other substances, including up to 1 % hydrogen sulphide (H<sub>2</sub>S).

### **Biogas Utilisation**

Biogas can be used in the same way as any other combustible gas. The biogas can be used in a modified gas stove, refrigerator, water heater, diesel engine, gas lamps and indeed any piece of equipment that uses liquid petroleum gas (LPG). The biogas can be piped to the various pieces of equipment via PVC pipes, which is used as gas lines. The gas cannot be economically liquefied. The calorific value of biogas is about 6 kWh/m<sup>3</sup> – this corresponds to about a litre of diesel oil. Biogas has a very high level of efficiency as outlined below in Table 3.

**Table 3:** *Biogas for cooking (practical values from India – Sasse, 1988).*

Amount cooked	Time (min)	Gas (L)
1 L water	10	40
5 L water	35	165
500 g rice	30	140
1000 g rice	37	175
350 g pulses	60	270
700 g pulses	70	315

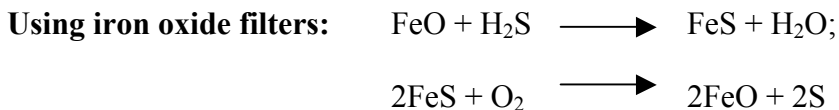
## Consumption of biogas

Table 4 outlines the amount of biogas that is consumed by the various types of equipment.

**Table 4:** *Utilisation and consumption of biogas*

<b>Equipment</b>	<b>Amount of biogas</b>
Household burners	200 – 450 L/h
Industrial burners	1000 – 3000 L/h
Refrigerator 100 L depending on outside temperature	30 – 75 L/h
Gas lamp, equiv. to 60 W bulb	120 – 150 L/h
Biogas/diesel engine per bhp	420 L/h
Generation of 1kwh of electricity with biogas/diesel mixture	700 L/h

The major disadvantage in the usage of biogas is the presence of Hydrogen Sulphide. The Hydrogen Sulphide combines with water vapour to form corrosive acids. Water heating appliances, utensils and refrigerators are particularly at risk. However biogas can be rid of the sulphur in the following way:



***NB: If gas is not used it should always be flared because non-combusted methane is harmful to the environment (it is a green house gas).***

Based on previous studies conducted the concrete structure does not degrade when subjected to anaerobic degradation.

### **4.3.2 Effluent**

The effluent from anaerobic process is rich in nutrient and is considered a rich source of liquid fertilizer. The effluent if it is to discharge or utilized for irrigation purposes will have to further treated. This is so because the anaerobic process does not accomplish complete removal of nutrient and bacteria. Tertiary treatment is employed to effect the removal of the bacteria and nutrients in order to comply with the national sewage effluent discharge standards and to be safe for reuse.

### **4.3.3 Sludge**

The sludge produced by the anaerobic process is the mineralized/stabilized biomass and is fit for reuse as fertilizer and soil conditioner.

## **5.0 POLICIES AND ACTIVITIES IMPLEMENTED TO ADDRESS WASTEWATER IN JAMAICA**

### **5.1 Legislation and Regulation**

In Jamaica there are at least fifty existing statutes which relate in one way or another to environmental management and protection. The existing legislation is widespread and fragmented that it is doubtful whether there is anyone in Jamaica who truly has a comprehensive knowledge and understanding of current environmental legislation and regulation.

With regards to wastewater management the most important statutes are:

- The National Resources Conservation Authority (NRCA) Act, 1991
- The Public Health Act 1974, amended in 1985
- The National Water Commission Act, 1963, amended in 1965, 1973 and 1980
- The Water Resources Act, 1995

The Public Health Act from the perspective of health while the NRCA Act focuses on the Environment. The NRCA Act has significant powers related to the management of the environment, and specifically for the regulation of effluent discharges, Section 9(4) and 12. The National Water Commission (NWC) Act of 1980 has responsibility for public water supply systems and public sewerage and sewage treatment. While the Water Resources Act was established to provide for the establishment of the now Water Resources Authority whose responsibility is to regulate, control and conserve water resources.

## 5.2 Regulations/Standards

The NEPA is currently developing the sewage regulations and has in place the National Sewage Effluent Discharge standard (see table 5 below) as well as consultation has commenced on the Trade Effluent Discharge Standards which should come into effect in early 2004.

The Public Health Act allows for the Minister to make regulations in relation to air, soil and water pollution in Section 14. It also allows the Local Board of Health to make regulations for the sanitary collection and disposal of garbage and other waste matter in Section 7(p).

The National Water Commission has adapted various regulations under the National Water Commission Act, mainly concerned with setting and collection of charges for water supply and sewerage services.

**Table 5: National Sewage Discharge Standards**

<b>PARAMETERS</b>	<b>EFFLUENT LIMIT</b>
BOD5	20 mg/l
COD	100 mg/l
TSS	20 mg/l
Total Nitrogen	10 mg/l
Total Phosphates	4 mg/l
pH	6 – 9
Faecal Coliform	200 MPN/100 ml
Residual Chlorine	1.5 mg/l

### **5.3 Government Policy**

The NEPA (then NRCA) and the Planning Institute of Jamaica (PIOJ) have jointly published the ‘Jamaica National Environmental Action Plan’ (JANEAP – 1995) which was produced with technical assistance from the World Bank. The stated purpose of JANEAP is:

‘to document the major environmental problems facing the country and to formulate the appropriate policy framework, Institutional arrangements, legal instruments, strategies, programmes and projects to address and mitigate these problems’.

This document is significant because it explicitly recognizes the need to pursue the goal of sustainable development and the role, which the Polluters Pays principle must play in order to achieve that goal. It contains the commitment that the Government must have in place standards for trade effluent, sewage effluent, ambient water quality, potable water, irrigation water and recreational water (pool and beaches). The JANEAP is updated annually.

### **5.4 Institutional and Organizational Arrangement for Wastewater Management**

With regards to wastewater management, the following agencies play a significant role:

- the National Environment and Planning Agency
- the Environment health Unit of the Ministry of health
- the National Water Commission
- the Water resource Authority

Other national public agencies having some involvement in wastewater management are:

- The Scientific Research Council
- The Urban Development Corporation
- National housing Trust
- Ministry of Agriculture

Local involvement in wastewater management has improved significantly over the past five years with establishment of a Northcoast Wastewater District by the NWC. It has also seen the strong involvement of Environmental Non-Governmental Organizations (ENGO) and Community Based Organizations (CBO).

## **5.5 Relevance of policies and activities to Small Island States**

The Small Island States (SIDS) are all very similar in many respects. These are as follows:

- Climatic conditions
- Tourism
- Beaches
- Infrastructure
- Cultural practices
- Waste treatment and disposal practices

These areas among others are very similar for most if not all of the SIDS therefore wastewater treatment solutions, sewage regulations as well as sewage and trade effluent standards are very important for survival and sustainable development of key industries such as tourism as well as improving well being and health of the people.

## **6.0 BENEFITS AND COSTS: ECONOMICAL, ENVIRONMENTAL AND SOCIAL RESULTING FROM THE TREATMENT MEASURES IMPLEMENTED**

### **6.1 Economical Implications**

The anaerobic technology being the major process being propagated and implemented by the SRC for the treatment of wastewater has significant economical benefits. This is so because the process produces two by-products, biogas for energy generation and the treated effluent, a rich nutrient source for irrigation.

In addition providing wastewater solutions will result in the preservation of our water resources thus enabling its use for economic activities such as tourism and recreational sports as well as making available more water for treatment for domestic purposes.

### **6.2 Environmental Implications**

Without doubt the main impacts of inadequate wastewater management in Jamaica are those associated with pollution and degradation of the natural environment.

Alongside deforestation, the management of water in all its manifestations probably represents the biggest environmental challenge in Jamaica today. According to the World Bank (Jamaica – Economic Issues for Environmental Management, 1993):

*“Jamaica’s largest problems, from the point of view of affecting the largest number of people’s lives and livelihoods, are related to water. Pollution of surface and seawaters threatens human health and tourism revenues. Clean water for domestic purposes has frequently been short in Kingston Metropolitan Area (KMA) and is presently facing a significant deficit. Due to degradation of watersheds, flooding is becoming more frequent and more severe, and pollution of ground water is raising cost of infrastructure, eroding agricultural productivity and posing health risks. Topsoil loss in the watershed areas is harming agricultural productivity and causing marine siltation. Although a number of*

*other environmental problems due exist, the water issue is by far the most serious. It must be recognized that action is required on a number of fronts and is likely to be of fairly long duration, with significant improvements only likely in the late 1990s. Realizing that these problems will be solved in short order implies making interim arrangements as well as planning for permanent and sustainable solutions”.*

Interestingly however, a significant number of Jamaicans regards solid waste management as a higher priority for action than wastewater management and water pollution control. This is no doubt due to the fact that solid wastes are a much more visible problem than water pollution, and appear to touch the average Jamaican’s daily life more directly.

As demonstrated by the statistics above, sewage is the single largest source of water pollution, although industrial water pollution takes a close second. The effects of water pollution are to be found virtually everywhere in Jamaica:

- Almost all surface waters are contaminated to some extent, some severely e.g. the Rio Cobre which flows through Spanish Town and discharges into the Kingston Harbour.
- Pollution of ground water is evident in most parts of the island. This is significant in view of the fact that ground water provides approximately 80 % of the potable water in Jamaica, and is extensively used in industry and agriculture. The sources of ground water pollution are principally the bauxite/alumina industry, agro-industries (especially from sugar factories and distilleries), sewage (especially from soakaways), leachate (from waste dumps sites) and saline intrusion (mainly from overpumping). The Liguanea aquifer is acutely affected.

- Kingston Harbour is very severely polluted, caused principally by the discharge of untreated (or poorly treated) sewage, but also by substantial pollution carried by surface watercourses entering the harbour. The pollution from Kingston Harbour is said to be affecting most of the south coast of the island as far as Negril. Eutrophic conditions, leading to algal blooms and consequent fish kills, have also been reported in around Kingston Harbour.
  
- As with all island countries, there is close interaction between terrestrial and marine ecosystems, and Jamaica is no exception. Some of the coral reefs have been badly affected by land based sources of pollution, as have some of the fisheries.
  
- Although the available data on contamination are generally insufficient to provide a comprehensive picture, there is evidence to suggest that several of the popular tourist beaches are polluted to the extent that bathing would be inadvisable.

The effects of water pollution have now reached a point where an increasing number of Jamaicans, especially the better educated and more influential, have at least recognized the connection between pollution and their own future well being and economic prosperity. It is indeed sad that the situation has been allowed to deteriorate to this point but, on a more positive note, with the implementation of the cost effective and sustainable options there is some reduction in the pollution caused by soakaway pits and ineffective wastewater treatment systems.

### **6.3 Social Implications**

The health hazards as well as the environmental degradation created by improper disposal and handling of wastewater result in a decrease in state of live for all Jamaicans. The following is true.

There is a decrease in economical opportunity and therefore the state of life that is created by the pollution of the receiving water bodies as well as the constant exposure to disease by people living in areas with improper waste disposal systems.

## **7.0 SAMPLES OF COST EFFECTIVE AND ENVIRONMENTALLY FRIENDLY SOLUTIONS IMPLEMENTED**

The SRC since 1993 has been involved in wastewater management with the key sectors of waste producers in Jamaica. Below are the highlights of activities undertaken.

### **Sugar Sector**

- Characterization of wastewater streams
- Introduction/implementation of cleaner production techniques
- Anaerobic Pilot Plant studies
- Anaerobic Demonstration Plant

### **Rum Distilleries**

- Characterization of wastewater streams
- Anaerobic Pilot Plant studies
- Proposals for wastewater treatment facilities

### **Municipal - Household and Hotels**

- Anaerobic pilot plant studies
- Implementation of the Biodigester Septic Tank (BST)
- Monitoring and Assessment of treatment facilities
- Optimization of existing facilities

### **Farming Communities**

- Characterization of wastewater streams
- Implementation of treatment facilities/ Biodigester systems

Three projects will be highlighted outlining the problems that existed and the solutions implemented. These projects are:

- i. Sherbourne Height
- ii. Villas of Kimberley

- iii. St. John Bosco Boys Home

## **7.1 Sherbourne Heights Project**

Sherbourne Heights is a housing complex in upper St. Andrew consisting of 16 houses. The complex consists of two sets of houses separated by an open lot. One set of houses has a septic tank and a soak-away as its sewage disposal system while the other set of houses has a septic tank and a manhole as its disposal system. The soakaways and the manhole have a constant overflow of sewage resulting in the constant flow of sewage on the roadways of the community. This is as a result of the soil type (clay) that exists in that area.

### **7.1.1 Problem Statement**

All the wastewater from the homes was discharged into the septic tanks via a piping system. The Citizens Association had expressed deep concern about the excess waste, the potential health hazard and the unsightly conditions, which overflows into the roadway becoming a nuisance. They were anxious to obtain a solution for this problem. They have gained knowledge of the biogas/anaerobic technology and expressed an interest for the SRC to determine the feasibility of implementing this technology in the form of the Biodigester Septic Tank (B.S.T).

### **7.1.2 Solution proposed and implemented**

An assessment of the site was conducted, samples analysed and a feasibility study done. It was proposed that a 50 m<sup>3</sup> BST along with a reed bed of 150 m<sup>2</sup> (10m \* 15m) be implemented. This system was implemented in 2001 January at a total cost of US\$9200. Results from the performance of the system are shown in Table 6 below.

**Table 6. Results of analyses from the Sherbourne Heights system**

<b>Parameters</b>	<b>Unit</b>	<b>Standard Value</b>	<b>Sherbourne Heights</b>
COD	mg/L	100	45
BOD5	mg/L	20	14.5
Nitrate-N	mg/L	10	5.28
TSS	mg/L	20	18
Phosphate	mg/L	4	0.75
Faecal Coliform	MPN/100 ml	200	120
pH	-	6 – 9	

## **7.2 Villas of Kimberley**

Villas of Kimberley is a housing complex consisting of seven townhouses in upper St. Andrew. The method of wastewater disposal at the location consisted of a two-chamber septic tank system in series followed by a soak-away pit. The wastewater first entered the first chamber where mainly large solid materials were separated and drained by gravity to the second chamber where further solids removal took place. The wastewater from the second chamber then entered the soak-away pit, which acted as the final disposal step by percolation through the soil. The entire system is gravity fed because of the natural slope and topography of the site.

### **7.2.1 Problem Statement**

It was found that the system worked satisfactory for one year after implementation, since those time however, the soak-away had been filled and overflowing unto the main driveway and nearby apartments. Absorption test carried out estimated that about 50 % percolation was taking place and that the problem may have been compounded by the

presence of a layer of clay below the top layer of sand found below the pit. Additionally a relative high water table (~ 40 feet) is present below the surface, which further impacted negatively on the rate of percolation.

### 7.2.2 Solution proposed and implemented

A system had to be put in place to provide for the biological treatment of the surplus runoff and final disposal consistent with the National Environment and Planning Agency (NEPA) standards. An assessment of the site was carried out and samples of wastewater from the pit taken and analysed. Results of analyses of samples from the pit as well as the BST and gravel filter bed system are shown in table 7. Based on the results obtained and the amount of sewage produced per day a 30 m<sup>3</sup> BST followed by a gravel filter bed unit was proposed and implemented at a cost US\$7500.

**Table 7. Results of analyses from the pit, BST and gravel filter bed and chlorination system at Villas of Kimberley**

Parameters	Unit	Standard Value	Pit	BST & Gravel Filter Bed
COD	mg/L	100	195	76
BOD5	mg/L	20	98	17
Total Nitrogen	mg/L	10	4.0	4.0
TSS	mg/L	20	35	8
Total Phosphate	mg/L	4	28.5	
Faecal Coliform	MPN/100 ml	1000	≥2400	400
pH	-	6 – 9	7.1	7.2

### **7.3 St. John Bosco Boys Home**

St. John Bosco Boys Home is located in Hatfield, Manchester and is a partially self sufficient organisation catering for the needs of over 150 orphaned boys between the ages of 4 – 18 years. The property is inclusive of a farm that produces pork, beef and chicken that is sold from a well established butchery. Vegetables and other crops are also grown.

#### **7.3.1 Problem statement**

The existing piggery underwent expansion and thus the waste being produced had outgrown the 50 m<sup>3</sup> floating drum digester commissioned in 1988. There was also the situation, which allowed for the waste to flow unto the adjoining property, which was not acceptable by the owners. The school's administration was very much interested in having a system established on the farm to treat the waste being produced and enable the use of the by-products.

#### **7.3.2 Solution proposed and implemented**

Following the request of the school, an assessment of the farm was carried out to establish data to determine the feasibility for the implementation of a biodigester system. From the assessment it was proposed that a 100 m<sup>3</sup> biodigester along with a drying bed and a polishing pond be constructed. This was implemented at a total cost of US\$14,200.

The system now produces over 50 m<sup>3</sup> of gas per day equivalent to 300 kWh per day and 25 litre of diesel oil per day. The school presently utilises the gas generated to operate Industrial cookers, stoves, water heaters, chicken and pig brooders.

## **8.0 CONCLUSIONS**

1. The anaerobic/biogas technology can become a cost effective and sustainable alternative for waste treatment in Jamaica as indicated by the following:

- Improves hygiene and protects the environment
- Provides water to assist in the recharging of aquifers
- Supplies energy to be used for cooking, refrigeration, lighting, heating and in diesel engine
- Provide effluent for irrigation purposes resulting in the reduction in the quantity of potable water for irrigation purposes
- Cleaner beaches which will enhance tourism
- Non pollution of ground water
- Low maintenance and operation cost

### **8.1 Challenges and Lessons Learnt**

#### **8.1.1 Challenges**

The challenges that are faced in Jamaica for having an integrated wastewater management framework are as follows:

- Having key organizations and individual recognizing the need for cost effective and sustainable approaches to wastewater management;
- Recognizing that wastewater is a resource and the treatment should form a link to the water company and the electricity company (wastewater treatment systems paying for itself);
- Having legislation in place that are clear and focus and capable of being enforced in a court of law;

- Having regulations enforced;
- Having the commitment of the private sector in wastewater management
- Resistance to new technologies

### **8.1.2 Lessons Learnt**

Some of the lessons learnt in trying to develop and implement cost effective and sustainable wastewater management in Jamaica is as follows:

- The approach must be to have all major organizations and individual a part of the process
- Legislation and regulations should be clear and focussed
- Legislation and regulations should be enforced
- New technologies and processes are not easily implemented

## **8.0 REFERENCES**

Alaerts, G.J., Veenstra, S., Bentvelsen, M., van Duijl, L.A. et al.. (1990). Feasibility of anaerobic sewage treatment in sanitation strategies in developing countries. Delft, The Netherlands. International Institute for Hydraulic and Environmental Engineering. IHE Report Series 20, 130p.

Lettinga, G (1996). Sustainable integrated biological wastewater treatment. *Water Science and Technology*, 33 (3): 85 – 98.

Lettinga, G (1995). Anaerobic digestion and wastewater treatment systems. *Antoine van Leeuwenhoek*. 67:3 – 28.

Lettinga, G., de Man, A.W.A., and van der Last, A.R.M. (1988). The use of the EGSB and UASB anaerobic systems for low strength soluble and complex at temperature ranging from 8 to 30 oC. *Proc. Of the 5<sup>th</sup> International Symposium on Anaerobic Digestion*. Bologna, Italy. Hall ER, and Hobson PN, Eds. P197 – 208.

McCarty, P.L. (1981). One hundred years of anaerobic treatment. In: Hughes, D.E. et al. Eds. *Anaerobic Digestion 1981*. Amsterdam. Elsevier. 1981, 3.

Votchten, P., Schowanek, D. & Verstraete, W. (1988). Aerobic vs. anaerobic wastewater treatment. *Proceedings of the 5<sup>th</sup> International Symposium on Anaerobic Digestion*. Bologna, Italy. Hall ER, and Hobson PN, Eds. P91 – 103.

Brown J., (1998). The feasibility of the anaerobic treatment of domestic wastewater in Jamaica. Thesis, IHE, Delft, The Netherlands.

The Public Health Act, 1985.

The National Resource Conservation authority Act, 1991.

The Water Resources Act, 1995.

The National Water Commission Act, 1980

The National Sewage Regulations, 2000 – National Environment and Planning Agency.

The National Sewage Effluent Standards – National Environment and Planning Agency.

Final Report of a study on Wastewater Management in Jamaica, Betts, Michael, 1995.

Jamaica – Economic Issues for Environmental Management, World Bank Country Study, 1993.