A Systemic Exploration of Waste to Guide Waste Reduction and Resource Management in the British Virgin Islands.

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Half Dissertation in Partial Fulfillment for the Degree of Masters in Industrial Administration

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LIST OF ABBREVIATIONS

BVI:	British Virgin Islands
BPoA:	Barbados Plan of Action
C & D:	Construction and Demolition
CARICOM:	Caribbean Common Market
CEHI:	Caribbean Environmental Health Institute
CEP:	Caribbean Environmental Programme
CLD:	Causal Loop Diagram
CRI:	Container Recycling Institute
CSME:	Caribbean Single Market Economy
DPU:	Development and Planning Unit
EPA:	Environmental Protection Agency
EPR:	Extended Producer Responsibility
EST:	Environmentally Sound Technologies
EU:	European Union
GDP:	Gross Domestic Product
GRRN:	GrassRoots Recycling Network
ISWA:	International Solid Waste Association
IMO:	International Maritime Organisation
IWM:	Integrated Waste Management
IWMP:	Integrated Waste Management Plan
MSW:	Municipal Solid Waste
NIDP:	National Integrated Development Plan
NIDS:	National Integrated Development Strategy
NIMBY:	Not In My Back Yard
OECS:	Organisation of the Eastern Caribbean States
PET:	Polyethylene Terephthalate
RCRA:	Resource Conservation and Recovery Act
RMP:	Resource Management Plan
RRR (3R's):	Reduce, Reuse, Recycle
SIDS:	Small Islands Developing States
Sq. km.:	Square kilometers
SSGWMP:	Solid and Ship Generated Waste Management Project
SVG:	Saint Vincent and the Grenadines
SWD:	Solid Waste Department
SWM:	Solid Waste Management
TNS:	The Natural Step
UK:	United Kingdom
UN:	United Nations
UNDP:	United Nations Development Program
UNEP:	United Nations Environmental Program
USA:	United States of America
WCED:	World Commission on Environment and Development
WEEE:	Waste Electrical and Electronic Equipment
WM:	Waste Management
WMS:	Waste Management Systems
ZERI:	Zero Emissions Research Initiative
ZWA:	Zero Waste Alliance

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TERMINOLOGY

Archipelago: A group or chain of islands.

Closed loop production system: A production systems that ensures the continuous recycling and reuse of materials so that no waste is produced.

Economies of Scale: Refers to the economic principle of lower costs per unit with increased output.

End of pipe solutions: Solutions that attempt to solve a problem after the problem has occurred. In contrast, front end planning attempts avoid or minimise potential problems at the outset.

Ferrous and non ferrous metals: Common ferrous metals include iron and steel. Common non ferrous metals include aluminum, tin and copper.

Fly Ash: Airborne ash produced when solid waste is burned or incinerated.

Integrated Waste Management: Integrated Waste Management refers to the waste hierarchy used to manage waste in many countries worldwide and consists of *reduce, reuse, recycle, treat and dispose.*

Leachate: The liquid that is formed in landfills as water (and other liquids) and passes through waste.

Life Cycle Analysis: The analysis of inputs and processes necessary to produce a product from design, through to production, consumption, and end use.

Linear production system: A production system that is linear in nature. Raw materials are extracted, processed, consumed. Remaining materials are disposed of in a landfill or incinerator.

Municipal Solid Waste: Municipal Solid Waste is waste that is collected from households, commercial enterprises and institutions, and includes construction and demolition wastes.

Polluter pays mechanisms: Legislative or financial mechanisms holding the producer of pollution responsible for the pollution they create.

Precautionary principle: If a product or process is suspected of being toxic, it should be avoided, even if there is no direct proof of harmful effects.

Residuals Management: Residuals management is the disposal of materials that cannot be reduced, reused or recycled. Residuals management may take the form of dumping, landfilling or incineration.

Scrubber: Filters on incinerator stacks to trap toxic particulates.

Waste Stream: The sum of all materials that constitute as waste to be disposed of. Rathje and Murphy (2001:46) comment that this is an "apt figure of speech. Waste flows unceasingly, fed by millions of tributaries."

White goods: Major appliances such as fridges, washing machines and ovens.

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Dedicated to Life, my ancestors and my son - for your generation.

With love and thanks to:

My husband - the best man I know

My sister who is my backbone

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ABSTRACT

Waste management is particularly challenging on islands where land is limited and the consequences of pollution more readily experienced. The British Virgin Islands (BVI), an archipelago of islands in the Caribbean Sea, has experienced a dramatic growth in population, economic development and tourism over the last two decades. One of the associated impacts stemming from these facets of growth is the large volumes of waste generated on the islands.

Tortola faces many waste management challenges such as insufficient incinerator capacity to handle the daily volumes of waste, increasing costs to manage waste, lack of landfill space, pollution from residuals management, and public, political and legislative pressure to manage waste safely and recycle.

This dissertation investigates how waste in the BVI can be reduced. A phenomenological approach is taken to investigate this topic. Stemming from this a systems perspective is adopted and the grounded theory methodology used. The respective methods and tools are used to analyse quantitative and qualitative data. Data collection is comprised of interviews, a literature review, participant observation and field notes.

Through a systemic exploration of waste from historical, global and local perspectives, a grounded theory of waste emerges that focuses on waste reduction and resource management. In line with this focus, six Caribbean islands were interviewed, with the aid of a questionnaire, to ascertain how waste is reduced on these islands.

This dissertation recommends waste reduction and resource management options for the BVI that go beyond conventional recycling and include tools such as extended producer responsibility and green procurement. Other suggestions include, but are not limited to, composting and utilising waste as raw material inputs for small businesses.

CHAPTER 1: INTRODUCTION

Safe and effective waste management is a global concern. Islands are considered particularly vulnerable to the increasing volume and toxicity of wastes, due to their fragile ecosystems and limited resources to manage wastes. Islands represent microcosms of larger continents and societies, and therefore, provide a unique opportunity to view a “closed” system in which to test the principles of waste reduction and resource management. Waste management in the British Virgin Islands (BVI) is the focus of this dissertation.

1.1 Outline of dissertation

Challenges to the safe and effective management of wastes in the BVI include the increasing volume of waste, its complexity and its toxicity. In Chapter 2, the current situation is explained by looking at the history and current factors influencing waste management in the BVI. The research question is based on the concerns arising from this situation.

Chapter 3 describes the philosophical stance, research paradigms, perspective, and the methodology and methods used to conduct this research. Justifications for these choices are made in this section.

Chapter 4 explores the current literature on waste management. Definitions of waste are given and a discussion on the major paradigm guiding waste management in developed countries, namely IWM, is discussed. This is followed by criticisms of the model and five case studies are highlighted that provide alternative methods of managing waste. Constraints islands face with regards to waste management are tabled.

Chapter 5 describes an emergent theory of waste, developed through the grounded theory methodology, which guides the focus of the research to waste reduction and resource management. With this focus, a quantitative questionnaire was developed to ascertain waste reduction initiatives within a sample population of Caribbean islands.

Chapter 6 documents the findings of the quantitative questionnaire gathered from interviews conducted in six Caribbean islands.

Both the theory and empirical data are combined in Chapter 7 to inform proposed recommendations to reduce waste and increase resource management in the BVI.

Chapter 8 evaluates the findings and the methodology of this dissertation in terms of relevance, utility, validity and ethics. Constraints of this research are also identified in this chapter. Recommendations for further research complete this chapter.

CHAPTER 2: CONTEXT FOR THE STUDY AND RESEARCH QUESTION

2.1 Introduction

This chapter describes the context of and concerns around waste management in the BVI. Drawing on data gathered through stakeholder interviews and participant observation - as described in the following chapter - and a literature review of government documents, an account of the context is provided in order to give the reader sufficient understanding of the research findings presented later in the dissertation. Variables are identified from this data and influencing relationships are presented. The research question is informed by the variables identified and their relationships.

2.2 The situation

As shown in figure 1, the British Virgin Islands is an archipelago of approximately 60 islands, rocks and cays. It is located in the North-Eastern Caribbean Sea, 60 miles east of Puerto Rico, at the Eastern end of the Greater Antilles. There are four main islands namely; Tortola, Jost van Dyke, Anegada and Virgin Gorda (BVI, 1999).

The BVI is a United Kingdom (UK) territory and, thus, falls under British jurisdiction. The British Foreign and Commonwealth Office and the Department for International Development (DFID) aim to meet environmental objectives through the Overseas Territories Environmental Charters[1]. In 2001, the BVI signed an Environmental Charter. Objectives include the control of pollution through *polluter pays mechanisms*, in order to promote sustainable patterns of production and consumption, and establish monitoring and enforcement mechanisms (Marcus, 2007).

[1] Funding is available through the Overseas Territories Environmental Programme (OTEP) and applications for funding can be made to the Governor's Office (The BVI Beacon, 2007).

Figure 1: Map and flag of the British Virgin Islands (Charles, 2008)

The National Environmental Action Plan (NEAP) guides environmental management and sustainable development within the BVI. Environmental impacts in the BVI, stemming from increased population growth, rapid development, and tourism, include: water pollution, marine ecosystems decline, coral reef degradation, fish stock depletion, species extinction, soil erosion and increasing volumes of waste that require safe and effective management (BVI, 2006). NEAP identifies waste and pollution, amongst others, as issues which are "serious and anticipated threats to the Virgin Islands environment, which if not immediately addressed to lead to the further deterioration of the environment and endanger the economy and livelihood of the territory" (BVI, 2004b:9).

NEAP conducted numerous focus groups to "determine issues and perception of residents and visitors respecting the environment and [to] identify mechanisms to protect and preserve the Territory's natural resources" (BVI, 2004b:8). With regards to disposal of *solid and liquid* wastes (including waste from the boating industry), 60% of respondents believed that current waste management (including sewage systems) "were inadequate" (BVI, 2004b:79).

2.2.1 History of waste management in the BVI

In 1965, dumps were located at Prospect Reef, Duff's Bottom, Cox Heath, Carrot Bay and the East End – areas which span the main island. To reduce waste volumes, open burning was common practice at these sites. Georges (2002) reports that, at this time, one government collection truck serviced both the capital, Road Town, and the densely populated area of the East End. On the Northern side of the Island, some areas were serviced by private individuals, through outsourced contracts. Households in unserviced areas managed their own wastes through burning or burying. In 1972, the dumpsites located at Coxheath, Carrot Bay and East End were closed. According to Georges (2002), Duff's Bottom was used until 1986/7 and Coxheath was reopened and used until the new incinerator was installed in February 1994.

In 1971, the first regulations affecting solid waste were passed, requiring households to dispose of “house refuse” in bins with lids and that any excessive wastes, such as white goods, had to be removed at the owner’s expense. Solid waste management fell under the Environmental Health Department until 1995 when the Solid Waste Department (SWD) was formed (Georges, 2002).

An Integrated Waste management Plan (IWMP) was compiled in 1990 by the consultants who installed the incinerator. In addition to recommending incineration as the preferred method of disposal, recycling was advised. However, no recycling initiatives were implemented and, to date, no comprehensive legislation regarding IWM has been passed (BVI, 2007a).

During the 1990’s, an aluminum can recycling project was implemented and a recycling committee established. The initiative ran for approximately ten years, but ended for numerous reasons, such as pest problems in the storage areas, mixed waste being added into the recycling bins, and transportation costs rendering the initiative unviable without government support. Appendix 1 details the initiative.

2.2.2 Status Quo

The SWD is responsible for the placement of skips, the collection of waste from skips, maintenance of road verges, street cleaning, the removal of derelict vehicles, management and maintenance of the incinerator and landfills, and waste education activities (BVI, 2007a). Ninety percent of the collection has been outsourced, mostly due to political pressure, and is supervised by the SWD. Numerous private waste companies exist in the territory and, in addition to government contracts, also serve businesses and small islands. Waste is disposed of in government facilities at no additional fee, as waste management in the BVI is financed solely through revenue generated through government taxes. Even though the island is dependent on a fuel fired power station, no energy is captured from the adjacent incinerator.

Public education initiatives using the mediums of television, radio and print are centered on teaching residents how to dispose of their waste correctly. School education programmes are complemented by competitions and a mascot. A jingle competition held in 2004 proved to be an effective educational tool since the winning jingle was used in subsequent radio advertisements. Community outreach programmes include volunteer cleanups to encourage residents to keep the island clean. A qualitative questionnaire was conducted in 2006 to ascertain the effectiveness of the waste education programme, however, the results are not yet available. In the meantime, a web site detailing pertinent information regarding solid waste management is being developed (BVI, 2007a).

The Conservation and Fisheries Department assists in highlighting the importance of a clean environment with an annual volunteer beach clean up in line with the International Coastal Cleanup initiative. In 2006, 710 kilograms of waste was collected over 8.5 kilometers. The three largest categories of waste collected included plastic bags, plastic utensils, and caps and lids at fourteen, thirteen and ten percent, respectively, of the total collected (ICC, 2006: 29).

In general the public is aware of how to manage their wastes correctly, although certain negligent behaviours still exist. In Tortola, although the public is encouraged to bring bulky items directly to the incinerator, some residents dump bulky goods, construction waste, and tree trimmings around skips, which the SWD then has to collect at an extra expense (BVI, 2007a).

The Litter Abatement Act is currently being promulgated and *litter wardens* are being appointed. The act was drafted in 1987 and amended in 2004. The Attorney General has been familiarized with the law and the police have been trained to write fines and follow necessary procedures. *Litter wardens* are comprised of police officers, community members, SWD staff and public health inspectors. The intention is to issue warnings to perpetrators in an attempt to change behaviour without clogging the legal system (BVI, 2007a).

Visually, waste is managed effectively within the BVI (BVI, 2007b) and the SWD is generally considered by politicians and officials as a competent and efficient department (BVI, 2007a). Tortola is generally clean and tidy. At times, skips can overflow or be surrounded by bulky waste. Roadside litter is evident but regular clean ups by the SWD ensure litter is managed.

The BVI, as with many small islands, does not have the financial and technical resources, nor the associated industry to recycle materials. Also the high cost of transportation renders recycling unfeasible in many instances and is, therefore, not pursued (BVI, 2007a). Furthermore, economies of scale render the quantity of recyclables insufficient. The island has limited storage space to collect sufficient volumes of waste to export recyclables for processing. There are, however, individuals on the island working both formally and informally with the SWD to recycle car batteries, derelict vehicles and glass.

In 2003, the Derelict Vehicle Act came into effect, requiring the collection of derelict vehicles to be outsourced. Ferrous and non ferrous metals are collected, sorted, compacted and exported from the island. See appendix 10 for image.

Car batteries are collected by the SWD and are shipped for recycling to Florida, in the United States of America (USA), by a private enterprise in Tortola. The shipping costs exceed the refund on the batteries and there are other costs including labour and time to pack the batteries. Although the recycling of batteries incurs extra expenses to the private company, moral obligations dictate that the initiative should continue. It is believed that only a minimal amount of batteries are being collected for reprocessing (BVI, 2007b).

A private glass recycling initiative was implemented in 2006. The glass is crushed and shipped to Puerto Rico. Current challenges include the expense of storage containers, transportation of materials, and collecting sufficient volumes of glass to ensure project viability.

Responses gleaned from SWD officials indicated that the implementation of first world waste management practices such as scrubbers and lined landfills would be the ideal. Waste reduction, although not currently a priority, would be pursued in the future (BVI, 2007a).

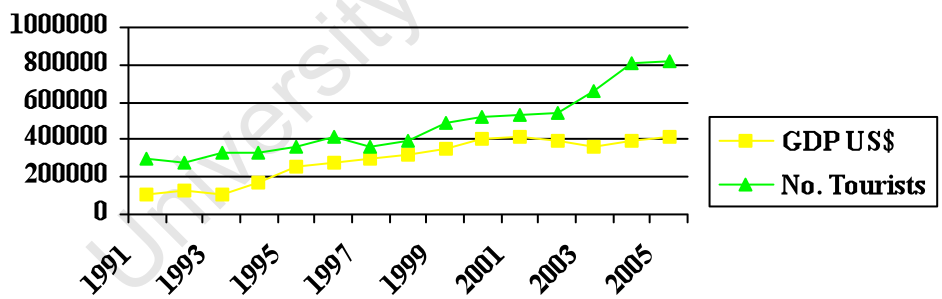
2.3 Concerns

The current situation described above and the implications for the future presents a number of concerns for the author, these are listed below.

2.3.1 Increasing waste volumes

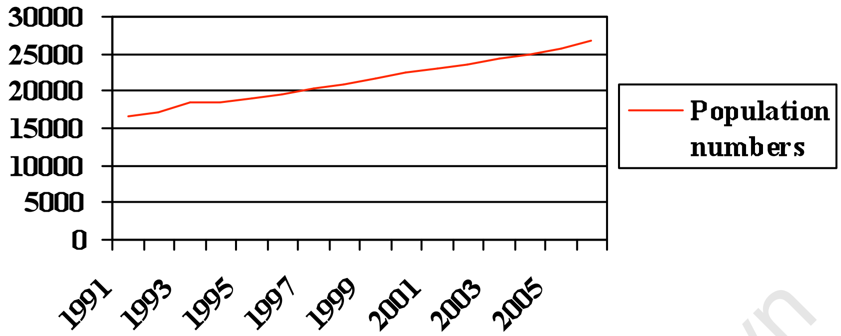
Appendix 6 explores a historical perspective on waste and demonstrates how was generation is linked to technological advances. The BVI is likewise subject to the changes discussed, with increased waste generation being an indicator of modernisation.

Figure 2: Growth in Tourism and GDP 1991 - 2006 (Source: DPU, 2007)



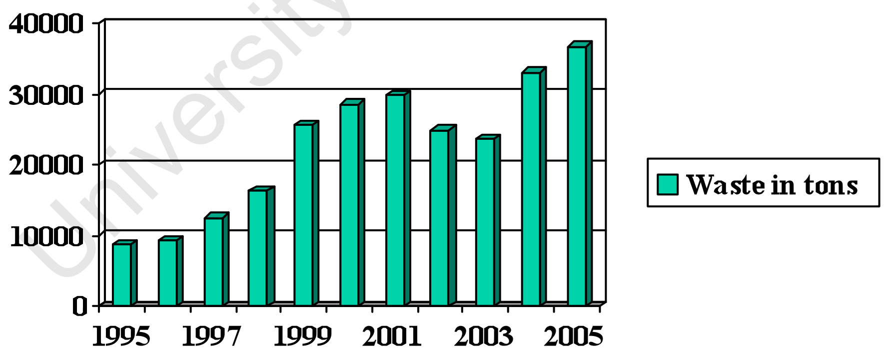
As seen in figure 2, the BVI has seen a steady growth in tourism and Gross Domestic Product (GDP) over the last decade. Increasing population numbers are depicted in figure 3.

Figure 3: BVI Population
1991 - 2006
(Source: DPU 2007)



The increases in tourism, GDP and population have had dramatic impacts on the amount of waste generated on the islands as shown in figure 4.

Figure 4: Growth in waste within BVI 1995 - 200
(Source: SWD & DPU 2007)



In 2004 approximately 31 964 tons of waste was generated representing "an increase of 27% over the previous years" (BVI, 2004:12). In 2006, waste generation amounted to approximately 37 000 tons (BVI, 2007). The decrease in waste in 2002 and 2003 is attributed to fewer American tourists visiting the islands following the terrorist attacks on the USA in September, 2001.

No heavy industry exists on the islands and most goods (and subsequent waste) are imported from abroad with $335 million worth of merchandise being imported versus $25 million of goods exported (BVI, 2007). Although no recent waste audit has been conducted, it can be assumed that, in addition to an increase in volume, the waste stream has become far more complex and toxic due to technological developments in the first world.

2.3.2 Disposal and treatment of waste

The SWD operate the disposal and treatment facilities within the territory with waste in the BVI being either landfilled or incinerated. There are four landfill sites currently in operation in the territory, situated on Tortola, Virgin Gorda, Jost Van Dyke and Anegada. Open burning, spreading and compacting of the waste are common practices and the landfills are unlined with no leachate treatment plants.

It is expected that the state owned site on Virgin Gorda has a remaining ten year life span. The landfill on Jost Van Dyke is situated on private land and is estimated to have over ten years capacity remaining. The Anegada site is situated on state land and is expected to be in service for twenty years. However, public pressure is mounting to relocate the site further away from residential zones. Although these landfills have capacity for the near future, waste reduction initiatives would not only extend the lifespan of the current sites, but also potentially remove hazardous materials.

The landfill on Tortola is on private land and negotiations are currently underway to renew the lease on the land for another year. Landfill space is still required for certain waste streams such as bulky white goods and incinerator ash. Due to the limited land space and hilly terrain of the main island of Tortola, landfill engineering is difficult and expensive. Macguire (2001) concluded that the construction of a landfill on Tortola would require special engineering and would cost approximately US$12 million, for an expected five year life span. Therefore, incineration is considered the most viable option of disposal currently available to Tortola "despite the high cost of technology, and possible environmental and health effects of the emissions" (Georges, 2002:3).

One incinerator exists in the territory with a second currently under construction; both located at Pockwood Pond. The incinerator, a Consumat CS-1600, has the capacity to burn 40 tons per day. During peak tourist seasons, waste generation is estimated at 100 tons per day (BVI, 2007a). Several problems occur when the capacity of the old incinerator is exceeded. A quote from a report written by the Incinerator Plant Manager summarises the concern:

> "What happens to the excess that cannot be processed in any day at the plant? Well that question can be easily answered by a visit to the facility, one will be greeted by flies that we try to keep under control with cutting edge pesticides, foul smells and man made mountains of waste …. The situation stresses out the workers knowing that we are trying our best but our equipment can no longer handle the workload" (BVI, 2004:5).

With the increased capacity secured by the new incinerator, the pressures of managing increasing waste in Tortola will be reduced. It is expected that the new incinerator will be operating in late 2009. Until then, Tortola is faced with waste streams that significantly exceed the daily capacity of the new incinerator.

In addition to incoming waste far exceeding the capacity of the incinerator, officials face other challenges such as maintaining the incinerator. Incinerator parts have to be imported and often take weeks to be shipped. Workers have created ingenious methods of maintaining the incinerator themselves to reduce downtime (BVI, 2007a).

Certain waste streams prove to be problematic in incinerators. A high organic fraction causes waste to burn less efficiently. Materials such as glass, metals, C & D wastes and bulky wastes cannot be incinerated. No separate collection or disposal methods exist for household hazardous wastes. The burning of household hazardous waste increases the likelihood of toxic emissions caused by the incineration process.

Tortola faces unsafe residual management issues arising from incineration and disposal. No scrubbers exist to trap toxins being emitted as air pollution[2]. The failure of the scrubbing system is attributed to erosion of the intake pipes and damage caused by the neighboring electricity department. Although these were repaired, the salt and sea debris caused the system to fail (BVI, 2007a). No specific data has yet been gathered to assess these emissions. There is a large body of information on health implication linked to incinerator emissions, some of these concerns are discussed further in section 4.4.2.2. It is expected that when the new incinerator is installed, the old incinerator will be shut down for repairs and options for a scrubber will be explored (BVI, 2007a).

Data on the waste stream composition is unreliable. To date, only one four-day waste audit has been conducted. As it was done in 1988 is unlikely to provide a good representation the current waste stream. Data on emissions from the incinerator and leaching from the landfills is non existent.

2.3.3 Increasing costs

The BVI is experiencing ever increasing costs to manage waste as is depicted in figure 5. According to the WIN (2006) and Platt (2004), incineration is an expensive disposal option and "is often economically viable only when land is scarce" (WIN, 2006:74). In addition to the expense of running an incinerator, ninety percent of the collection of waste has been outsourced mostly due to

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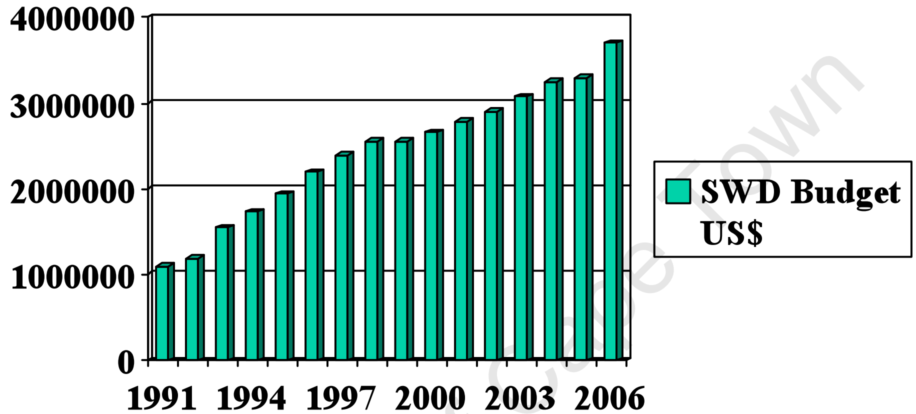
[2] Even if scrubbers were present, toxic materials would then find their way into the environment through the soil and water when disposed of in an open dump. Heavy metals such as cadmium, lead and mercury add to the toxicity of incinerator ash.

political pressure. This has further increased costs to manage waste and the annual budget currently exceeds US$3.2 million (BVI, 2004). The current budget however, falls short of the amount required to ensure the maintenance and replacement of heavy equipment (BVI, 2007a).

Figure 5: Solid Waste Budget 1991 - 2004

(Source: Georges, 2001. SWD, 2004)



2.3.4 Public and political pressure

The SWD in the BVI is being subjected to public and political pressure to implement and encourage further recycling initiatives (BVI, 2007a). The demands, although well intended, may not be realistic. The concerns regarding recycling are discussed in section 4.5.2.6.1.

2.3.5 Pending legislation

The major factor facing the BVI is the balance between development and environmental considerations. Economic development is prioritised at the expense of water, air and soil quality and there is a general lack of concern for the environment (BVI 2006). Among many environmental issues, NEAP aims to guide policy that provides safe and effective waste management services and standards that meet the needs of the society it serves. The NEAP proposals include (NEAP, 2004:52):

- the monitoring and control of pollution from landfills and the incinerator,
- early warning systems for potential waste disposal hazards such as oil spills.
- the need for the development of a national strategy for waste management
- charging a tariff for waste disposal services and
- "an air pollution control device" being installed at the incinerator.

NEAP is spearheaded by the Conservation and Fisheries Department of the BVI, who are currently finalizing the Environmental Management and Conservation of Biodiversity Bill (EMCB). This environmental bill is one of the most comprehensive in the region, and is in line with the numerous national, regional and international protocols, treaties and conventions that guide environmental policy.

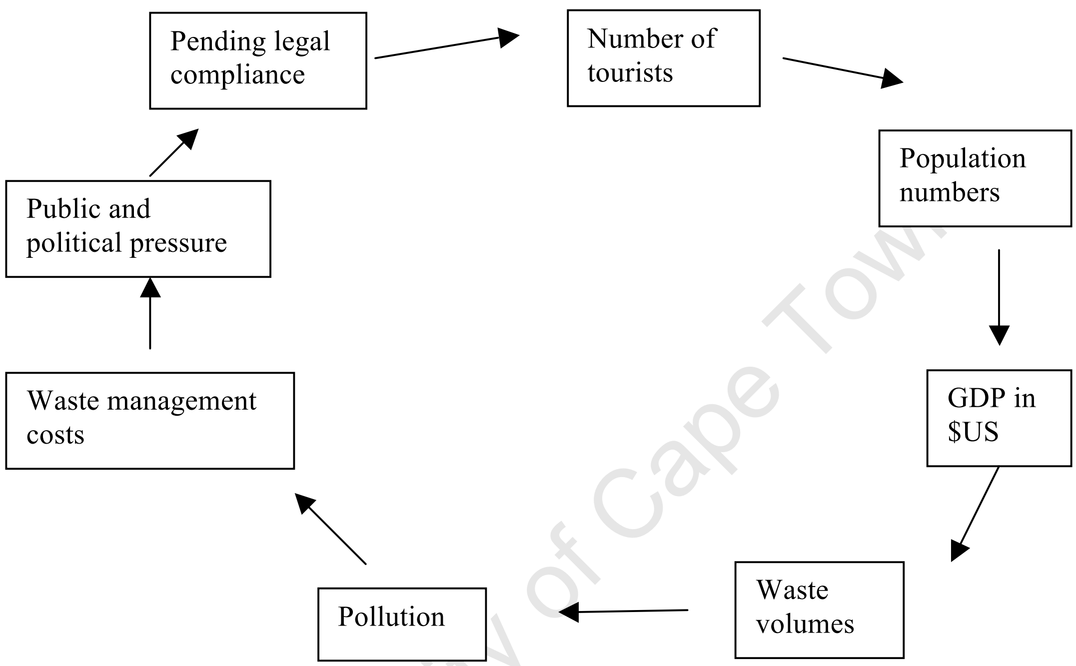
The bill aims to develop mechanisms to conduct a waste audit to understand the nature of the wastes in the Territory, in addition to identifying the "significant sources of such wastes" (BVI, 2008:38). Hazardous wastes are to be classified with licensing and permitting standards being implemented to manage these wastes safely. In addition, the bill aims to set up monitoring mechanisms to measure all forms of pollution, including those derived from waste management practices (BVI, 2008).

The concern of the researcher regarding the pending legislation, is that significant changes required by NEAP will require sufficient resources being made available. A prioritising of waste management within government will be required.

2.3.6 Variables and influencing relationships

The variables in this situation are identified below in figure 6, and the influencing relationships are depicted:

Figure 6: Variables influencing waste in the BVI



The relationships between the variables can be described as follows: Increasing population growth, tourism and consumerism have lead to an increase in demand for goods, most of which are imported into the BVI. Population growth, tourism and consumerism have demonstrated exponential growth rates over the last few decades with waste volumes, pollution, and costs to manage waste increasing accordingly. In addition to increased waste volumes, pollution, and costs, political pressure and pending environmental legislation are challenging the status quo of waste management.

The SWD are to be commended for their dedication, and for many facets of their operations that keep the BVI clean. However, they face many constraints such as limited finances, physical, and human resources as well as a lack of environmental monitoring and legislation which prevent waste management practices such as: waste reduction initiatives, hazardous waste management strategies, scrubbers, liners and leachate treatment plants. The current incinerator is unable to manage waste volumes generated, and landfill and incineration methods pose potential threats to both human health and the environment.

Environmental impacts from leachate and incinerator emissions lead to soil, water and air pollution, environmental degradation, and associated health concerns. New environmental legislation will require the measuring and monitoring of these pollutants, as well as introduce standards for waste management practices.

2.4 Research question

The central research question to be addressed in this research paper is:
How can the amount of waste being incinerated and landfilled in the BVI be reduced?

In attempting to address this question the following areas were drawn on:
- Definitions of waste
- A historical exploration of waste and waste management systems
- Investigating global waste management paradigms and methodologies
- Researching how waste is currently managed and reduced within the BVI and on other Caribbean islands
- Ascertaining what global and local paradigms, policies, and practices would be appropriate for application to the BVI context to reduce waste and optimise resource management.

Solid waste will refer to all municipal waste produced from households, institutions, hospitals, commercial and industrial activities, but will not include sewage sludge, as this is not currently a component dealt with by the Solid Waste Department of the BVI.

2.5 Summary

The BVI faces many challenges regarding waste management. These have been highlighted in this chapter, and used to guide the research question.

CHAPTER 3: FRAMEWORK FOR INQUIRY AND METHODOLOGY

3.1 Introduction

This chapter describes the philosophical framework and methodology for this inquiry through discussion of the philosophical stance and key philosophical issues relating to epistemology and ontology.

The methodology is informed by the philosophical approach adopted, and supports the notion that methods of research are based on procedures that best suit the situation of the research and the researcher. Justification for the choice of paradigms, perspectives and methodology is given, in addition to a description of data collection techniques.

3.2 Philosophical issues in research

According to Burke (2007:476), "[p]hilosophy can be defined as the questioning of basic fundamental concepts and the need to embrace a meaningful understanding of a particular field." Having a philosophical approach that indicates the stance of the research, in addition to "provid[ing] a means for clearly articulating the results of that research" (Ibid:476) makes for better research and easier identification by readers. Key philosophical issues of epistemology and ontology are examined in this section.

Epistemology is defined as the philosophy of knowledge and how that knowledge is created, whereas ontology is the philosophy of being. "Epistemology is intimately related to ontology and methodology; as ontology involves the philosophy of reality, epistemology addresses how we come to know that reality while methodology identifies the particular practices used to attain knowledge of it" (Krauss, 2005:758-759). The epistemological stance of phenomenology is taken in this research and is discussed in the following section.

3.3 Research paradigms

"Philosophical assumptions or a theoretical paradigm about the nature of reality are crucial to understanding the overall perspective from which the study is designed and carried out. A theoretical paradigm is, thus, the "identification of the underlying basis that is used to construct a scientific investigation" (Krauss, 2005:759). Mangan et al, (2004:567) describe key features of two major paradigms that guide research, as shown in table 1:

Table 1: Key features of the positivist and phenomenological paradigms
Source: Easterby-Smith et al, 1991 in Mangan et al, 2004:567.

	Positivist paradigm	Phenomenological paradigm
Basic beliefs	The world is external and objective	The world is socially constructed and subjective
	Observer is independent	Observer is part of what is observed
	Science is value-free	Science is driven by human interests
Researcher should	Focus on facts	Focus on meanings
	Look for causality and fundamental laws	Try to understand what is happening
	Reduce phenomena to simplest events	Look at the totality of each situation
	Formulate hypotheses and then test them	Develop ideas through induction from data
Preferred methods include	Operationalising concepts so that they can be measured	Using multiple methods to establish different views of phenomena
	Taking large samples	Small samples investigated in-depth or over time

The phenomenological paradigm guides the researcher to view data as qualitatively derived from meanings of the world deemed "socially constructed and subjective" (Easterby-Smith et al, 1991 in Mangan et al, 2004:567). The phenomenological paradigm allows the researcher to search for meaning in understanding a phenomenon. Here, reality is considered subjective and mutable. It is created by maps or preconceptions of that reality.

Senge (1994) describes the "ladder of inference" as the social construction of reality, whereby the observer selects data through observation. This observation is combined with cultural and personal meanings to make assumptions. Over time, the observer adopts certain beliefs that are reinforced when data is again selected through observation. Thus, the ladder of perception continues to be built upon, thereby creating unique, individual worldviews. Through social interactions, individual realities combine to create a shared social reality which guides understanding and behaviour within a society or situation.

3.3.1 Justification for phenomenological paradigm

Burke (2007:481) citing Meyers (1997) describes five epistemological assumptions that underlie a phenomenological approach. These are shown below in table 2 and the applications of these assumptions are described:

Table 2: Application of epistemological assumptions in this dissertation

EPISTEMOLOGICAL ASSUMPTIONS	APPLICATION IN DISSERTATION
"Epistemological assumption 1 **Data are not detachable from theory, for what counts as data is determined in the light of some theoretical interpretation, and the facts themselves have to be reconstructed in the light of interpretation.**	**Data was inductively used to generate theory through an iterative process thus making the phenomenological paradigm suitable for this dissertation.**
Epistemological assumption 2 **In the human sciences theories are mimetic reconstructions of the facts themselves, and the criterion of a good theory is understandings of meanings and intentions rather than deductive explanation.**	**Waste is explored through many perspectives and lenses to understand the situation. The theory was developed through an understanding of the meanings held by the various perspectives.**
Epistemological assumption 3 **The generalizations derived from experience are dependent upon the researcher, his/her methods and the interactions with the subject of the study. The validity of the generalisations does not depend upon statistical inference "but on the plausibility and cogency of the logical reasoning used in describing the results from the cases, and drawing conclusions from them (Walsham, 1993).**	**Phenomenology allows the researcher to take on a subjective role through which a theory of waste, using qualitative data, could be developed.**
Epistemological assumption 4 **The languages of human science are irreducibly equivocal (because of multiple emergent meanings) and continually adapt themselves to changing circumstances.**	**Meaning is mutable and constantly changing. Reality is socially constructed and waste is explored through many of these constructs. Phenomenology offers the flexibility to incorporate this fluidity (Burke, 2007).**
Epistemological assumption 5 **Meanings in the human sciences are what constitute the facts, for data consists of documents, intentional behaviour, human**	**The phenomenological paradigm permitted the exploration of how waste was and is treated within society. Waste is viewed as "human artifacts" (Burke, 2007:481) that**

artifacts etc. and these are inseparable from their meanings for agents" (Burke, 2007:481)	**provides factual evidence of human perceptions and behaviours.**

3.4 Research perspectives

In order to focus the phenomenological perspective of this thesis, the systems thinking perspective was selected as the "lens'. Systems thinking provides a framework for dealing with complex problems which is an alternative to a mechanistic or reductionist approach. Within systemic thinking, the concept of "boundary" is critical i.e. a boundary of personal or social constructs as defined by the researcher. This boundary of an abstract system defines the limits of knowledge to be considered pertinent to the analysis such that it can be investigated comprehensively or as a whole as it "cannot be divided into independent parts without loss of its essential properties or functions" (Ackoff, 1999). Complex interrelationships between the components need to be explored rather than viewing the components in isolation (Flood and Jackson, 1991). Thus, from a systems perspective, waste will not be viewed in isolation but as a system with interconnected parts with emergent properties which arise from the interactions of the parts.

Systemic thinking therefore allows a broad, complex perspective of waste management by taking into account:

- social perceptions and behaviours
- economic drivers
- extraction and production methods.
- waste can be explored through other professional sectors such as design, chemistry, economy, medicine and business.

Thinking systemically thus allows for a full exploration of a situation to enable identification of factors that influence the system. In this dissertation, systems thinking tools were used in the formulation of the initial research question as it highlighted possible points of intervention within the system. These tools were used in a process of analysis and synthesis to identify the major drivers of the situation and to examine the relationships between them. The CLD is shown in section 2.3.6.

3.5 Research methodology

Stemming from the phenomenological paradigm and the systems thinking perspective, grounded theory was chosen as the preferred methodology.

3.5.1 Grounded theory methodology

Grounded theory permits the analysis of qualitative data through the constant comparison of data from a number of sources. Grounded theory allows an exploration of a broad spectrum of information, from multiple perspectives, to identify patterns and develop subsequent theories on waste.

Grounded theory provided all the necessary tools to induce the theory of waste pertinent to the BVI, especially since the researcher is relatively new to waste management practices within an island setting. “Grounded theory is one that is inductively derived … it is discovered, developed and provisionally verified through systematic data collection and analysis ….data collection, analysis, and theory stand in reciprocal relationship with each other” (Strauss and Corbin 1990:23). The authors claim that grounded theory involves “systematic techniques and procedures in analysis that enable the researcher to develop a substantive theory that meets the criteria for doing ‘good’ science, these criteria include:

- significance,
- theory-observation compatibility,
- generali[s]ability,
- reproducibility,
- precision, rigor and verification (Strauss and Corbin 1990:31).

Strauss and Corbin have been criticized for presented a highly procedural form of grounded theory. Recently, more flexible approaches to grounded theory analysis have emerged, particularly those approaches which are appropriate to management research as they seek to develop theory which reflects the real world context to produce actionable knowledge in order to improve problem situations (Partington, 2000). Since actionable knowledge is the goal of this research, grounded theory provides a methodology where the theory is inductively developed from data to incorporate the various perspectives of individuals in the research situation, as well as the researcher. Although the researcher is considered an integral part of the investigation, Strauss and Corbin (1990:18) state that the researcher should be able "to step back and critically analy[s]e situations, to recogni[s]e and avoid bias, to obtain valid and reliable data, and think abstractly."

Grounded theory provides detailed process for analysis of data, however, it does not specify how data should be collected. Participant observation is commonly used as a method for data collection. In this dissertation, both qualitative and quantitative data was used for analysis - these are described below.

3.5.1.1 Qualitative data

Qualitative data collection has been triangulated to increase confidence in the data and interpretations and includes:

- **Interviews**: People interviewed included solid waste officials within participating islands, individuals spearheading projects and international waste experts. Data was used to develop a rich picture of the situation and the concerns therein. Interviews were conducted to collect responses for the waste reduction questionnaire.
- **Field Research**: Observation and Field Research took place at various waste management facilities and independent projects.
- **Literature reviews**: Reviewing documentation from academic papers, journals, government reports, research papers, books and the Internet.

- **Participant Observation**: Attendance at the annual Recaribe Conference, a waste conference for the wider Caribbean region, provided an insight into local waste management issues and initiatives. More details on Recaribe can be found in section 4.6.3.6.
- **Case studies** Leonard and McAdam (2001) cite Van de Ven (1992) and Yin (1989) "argue that case studies are especially appropriate within grounded theory methodology where real-life contexts are being investigated over a period of time."

3.5.1.2 Quantitative data

Although grounded theory methodology is normally associated with qualitative data, use has been made of a quantitative questionnaire to gather relevant waste management information relating to waste reduction from Caribbean islands using purposeful sampling. As all islands are governed independently, no central body of information on waste reduction initiatives on Caribbean islands is available. Quantitative data on waste reduction could then be compared and assimilated with the qualitative data to provide a clearer understanding of waste issues as they specifically pertain to the Caribbean region.

The justification for using the quantitative questionnaire is that this represents "methodological triangulation" as described by Easterby-Smith et al (1991) in Mangan et al (2004). Triangulation of methods, using both qualitative and quantitative techniques, are advocated by the authors as it allows the strengths of the methodologies to be highlighted and the weaknesses minimised.

The questionnaire (see Appendix 2) focused specifically on:

- **Background island information** such as island size, population, GDP, waste produced annually and disposal methods;
- **Waste reduction / resource management policies or initiatives** in place or being considered to reduce waste being disposed of;
- **Recycling and composting activities** existing or planned on the islands,

who is responsible for the activities, where the materials are processed and strengths and weaknesses of the projects;

- **Main challenges** facing islands now and in the future with regards to waste management;
- **Key areas for improvement**

An important aspect to be gleaned from this questionnaire was to determine what the waste streams of the sample population are comprised of. This information is necessary as it reveals areas of focus for waste reduction strategies.

Three waste management officials from Anguilla, St. Vincent and Antigua were approached at the Recaribe Waste Conference, held between 5-8 November 2007, to contribute to the study. Due to time constraints at the conference, the officials were contacted telephonically the following week to conduct the interviews in order to answer the questionnaire. Answers were recorded by the researcher.

To enlarge the sample size, the questionnaire was emailed to a further six waste management departments, through random selection, from various other Caribbean islands. Two responses were generated in this manner thus setting the response rate at thirty three percent. Six, out of one hundred and fifteen, Caribbean islands were questioned with five of the six islands being comparable in area. Purposeful sampling was used to gather a range of opinion rather than to provide hard statistical data.

Two pilot interviews were conducted to test the strength and validity of the questionnaire. The same interviewer held the interviews thus providing consistency in the data gathered. All interviews were noted. Responses are itemised according to island names as the names of the respondents themselves have been kept confidential. Respondents were informed of the purpose for the interview and the necessary documentation, including copies of the dissertation will be forwarded to them on acceptance of the thesis.

3.5.1.3 Data Analysis

Grounded theory systematically analyses data in a procedural manner and data analysis incorporated many steps as outlined by Babbie, 2001; Strauss and Corbin, 1990; and Stern et al, 1982:

- Data was coded and according to Strauss and Corbin (1990:62) open coding is the "part of analysis that pertains specifically to the naming and categorising of the phenomena through close examination of data." An example of a coded text can be found in Appendix 3.
- Patterns or categories will emerge from the codes. The use of many categories is encouraged and "reflects the creative, exploratory nature of the process" (Open University, 1993:15).
- Constant comparison aims "to identify sub-categories and relations amongst categories … [that] usually form the main claims of the resulting research reports" (Open University, 1993:17 - 18). Table 3 provides an example of the process of constant comparison used in this study in addition to the memoing notes discussed below:

Table 3: Comparison between SRM and IWM

- Babbie (2001:368) states that “memoing is simply writing notes to yourself” and describes three types of memoing:
  1. “Code notes identify the code labels and their meanings
  2. Theoretical notes reflect on the dimensions and deeper meanings of concepts, relationships among concepts, theoretical proposition and so on
  3. Operational notes deal primarily with methodological issues”

- Selective sampling allows researchers to collect additional data that enriches and develops existing categories. According to Stern et al, 1982, saturation occurs through selective sampling.

- “Saturation refers to the completeness of all levels of codes when no new conceptual information is available to indicate new codes or the expansion of existing ones. The researcher, by repeatedly checking and asking questions of the data, ultimately achieves a sense of closure” (Hutchinson

IWM	SRM	Memoing theoretical	Memoing methodology
reduce	reduction not sufficient, incorrect paradigm, waste = food	Linear vs cyclic	Research question to explore IWM in the BVI or SRM?
reuse	reuse	Full use of all resources in SRM	
recycle - open or closed	closed recycling		
composting	composting		
incineration	no incineration	Waste inevitable vs Remove concept of waste	
landfill	no landfill		
landfill	no landfill		

1986:125). Through this “closure” the core variables are identified.

- The core variable serves as the foundation of the theory generated. Strauss (1987:36) states that "the core variable has six essential characteristics:
    1. It recurs frequently in the data.
    2. It links various data.
    3. Because it is central, it explains much of the variation in the data.
    4. It has implications for a more general or formal theory.
    5. As it becomes more detailed the theory moves forward.
    6. It permits maximum variation and analysis."

The core variable identified though the grounded theory process was waste volumes. It met the criteria listed above, could link all the data and could be used as the basis for developing a theory on waste.

Through the emergence of the core variable, the research question could be focused. The research question started off as a broad topic of exploration into integrated waste management systems on islands and finally ended up focusing on waste reduction and resource management. With this new focus, it was necessary to obtain data on waste reduction strategies within Caribbean islands.

3.6 Research design

Maxwell (2005) describes a systemic or interactive model of designing qualitative research that is not linear - wherein each aspect of the research influences the other. Four research phases over the period of a year were conducted using both quantitative and qualitative data:

- Phase 1 began the exploratory research into waste management within the BVI. Using qualitative data collection tools of interviews, field visits, participant observation and literature reviews, a CLD could be developed to highlight the concerns of the situation.

- Phase 2 consisted of exploring waste from a systemic, historical, global and local Caribbean perspective. Inquiry into these perspectives was necessary to understand broad issues surrounding of waste. Grounded theory was the chosen methodology analyse the data and resulted in a theory of waste (chapter 5). This theory was used to guide the research question and phase 3 of the research.

- Phase 3 was the selective sampling of quantitative information on waste reduction initiatives within the local context of Caribbean islands. A questionnaire was developed and piloted. Interviews were conducted with six islands participating. This process is described in section 3.5.1.2.

- Phase 4 consisted of using grounded theory to assimilate the information in all the phases so as to develop recommendations to guide waste reduction and resource management in the BVI.

Using grounded theory to assimilate data from phase 1 and phase 2, the research topic and question was refined through an iterative process of induction and deduction. Through the exploration of data on waste and waste management, a theory of waste emerged that narrowed the scope of the dissertation down to focus specifically on waste reduction and resource management. The emergent theory guided the focus of the questionnaire conducted in phase three to gather waste management information related to waste reduction and resource management.

3.7 Conclusion

The research question is influenced by the Philosophical frameworks, the personal and academic goals of the researcher as well as the context of the situation. This in turn influences the data collection and the analysis methodology - and their respective rigour and validity. In summary, the research framework for this thesis can be depicted as follows:

Table 4: Research Framework

Epistemology	**Phenomenology**
Perspective	**Systems Thinking**
Methodology	**Grounded Theory**
Methods	**Qualitative analysis, quantitative questionnaire**

“The researcher should be a reflective practitioner, continually thinking about the process of research and especially about her or his in it, and the implications for research …throughout the whole process of the research” (Open University, 1993:22). Relevance, utility, ethics, validity and rigour of the research process have to be taken into account and these aspects are discussed in chapter 8.

CHAPTER 4: LITERATURE REVIEW

4.1 Introduction

This chapter reviews current literature on waste and waste management systems.

4.2 Definition of waste

Many definitions exist for the word waste and there is much debate as to how waste should be defined. Adopting a suitable definition of waste is crucial as it guides the thinking, legislation, methodologies and technologies for solid waste management within societies.

The United Nations Division for Sustainable Development defines waste as a noun: “material which has no further useful purpose and is discarded. It is, therefore, perceived to have no commercial value to the producer. This does not, however, preclude it being of value to some other party” (UNDESA, 2004a). The Oxford Dictionary (2002) defines waste as a verb: “(1) use carelessly, extravagantly, or to no purpose. (2) fail to make full or good use of” (Oxford, 2002:953).

Pongracz (2002) in her doctorate dissertation claims that the current definitions of waste ensure that waste management is simply a reaction to goods that no one wants and that these definitions are in fact are in conflict with the goals of waste reduction restricting reuse, trade and transportation. These definitions accept waste as a natural consequence of human activity without examining its root causes. Pongracz (2002) claims that redefining “waste” is fundamental to changing the way it is managed and that understanding the causes of waste will lead to effective waste management.

Palmer, (2004:88) redefines waste as “any object whose owner does not wish to take responsibility for it” claiming that ownership and responsibility are the keys to solving the waste problem. Palmer (2004) attempts to avoid using the term waste in his book *Getting to Zero Waste* as it “carries a connotation of unusable, unwanted, unrecyclable. It implies that waste is somehow an intrinsic property of the article, rather than an artificial, socially imposed deficiency of imagination” (Palmer, 2004:17). McDonough and Braungart (2002), Hawkin et al (1999) and Pauli (1998) consider waste as food, resources to be used in other production processes thus mimicking the use of materials as exemplified by nature.

4.2.1 Waste categories

Under current definitions of waste, solid waste is generally produced in three ways: “Through the production and consumption of goods and services; through the processing of wastes from these services; and through end-of-pipe control or treatment of emissions.

Waste is generally categorized by origin under the following categories: “mining and construction wastes; energy production wastes; agricultural wastes; municipal wastes; and industrial waste or sludge” (UNDESA, 2004a).

Volumes and types of waste categories vary significantly depending on the economic development and activities of the region. Hawkins et al (1999:48) describe waste as occurring in all forms of matter namely solid, liquid and gas such as “tailings, gangue, fly ash, slurry, sludge, slag, flue gases, construction debris, methane and other wastes.” Typical waste found in a first world urban waste stream include categories such as organic material, construction and demolition waste, paper, plastics, tyres, metals, wood, textiles, glass, ceramics, white goods, nappies, electrical goods, hazardous waste, chemicals and sewage sludge.

Palmer (2004:2) notes that although these categories sound inclusive and conclusive, it must be acknowledged that each category listed consists of thousands of variations of each substance. There are 50 000 commercial chemicals each with its own "manufacturers, its own users, its own lines of distribution and its own recycling possibilities." Plastic, although simplistically divided for recycling purposes into six different types, in fact consists of thousands of different types, each one a separate entity in itself. Since plastics are often mixed with other materials, possible variations are greatly increased.

Rathje and Murphy (2001) in their waste studies, spanning over a period of three decades, have found that common perceptions regarding waste are incorrect. Apparent culprits that are thought to dominate landfills include plastics, disposable nappies and fast food packaging. The main perpetrators however are construction and demolition wastes and wastes from industrial and agricultural processes which combined "constitute more than 98% of the 12 billion tons of material in America that … get discarded each year" (Rathje and Murphy, 2001:46). The authors warn that these and other misconceptions regarding waste can lead to "counterproductive" policies and actions (Ibid: 106).

4.3 Evolution of waste

Initiated as an archaeological study at the University of Arizona, Rathje and Murphy (2001) set out to explore the complex interconnections between waste, economic markets, and human behaviour in "The Garbage[3] Project." In the "Garbage Project", waste is viewed as a physical reality which represents an accurate portrayal of human activities and world views. Over a period of 30 years, more than 114 000 kg of waste was rigorously sorted by "garbologists." Rathje and Murphy claim that "[g]arbage most usefully comes alive when it can be viewed in the context of broad patterns, for it is mainly in patterns that the links between artifacts and behaviours can be discerned" (Rathje and Murphy

3 The words waste and solid waste are used interchangeably to describe rubbish, garbage and trash. It is generally understood that garbage is organic and compostable waste such as food waste and trash refers to household waste that is inorganic such as packaging waste. However, the words rubbish, garbage and trash will only appear in quotes.

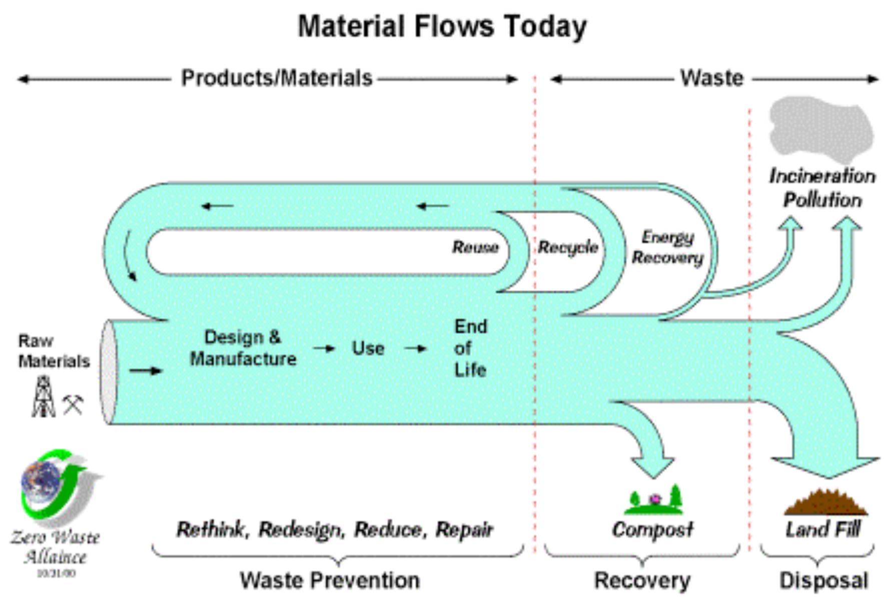
2001:19). Appendix 6 documents the evolution of waste from a historical perspective to highlight these “broad patterns.”

An abundance of data is available on waste policies, strategies, systems, infrastructure and tools throughout the world today. All communities rely on some form of waste management system, the processes of which are widely documented. However, information on the social and cultural systems that have created this waste is sparse. Rogers (2005), in her book “Gone Tomorrow: The Hidden Life of Garbage” refers to waste as being a “hidden” externality. Historian Susan Strasser (1999) states in her book *waste and want*:

> “The topic of waste is central to our lives yet generally silenced or ignored. My initial work revealed both the silence and the centrality... I had to poke around for pieces of evidence that might be found nearly anywhere … but that were often little more than shreds and scraps. Nor was there much theoretical help. Because conventional economics generally treats trash and other forms of pollution as ‘externalities’, it ignores most of the topics for a social and cultural history of trash” (Ibid: 1999: 18).

By investigating the processes that create waste, the causes of increasing waste volumes can be addressed. The waste disposed of by consumers represents valuable materials that have been derived at great expense and effort. On average, our current production methods produce 70 tons of waste for every ton of household goods created (Rogers, 2005:4). Hawkin et al (2004), McDonough and Braungart (2002:27-28) and Pauli (1998) cite higher figures of wasted resources and estimate that between eighty to ninety five percent of virgin materials extracted go to waste and that the actual percentage of materials used in the finished product can be as low as five percent. Figure 2 below is a representation of this linear material flow, depicting how, in today’s current linear production systems, the majority of raw materials processed become waste.

Figure 7: Current materials flow (ZWA: 2007)



In her animated documentary, Leonard (2007) describes the *Story of Stuff* wherein she highlights the various components of current production systems, namely extraction, production, distribution and consumption. Leonard (2007) follows the journey of goods through these components and shows how they contribute to the waste problem.

An example of waste created within a system is described by Womack and Jones (1996) who analysed the life cycle of a cool drink can in the United Kingdom. The journey begins when bauxite, to make aluminium, is mined, and ends with a consumer throwing away an empty can. The story of the can is found in Appendix 4.

All products undergo complex processes before they are found on supermarket shelves and result in “Americans wasting … nearly 1 million pounds of material per person per year” (Hawkin et al, 1999:52). Appendix 5 lists three common types of Municipal Solid Waste (MSW) and the materials required to produce them.

4.4 How is waste managed?

IWM is the dominant paradigm guiding waste management systems in developed countries such as the USA, the EU, the UK, South Africa and Australia. It is noted that the vast majority of countries in the world are attempting to meet basic solid waste management objectives through adequate collection systems and safe disposal methods (IWMA: 2002, WIN: 2006). The WIN report cites a Yale study (1992) that is developing working papers on solid waste policy. The study claims that “the waste hierarchy is a sound technical, financial and environmentally desirable approach” (WIN 2006:14).

The global issue of waste management is addressed in Chapters 20, 21 and 22 of the United Nations Agenda 21 Sustainability Framework. Chapter 21 describes the aims of the IWM strategy as:

- Reduce as much waste as possible so that waste is not produced in the first place.
- Reuse all possible materials remaining.
- Recycle what cannot be reduced or reused.
- Treat what cannot be recycled, reused or reduced
- Landfill or treat only those wastes that cannot be filtered through the above tiers

(UNDESA, 2004).

A funnel depicts the focus areas of IWM in descending order of importance with disposal as the least desirable waste management option.

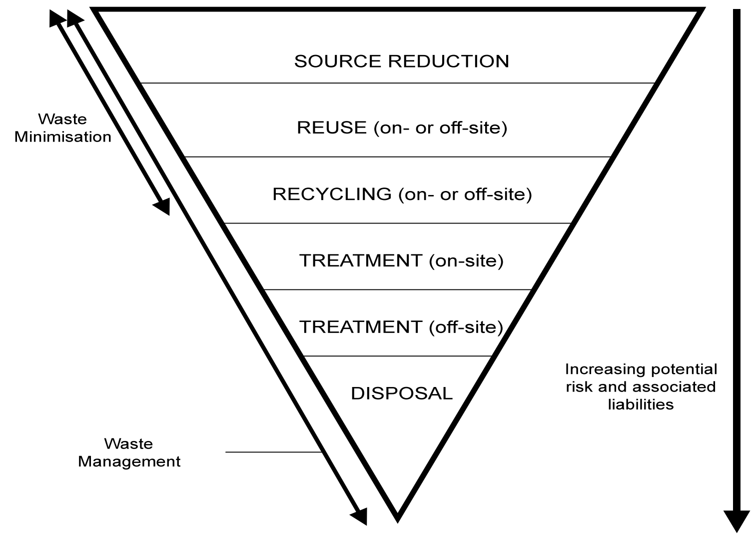


Figure 8: The IWM hierarchy as a funnel (Dittke, 2007).

The focus on one facet of the hierarchy affects the logistics of the entire system. For example, the collection system implemented, the type of vehicles procured, the types of storage containers used and the waste education and awareness initiatives implemented will vary according to which component is chosen.

The component selected not only influences waste management systems but also other facets of society. For example, in Curitiba, an initiative to recycle household waste has resulted in a 70 percent recycling rate. Sorting stations, built reusing discarded materials, are used to sort recyclables. People from lower socio-economic groups are employed to sort recyclables as a job creation initiative (Hawkin, et al, 1999). In areas not served by formal collection services, citizens living therein can swap their waste at specified collection points for "food tickets[4], bus tokens, school notebooks, or Christmas toys" (Ibid: 300-301). Waste management systems in Curitiba thus positively influencing environmental, economic, health and education systems and improve living standards through public participation, innovation and creativity.

[4] The food tickets can be used to purchase locally grown produce thus supporting local farmers.

4.4.1 Components of IWM

Components of IWM, namely reduce, reuse, recycle, incineration and landfill are discussed below:

4.4.1.1 Rethink and Reduce

Reducing waste at source on industrial, commercial and residential levels is the ultimate aim of the IWM hierarchy, and ensures that less waste requires treatment through reuse, recycling, incineration and disposal. As Taylor (1974:9) states:

> "Ideally, every method of waste reduction should be explored before resource recovery [recycling] methods are implemented. Taxpayers should not finance resource recovery facilities designed to handle materials that need not have been produced in the first place."

Rethinking and redesign of current production methods and consumption patterns are required to reduce the volumes of waste produced. Numerous initiatives exist to reduce the amount of waste generated by society, industry in particular. UNEP (2001) identifies the various methodologies, initiatives and tools for reducing waste such as Cleaner Production, Eco-efficiency, Pollution Prevention, Waste Minimisation, Green Productivity and Industrial Ecology or Industrial Metabolism.

Although different initiatives, they share a common framework and aim to minimise the amount of waste produced industrially. According to Pongracz (2002), there are four ways in which waste minimisation is achieved:

- "using less materials to produce a product" (Ibid:29)
- "creating durable products" (ibid:30) that last longer, thereby creating less waste
- "waste evasion"(Ibid:30) where production systems are changed to reduce

the amount of waste produced during production

- "using less harmful substances" (Ibid:30) as substitutes for more toxic materials.

The benefits of waste minimisation are numerous: it saves money, decreases the use of raw materials, water and energy, decreases the quantity and toxicity of wastes, increases worker safety and reduces the impact of industry on the environment. The combination of tightening environmental legislation with diminishing resource bases has encouraged many companies to embrace waste minimization. However, as discussed in appendix 6, there is general resistance to change linear production processes in part due to the large investments in current production and waste management systems.

4.4.1.2 Reuse

Waste materials that cannot be reduced should be reused. Reusing items differs from recycling in that the object of reuse is not broken down and remade, the original form of the object is kept and simply the function of the object can be changed.

Deposit laws on beverage containers provide an example of reuse. The benefits of reuse are plentiful. Following the deposit law initiated in Oregon in 1973, forcing the reuse of beverage containers, Rogers (2005) cites Fenner and Gorin (1976) as stating:

> "Oregon's deposit law …was an indisputable success. Roadside litter was down 35 percent by volume, 385 million fewer beverage containers were consumed due to increased reuse and recycling; energy savings were sufficient to heat 50 000 Oregon homes … and the public liked the bill, giving it a 91 percent approval rating" (Rogers, 2005:147).

In addition to reducing waste and litter, reuse has economic, environmental and social benefits. Reuse saves on the use of raw materials and reduces impacts from extraction processes.

4.4.1.3 Recycle

According to the IWM hierarchy, the waste portion that cannot be reduced or reused must then be recycled. Recycling is the reuse of matter by transforming it from one form to another. This concept is abundantly evident in natural ecosystems where waste products from one organism are used as food for another.

Pongracz (2002) identifies three major types of recycling:

- Closed Loop Recycling whereby the quality of the original molecules are preserved
- Open Loop Recycling consists of altering the original molecules to fit another function
- Down-cycling whereby the original quality of the molecules is degraded or only partially used.

Recycling has multiple benefits such as using less energy and water, creating less pollution, generating fewer wastes than extractive industries. For example, "Recycling scrap requires a third as much energy … cuts air pollution by more than 85 percent … and cuts water usage by 40 percent … every ton of steel that is recycled saves 2,500 pounds of iron ore, 1,400 pounds of coal, and 120 pounds of limestone" (Royte, 2005:145). Private companies, governments, schools, communities and organizations can organise recycling initiatives.

Recycling is organised by governments, schools, communities, organizations and businesses and has numerous benefits such as using less energy and water, creating less pollution, generating less wastes than extractive industries. For example, "Recycling scrap requires a third as much energy… cuts air pollution by more than 85 percent … and cuts water usage by 40 percent … every ton of steel that is recycled saves 2,500 pounds of iron ore, 1,400 pounds of coal, and 120 pounds of limestone" (Royte, 2005:145).

➢ **Composting**

Composting is the biological decomposition of organic waste and is considered a natural recycling option. Bacteria and micro organisms decompose the organic waste either aerobically (with oxygen) or anaerobically (without oxygen). Composting has two major benefits. It significantly reduces the amount of waste and provides nutrient rich compost, important for soil regeneration.

Organic waste, such as food waste and garden waste, can be composted utilising a wide array of methods and technologies such as windrows, in-vessel composting, vermiculture and mechanical processing which are detailed by UNEP (2005a), EPA (2007) and CEHI (2004).

Although composting is a fairly simple process, it requires vigilant attention to prevent odours, vermin and sludge. Furthermore, it is essential to choose a composting system appropriate to the environment it serves.

4.4.1.4 Incineration/ Treatment

Treatment mostly commonly refers to incineration which is the thermal destruction of material under controlled conditions. Waste is "fed into a furnace where it falls on moving grates which tumble the garbage around at temperatures of 1800 to 2000 degrees Fahrenheit" (Rathje and Murphy, 2001:179). Although of low desirability on the IWM hierarchy as a method for managing waste, Pongracz (2002) lists some advantages of incineration:

- It reduces the volume of waste up to 90 percent and weight up to 75 percent
- It renders some harmful substances harmless

- Organic waste is burned leading to less methane gases being produced in landfills
- Can produce energy saving fossil fuel use

Incineration can take place with energy recovery or without. The former is higher on the waste hierarchy as the burning process has the advantage of creating energy and additional revenue.

Regulations in many developed countries are becoming increasingly stringent regarding emissions from incinerators. Royte (2005:79) provides the following description of pollution controls present in state-of-the-art incinerators:

> "[S]crubbers, electrostatic precipitators (to charge particles so they could be collected), flue gas cleaning, combustion controls that minimised carbon monoxide, and injections of carbon (to absorb mercury), lime (to control sulphur dioxide and hydrochloric acid), and ammonia (to control nitrogen oxides)."

Residual ash and scrubbers from incinerators need to be disposed of in a landfill and can contain hazardous materials. Depending on the laws of a particular country, residuals from incineration are considered hazardous waste and need to be treated as such. In other countries, incinerator ash is considered safe and is used for a variety of purposes such as landfill cover or building material.

4.4.1.5 Landfill

A landfill site is a designated piece of land used to dispose of domestic, industrial/commercial waste and waste water sludge according to the governmental policies of that region. The site can be classified as a general, low hazardous or high hazardous waste site. New sites are highly technical, carefully planned and, if required, lined with geosynthetic liners to prevent leachate from filtering down through the landfill and out into the surrounding environment.

Certain landfill requirements include a layer of impermeable clay in addition to the liners and a leachate treatment plant.

Waste is tipped out onto the working face of a landfill and is compacted to reduce the “airspace” between waste materials. The compacted waste is then covered with sand or crushed construction and demolition waste to prevent fires, odours, vermin and flies.

4.4.2 Challenges and Criticisms of IWM

Even though IWM policy may exist for a certain country, it is often the case that treatment and landfill are the dominant strategy to manage waste with large investments in landfill and incineration detracting from waste reduction initiatives. In recognition of this, the EU has recently revised the Waste Framework Directive and has committed member states to follow the IWM hierarchy flexibly but to prioritise and to set waste prevention targets (EU, 2007).

4.4.2.1 Criticisms of recycling

Within the IWM hierarchy, recycling tends to receive more attention than reduction, particularly within the public domain and is often mistakenly regarded as the panacea to the waste problem. Although recycling is preferable to manufacturing items from extracted virgin materials, **recycling** relies on manufacturing processes that often **consume vast amounts of energy, water and create pollution.** For example, “[a] malignant by-product of the resmelting process [sic] of aluminium resmelting process, aluminum dross – a chemically active waste exempt from federal regulations- is frequently dumped on open land, left to contaminate soil and seep into groundwater” (Rogers 2005:178) and pulping mills require 100 – 160 tons of water to recycle a ton of paper (Pauli, 1998).

Rathje and Murphy (2001:210) cite a 1988 U.S. Office of Technology Assessment Report on solid waste that stated that it is unclear as to whether recycling causes less pollution per ton of material than primary manufacturing. Royte (2005) cites Samantha MacBride, a PhD candidate in New York University's Department of Sociology, who scathingly claims that "[t]here are very few environmental benefits to recycling … the focus of environmental concern away from material unsustainability of the current economic system, instead turning it inward on the self [left household recyclers] simultaneously uninformed and concerned about ecological problems, as well as enthusiastic and active in largely meaningless solutions" (Royte, 2005: 281 – 282).

Global consequences of recycling in developing countries are of concern. E-waste is often shipped for recycling to developing countries where labour is often cheaper and environmental legislation non existent or not enforced. Royte (2005) discusses impacts of computer recycling in third world countries and the impact of the toxicity of breaking a computer down to basic components using chemicals. What cannot be used is burned and dumped, contaminating the surrounding environment and negatively impacting the health of those living in the vicinity. The unsafe recycling of e-waste has 'contributed to high rates of birth defects, infant mortality, tuberculosis, blood diseases, and severe respiratory problems" (Royte, 2005:170).

Economic factors generally inhibit the success of recycling in two ways. Firstly, virgin materials are often cheaper than recycled materials due to the subsidies and grants offered to extractive industries (GRRN, 2004). Secondly, variable markets for recyclables impact their viability.[5] Rathje and Murphy state that the focus of recycling should be to expand the markets of recyclables before setting up recycling systems and that care should also be taken not to disrupt foreign markets by supplying them with cheap materials that out price local recyclables. As Rogers (2005) observes:

5 Rogers (2005) makes an interesting point in that recycling programmes are expected to pay for themselves whilst disposal facilities are often subsidised by governments.

> "[E]ven if the dutiful separate their metal from glass, much of it still ends up in the landfill or incinerator, having found no buyer on the other end. If substances sent to recovery centers can't compete with lower-priced 'virgin' materials, they get dumped … 50 percent of all paper ends up as garbage … only 5 percent of all plastic is recycled, while almost two-thirds of all glass containers and half of aluminium cans get trashed" (Rogers, 2005, 6 - 7).

Downcycling refers to the decreasing quality of recyclables each time they are recycled. Plastics, glass and paper have limited recycling potentials and are ultimately landfilled or incinerated. In paper recycling, paper fibers become shorter and weaker producing inferior quality paper and according to "the giant paper manufacturer Weyerhauser, clean white paper can theoretically be recycled nine times, but the reality of inks, clays, and glues drags that number down to four times" (Royte, 2005:134). Aluminium recycling degrades the quality of the original metal as it is combined with other alloys, coatings and paint (McDounough and Braungart, 2002).

Logistical problems with recyclables are common and include issues such as storage, transportation and contamination. Palmer (2004:2) criticises plastics recycling in particular as "it is not just the type of material affecting the recycling of plastic but the way it is made making plastics recycling very complex and contamination of plastics almost inevitable."

According to McDonough and Braungart (2002), inappropriate choices are made to fit recycled goods into functions they were never designed for. For example, they claim that plastic (in the form of synthetic clothes) was never meant to be worn next to the skin as the skin absorbs the fine particles of plastic that accumulate as toxins in the body. Recycling can produce products that are in turn not recyclable in themselves.

Although recycling prevents extraction wastes and conserves raw materials, recycling rates cannot significantly reduce the ever increasing volumes of waste. In table 1, waste statistics from 1960 to 2005 in the USA show that recycling and composting activities have increased by 26 percent. During the same time period however, waste volumes have increased threefold and waste being landfilled has almost doubled.

Table 5: USA municipal solid waste facts (in millions of tons) 1960 – 2005 (Adapted from EPA, 2006).

Activity	**1960**	**1970**	**1980**	**1990**	**2000**	**2003**	**2004**	**2005**
Generation	88.1	121.1	151.6	205.2	237.6	240.4	247.3	245.7
Recovery for recycling	5.6	8.0	15.5	29.0	52.7	55.8	57.2	58.4
Recovery for composting	Neg.	Neg.	Neg.	4.2	16.5	19.1	20.5	20.6
Total materials recovery	5.6	8.0	15.5	33.2	69.1	74.9	77.7	79.0
Combustion with energy recovery	0.0	0.4	2.7	29.7	33.7	33.7	34.1	33.4
Discards to landfill, other disposal	82.5	112.7	134.4	142.3	134.8	131.9	135.5	133.3

According to Hawkin et al (1999: 52-53), "less than two percent of the total waste stream is actually recycled … [o]ver the course of a decade, 500 trillion pounds of American resources will be transformed into nonproductive solids and gases."

4.4.2.2 Criticisms of incineration

McDonough and Braungart (2002) lament the destruction of valuable resources during the incineration process. Incinerators require large amounts of waste to operate viably and unlike landfills that can be mined, items that are incinerated cannot not be recovered at a later date.

Incinerators are often situated in lower socio economic areas (Royte, 2005; Rogers, 2005). As information regarding the health hazards of emissions from incinerators stacks became more widely researched and publicised (Platt, 2004; GrassRoots Recycling Network, 2000; EU, 1999; Gibbs, 1995), many grassroots activists successfully prevented incinerators from being built in their neighbourhoods, cities and countries. The incineration industry termed this resistance as NIMBY – Not In My Back Yard.

One of the major concerns regarding incinerators is the emissions during the incineration process. Toxins emitted include "dioxin, mercury, cadmium, lead, hydrochloric acid and sulphur dioxide" (Royte, 2005: 81). Dioxins are created when chlorine compounds, occurring in everyday products such as paper and plastic, are burned with organic matter. Dioxins are described by Rogers (2005:162) as "the most toxic molecules known. Dioxins are carcinogenic, reduce fertility, affect fetal development, cause the skin condition 'chlorachne' and compromise the immune system …they accumulate in the body over time … they can cause harm at very low exposure levels."

Through stringent legislation, air quality standards and improved technology many "metals – like chromium, copper, manganese, and vanadium – [are] out of the smokestack only to concentrate them in bottom ash, which falls through the grate on the boiler's floor" (Royte, 2005:79). Cautious management of incinerator ash is thus required.

Rathje and Murphy (2001) claim that the major drawbacks of incinerators include their expense, and decrease in performance as they get older.

4.4.2.3 Criticisms of landfilling

New sanitary landfills are expensive to build and manage. Social perceptions of landfills are one of the main challenges facing potential new sites. NIMBY (not in my backyard) is a popular acronym used with regards to landfills and incinerators. As with incinerators, public opposition to landfills is on the increase causing new sites to be situated in rural or lower socio economic areas (Royte, 2005; Rogers, 2005; Rathje and Murphy, 2001) and further away from urban areas.

Methane is emitted as part of the decomposition process and is highly flammable. Risks of landfills catching alight are a common concern as the fire is difficult to extinguish and control. In addition, methane is also known to contribute to global warming. “As it filters up through layers of buried garbage, methane can pick up carcinogens like acetone, benzene and ethyl benzene, xylenes, trichloroethylene, and vinyl chloride” (Royte 2005:74).

The EPA only requires landfills to be monitored for thirty years after closure which as Royte (2005) observes is ironic as landfills increase their threats over time. Although tighter legislation has made new landfill construction safer, Royte (2005:59) is skeptical of the measures taken;

> “[E]ven the most sophisticated liners will eventually leak. Geomembranes are eaten away by common household chemicals … And then there’s human error – seams improperly sealed, holes poked by heavy equipment. Leachate collection pipes become clogged with silt or mud, or are blocked by the growth of microorganisms or the precipitation of minerals. Weakened by chemical attack, pipes are crushed by garbage

> …state-of-the-art landfills merely delay, rather than eliminate, massive pollution to groundwater."

In contrast, Saffron et al (2002:191) in a review of 220 papers on landfills and health, argue that "evidence linking any adverse health outcomes with incineration, landfill or landscaping with sewage sludge was 'insufficient' to claim any causal association." However, the authors admit that cause and effect relationships are hard to establish mainly due to lack of data and the variability in human populations studied.

4.5 Alternative methods of managing waste

Given these concerns stemming from IWM, research was conducted into alternative methods of managing waste that attempted to avoid the pitfalls of this paradigm. The following case studies highlight alternatives to managing waste:

- The Natural Step
- The Next Industrial Revolution
- Zero Emissions Research Initiative
- Zero Waste
- Natural Capitalism

4.5.1 The Natural Step (TNS) case study

In 1989, whilst exploring the link between damaged cells in the human body and possible environmental causes, Dr. Karl-Henrick Robert, in collaboration with eminent scientists and thinkers in Sweden, developed The Natural Step (TNS). TNS provides a systemic overview of the natural laws that govern the Earth in order to better understand how the system we live in functions as a whole, without getting distracted or misled by isolated problems or issues. TNS provides a mental model to encourage understanding and co-operative problem solving.

TNS identifies four system conditions or universal laws, see figure 11, which should be met by society in order to achieve sustainable development (Robert, 2005).

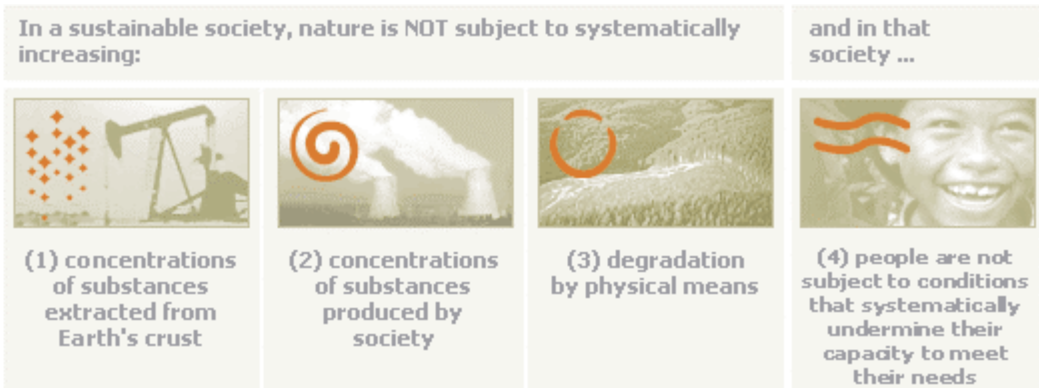


Figure 9: Conditions for a sustainable society

(The Natural Step, 2003)

TNS claims that substances brought from the Earth's crust, such as metals and petroleum, accumulate as toxins as they are not food for the natural systems on the Earth's surface. Increasing concentrations of these substances lead to the physical degradation of natural systems on which human life is dependent. If society cannot meet the basic needs of people, their needs will be met through the expense of others and the environment (TNS, 2003).

TNS outlines the funnel framework that can guide management and leadership decisions. With the decline of life-supporting systems and the increased demand for ever depleting resources, pressure is being felt within today's society to balance these opposing forces. Robert (2005) argues that business, government and society at large can strategically plan to open up the walls of the funnel and move toward sustainability as depicted in figure 10.

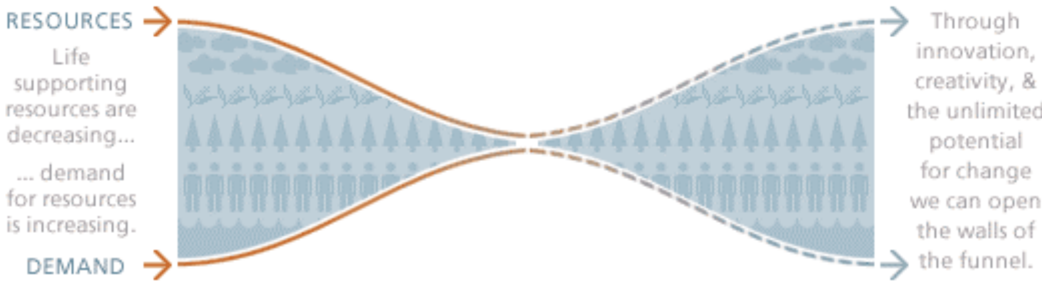


Figure 10: Reversing the funnel (Natural Step: 2003)

4.5.2 The Next Industrial Revolution (TNIR) case study

The Next Industrial Revolution (TNIR) is a term used to describe a new industrial system based on the principles governing natural systems (Hawken, 1993; McDonough and Braungart, 2002). McDonough and Braungart (2002) argue that intent determines design and that what is required by TNIR is the intention to design waste out of the system completely. By utilising "nature's surprisingly effective design principles … human creativity and prosperity … respect, fair play, and good will" (McDonough and Braungart, 2002:6) an "inspiring engagement – a partnership with nature" (Ibid: 156) can be developed.

Within this framework, it is not enough to minimise waste and the concept of eco-efficiency is criticized as:

> "an outwardly admirable and certainly well intended concept, but, unfortunately, it is not a strategy for success over the long term, because it does not reach deep enough. It works in the same system that caused the problem in the first place, slowing it down with moral prescriptions and punitive demands. It presents little more than an illusion of change" (McDonough and Braungart, 1998)

In a process known as "cradle to cradle", McDonough and Braungart (2002) propose that all products (and associated processes), should be designed with the entire life cycle of the product in mind: from design, production, use and end use - once the product is no longer required, how will the “nutrients” of the product be used as raw material inputs for other new products?

McDonough and Braungart (2002) view traditional recycling as inferior for it results in the loss of valuable resources in time, energy, water and labour. The type of reuse and recycling proposed is one where materials are designed for reuse as “technical” and “biological nutrient” bases. “Technical nutrients” refer to all man-made molecules, and “biological nutrients” are all organic, compostable materials.

Composting is the proposed method of handling biological wastes, and closed loop recycling is advocated for technical wastes, so that the original qualities of the materials are retained throughout. McDounough and Braungart (2002:103) note: “if we continue to throw away technical materials or render them useless, we will indeed live in a world of limits, where production and consumption are restrained, and the Earth will literally become a grave.” However, if we endeavour to learn, to imitate and to abide by the rules of the natural system, a rich, fecund scenario is presented, one wherein ‘plenty’ is the paradigm, and provision is ensured for all for generations to come.

McDonough and Braungart (2001) have initiated numerous projects based on these principles. One such project was the design of a children’s nursery where an effort was made to use safe fabrics in all aspects of design. The initiative is described below in box 1:

Box 1: The Next Industrial Revolution – a case study

McDonough and Braungart worked with Design Tex and Rohner, to create a biological nutrient, a compostable upholstery fabric that was so safe it could be eaten. A mixture of safe, pesticide free plant and animal fibers were chosen by a team who then began working on perhaps the most difficult aspect: the finishes, dyes, and other processing chemicals.

Sixty chemical companies were approached to partner with the project but they all declined stating that their products were proprietary knowledge, uncomfortable with the idea of exposing their chemistry to scrutiny. Finally one European company, Ciba Geigy, agreed to join.

Out of the 8000 chemicals used in the textile industry only 38 were found to be safe. These, in addition to the natural fibers of wool and ramie, created a fabric that could be composted as it was no longer hazardous waste material.

Typical toxins produced by a textile factory include cobalt, zirconium, heavy metals and finishing chemicals. According to new environmental legislation in Sweden, fabric trimmings were to be classified as hazardous waste, and disposed of accordingly. Rohner could now compost their textile waste and avoid hazardous waste disposal, the expense of which was threatening to close the company down. In addition the Swedish mill could now use their effluent water back in their processes as it was as clean going out as it was coming in.

As McDonough states: “If a factory is not emitting dangerous substances and needs no regulation, and can thus compete directly with unregulated factories in other countries, that is good news environmentally, ethically and economically.”

(Adapted from McDonough and Braungart 1998, 2001).

4.5.3 Zero Emissions Research Initiative (ZERI) case study

Pauli (1998) is the former President of Ecover (a product line of plant based detergents) and constructed Europe’s first ecological factory. During this time, Pauli came to the realization that although his factory was promoting environmentally friendly products, his factory only utilized five percent of the raw material input with 95 percent being incinerated. As Pauli (1998: Introduction) observed:

> “While I may have made a marginal contribution to reducing the contamination of rivers in a few European rivers, I had to accept responsibility for massive amounts of waste, generated through my demand for this biodegradable surfactant.”

In 1994, Pauli founded the Zero Emissions Research Initiative (ZERI) which focuses on utilising all resources available in natural materials aiming to prove their superiority to synthetic materials. Natural materials have the innate potential to expand markets, create jobs, alleviate poverty and the increase diversity of products by creating more with less. Pauli (1998) cites many examples of current inefficient production systems and the potential resources that are present in discarded materials. Examples include:

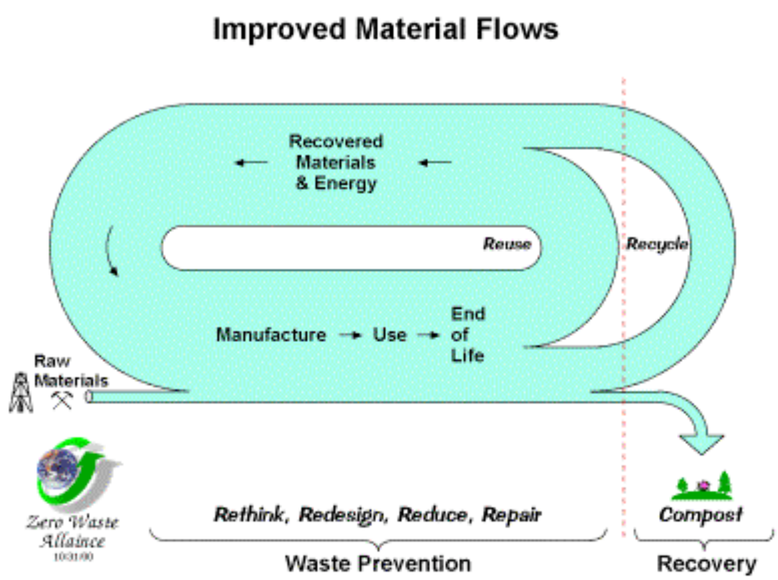
- In paper making 20 – 30 percent of the biomass of the tree is utilised, with the remaining 70 – 80 percent of hemicellulose and lignin becoming waste. Hemicellulose, when hydrolysed, becomes xylan a natural sweetner, 50 percent sweeter than sugar, low in calories and does not cause plaque. Lignin can be used as a clean fuel or as a natural glue.
- In making biodegradable detergents, only 5 percent of palm or coconut plant is used with the remaining 95 percent, rich in vitamin E, betacarotene and antioxidants, becomes waste (Ibid:25)
- Sugar represents 17 percent of the biomass of sugarcane, and the remainder of the plant becomes waste known as bagasse. Baggase can be used as a strengthener in cement or the fibers can be used for paper production. Considering the speed at which sugar cane grows, using these fibers for paper production, makes sense (Ibid: 1998:19)

Pauli argues that humans are unaware of how wasteful we are and that our success as a species depends upon “changing our perception of reality … we need industry to take both society and nature into account” (Pauli, 1998:15). Industrial systems should emulate nature and be clustered to form a network of co-operative industries in which the waste of one factory would serve as raw materials for another.

4.5.4 Zero Waste case study

Zero Waste is a "pragmatic and visionary" philosophy that aims to eliminate waste, pollution and toxins out of current industrial systems by mimicking natural systems, thus ensuring full resource utilization (ZWIA, 2004). The goal of Zero Waste is that zero emissions end up going into soil, air and water – meaning that no waste requiring landfill, or incineration (even with energy recovery). The diagram below shows how Zero Waste aims to close the loop of all material flows:

Figure 11: Zero Waste material flow (ZWA: 2007)



Zero Waste advocates triple bottom line accountability with respect to environmental, social and economic factors. Use of the precautionary principle is advocated for all new products and processes. Tools such as Extended Producer Responsibility (EPR) and green procurement (see descriptions in section 4.5.5) are promoted. Zero Waste advocates the cradle to cradle philosophy. Products and packaging should be designed with the end life in mind so that materials can be reused and recycled (ZWIA, 2004).

Within the philosophy of Zero Waste, incremental strategies, such as cleaner production, pollution prevention, environmental management systems and eco-efficiency are all useful, but will not necessarily achieve sustainable development. Although the above strategies reduce the amount of waste produced and ensure more efficient production, they do not eliminate the concept of waste from man made systems.

Box 2: Zero Waste – a case study

"Location: Taiwan, North Pacific Ocean

Background: Taiwan is a densely populated island with over 23 million people, located 200km of the south east central Chinese coastline. It has a strong economy and is highly industrialised but suffers from widespread pollution as a result.

Issue: Long-term rates of waste generation have seen the cost of waste management escalate and natural resource availability diminish.

Solution: Due to this pressure, the waste strategy has shifted from traditional treatment methods to waste minimisation, source separation, reuse and recycling. Communities are rewarded by reducing waste generation, and are involved in waste management schemes. The government adopted a Zero Waste approach. As explained by H.W. Chen (Director General of Solid Waste Management Bureau, Environemntal Protection Administration) and H. Houng (Advisor, Environmental Protection Administration):

"Although the adoption and the implementation of the strategies and policies of 'Zero Waste' will encounter certain obstacles, we should still actively strive to establish concrete policies and objectives for campaigns, strict law enforcement and the encouragement of innovation and trials. What we will need to achieve this will be: understanding and support of the general public, the cooperation of the public sectors, as well as the open-mindedness of the public sectors. Our natural resources are so scarce and so precious that we must work in tandem with the global trend to achieve a 'Zero Waste' world.""

(Source: WIN, 2005:15).

Zero Waste has developed strategies for all sectors of communities – governments, industries, schools and homes. Zero Waste has been adopted by New Zealand and Japan, and numerous counties and cities in the USA, Australia, the UK, the Philippines and India (ZWIA, 2007).

4.5.5 Natural or Green Capitalism case study

Natural or green capitalism is a progressive theory that combines ecological and economical values in which natural resources are given financial value.

Natural capitalism promotes the value of the Earth's capital within current economic systems and claims that natural systems are the foundation of all social systems. Hawkin et al (1999) state that natural capitalism is not politically affiliated and so provides the basis for development across all ideologies and philosophies because there is no "true separation between how we support life economically and ecologically" (Hawkin et al, 1999:21).

Natural capitalism challenges current government and business practices, in which certain policies and subsidies prevent the true costs of resources from being realised. As long as these policies and subsidies are in place, "free goods in the world – pure water, clean air, hydrocarbon combustion, virgin forests, veins of minerals" will continue to be undervalued, consumed, wasted and destroyed and "large-scale, energy- and materials-intensive manufacturing methods will dominate" (Hawkin et al 1999:15).

According to Hawkin et al (1999), natural capitalism advocates:

- Maximising the use of available resources to their full potential
- Replicating the systems of the natural environment
- Changing the relationship between the producer and consumer to one of service where: "Manufacturers cease thinking of themselves as sellers of products and become, instead, deliverers of service, provided by long-lasting, upgradeable durables. Their goal is selling results rather than equipment, performance and satisfaction rather than motors, fans, plastics, or condensers" (Hawkin et al, 1999: 16).
- Investing in natural capital to reverse damage done to ecosystems.

Many businesses are attempting to apply these principles to their everyday practice. One such example is that of Interface, the world's largest producer of commercial floor coverings. Interface has embraced a sustainable framework to guide them into the future. They produce carpets that can be leased, and when the customer no longer requires the product, it is returned to Interface for recycling. Although not a perfected system many social, economic and environmental benefits have been attained (Anderson, 1998).

Interface is a company dependent on petrochemicals, yet their aim is to "first reach sustainability, then to become restorative" by using the principles of Redesign, Reduce, Reuse, Reclaim and Recycle (Anderson, 1998:43). Hawkins (1993) and Anderson (1998) state that business and industry should lead the path to sustainability because they are responsible for the current destruction of the natural environment and possess the ability to respond with speed and efficiency to these pressing concerns.

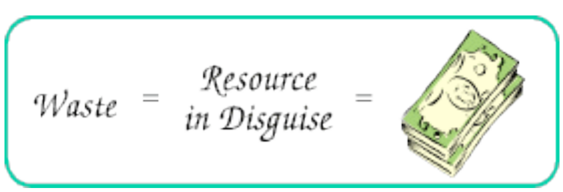
According to Theyel (2001) and Davis et al (1997) companies adopting the green capitalism philosophy are able to:

- pre-empt stringent legislation
- market the green image consumer trends are seeking
- minimise production and disposal costs through more efficient resource use
- increase their competitiveness on the global market
- increase worker's safety by reducing hazardous content of products

4.5.6 Discussion on case studies

Through various professional *lenses* such as design, science, medicine, economics and business, the above case studies permit the construction of a paradigm that treats waste as a resource as depicted below in figure 12 (Robert 2005; McDonough and Braungart, 2002; Hawkins et al, 1999; Anderson, 1998; Pauli, 1998).

Figure 12: Waste as a resource (ZWA: 2007)



The responsibility of waste is placed firmly on producers who are expected to redesign products, using the cradle-to-cradle philosophy in every facet of extraction, production and consumerism. The authors listed above advocate that business can respond with speed and agility and should be driven by market forces to voluntarily redesign their products and processes to eliminate the waste from the system.

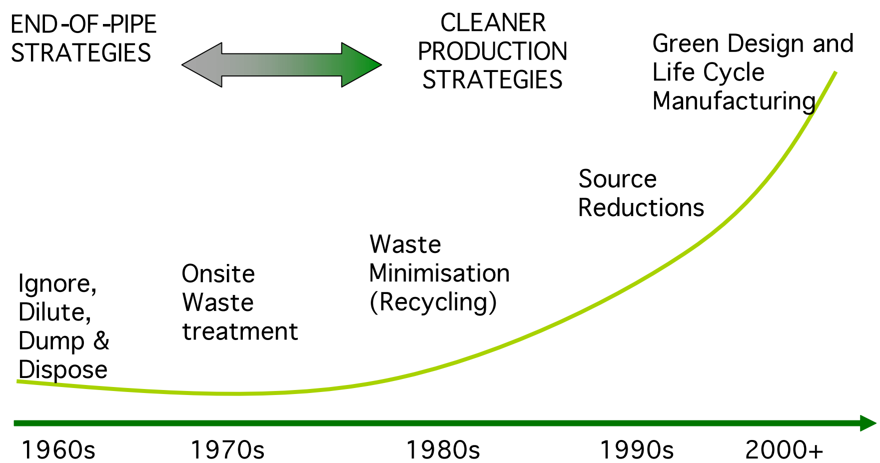
McDonough and Braungart (2002) and Robert (2005) advocate the elimination of all toxins from the system. Pauli (1998) differs in that he aims to use all waste as a resource and sees the potential of all wastes, even that of toxic wastes, as food for other kingdoms.

Rogers (2005) is critical of TNIR as she claims that the fundamental problem lies with consumerism and society's waste culture. Unabated production levels, even if they fit into the technical or biological as McDonough proposes, still consume large amounts of resources. She argues that a problem of biodiversity may also result if plastic is replaced by bioplastics made from starch, soy and hemp. Monocultures, genetically modified organisms, increased use of pesticides and chemical fertilisers would continue to pollute the environment and decrease biodiversity. Furthermore, Rogers (2005) is suspicious of green capitalism's aversion to regulatory legislation as she believes that industry will not change on their own accord and insinuates that companies will claim environmental and social responsibility with no real action to back it up.

However, according to Dittke (2007) and Theyel (2000), the increasing trend to treat waste as a resource is demonstrated when examining waste management strategies over the last fifty years, as shown in figure 10. Legislation guiding waste management and waste reduction can be found in appendix 7.

Figure 13: The evolution of strategies to manage waste

Dittke (2007)



4.6 Tools to guide waste reduction and resource management

The list below is by no means conclusive, but serves to highlight additional tools, besides the familiar recycling and composting options, that are being used internationally to reduce waste and improve and encourage resource management.

4.6.1 Extended Producer Responsibility (EPR)

Extended producer responsibility (EPR) promotes the shared responsibility of the impacts of extraction and production onto designers, producers, distributors and consumers (Davis et al, 1997; Canning, 2006; Fernie and Hart, 2001). Under the European Unions (EU) Waste Electrical and Electronic Equipment (WEEE) legislation that came into effect in 2005, producers are required to take back electronic and electrical products for reuse and recycling (Mayers et al, 2002; Canning, 2006). The EU has implemented EPR onto packaging wastes and batteries and is exploring tyres, cars and C & D wastes (Mayers et al, 2002)

EPR is based on the premise of “polluter pays” and permits mechanisms that consider waste disposal as part of the products life. EPR challenges linear production and promotes a closed loop flow of materials. Mayers et al (2002) lists three strategies have been adopted by UK information technology companies to comply with EPR namely:

- Leasing products – when the customer no longer requires the services of the product or prefers an upgrade of equipment, the producer takes back the product for reuse, recycling or disposal
- Product take back – the producer sets up a collection system to recover their products that are no longer required
- Refurbishing known brands for resale

The authors claim that EPR minimises the negative environmental effects of consumption and disposal and encourages “enduring customer relationships through the provision of full product life cycle services” (Mayers et al, 2002:372)

Challenges to EPR include logistical and financial implications for the collection of products for reuse and recycling. A high level of co-operation is required from all participants within the producer /consumer chain.

4.6.2 Green procurement

According to the UN’s Production and Consumption Branch (UNEP, 2005), green or sustainable procurement is the “process in which organisations buy supplies or services by taking into account:

- the best value for money (price, quality, availability, functionality);
- environmental aspects ("green procurement") over the entire life cycle of products;
- social aspects (issues such as poverty eradication, labour conditions, human rights).

The implications of green procurement are numerous. For example procurement guidelines can state that all printers must be energy efficient, must have double sided copying, be made from recycled content, have refillable and recyclable cartridges and paper used must have a recycled content.

In 2001, Japan began implementing its green procurement laws. Government departments are required to draw up procurement guidelines that ensure that products purchased are necessary and environmentally friendly. Through information sharing, businesses and the general public are encouraged to participate. An overview of the legislation is provided in appendix 9.

4.6.3 Environmental Management Systems (EMS)

Numerous international research studies into the nature and impacts of Environmental Management Systems (EMS) within companies have been conducted. Theyel (2000) identifies the most commonly used EMS used in the chemical industries in the USA as:

- **Waste audits** identify and measure sources and quantities of wastes generated through production processes
- **Total Quality Management (TQM)** in which employees participate in the continuous improvement of processes and products to reduce pollution and waste and increase productivity and worker safety
- **Pollution prevention** plans that aim to reduce pollution generated through production processes
- **Total cost accounting** which is generally understood as "a financial assessment of a project that includes waste management costs" (Ibid:256)
- **R & D** was identified "as an important source of new ideas and technology for pollution prevention" (Ibid: 257)
- **Life Cycle Analysis (LCA)** is the analysis of the impacts of a product through all stages of development from extraction, production, distribution, consumption and disposal. LCA aims at: Closing production loops, finding

ways to recycle wastes and products, and generally identifying places in the life of a product to prevent pollution" (Theyel, 2000:257)

According to Lawrence et al (2002) an increasing number of international companies are becoming ISO 14001, an environmental management certification programme, compliant for reasons including cost savings, consumer demands, environmental responsibility and legislation.

4.6.4 Other tools to reduce waste

Other tools that can be used to reduce waste include:

- **Cleaner Production** (CP) which can be used to continuously improve production processes to reduce waste in all forms (UNEP, 2001). **Waste Minimisation Clubs (WMC)** can constitute a group of companies or organizations who regularly meet to share their best practice examples of waste reduction strategies implemented within their organisations. Numerous examples of case studies utilising the tools of CP and WMC's can be found at the National Cleaner Production Center, South Africa (NCPC, 2007)
- **Eco-Industrial Parks** link production processes so that waste from one factory can be used by another thus maximising resource usage as demonstrated in natural systems (Theyel, 2000).
- **Ecolabeling:** Symbols, such as the Flower, used by the European Union (EC, 2008), can be used to label products that have met environmental standards during one or more stages of its life cycle, to encourage consumers to purchase environmentally friendly products.
- **Plastic bag legislation** that prohibits the dispensing of free plastic bags, by vendors, for goods purchased in their stores has been enacted in many countries all over the world. As an example; in South Africa, customers are charged per bag at supermarket checkouts. The aim of the legislation is to encourage the reuse of thicker plastic bags. In addition, the legislation is aimed at decreasing litter caused by plastic bags - dubbed

the “national flower” due to its’ proliferation along the side of roads. Hassen et al (2007) state that the legislation has successfully, for the short term, curbed the demand for plastic bags.

4.7 Waste management on islands

> “Within a small island, no problem or area of study can stand by itself, no piece of life remains isolated; every living and non-living thing forms an integral part of a structured whole. Similarly, an island chain is a delicate and fragile network, representing a set of highly interdependent relationships—island to island, system to sub-system, island to sea” (Towle, 1972).

Islands face unique constraints with regards to waste management. Due to the relative small size of islands, “environmental dimensions of social and economic actions taken by the human society are more immediately evident” and this is particularly relevant to waste management on islands (Georges, 2002: 32). The World Island Network report (WIN, 2006) is based on a survey of fifty one islands worldwide, tables a broad spectrum of factors influencing the complexity waste management on islands as shown in Table 5:

According to WIN (2006), UNDESA (2005) and Georges (2002), waste management is not usually considered a priority area with regards to island development and there is generally a lack of institutional resources, human, technical and financial, within the field to handle increasing and complex waste streams. In addition, the small land areas of many islands lead to limited disposal options.

Table 6: Contributing factors to the complexity of waste management on islands (WIN 2006:6)

Contributing factors	Issues
Organisational & institutional capacity	• Political priorities often lie with economic and community development • Lack of coordination in institutional systems, administrative bodies, management capabilities and human resources: - difficult to respond effectively to issues, assign responsibilities, develop coherent plans and policies
Economic strength & stability	• Globalisation and trade affecting more and more of what is imported and exported • Poor economies of scale on islands, due to small population and local markets, leading to: - lack of financial management capacity, resulting in failed aid projects - high cost of technology for low quantities of waste
Socio-political status	• Lifestyle changes (consumerism) and population growth resulting in: - an increase in non-biodegrabable and hazardous waste, e.g. nappies, plastics. • A loss of traditional links with the local environment • A disintegration of traditional communities and family units • A change in land-use patterns • Cultural beliefs and values prohibit certain activities and affect litter and dumping • Communities sometimes have unrealistic expectations of authorities, and become demotivated, distrustful and unwilling to cooperate if these are not realised • Social problems are exacerbated by bad decisions in waste management that affect quality of life and loss of industry-linked livelihoods
Human & technical resources	• Limited capacity in island institutions and domestic markets to retain skilled human resources • Limited ability to evaluate and implement technology or management methods • Lack of specific management and operational skills • Lack of research for future improvements to current practices • Lack of technical resources e.g. computers, information systems
Environmental considerations	• Sensitivity of ecosystems, vulnerability to contamination • Lack of space and resources for waste facilities • Climatic factors affecting waste handling • Geographical remoteness and cost effectiveness of imports and exports, access to resources

Islands are dependent on external markets and exhibit a high dependence on importations. Poor economies of scale lead to high costs for managing relatively small quantities of waste. For example, islands are isolated from mainland markets rendering the cost of transporting recyclables unfeasible. Within these constraints however, lie opportunities, specific to island communities, to develop innovative solutions to manage increasing waste volumes.

Acknowledging the complexity of waste management and to manage ever increasing volumes and complexities of waste, islands in the Caribbean have made concerted efforts to address waste management issues. International policy frameworks are available to guide waste management and some international initiatives relevant to the Caribbean are highlighted in appendix 7.

4.7 Summary

This literature review covers the definition of waste and the components of IWM, namely reduce, reuse and recycle, incinerate and landfill. Challenges and criticisms facing the model are discussed. Five case studies are highlighted that propose alternative methods to manage waste. The unique constraints that islands face are tabled and discussed.

CHAPTER 5: EMERGENT THEORY OF WASTE

5.1 Introduction

The theory of waste presented in this chapter emerged using grounded theory developed from the analysis of the data in Chapter 4. Locke (2001) notes that Glaser and Strauss presented their findings in the form of a richly descriptive theoretical narrative organized around their main categories. The concept of telling the story while showing the data is often used as a way of presenting the theory that was developed. In this chapter, the theoretical framework is presented by using headings with constitutive elements and noting variations. The social reality of waste management is revealed in the voice of the author and the data incidents drawn on to develop the elements of theory.

5.2 Definition of waste

The definition given to waste dictates the way it is treated within society. Current definitions treat waste as items to be discarded. However, with the short-comings that have arisen from treating waste in this manner (see section 4.4.2) a redefinition of waste is advocated in order to shift in perceptions of 'waste'. Following the analyses of the data, it is the strong view of the researcher that waste needs to be redefined and treated as a resource.

5.3 A systemic perspective on waste

The cycles of reuse that exist in natural systems ensures that all substances created and discarded by living organisms become nutrients or building materials for others - no "waste" exists in natural systems. The human species is the only organism on the planet to produces waste that cannot be digested within the natural system. Viewing waste systemically provides a deeper, more holistic understanding of waste.

Large volumes of waste are created by extractive and industrial processes that are seldom witnessed by the average consumer. Viewing waste systemically brings these “hidden” wastes to the forefront so that the root causes of waste, namely linear industrial processes are highlighted. By altering our definition of waste, the systems creating ‘waste’ would thus be altered.

5.4 Historical perspective on waste

When viewed from a historical perspective (as summarized in Appendix 6), it can be seen that waste is a human creation and a direct result of linear production systems. Increasing industrialisation and consumerism have led to increasing volumes, categories and complexities of waste, with waste management systems evolving accordingly.

5.5 Global perspective on waste

The dominant paradigm guiding waste management globally in developed countries is discussed in section 4.4. IWM is a hierarchy of waste management that proposes that waste be reduced, reused and recycled. What cannot be managed through these options should then be incinerated or landfilled. IWM accepts that waste is inevitable and proposes that state of the art treatment and disposal methods can safely manage wastes that could not be processed by upper tiers of the waste management hierarchy. As listed in chapter 4, there are numerous concerns associated with the components of IWM.

In contrast, the case studies presented in section 4.5 advocate a new paradigm when waste is viewed systemically. Within this paradigm waste equals food as demonstrated within natural systems. While not currently a dominant paradigm guiding waste management, the redefinition of waste as a resource is being increasingly embraced internationally by businesses, cities and counties.

5.6 A local perspective on waste

In exploring the complexity and constraints islands face with regards to waste management (see section 4.7), adopting IWM as the ultimate paradigm to guide waste management into the future is fraught with problems. The most obvious concern is that islands often physically lack the space to develop landfills. Even if incineration is chosen as the preferred option, landfill is still required for incinerator ash and items that cannot be burned. The sensitivity and relative size of island ecosystems make islands particularly vulnerable to potential pollution and emissions including those from waste facilities.

Islands often lack the capacity to recycle materials and the cost of transporting recyclables to markets often render recycling initiatives unfeasible. Even composting, a relatively inexpensive and simple waste reduction technique, faces the challenge of quick decomposition in tropical climates.

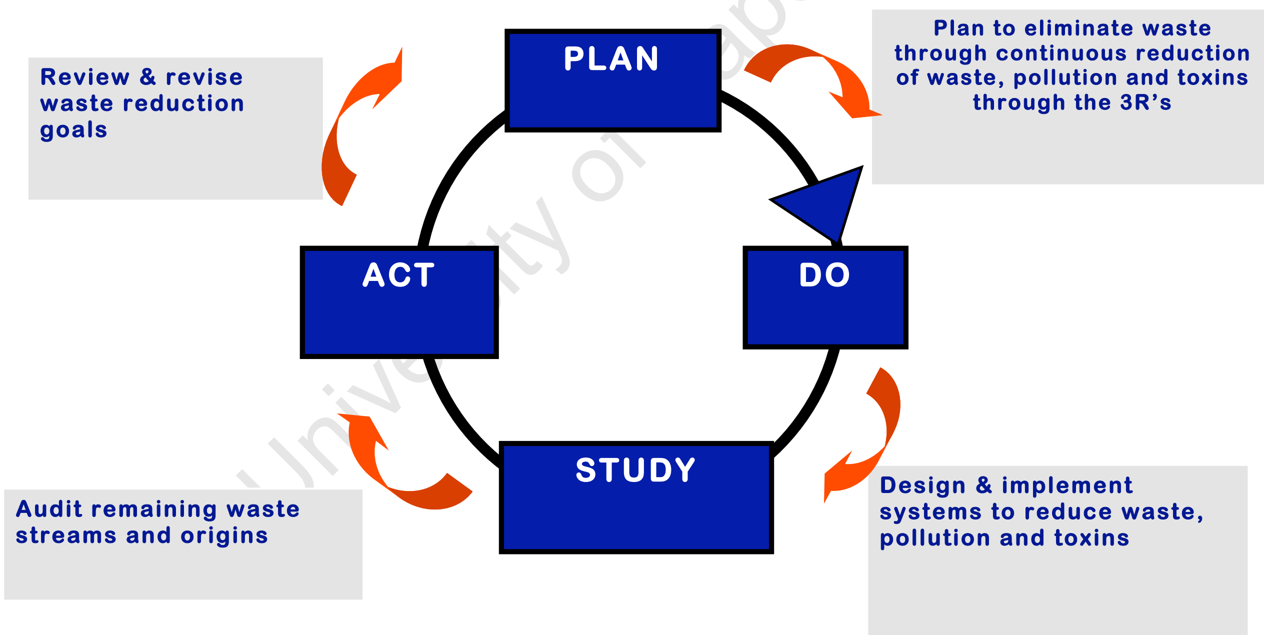
5.7 Emergent theory

Systemic Resource Management (SRM) is a term that has been created for the purposes of this dissertation. SRM will be the term used to describe and encompass the philosophies, paradigms and methodologies across various disciplines that aim to eliminate the concept of waste from systems as exemplified by the case studies. SRM takes a systemic approach to waste and views waste within the context of the systems that create it. The tenet in SRM is that waste is a resource therefore all "wastes" should become "nutrients" or raw materials for other processes so as to mimic natural systems in which no real 'waste' exists. In other words, the "cradle to cradle" design of products would ensure a closed-loop production system wherein all resources can be continually reused and recycled.

It is argued here that the acceptance of waste as a necessary component of human activity is a flaw in IWM. However, IWM provides a useful framework to achieve SRM. Anderson (1999:58) discusses the Hegelian view of "[t]hesis and antithesis, reconciled through synthesis." The concept of reconciliation through synthesis can be applied to the discrepancy between IWM and SRM. In IWM, waste is accepted as a given outcome of human activity whereas SRM aims to eliminate waste from the system. Although seemingly opposing paradigms, both depend on human intelligence to achieve their goals. IWM aims for the safe and effective management of waste through the IWM hierarchy whereas SRM intends to use resources optimally.

Utilising the facets of the IWM hierarchy, with waste reduction being the ultimate aim, human intelligence could significantly begin reducing the amount of waste that requires treatment or disposal. Landfills and incinerators could play a pivotal role in serving as indicators of what waste streams are still in need of strategies to reduce and ultimately phase them out entirely. By applying the Action Research methodology of Plan, Do, Study, Act cycle (Scholtz, 1998), IWM can be used as a tool to incrementally realise SRM.

Figure 14: Realising SRM through IWM



SRM could guide islands into sustainable waste management that would eliminate the need for landfills and incinerators in the long term. SRM would aim for "zero waste" to landfill and systematically reduce waste using the IWM tools of reduce, reuse and recycle.

5.8 Conclusion

This chapter redefines waste and describes a systemic theory of waste. SRM is combined with IWM to produce a theory outlining a potential method to manage waste sustainably on islands.

Using this grounded theory, the research question was refined and the focus of the dissertation shifted toward waste reduction and resource management. In line with the grounded theory methodology, the theory on waste influenced the research process. A questionnaire was developed to determine what waste reduction and resource management initiatives exist on islands. Six islands were interviewed and the findings are presented in the following chapter.

CHAPTER 6: KEY FINDINGS

6.1 Introduction

In this section the findings of the waste reduction and resource management questionnaire are reported. Six islands namely Anguilla, Antigua and Barbuda, BVI, Curacao, SVG and Jamaica were interviewed and questioned to gain insight into local waste management with particular focus on waste reduction initiatives. These islands are highlighted on the map below in figure 15:

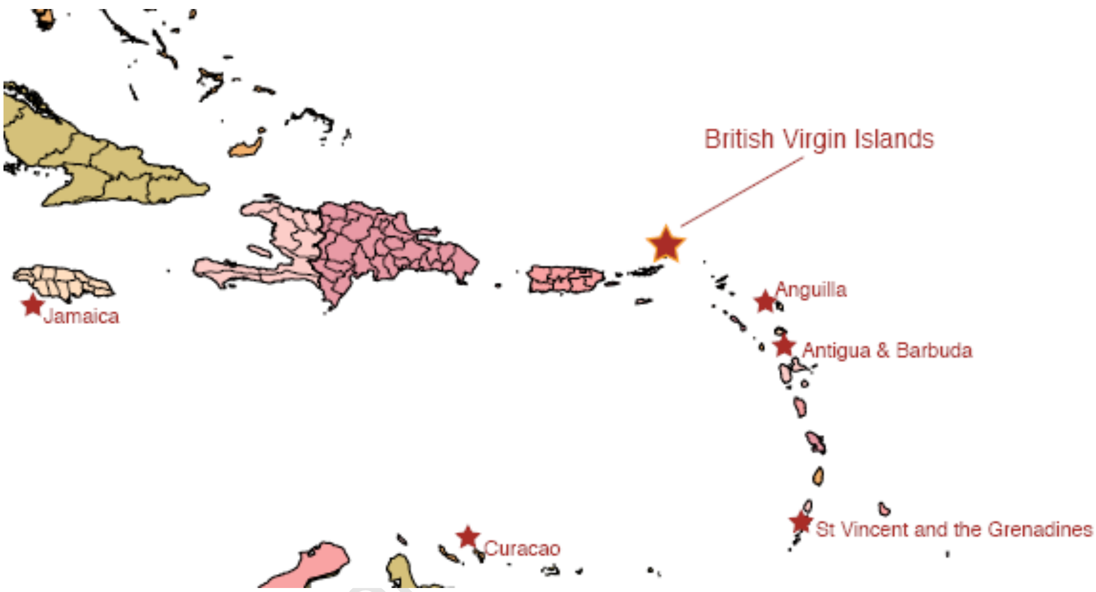


Figure 15: Map of the Caribbean (Charles, 2008)

6.2 Comparing relative area, population, GDP of islands and annual waste quantities disposed per annum

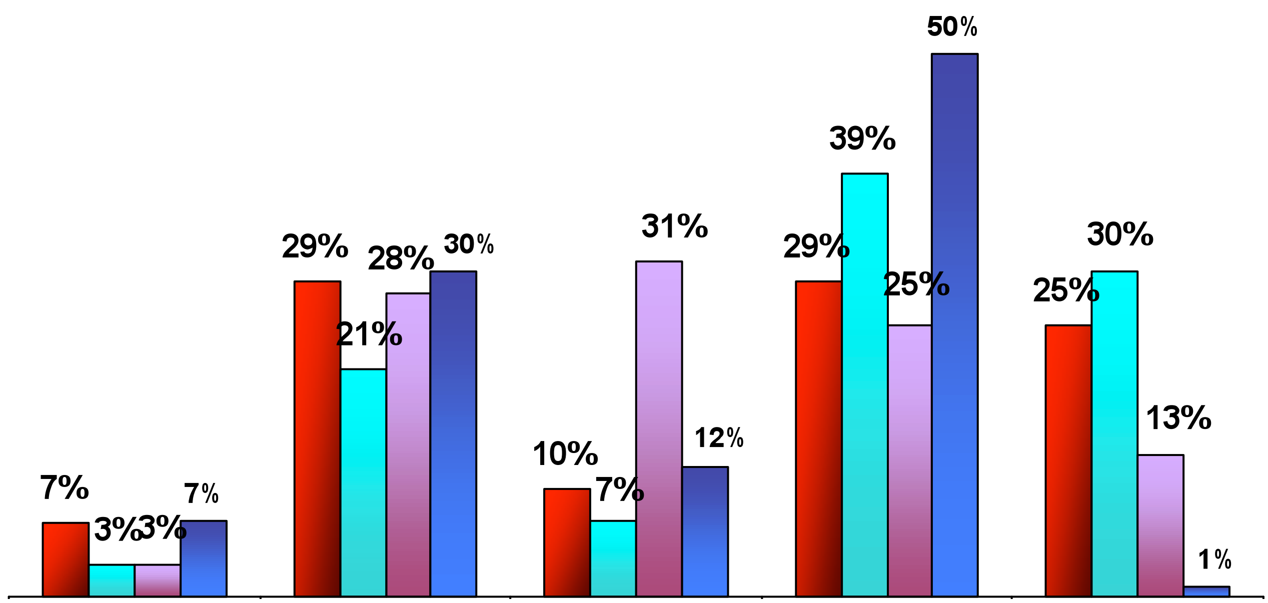
The islands sampled consisted of landmasses less than 500 sq. km[6], with the exception of Jamaica which covers an area of 10 991 sq. km. The islands, with the exception of Jamaica, are shown in figure 16 in relative sizes to each other. Jamaica has been excluded in figure 16 due to the relative large size of the island nullifying the data from the other islands.

[6] Jamaica is not included in this graph as its size in comparison to the small islands negates data from other islands.

As can be seen in figure 16, Antigua and Curacao are approximately the same size with Anguilla being the smallest. Generally, larger islands support larger populations. There are exceptions to this rule however, as is demonstrated by Antigua, represented as the second largest island with the third largest population. When comparing size, population and GDP of the individual islands, GDP shows no direct link to either population numbers or island size. For example, the BVI, the second smallest area, exhibits the largest GDP.

The global trend of increasing waste with increasing GDP and population numbers is reflected on islands. Increasing tourist numbers further exacerbates quantities of wastes generated and, as is evident on all the islands, waste generation exceeds population numbers.

Figure 16: Comparison of area, population, GDP and waste volumes disposed of. Base: % All islands (n=6)

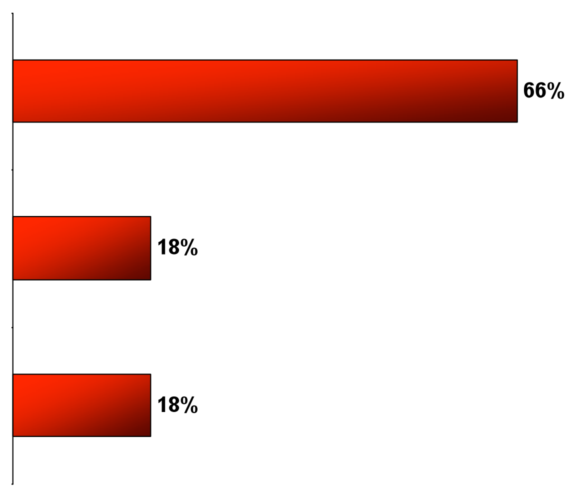


The low volume of waste depicted for SVG are attributed to data only reflecting receipts from one out of five disposal sites. No weigh bridge is in operation at this site and waste receipts are estimated on truck sizes using the facility. The high waste volumes in Curacao are attributed to a working weigh bridge and waste volumes are in line with the other islands within the Netherlands Antilles territory.

6.3 Integrated Waste Management Plans

As can be seen in figure 17, the majority of islands have IWMP being implemented or in the process of being implemented. With the exception of one island, waste management plans or policies guiding waste management practice include waste reduction, recycling and composting components. However, none of the islands have set waste reduction targets.

Figure 17: Integrated Waste Management Plans
Base: % All islands (n=6)



6.4 Waste Audits[7]

Five out of the six islands have conducted waste audits. Table 3 indicates the date of the audit and what methodology was used.

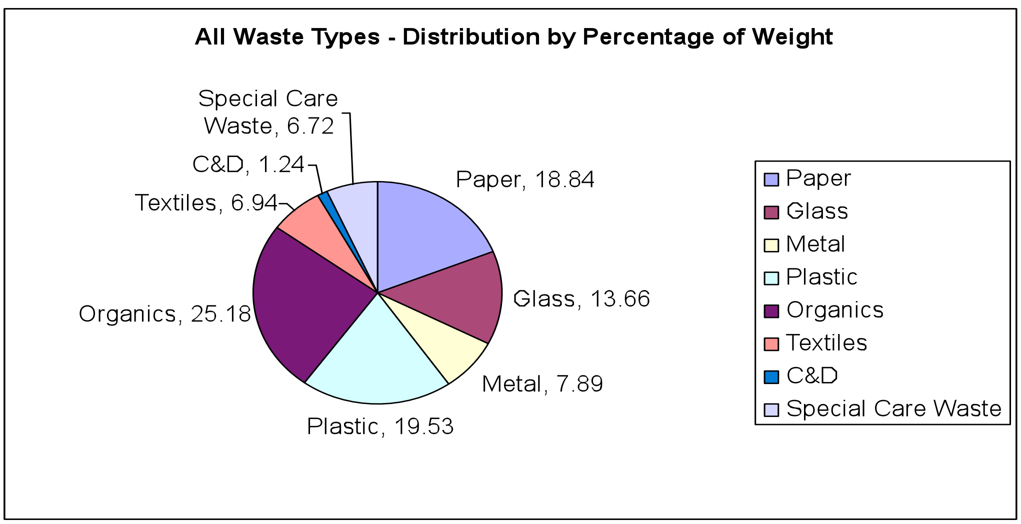
[7] Waste Audits are also commonly referred to as waste characterisation studies.

Table 7: Waste Audits conducted on islands

ISLAND	DATE	METHOD
Antigua and Barbuda	2006	5 days with technical support from CEHI
BVI	1988	4 days conducted by consultants installing incinerator[8]
Curacao	2003 / 2005	No information
Jamaica	no data	An audit has been conducted but no data available
SVG	2002	10 days adapted from the Antigua and Barbuda Waste Characterization Training and Demonstration Program

Although the data were gathered over various time frames and using various methodologies, they can still serve to provide insight into general trends. The results from the audits tabled above are shown in figure 18, 19, 20 and 21 and compared in figure 22.

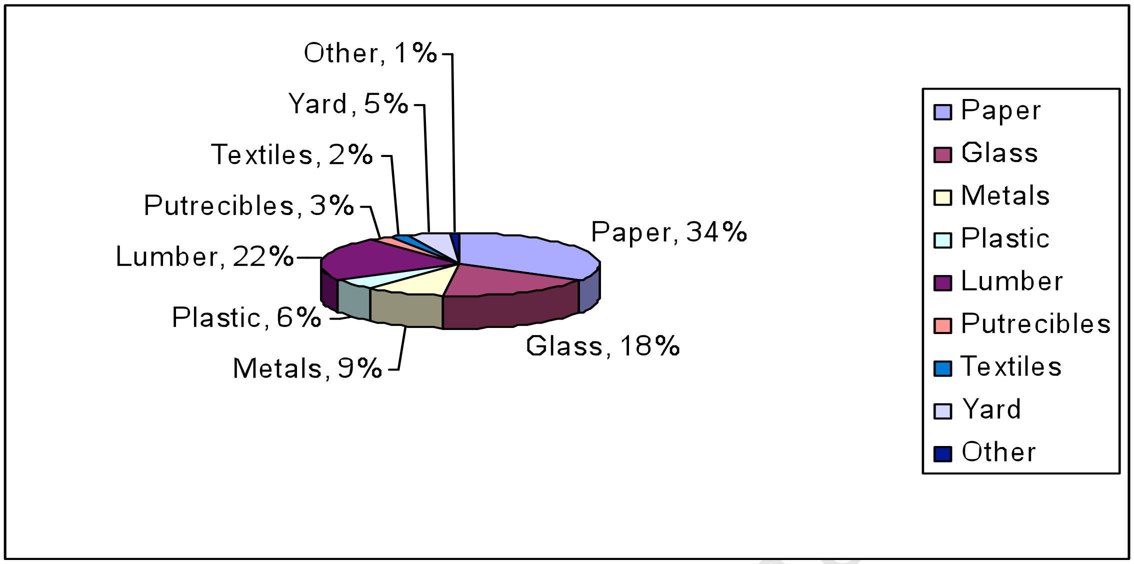
Figure 18: Antigua waste audit for 2006 (Antigua, 2007)



The findings of the audit done at the Cook sanitary landfill highlighted that organics, plastics, paper and glass were of major concern. Organics constituted the largest fraction of the waste stream at twenty five percent **(Antigua, 2007)**

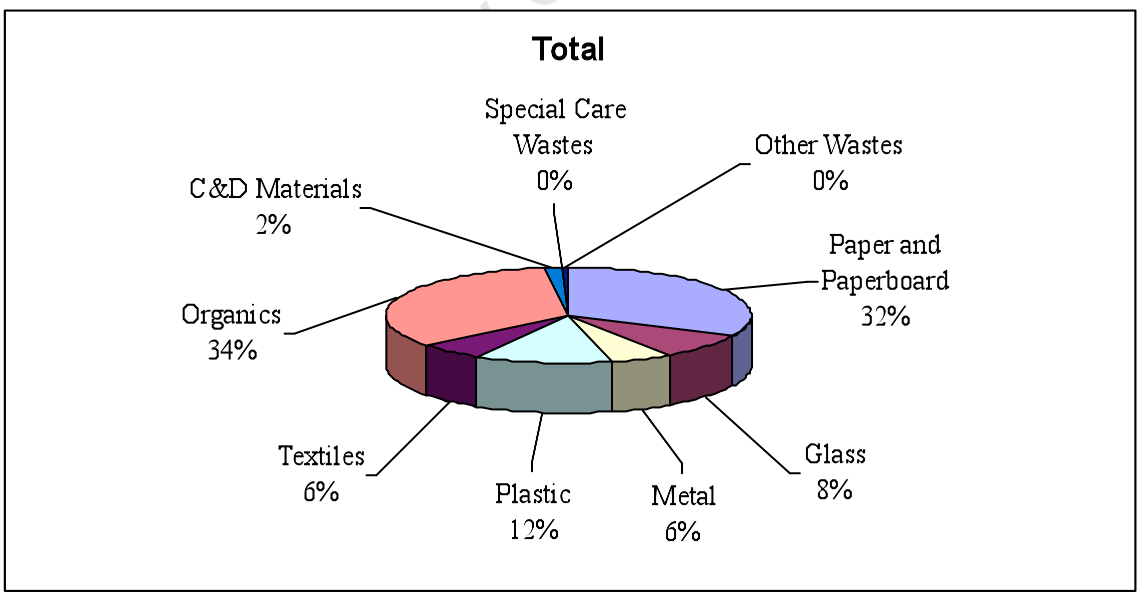
[8] Georges, 2002:65

Figure 19: BVI waste audit for 1988 (Georges, 2002:65)



The waste characterisation study for the BVI was conducted in 1988 and it is questionable as to how accurate the findings are. A present day audit is likely to find less glass, and more aluminium and plastic.

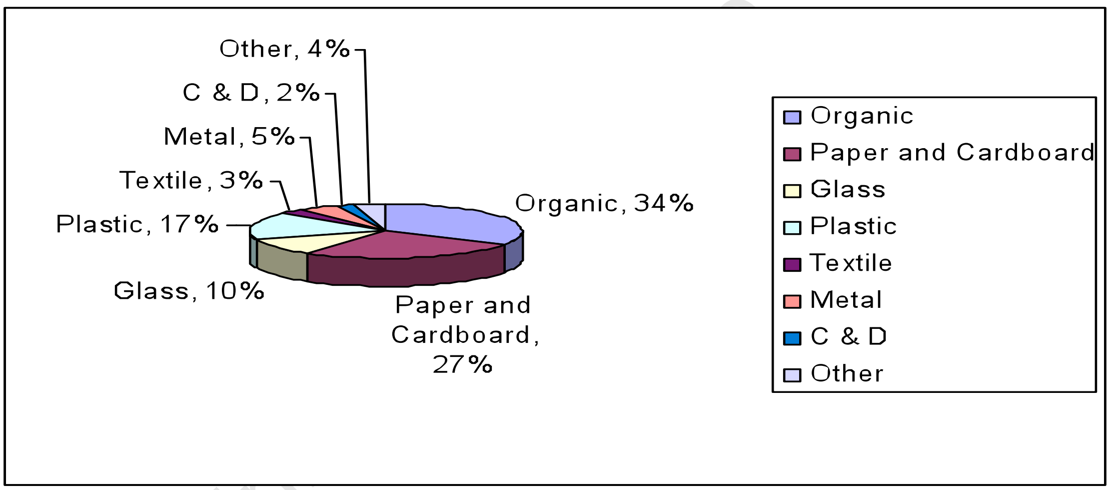
Figure 20: SVG waste audit for 2002 (SVG, 2007)



Within SVG the organics fraction was the largest representing thirty four percent of the combined residential and industrial and commercial waste stream. Examining the residential stream alone, organic waste constituted almost fifty percent by weight. Paper and cardboard constitute the next largest waste stream category at thirty two percent with cardboard being the major contributor. In the commercial audit, cardboard represented almost forty nine percent of the waste stream. Plastics formed the third largest component and were the second largest component in the residential audit. Film plastics were significant (SVG, 2007)

As depicted in figure 18, Curacao's largest waste stream is comprised of organics representing thirty four percent of the waste stream. This is followed by paper and cardboard at twenty seven percent and plastic at seven percent respectively.

Figure 21: Curacao waste audit for 2005 (Curacao, 2007)



6.5 Comparative audits

As shown in figure 22, when comparing the data from all the audits of the sample population, the organic fraction is consistently the largest waste stream representing thirty one percent of all the combined waste streams. This is followed by paper and cardboard, representing twenty six percent. The third largest overall waste stream is plastic at fourteen percent followed closely by glass at thirteen percent. Metals, textiles, C & D waste and special waste occur in significantly lower quantities. Although special waste quantities are not large, management of these wastes are important as they can be hazardous in nature.

As can be seen, SVG has the lowest percentage of glass present in the waste stream. This is likely due to the **bottle bills** in place that encourages reuse of many beverage containers that are bottled in St. Vincent.

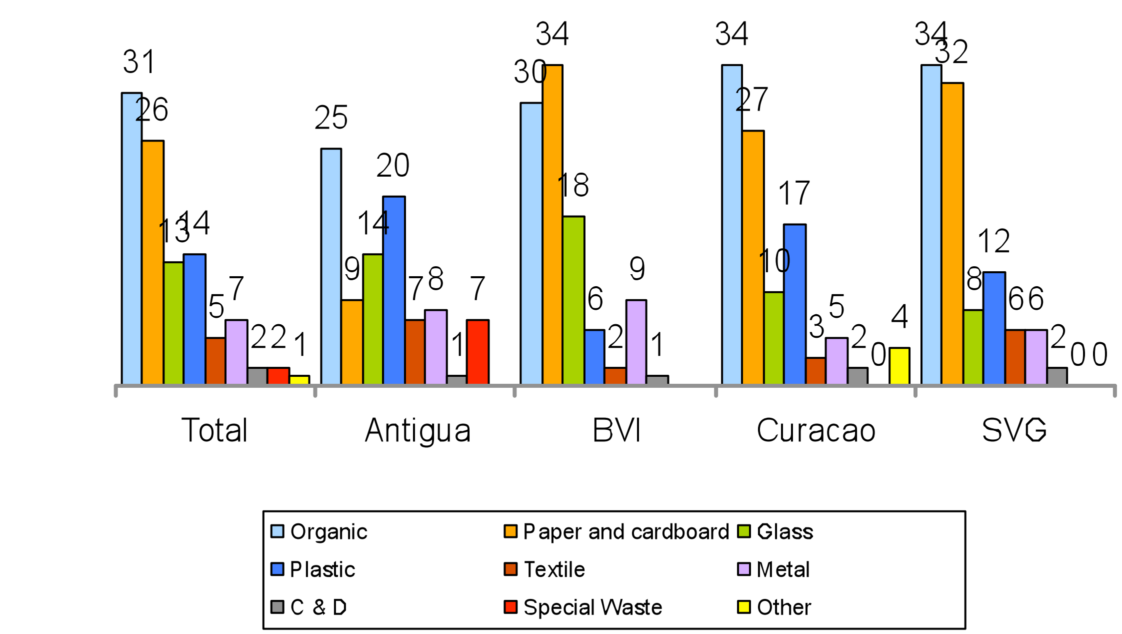


Figure 22: Waste Audits Combined

6.6 Disposal Methods

The data, illustrating the methods of waste disposal in figure 23, are in line with the global trends of landfill being the preferred waste management option. It is evident from the graph that landfill is the most popular method of disposal on the islands with the exception of the BVI being the only island to incinerate the majority of their waste. Antigua has the only sanitary landfill including a leachate collection and treatment plant. Unfortunately a fire has damaged some of the liner.

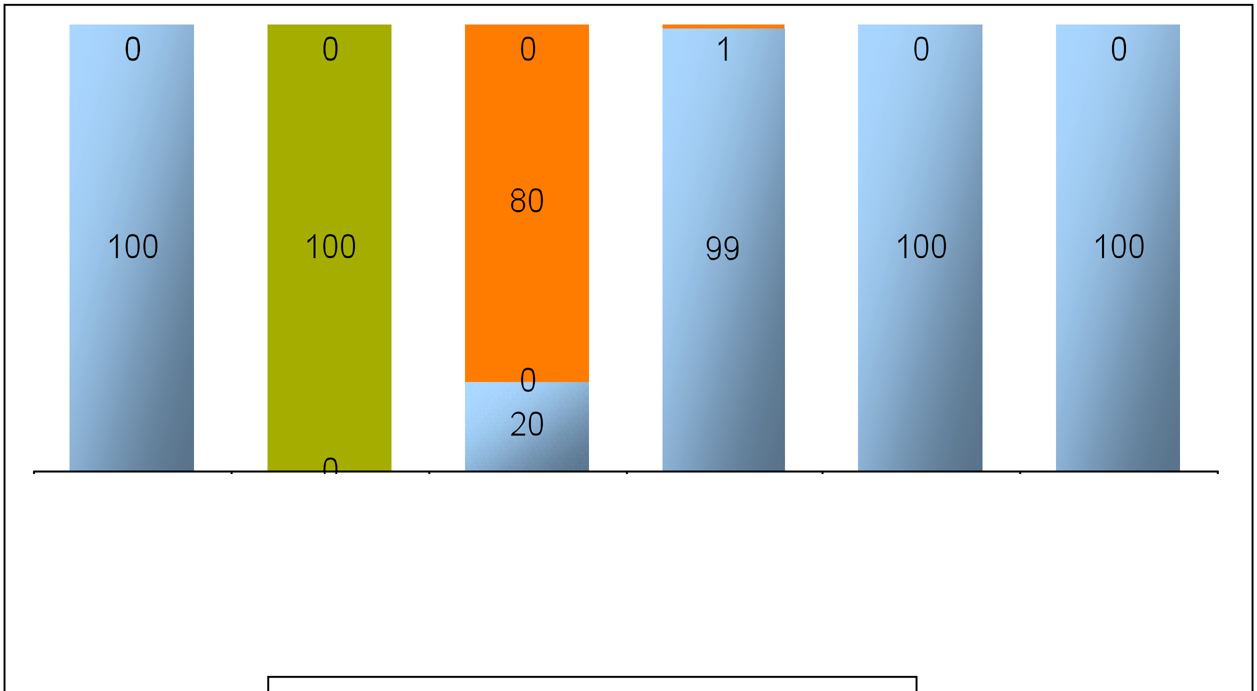


Figure 23: Disposal Methods on islands Base % All islands (n=6)

6.7 Laws guiding waste management

International laws included the Basel Convention, MARPOL laws applying to islands under the jurisdiction of overseas countries such as UK laws for Anguilla and the BVI and Dutch laws applying to Curacao. A regional law, the Cartagena Convention, was not mentioned by any islands except in a policy document for Curacao.

ISLAND	INTERNATIONAL	REGIONAL	LOCAL
Anguilla	√	-	√
Antigua and Barbuda	√	-	√
BVI	√	-	√
Curacao	√	-	√
SVG	√	-	√

Table 8: Laws guiding waste management

6.8 Waste reduction and resource management tools

As can be seen from the data, penalties for the mismanagement of waste, in the form of fines or jail time, are the preferred waste reduction tool. All the islands have established relevant legislation with one island awaiting promulgation. Penalties serve to decrease the volumes of waste littered and dumped. Fifty percent of respondents claim to have taxes, often in the form of Environmental Levies, to obtain additional funds to manage wastes generated. Bans, deposit systems and partnering with other islands are used on thirty three percent of the islands as waste reduction tools. As is illustrated in figure 21, no initiatives or policies regarding green procurement or EPR have been implemented on any islands.

The Government of Jamaica (GOJ) has drafted a policy for the management of e-waste in partnership with Grenada and Antigua. The draft calls for an inventory of e-waste across the islands, and identifies collection and storage options for existing e-waste until it can be managed appropriately. The public and stakeholders in the electronic sector are being made aware of the correct management and disposal of e-waste (Jamaica, 2007).

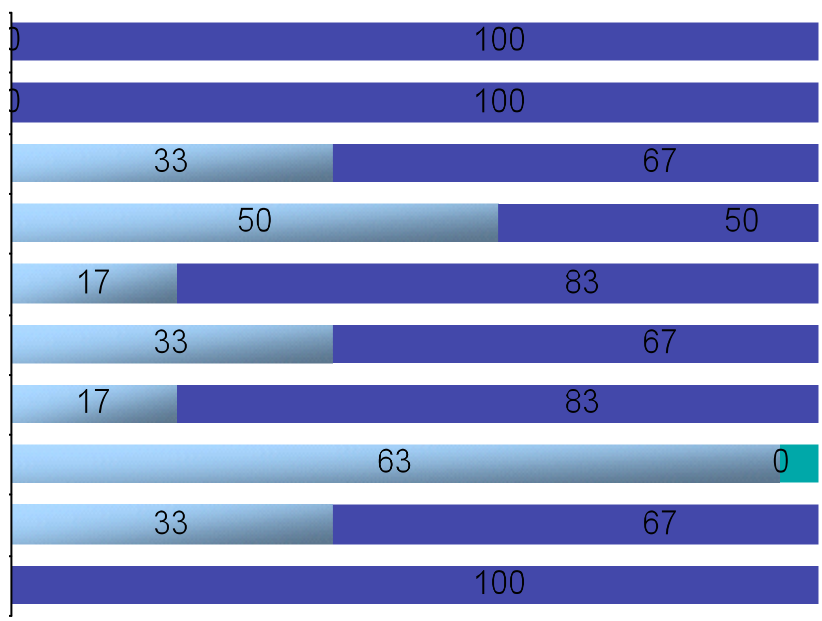


Figure 24: Waste reduction or resource management policies or initiatives Base: % All islands (n=6)

6.9 Educational Programmes

As illustrated in figure 25, schools education is implemented on all the islands and by next year all islands will be conducting complimentary community programmes. Sixty seven percent of the islands sampled have business and special events educational initiatives whilst fifty percent of the islands have government waste education initiatives. Waste education programmes for institutions, such as hospitals, are found on thirty three percent of the islands.

Seventeen percent of the sample population has waste education for industry. Education strategies for industry are not required for fifty percent of the respondents as there is no or little industrial activity on the islands.

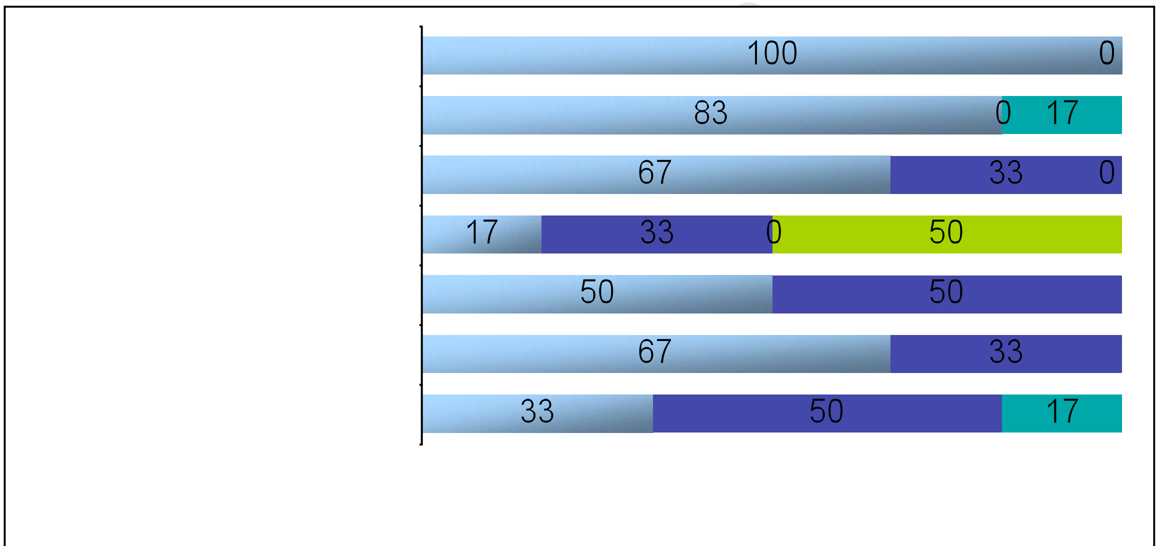
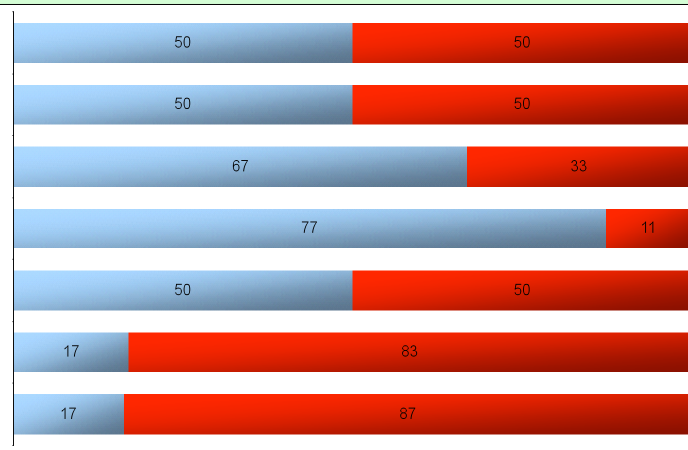


Figure 25: Waste education initiatives
Base % All islands (n=6)

6.10 Recycling initiatives

Figure 26 summarises the percentage of islands with recycling initiatives. Lead Acid Batteries are the most recycled item with seventy seven percent of the islands participating. Glass recycling is practiced on two thirds of the islands whereas paper and cardboard, Polyethalene Terephthalate (plastic), and scrap metal are recycled on fifty percent of the islands. Aluminium cans and C & D waste are the least recycled materials within the sample.

Figure 26: Percentage of islands recycling
Base: % All islands (n=6)



Further details on recycling initiatives are explored in table 4 below. Curacao is the only island where the government manages the recyclables. On all the other islands within the sample, recycling is run as private, commercial enterprises. In general market forces determine where the recyclables are processed. The main weaknesses in the recycling programmes are the small economies of scale and problems with separation at source. Strengths of recycling initiatives include some minimising of waste being disposed and some schools involvement in recycling initiatives.

Of interest is the practice used in Anguilla to landfill waste in categories so that should future initiatives arise to recycle materials, these can be excavated ensuring resource use and extended landfill capacity.

Recyclable	Island	Responsible	Processed	Weakness	Strengths
Paper and	Anguilla	Private	?	Small volumes	Some Reduction in waste
cardboard	Curacao	Selikor (Government owned)	Market dependent	Small volumes Cardboard not separated by generator	Some reduction in waste
	Jamaica	Private	Market forces	-	Some reduction in waste
PET	Antigua	Rotary (with some Gov. assistance)	Far East ?	Lack of separation, drop off points, not a buy back system	Diverts some waste, schools involved
	Jamaica	Private	Market forces		Some reduction in waste
	SVG	Private	Trinidad	Small scale	Some reduction in waste
Glass	Antigua	Private	?	Small scale	Some reduction in waste
	BVI	Private	Puerto Rico	Costs of collection	Some reduction in waste
	Curacao	Selikor (Gov)	None at present	Local crushing company no longer in business -	Dozens of bins strategically placed on island
	Jamaica	Private	Market forces	-	Some reduction in waste
Lead Acid	Antigua	Private	?	-	-
Batteries	BVI	Private	USA	Small volume, not viable	Reduces hazardous material being incinerated
	Curacao	Selikor	Market forces	Acid sometimes dumped by user	Most batteries collected
	SVG	Private	Private	Small volume	Some reduction in waste
Scrap Metal	BVI	Contractor for gov	?	Cost	Removes derelict vehicles
	Curacao	Selikor and Private	Market forces	None. Working well	Well funded. White goods collected free of charge
	Jamaica	Private	Market forces	-	Some reduction in waste
Aluminium cans	Antigua	Rotary	?	Small scale	Diverts some waste, schools involved
C & D	Curacao	Private	Local	Low volumes – not separated by generators	Recycled product well accepted by construction community

Table 8: Summary of recycling activities
n=6

6.11 Composting

Only two islands have composting programmes namely Anguilla and SVG and both use the windrow method sited at the landfills. The Anguilla SWD has appointed a private contractor to run the programme whilst the composting programme in SVG is run by the SWD. Antigua is planning a formal composting system for 2008 and currently promotes home composting as does the BVI.

6.12 Hazardous waste

Table 6 highlights hazardous materials and their management on the islands sampled. Antigua has a small hazardous disposal site to deal with hazardous material. In Jamaica hazardous wastes are strictly managed. Permits are required from the Planning and Research Department to dispose of hazardous waste. The Authority considers the human and environmental impacts of the waste and the packaging, containerization, transportation, treatment, and disposal of the waste. All hazardous materials accepted are logged and disposed in designated areas. There is interagency collaboration with the National Environment and Planning Agency (NEPA), Jamaica Bureau of Standards, the Scientific Research Council and the Chemistry Department of the University of West Indies to ensure the safe disposal of hazardous waste.

Table 10: Hazardous materials and management

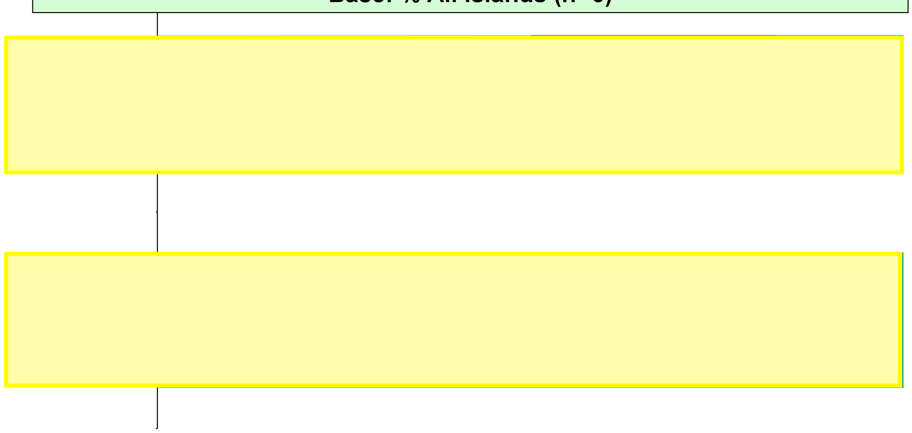
Hazardous material	Island	Method
Oil	Anguilla	Oil collected for electricity company
	SVG	Some recycling
Lead Acid batteries	Anguilla	Lead used for ballots in bare boats
	Antigua	Have small hazardous waste disposal site
	SVG	Some recycling
	BVI	Recycled
	Curacao	Recycled
	Jamaica	Recycled
Medical waste	Curacao	Incinerated
Asbestos	Antigua	Have small hazardous waste disposal site
	BVI	Landfilled

6.13 Current and future challenges facing islands

Figure 27 shows that fifty percent of the respondents highlighted littering and illegal dumping as the main issue currently facing waste management. Closely linked to litter and dumping, thirty three percent of the respondents identified the lack of ownership and responsibility for waste management as the major challenge on their islands. Suitable disposal sites were the major current concern of 17 percent of the sample.

The disposal of waste in terms of dealing with increased volumes and decreased capacity to handle waste was identified as the main challenge to be faced in ten years time.

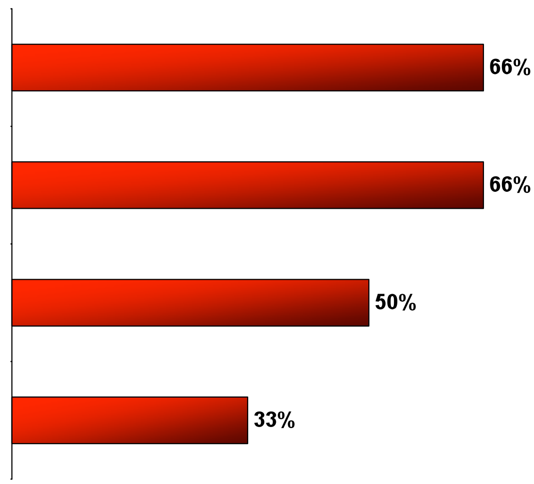
Figure 27: Current and future waste management challenges
Base: % All islands (n=6)



6.14 Suggestions for improved waste management

When questioned for suggestions to better manage waste, sixty six percent of the respondents highlighted implementing the 3R's and increasing public awareness and participation. Upgrading facilities was identified as important by fifty percent of the respondents with thirty three percent of the respondents identifying that waste management itself needs to be prioritised on islands. These suggestions are shown in figure 28.

Figure 28: Suggestions for better waste management
Base: % All islands (n=6)



The findings from this questionnaire provide empirical evidence to complement the grounded theory developed in this dissertation. The combination of qualitative and quantitative data provides the impetus to develop pragmatic suggestions for waste reduction and resource management within the BVI.

6.15 Summary

This chapter has highlighted the key findings from the questionnaire responses obtained from six Caribbean islands and demonstrated that all of the participating islands are involved in waste reduction initiatives to varying degrees. All respondents interviewed agree that waste disposal will be the main challenge facing their islands in the near future.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS FOR THE BVI

7.1 Introduction

This chapter summarises the key findings from the questionnaire. The grounded theory developed on waste is then used in conjunction with these findings to develop recommendations for waste reduction within the BVI.

7.2 Conclusions from the findings of the waste reduction questionnaire

At a local level, within the questioned Caribbean islands, it can be seen that waste generation is linked to population numbers, GDP and the size of an island with waste volumes increasing annually. Data on waste volumes are variable and unreliable due to operational issues at disposal sites, such as broken weigh bridges and not all incoming waste being tallied.

Although most islands have IWM plans to manage their wastes that include the 3R's, none of the islands have set waste reduction targets, indicating that waste reduction is perhaps not considered a priority area at this point in time. Considering the relative newness of SWD on the islands, this is to be expected as the priorities have been directed at establishing efficient collection systems and safe disposal sites. With significant improvements in both collection and disposal, waste reduction is the next area of focus as the islands questioned face a shortage of disposal options in the coming future.

Waste audit findings indicate that across the islands interviewed, the largest waste streams are comprised of organics, paper and cardboard, glass and plastic respectively. Examples of recycling initiatives of these waste streams can be found within the sample population and are mostly run by private enterprises. Economies of scale and source separation are considered the major obstacles facing recycling initiatives. Composting is not done on a large scale even though organics constitute the largest volumes of the waste stream. Although low in volume, hazardous waste management is being addressed on certain islands within the sample population with a focus on e-waste and batteries.

International and regional legislation and initiatives[9] are underway to guide waste reduction and resource management within the Caribbean. Details of these initiatives can be found in Appendix 7. All islands interviewed are using waste reduction tools to varying degrees with the exception of EPR and green procurement that are not currently being utilised.

The future challenge to be faced on all the islands questioned involved how to dispose of wastes in the future and officials interviewed recommended the implementation of IWM with increased public participation through increased awareness and education. Education and inter–island collaboration are believed to be the keys in waste reduction and recycling initiatives and the islands seem poised to initiate waste reduction and resource management as the future focus areas of waste management.

7.3 Recommendations for the BVI

Based on the findings of this dissertation, various long and short term strategies for waste reduction and resource management are recommended for the BVI and are in line with many of the recommendations made by the Caribbean Environmental Health Institute (CEHI, 2004a) and the WIN report (2006).

[9] It is interesting to note that the islands interviewed stated they were not governed by regional laws although the Cartagena Convention has been signed by all, indicating a possible gap in information and application of the convention.

Recommendations made in this section serve only to advise on possible strategies and tools that can be applied to waste reduction and resource management and are based on the SRM philosophy of utilising waste as a resource.

7.3.1 Develop a Resource Management Plan

The development of a comprehensive **Resource Management Plan (RMP)** is advised, as a component of an IWMP[10] and NEAP, in line with all regional and international policies and initiatives affecting waste management and sustainable development. The RMP would inform necessary technical, legal and fiscal instruments in addition to physical and human resources to achieve resource management. As outlined in the WIN report (2006), the RMP should include the following components:

- **Future scenario of waste volumes, proposed costs and methods of management** is required to demonstrate the importance of waste reduction and resource management. Education initiatives would highlight these findings to achieve buy in from politicians, government departments and the general public to understand the importance of waste reduction and resource management on the islands.

- **Generation of accurate data** is necessary to understand present waste stream constituents, quantities and origins before embarking on any waste reduction and resource management initiatives. A thorough waste audit is required and it is recommended to partner with CEHI and/or other islands to facilitate the design of an appropriate and effective waste audit methodology. The audit should be conducted regularly to monitor progress and track changes in the waste stream. Waste reduction strategies can then be prioritised with realistic waste reduction and resource management targets being set.

[10] NEAP recommends the development of a national IWMP (see section 2.4). The IWMP drafted by Dillon in 1988 should be revisited as part of the review process for the IWMP

- Set **objectives, a vision and targets** to reduce waste and manage resources. It is recommended to adopt a SRM vision to eliminate waste from the BVI islands as a long term goal. Although this may sound like an idealistic vision it must be remembered that before any major breakthrough in paradigms occurred, resistance to new ideas is to be expected. If a sustainable solution is to be found for waste management, the goal should be to aim for "zero waste" to landfill and incineration.

  To achieve this, the SRM philosophy is to be implemented by continuously applying IWM strategies as discussed in section 5.7 with the aim of incrementally improving resource management until no landfill or incineration is necessary. Resources would be monitored through regular audits that would guide priorities and targets to reduce remaining resource streams. Once targets have been set, policy frameworks can be developed with performance indicators to measure progress with each resource stream requiring individual strategies. Each resource stream would require a specific strategy. An example of a strategy for organic waste is shown below in table 6 and highlights the necessary components required to achieve reduction for this waste category.

Policy	**To utilise all resources optimally and create a safe and sustainable community**
Measurable Target	**By Year (0 + N), reduce organic resources being incinerated and landfilled by X%**
Measurable Indicator	**By year (0 + N),composting facilities will be complete**
Instrument	**By year (0 + N), a legislative framework will be approved, educational strategies will be designed**
Precondition	**A baseline waste audit will be conducted to monitor organic resources**

Table 11: Strategy for reducing organic waste

(Adapted from WIN, 2006:22)

- **Physical and non physical instruments** should be planned. Physical requirements include relevant facilities and technologies necessary for waste reduction and resource management and non physical instruments such as policies, legislation, capacity building, skills development, management and education to facilitate initiatives.

- **A feasibility analysis** is required to assess costs and appropriateness of initiatives. Financing mechanisms must be explored and can take the form of taxes, environmental levies, subsidies, public private partnerships and donors. The WIN report (2006) cautions that donor projects must be locally owned and applicable with sufficient skill transfer to ensure ongoing project success.

7.3.2 Possible tools to achieve SRM

The following are suggested for further study as they may serve as invaluable tools to assist in reducing waste and managing resources:

- **Composting** is perhaps one of the most simple and effective strategies to apply to waste management systems as organic waste can constitute up to 80 percent of the waste stream in certain regions (UNESCAP, 2006). It is recommended to explore suitable **composting** options as the organic fraction is consistently the largest component of the waste streams as shown in section 5.5. Commercial fertilisers are imported whilst valuable organic waste is rendered useless through burning and burying. Reducing the organic fraction in the waste stream is likely to reduce dioxin emissions as dioxins are formed when organic waste is burned with plastics and paper that contain chlorine (Platt, 2004; Rogers, 2006).

  Although there are many problems associated with composting such as quick decomposition in the tropical climate, contamination, failure to secure markets for the compost, and the risk of diseases (WIN, 2006), composting is a relatively simple and viable method to significantly reduce waste volumes. The challenges listed above need to be considered when designing a suitable composting system with a full assessment done prior to selecting a composting method.

Of the islands questioned, windrow composting was the preferred methodology but this is not likely to be suitable for Tortola due to limited land space and mountainous terrain. However, the viability of vermiculture (worm composting) could be explored. Windrows (aerobic composting in done in long rows) may be suitable for less mountainous islands of the BVI such as Virgin Gorda so it is probable that various composting methodologies are developed to suit local needs of specific islands within the BVI.

It would be necessary to precede the composting initiative with an educational campaign demonstrating home composting, and the benefits of compost over artificial fertilisers. Economic incentives could include subsidising home composting bins and locally produced compost. Imported fertilisers could be subjected to increasing taxes.

- **Extended Producer Responsibility (EPR),** as discussed in section 4.6.1, is potentially a powerful key leverage tool that can be used to minimise waste and manage resources as it focuses on root cause of the problem. The responsibility for waste is transferred onto producers, suppliers and consumers through economic instruments and legislation.

  EPR would most effectively be implemented by a regional Caribbean body as the purchasing power of the BVI is small within the world market place. Legislation or policies at a regional level could stipulate the return of problematic wastes that cannot be used as resources on islands back to the producer for reprocessing. EPR can be used to reduce and eliminate current problematic wastes such as e-waste and hazardous wastes thereby reducing the accumulation of toxic materials in the BVI.

- **Regional and internal inter-departmental partnerships** are required to facilitate skill, information and technology exchanges and increase synergy between departments and islands. Waste management affects economic, social and environmental facets of society and is not simply the sole responsibility of the SWD. Inter-departmental co-operation would be required to successfully implement and execute a RMP.

  It is recommended the BVI actively partner with outside organisations (see appendix 7) such as CEHI, the Organisation of the Eastern Caribbean States (OECS) and the Caribbean Community (CARICOM), to increase the cooperation and collaboration between islands so that resources (human and physical) can be shared. This may make the recycling more viable within the island chains and realise the potential of EPR. CEHI could assist with waste audits, the waste diversion strategy and CP initiatives. Success stories and best practice should be shared through a coordinating body such as Recaribe or CEHI.

  The BVI could partner with Jamaica, Trinidad and Tobago and the United States Virgin Islands (USVI) who are all currently dealing with **electronic or e-waste initiatives and legislation** to develop strategies to deal with increasing e-waste quantities. A regional strategy for e-waste would be the ideal and could be included in CEHI's waste diversion strategy. It would be advised to learn from the strengths and weaknesses of the EU WEEE initiative and adapt necessary frameworks to suit local environments. Caution is advised to ensure that e-waste is processed by registered recyclers to ensure the safe reprocessing of this hazardous waste stream.

  External partnerships and internal inter-departmental cooperation within the government of the BVI itself would strengthen and increase the effectiveness of any resource management initiatives implemented.

- **Green Procurement:** Due to the high rate of imports, green procurement could effectively be used to encourage environmentally friendly products being imported. One example is that biodegradable utensils and plates could be imported and perhaps subsidised by government to replace the plastic counterparts that constitute the largest litter fraction on beaches (ICC, 2006).
- The **development of construction guidelines** that stipulate the reuse of certain materials in construction and the deconstruction of buildings to enable reuse.
- Partner with local businesses to develop best practice waste management practices perhaps through using forums such as **Waste Minimisation Clubs** (see section 4.6.4). The BVI could affiliate with the Caribbean Alliance for Sustainable Tourism (CAST, 2007) to decrease waste generated from the tourism industry.
- **Facilitate small enterprises and public-private partnerships** utilising waste as resource. Numerous examples can be found in appendix 9. Environmental impacts stemming from any proposed projects should be incorporated into the design phase and addressed accordingly.
- Explore **plastic bag legislation**, such as implemented in South Africa and Ireland, to reduce the use of double bagging flimsy plastic bags and encourage reuse of durable bags. Durable bags can be made locally using available materials.
- Develop strategy for **hazardous waste** in line with international and regional conventions. Autoclaving can be explored for medical waste
- Current **education and public awareness initiatives** should continue and be supported by regional and international initiatives and incorporated into a wider environmental education strategy for the BVI. It is suggested that assistance should be provided to schools, communities, commercial enterprises including the tourist and boating sector, special events, institutions (such as churches and hospitals) and government departments who wish to participate in waste reduction and resource management initiatives such as Waste Minimisation Clubs.

7.4 Summary

It is believed by the author that through continuous improvement cycles of IWM, the principles of SRM can be achieved. SRM will significantly contribute to a safe and sustainable environment for the BVI. Utilizing resources optimally will improve human health, create jobs and utilize creative potential to transform the current waste challenges into opportunities for betterment.

CHAPTER 8: EVALUATION:

8.1 Introduction

Known and unknown variables have impacted on the research. This chapter highlights some of the known constraints affecting the research. The evaluation of the research and research methodology is assessed according to prime areas of relevance, utility, validity, and ethics. Finally, suggestions for areas of further study are listed.

8.2 Constraints and limitations

Certain constraints and limitations were inherent in the research process and these included:

- The author is not a citizen of the BVI nor employed by the department responsible for waste management on the island and is thus an outsider to both the island and the systems that govern the functions therein. This research study has been conducted independently and has not involved stakeholders in the process. This paper instead has served to address a theoretical paradigm shift regarding waste with practical applications. Any follow up work would require suitable methodologies such as action research methodologies that would actively involve stakeholders in the process.
- Data on emissions and potential health threats from residual waste management in the BVI is limited or does not exist
- BVI has the constraints of being a small island with limited resources and is vulnerable to outside market forces
- Large gaps in knowledge on waste (and associated human behaviour) exist (Rogers, 2005; Royte, 2005; Rathje and Murphy, 2001; Strasser, 1999)
- Many problems exist with determining accurate data on waste quantities. Most islands represented have no weigh bridge to weigh the incoming amounts of waste. In many cases, information is gathered in cubic meters and converted to tons leading to inaccuracies. Furthermore, not all waste

entering a site is audited and it is generally accepted that waste figures are higher than represented.

- The sample population for the questionnaire is small and a larger sample may reveal variations to the data presented.
- Personal assumptions exert bias and although the grounded theory process minimises this, the researcher is conscious of potential bias.

8.3 Relevance

Within the island setting of the BVI, managing waste faces numerous constraints. The research identifies waste management concerns and proposes recommendations to address these constraints. Grounded theory proved to be a relevant methodology for this research as the theory emerged from the data itself. The methodology allowed for the evolution of theory to emerge across many disciplines and be applied to a real life phenomenon.

8.4 Utility

Islands face severe waste management constraints and waste reduction options using the SRM philosophy can address these constraints to achieve sustainable waste management practices on islands. It is believed that the research has utility and can be applied to practical solutions within the BVI, in addition to other Caribbean islands. It is hoped that this paper can assist in contributing to the body of knowledge available on waste reduction and resource management and that this dissertation can assist in the implementation of practical projects. Any future research projects should be conducted through a regional Caribbean organization such as Recaribe, the OECS or CEHI to increase the relevance and utility of the research.

8.5 Validity

Validity assesses the rational argument of the answer to the research question of: **How can the amount of waste being incinerated and landfilled in the BVI be reduced?** Grounded theory methodology allowed for constant comparison of data on waste. Collected through literature reviews, interviews and a questionnaire, data was sorted into categories and their properties and relationships analysed to derive a theory of waste - from which the question could be answered. The emergent theory of waste was derived from the data itself, thus grounding it in the situation, using a known methodology to strengthen the validity of the research.

8.6 Ethics

Ethically, the author attempted to develop good relationships with participants through contracting and entry. Responses were kept anonymous for ethical reasons to assure confidentiality and to encourage open inquiry - as many facets of waste management can be "hidden" due to their sensitive nature. It was agreed to share findings from the study with participants. Findings were documented as accurately as possible, but it is acknowledged that there may be a margin of error as notes, not recordings, were made during interviews.

8.7 Reflections

Partington (2000:93), citing Glasser and Strauss (1971), lists four criteria that theory should satisfy. Theory should:

- "fit the real world"
- "work across a range of contexts"
- "be relevant to the people concerned"
- "be readily modifiable."

The grounded theory developed on waste fulfills these criteria. The principles and procedures of grounded theory with respect to analysis of data were adhered to, to reduce bias and error, thus applying rigour to the research. Although grounded theory proved to be a time consuming and complex methodology, it permitted the exploration of waste from multiple perspectives to inductively derive a theory of waste, which in turn guided the research process to focus specifically on waste reduction and resource management.

8.8 Recommendations for further studies;

- **Health and environmental impacts of emissions from incinerator and landfills:** It would be advised to gather data on air emissions from the incinerator and from the landfills to determine the possible impacts these facilities are having on the local environment. Use could possibly be made of the H. Lativity Stout Community College laboratories for these purposes to measure dioxin levels in cisterns and water and soil quality around landfills. Data could be gathered to explore potential links between health issues such as asthma and cancer from incinerator and landfill emissions.
- **Further research into waste management activities into neighbouring islands to explore partnering opportunities with these sister islands**
- **A materials flow analysis,** as suggested by Georges (2002), to understand what resources are being imported into the BVI, what is processed and what accumulates as waste or litter. This information can be used as part of indicators for sustainable development purposes.
- **A systemic analysis to assess the role of various government departments (and their associated policies) that relate to waste reduction and resource management within the BVI and to determine administrative control over revenues associated with waste.**
- **Explore potential mechanisms and funding to implement joint planning and administration between islands** to encourage inter-island co-operation and capacity building.
- **A detailed study into cost effective, simple and diverse technologies to manage resources efficiently and effectively.**

8.9 Conclusions

The research question has been answered using a rigorous research methodology that is relevant within the context of the problem. The answer has utility and can be applied to the situation. Grounded theory has added validity to an ethical research process.

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APPENDICIES

Appendix 1: Aluminium recycling in the BVI.

Recycling scrap metals

BY CHRIS BERGERON

Mike Masters' Magic Metals monster machine munches scrap.

And leaves the BVI more beautiful.

Mike Masters has begun the territory's first re-cycling operation and hopes to turn his commitment to the environment into a profitable sideline business.

RECYCLERS: Mike Masters, left, and Robert Richardson of Magic Metals.

Photo by Chris Bergeron

Since early February he been purchasing scrap metal, principally copper, bronze and aluminium, which he crushes and sends to Puerto Rico for smelting.

Mr. Masters, managing director of NauTool Machine Ltd., saw unsightly scrap metal littering the territory's roads and vacant lots for years and decided to capitalize on it.

Wasteland

"Basically, I'm trying to change the environmental outlook. I see waste everywhere.

"Since I've first come I've seen literally tons of old bronze boat fittings lying everywhere. But there was no means or incentive for collecting it," he said.

"One of the biggest shocks is going into the pristine waters and finding metal and glass junk.

"I really am committed to an environmental clean up. I've found an outlet for scrap."

He formed Magic Metals and acquired a metal crusher, which separates various metals with a magnet and crushes them in the apparatus' steel jaws.

The metals are stacked in blocks and shipped in a 27-foot container, which has a 10,000 pound capacity, to Puerto Rico where a scrap metal company purchases them.

Scrap metal of any quantity will be weighed and purchased for cash on site at Wickham Cay II.

Dollars for scrap

Mr. Masters, who came to the BVI 10 years ago, is currently paying 40 cents a pound for "clean" copper and 15 cents a pound for aluminium.

He noted that aluminium window frames and maritime scrap are routinely dumped by people who don't realize they're throwing away a redeemable commodity.

Redemption fees will be paid according to a "sliding rate," based largely on world supply and demand.

"Rates can change. Two months ago aluminium was high. Now there's a world glut," he said.

Mr. Masters, a tall, wiry Canadian, said he hopes to expand his operation to include the thousands of beer bottles that litter the territory's roads.

He said that preliminary discussions have been held and the bottler who provides Heineken and Budweiser bottles has indicated a willingness to redeem used bottles.

Trash visionary

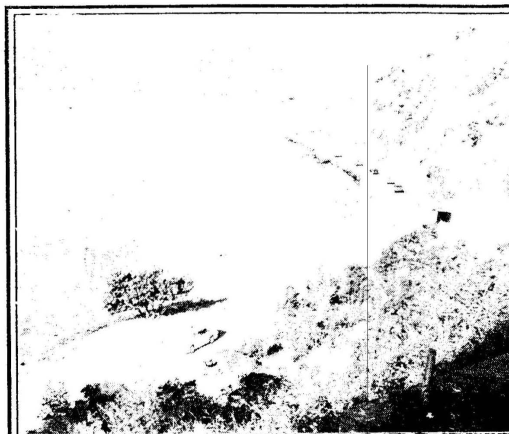
When it comes to recycling trash, Mr. Masters virtually bubbles with visionary enthusiasm.

He said he wants his efforts to stimulate an awareness among residents and visitors that recycling can be a profitable way to preserve the BVI's scenic beauty, which remains one of the essential ingredients of the tourist industry.

He hopes that with "encouragement" from various government agencies and civic groups he could organize competitions among scout and school groups to collect scrap for prizes.

Mr. Masters said he intends to explore other avenues for recycling, including glass which can be used in road building.

"Right now we're providing a service that wasn't in the BVI before and with a little encouragement from the restaurants, schools, buinesses and boating industry we could could really make a contribution to a cleaner, more beautiful BVI," he said.



WORK SET: Repair work on this section of Drake's Highway, between Slaney and Parker's garage at Duffs Bottom, is slated to begin on or about March 1, according to Minister of Communications and Works T.B. Lettsome. Heavy vehicles will begin moving rock and equipment to the area soon and Mr. Lettsome asked motorists to "exercise patience and to remain alert during the coming months." When construction begins, eastbound traffic will be diverted over Slaney Hill, while westbound traffic will be allowed to pass through the area in the right hand traffic lane. Property owners in the area have been asked to cooperate with Modern Construction Ltd., primary contractor for the project.

Photo by Gary Metz

No more recycling

By Chris Larson

The fledgling recycling industry here apparently has ended.

Mike Masters, managing director of Nautool Inc., last month sold his can-crushing machinery to a company in Puerto Rico. Nautool was, it is believed, the only place in the territory for aluminium cans and other scrap aluminium to be recycled.

Mr. Masters said he had been crushing cans for about 18 years, as a sideline to Nautool's primary business of a machine and fabricating workshop. "I was losing money" with the recycling, he said. "I was getting very little help from the Virgin Islands, both private and public, except for a few diligent individuals."

Mr. Masters had offered to sell the machine to the BVI's Solid Waste Department. Solid Waste turned it down, however, because of the size of the machine, said Clyde Lettsome, the department's manager.

"We looked at setting [the machine] up at the incinerator," Mr. Lettsome said. "But there was no way we could fit such a big piece of equipment. We would have loved to take it, and Mr. Masters wasn't asking for much for it. There was just nowhere to put it."

Service stopped

Nautool was part of a voluntary recycling programme. A few years ago, Solid Waste set up baskets to accept aluminium cans at several places throughout the territory. The idea was that various youth groups would collect the cans for delivery to Nautool, Mr. Lettsome said. Nautool would pay the groups for the cans, crush them and send them on to Puerto Rico.

The programme didn't last long, however. Some of the groups "stopped servicing the baskets," Mr. Lettsome said, or didn't collect the cans often enough. And residents were throwing all sorts of trash into the baskets. "Sooner or later, the project came to a halt," Mr. Lettsome said. Schoolchildren on Virgin Gorda are believed to be the only group that continued the effort.

Students from the Valley Day School there would collect cans from places such as the Mad Dog bar, the Guavaberry vacation homes, and private residences, said Tina Goschler, owner/manager of the Guavaberry homes. Ms. Goschler helped coordinate the programme. Dive BVI would also give the students their used aluminium dive tanks, she added.

"When the kids collected enough, they were sent to Mr. Masters on Tortola," she explained. "The school would get some money, but it was mainly to educate the kids about recycling." Because it was a charity, Ms. Goschler added, the captain of the boat that ferried the cans to Tortola wouldn't charge for the cargo.

Ms. Goschler found out about Nautool's decision only after sending 23 large bags full of cans, cans that now will likely end up in the incinerator or landfill. The children aren't in school now, but she said she doubts the programme will continue when classes resume. "They can't do it if there's nowhere to send the cans."

Recycling Advisory Board

Recycling in the territory had been pushed by the BVI Recycling Committee. That group was disbanded some time ago,

Continued on p. 9

Recycling

from p. 4

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Appendix 2: Waste Reduction and Resource Management Questionnaire November 2007

1) Name of Island:

2) Population:

3) Gross Domestic Product:

4) Amount of waste disposed of per annum:

5) Method of disposal: Landfill / Incineration / Other

6) Does your island have an Integrated Waste Management plan? YES / NO

7) Has your island conducted a waste audit? YES / NO. If so:

   a) When?
   b) Over what period?
   c) What were the results?

8) Does your island have any waste reduction targets? YES / NO
   If so, please provide details.

9) Is your Integrated Waste Management Plan governed by:

   a) Regional laws and regulations YES / NO
   b) International laws and regulations YES / NO
   c) Island or Country laws and regulations YES / NO
   d) Other

10) Does your island have any current or proposed waste reduction legislation or initiatives such as:

   a) Green procurement for government/ business YES / NO
   b) Extended Producer Responsibility YES / NO
   c) Banning certain goods/ products from being imported YES / NO
   d) Environmental or packaging taxes on certain materials/goods/ products that become problematic wastes YES / NO
   e) Waste Electrical and Electronic Equipment (WEEE)
   f) Deposit systems for items such as bottles, batteries and tyres YES / NO
   g) Building /demolition guidelines to reduce construction waste YES / NO
   h) Penalties for improper waste disposal YES / NO. If so, what are the penalties?
   i) Partnering with other islands to reduce waste YES / NO
   j) Training or awareness programs to reduce waste for:
      - Schools YES / NO

- Communities YES / NO
- Business YES / NO
- Industry YES / NO
- Government YES / NO
- Special Events YES / NO
- Institutions such as hospitals YES / NO

k) Other

11) Are there any recycling programs on your island? YES / NO. If so, please fill out the table below in answer to these questions:

a) What material/s is/are recycled?
b) Who is responsible for the project/s?
c) Who funds the program/s?
d) Where are the recyclables sent to be processed?
e) Thinking about the program/s, can you think of weaknesses?
f) Thinking about the program/s, can you think of any strengths?

Material Recycled	Responsible?	Funding	Processed	Strengths	Weakness

12) Does your island have a composting program or facility? YES / NO. If so,

a) What method of composting do you use?
b) Who is responsible for the project?
c) Thinking about the program/s, can you think of any weaknesses?
d) Thinking about the program/s, can you think of any strengths?

13) How does your island manage universal or hazardous materials such as batteries, pesticides, mercury containing equipment and fluorescent bulbs

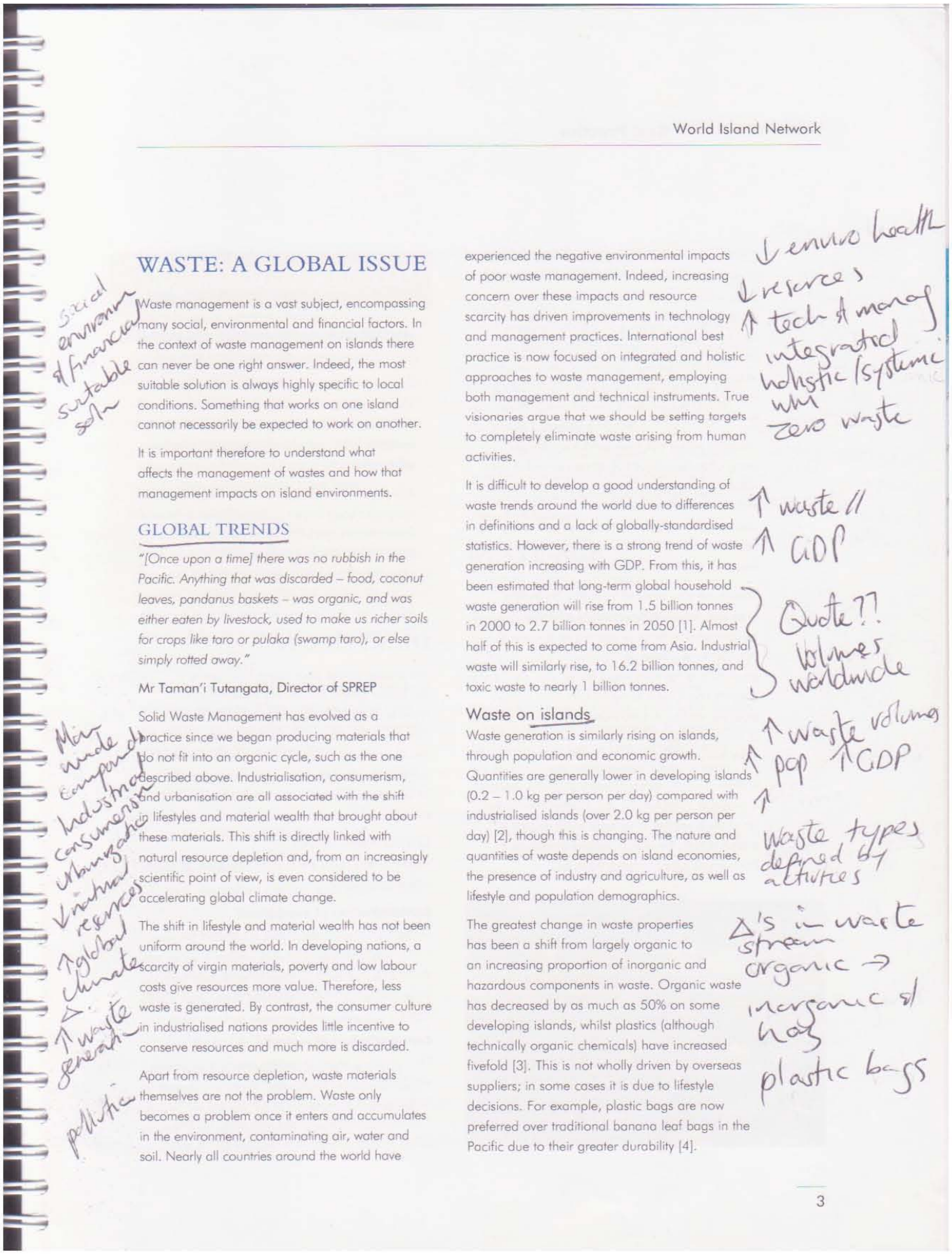
14) What is the main waste management challenge currently facing your island?

15) What do you predict the main waste management challenge will be in 10 years time?

16) Please list three suggestions to improve waste management on your island that you would like to see implemented.

Thank you for taking the time to complete this questionnaire.

Appendix 3: Examples of grounded theory coding



World Island Network

WASTE: A GLOBAL ISSUE

Waste management is a vast subject, encompassing many social, environmental and financial factors. In the context of waste management on islands there can never be one right answer. Indeed, the most suitable solution is always highly specific to local conditions. Something that works on one island cannot necessarily be expected to work on another.

It is important therefore to understand what affects the management of wastes and how that management impacts on island environments.

GLOBAL TRENDS

"[Once upon a time] there was no rubbish in the Pacific. Anything that was discarded – food, coconut leaves, pandanus baskets – was organic, and was either eaten by livestock, used to make us richer soils for crops like taro or pulaka (swamp taro), or else simply rotted away."

Mr Taman'i Tutangata, Director of SPREP

Solid Waste Management has evolved as a practice since we began producing materials that do not fit into an organic cycle, such as the one described above. Industrialisation, consumerism, and urbanisation are all associated with the shift in lifestyles and material wealth that brought about these materials. This shift is directly linked with natural resource depletion and, from an increasingly scientific point of view, is even considered to be accelerating global climate change.

The shift in lifestyle and material wealth has not been uniform around the world. In developing nations, a scarcity of virgin materials, poverty and low labour costs give resources more value. Therefore, less waste is generated. By contrast, the consumer culture in industrialised nations provides little incentive to conserve resources and much more is discarded.

Apart from resource depletion, waste materials themselves are not the problem. Waste only becomes a problem once it enters and accumulates in the environment, contaminating air, water and soil. Nearly all countries around the world have experienced the negative environmental impacts of poor waste management. Indeed, increasing concern over these impacts and resource scarcity has driven improvements in technology and management practices. International best practice is now focused on integrated and holistic approaches to waste management, employing both management and technical instruments. True visionaries argue that we should be setting targets to completely eliminate waste arising from human activities.

It is difficult to develop a good understanding of waste trends around the world due to differences in definitions and a lack of globally-standardised statistics. However, there is a strong trend of waste generation increasing with GDP. From this, it has been estimated that long-term global household waste generation will rise from 1.5 billion tonnes in 2000 to 2.7 billion tonnes in 2050 [1]. Almost half of this is expected to come from Asia. Industrial waste will similarly rise, to 16.2 billion tonnes, and toxic waste to nearly 1 billion tonnes.

Waste on islands

Waste generation is similarly rising on islands, through population and economic growth. Quantities are generally lower in developing islands (0.2 – 1.0 kg per person per day) compared with industrialised islands (over 2.0 kg per person per day) [2], though this is changing. The nature and quantities of waste depends on island economies, the presence of industry and agriculture, as well as lifestyle and population demographics.

The greatest change in waste properties has been a shift from largely organic to an increasing proportion of inorganic and hazardous components in waste. Organic waste has decreased by as much as 50% on some developing islands, whilst plastics (although technically organic chemicals) have increased fivefold [3]. This is not wholly driven by overseas suppliers; in some cases it is due to lifestyle decisions. For example, plastic bags are now preferred over traditional banana leaf bags in the Pacific due to their greater durability [4].

3

Mr x 10/4/07

① What is primary function of dept?

② Do you have an IWMP?

---

① Collection Disposal treatment of SW on Island in enviro friendly way (as possible)

90% collection privatized (not always) supervise contractors keep schedules pick up @ certain hrs make sure do job in satisfactory manner - clean up around bins

Treatment → incineration combustible

Disposal → ash noncombus waste → C+D, white goods. Other islands dump sites compacted + covered maybe weekly burning. Vi dump remote. Anegada - call's to remove site & relocate. Few complaints about smoke.

② IWMP had one 90's consultant did it. Document compiled like everything else went to politicians to finance implementation → kinda just went dead on administrative level.

SWD functions

collection privatized

SWD oversee

incineration

waste types

C+D

white goods

- landfill mangmnt

- covering

- burning

- compact

complaints - smoke health?

IWMP politics)

Appendix 4: The story of a can.
Adapted from Womack and Jones (1996).

Bauxite to make aluminium is mined in Australia where millions of tons are extracted and transported to a nearby chemical reduction mill. The bauxite is converted to alumina with two tons of bauxite making one ton of alumina.

Alumina is then shipped to Norway or Sweden for smelting (using cheap hydroelectric power) and two tons of alumina are converted into one ton of aluminium. Aluminium blocks are transported to a rolling mill in Germany or Sweden to reduce their thickness from one meter to three millimeters. The sheets are trucked to another German or Swedish mill to further reduce their thickness from three millimeters to 0.3 millimeters, the thickness required by manufacturers. Equipment required for these processes are expensive and complex and setting the specifications for the rollers is more viable when specifications are done in big batches.

The aluminium sheets are then transported to the United Kingdom (U.K.) by truck, sea and then truck again and made into cans. Cans are washed, dried, painted, lacquered and sprayed on the inside to prevent corrosion. The empty cans are sent to a warehouse for storage and when required are trucked to the bottler's warehouse. Here they are washed and filled with the soft drink ingredients such as water, caramel, sugar and carbon dioxide. Cans are filled at a rate of fifteen hundred cans per minute and packed into cartons, palletized, stretch-wrapped and trucked to warehouses and retail outlets.

The entire process takes approximately three hundred days. Pallets are stored in a supermarket for about three days, bought, consumed and thrown away. If the cans are recycled, they are smelted and shipped back to Norway. The waste produced in the process is illustrated in the following graphic:

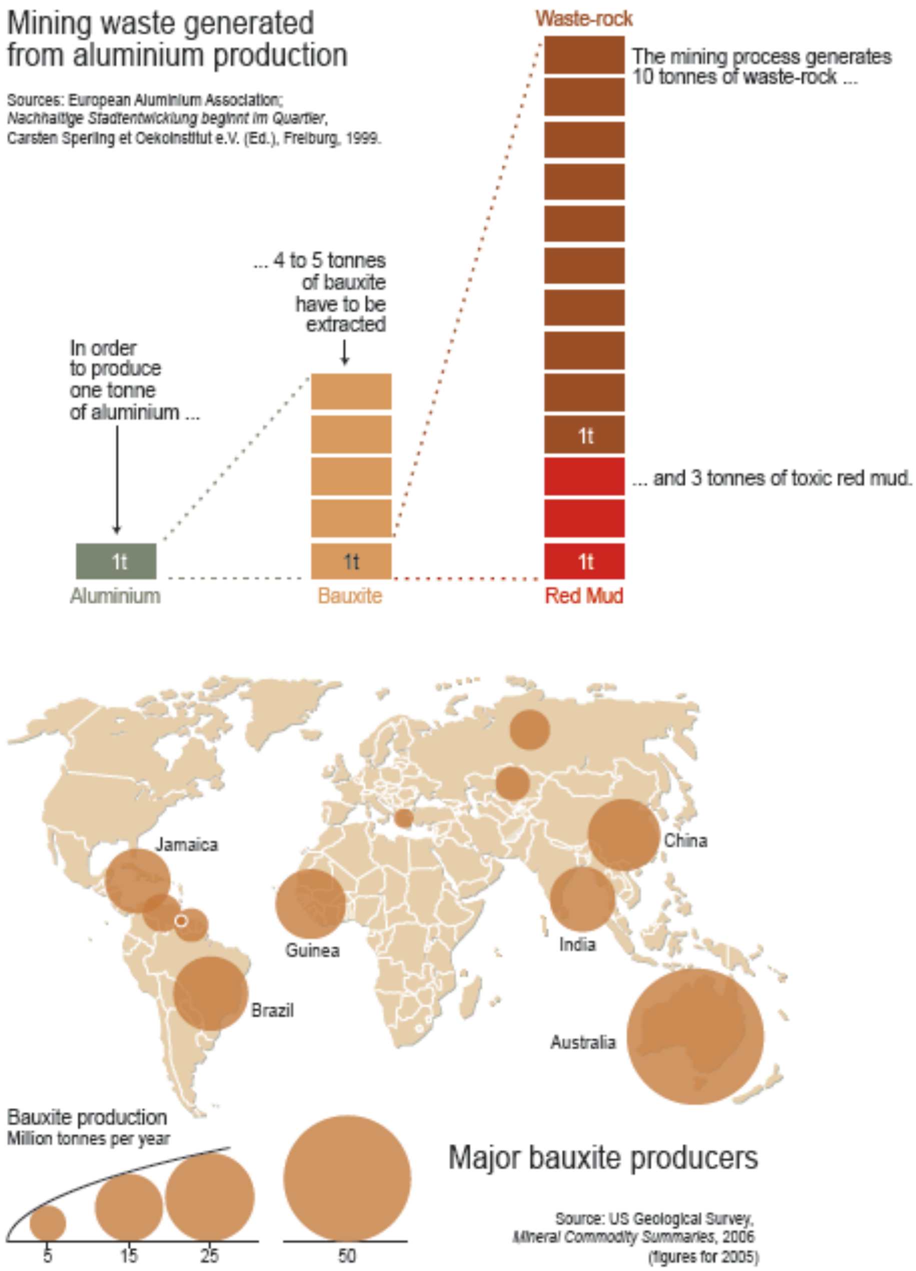


Figure 1: Mining waste generated from aluminium production (UNEP/GRID, 2006).

References:

Womack, J., and Jones, D. 1996. *Lean Thinking. Banish Waste and Create Wealth in your Corporation.* Simon and Schuster. New York. NY.

UNEP/GRID, 2006a. *Mining waste generated from aluminium production*. Available online at: http://maps.grida.no/go/graphic/mining_waste_generated_from_aluminium_production. UNEP/GRID-Arendal Maps and Graphics Library. Last Accessed November 2007.
Sources: US Geological Survey, Mineral Commodity Summaries, 2006 (figures for 2005). **Cartographer/ Designer** Cécile Marin, Emmanuelle Bournay .

Appendix 5: Examples of municipal solid waste

Three MSW categories are discussed to explore the "hidden" wastes behind the product.

5.1 Plastics

Following e-waste, plastics are the next fastest growing MSW stream with "3.2 billion pounds of PET bottles [being] buried or burned [in 2002]" (Royte, 2005:177). The proliferation of plastic waste is demonstrated by a study conducted by Charles Moore in 2001. It was found that "there are six pounds of plastic floating in the North Pacific subtropical gyre for every pound of naturally occurring zooplankton" (Moore, 2003). Plastic does not biodegrade, and thus accumulates in the system as waste.

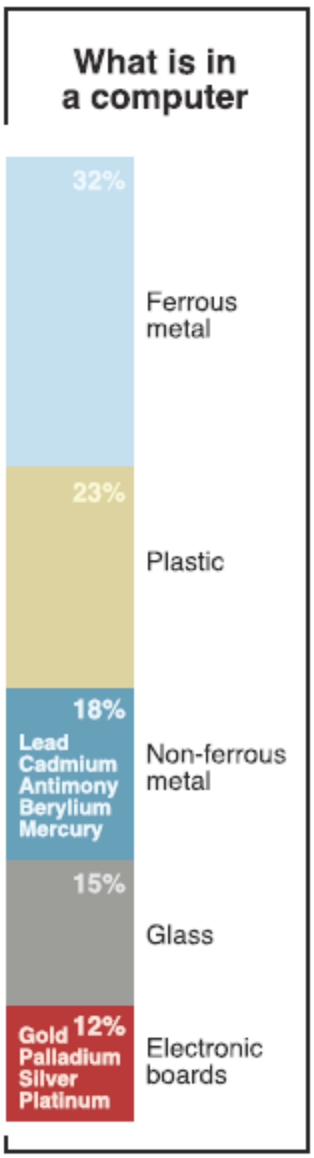
Even though the overall quantity of plastic waste in landfills is relatively small, plastic manufacture itself is energy intensive and toxic. The EPA lists the hazardous materials in the production of plastic and the related health implications such as "birth defects, damage to the nervous system, blood, kidneys, and immune system … the EPA ranking of the twenty chemicals whose production generates the most total hazardous waste, five of the top six are chemicals commonly used in the plastics industry" (Roythe, 191).

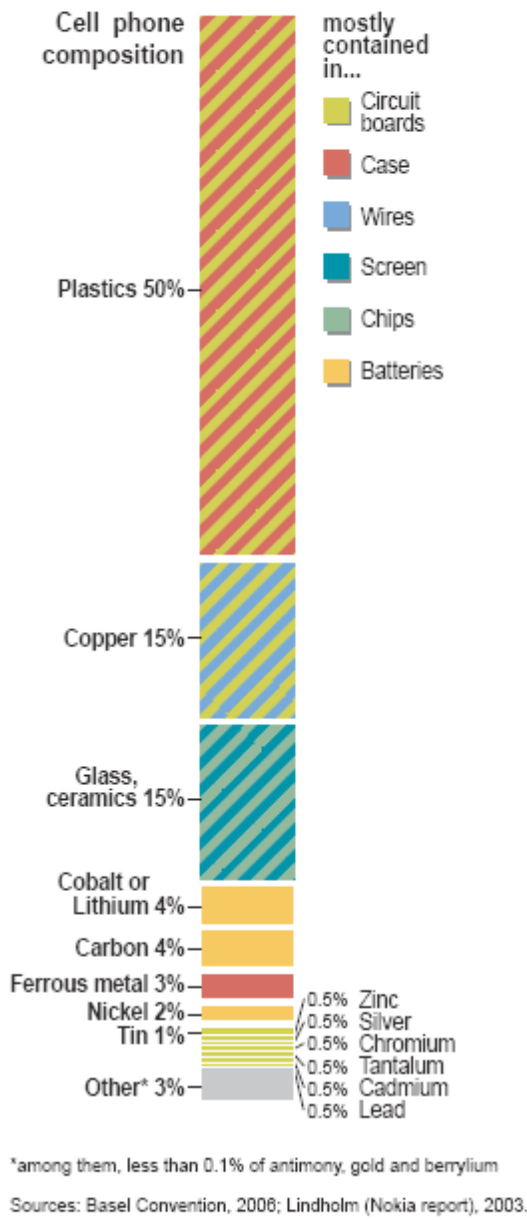
5.2 Household Hazardous Waste

Household Hazardous Waste (HHW) includes everyday items such as detergents, cleaners, and nail polishes and are seldom considered by the typical consumer. "A typical half –ounce bottle contains xylene, dibutyl phthalate, tolulene …are known as 'listed' hazardous waste … hazardous substances that travel from household to place of final disposal are as manifold as they are mundane" (Rathje and Murphy, 2001:122-123). Whilst HHW is a small percentage of the MSW stream, the combined effect of billions of products that have been produced and used for over half a century, will impact the natural environment and human health.

5.3 WEEE or e-waste

WEEE or e-waste is the fastest growing municipal waste stream and include products such as computers, cell phones, blenders and televisions. E-waste is comprised of raw materials that entail environmentally destructive extractive and manufacturing processes. In addition e-wastes are problematic to landfill or incinerate due to the hazardous materials contained in them. When considering the extractive and production processes required to make a single item, one can understand how it is estimated that 75kg of waste is generated to produce a cell phone and 9 tons of waste is generated for a 2.3 kg laptop (Dittke, 2007).





Sources: Unknown,
Cartographer/ Designer Cécile Marin
(UNEP/GRID, 2006

Designer/ Cartographer Claudia Heberlein
(UNEP/GRID 2006)

References:

Dittke, S., 2007. Email, 6 July and 11 February.

Moore, C., 2003. Trashed. Across the Pacific Ocean, Plastics, Plastics, Everywhere. *Natural History* Volume112 Number 9 November.

Rathjie. W. and Murphy. C., 2001. *Rubbish! The Archaeology of Garbage.* The University of Arizona Press.

Royte, E. 2005. *Garbage Land. On The Secret Trail of Trash.* Little, Brown and Company. New York.

UNEP/GRID, 2006b. Cell phone composition. Sources: Unknown. Designer/ Cartographer: Claudia Heberlein. In *UNEP/GRID-Arendal Maps and Graphics Library*. Last Accessed, November 2007 from http://maps.grida.no/go/graphic/cell_phone_composition.

UNEP/GRID, 2006c What is in a computer. Sources: Basel Convention, 2006; Lindholm (Nokia report), 2003. Cartographer/ Designer: Cécile Marin. In *UNEP/GRID-Arendal Maps and Graphics Library*. Last Accessed November 2007 from http://maps.grida.no/go/graphic/what_is_in_a_computer.

Appendix 6: A historical perspective on waste

> "[B]ehaviour is reflected in artifacts … [that] not only … define us at any given moment but also [contribute] to a changing of the definition of itself over the course of time" (Rathje and Murphy, 2001:55).

The purpose of this chapter is to contextualise waste and provide a broad, historic overview of dominant social and economic systems that have shaped the waste streams, and waste management systems, in the USA. New production methods, subsequent consumerism and their resulting wastes can be seen systemically, when examined over a period of time.

The latter part of this chapter explores the history of packaging production. It would be beyond the scope of this paper to explore the histories of all waste categories but suffice to understand that all waste is derived from complex systems that have evolved throughout the history of mankind.

1. A History of Waste

What follows is a brief description highlighting points in time that have influenced waste and the way it is managed. Although the beginning paragraphs refer to examples of early waste management systems in Europe and the United Kingdom, the subsequent historical summary focuses on waste management within the United States of America, as "American culture offers the world's most advanced example of the throwaway society" (Strasser, 1999:16).

1.1 Ancient civilisations

Throughout history, waste was discarded, buried or burned. Evidence of these methods can be found on archaeological sites worldwide dating back to 5000 BC, such as "the first municipal rubbish dump, a mile outside Athens" (Girling, 2004:3). Rathje and Murphy (2001) cite archaeological work that claims that certain early civilisations, such as the Maya in 800 B.C., and the paleo-Indian hunters in 6500 B.C., produced as much waste per capita as first world societies do today, if not more. Items discarded included stone, clay and bones.

1.2 Middle Ages

Waste in the Middle Ages was an integral and obvious part of everyday life, as illustrated by this description of a British fourteenth century city:

> "Muck there was plenty. Horses fed dunghills that were frequently big enough to obstruct the highway and were reinforced in their endeavours by dung and urine from the city's pigs, cattle and poultry … the stink from the discarded butchers' offal, never mind the fishmongers', would turn even stomachs accustomed to rotting meat … straw, sawdust, rushes, earth from cesspools and other diggings, builders rubbish, dead dogs" (Girling, 2004: 6-7).

Waste consisted primarily of organic discards and most could be returned to the natural cycle for re-absorption. Manufactured goods however, such as metal and cloth, were often not disposed of. They were in high demand due to the cost and scarcity of manufactured goods and became part of barter systems.[11]

1.3 Nineteenth Century

During the nineteenth century, in the USA, waste was managed through composting and bartering systems that continued into the end of the nineteenth century.

> "Animal dung, human excrement, kitchen slop, street sweepings, and household wastes like ash were reused extensively by farmers to fertilise their fields. These discards were gathered from city streets, shops and

[11] As more people clustered around urban centres they required increasing resources from the surrounding environment. McDonough and Braungart (2002) argue that this is the basis for imperialism as resources were required from further a field to meet the demands cities and sparked conflict over resources.

houses to sell to growers for use as soil amendment, marking one of the earliest forms of waste collection" (Rogers, 2005:30).

Within this system, cities and farms formed a symbiotic relationship. The farms fed the people and livestock of the cities, and the subsequent waste from the cities fed the soil of the farms. Traders developed collection systems which served as conduits between the two systems, often exchanging goods for others.

> "Soap boilers traded soap for ashes and fats in the eighteenth –and early nineteenth century American cities. Pewter, brass, copper, and iron craftsmen took old metal for cash or barter" (Strasser, 1999: 73).

> "Peddlers also relieved households of ashes, old metal, bones and rubber, delivering them to soap manufacturers, tinsmiths, button- and boot-makers. The peddlers, in turn supplied housekeepers with manufactured goods. This two way trade – the earliest form of household recycling – allowed housewives to acquire goods without cash" (Royte, 2005:18).

Waste management systems of collection, disposal and treatment were handled privately through scavengers, peddlers, waste merchants, industry and farmers. Recycling and reuse were evident in all households of the nineteenth century. For example, "sheets, when too worn or stained, would become pillowcases, bandages, diapers, sanitary napkins and rags" (Rogers, 2005:37). When rags could no longer be used in the home, householders were encouraged to save and trade their rags. Rag men would then collect these rags, sort them and sell them for processing in paper mills. Rathje and Murphy (2001:44) state that the reason for the reuse and recycling of rags was economic, "[m]easured in 1990 dollars, the price per ton of rags was $350, which is not much below what aluminium, one of the most lucrative of modern recyclables fetches today." [12]

[12] It must be noted that even though the rag trade ensured a closed loop for the flow of rags, the production process of converting rags to paper were linear. Paper mills were considered "notorious polluters" due to the "bleach, lime chloride and sulfuric acid" they released into the surrounding environment. (Strasser, 1999: 90).

In general, the nineteenth century waste management system formed a cyclic flow of materials but it was not entirely perfect or harmless. Waste such as broken crockery and glass did accumulate and mismanaged food waste and excrement caused illness and disease. But overall during the 1800s, “waste” was either reused within production cycles, or it decomposed back into the natural environment. As Rogers notes, “the contents of the rubbish bin were relatively benign. Traditionally, castoffs did not stand in opposition to nature so much as they were nature temporarily out of place” (Rogers, 2005:31).

As the nineteenth century progressed, factories drew more people, and their animals, into urban hubs. Rogers (2005), Royte (2005), Girling (2004), Rathje and Murphy (2001) and Strasser (1999) provide evidence of pigs, goats, chickens, dogs, cats and rodents being commonly found on city streets and feeding off waste thrown out by households. These animals assisted in reducing organic food waste and their defecations were collected with human “night soil” as compost for surrounding farms. Horses, being the predominant mode of transport, contributed significantly to waste matter accumulating in streets. Royte (2005:22) provides the example of Manhattan where “city horses dumped 500 000 pounds of manure a day on its streets, in addition to 45 000 gallons of urine … In 1880, 15 000 dead horses had to be cleared from the streets”.

The symbiosis between farms and cities began to erode as farmers grew reliant on manufactured fertilisers and no longer required as much waste, in the form of excrement and ash, from cities. Although convenient, the use of artificial fertilisers introduced toxic substances in the soil and resulted in natural fertilizers accumulating as waste. “[S]ynthetic fertilizers were often heavily contaminated with cadmium and radioactive elements from phosphate rocks” (McDonough and Braungart, 2002: 95).

The increasing population of both humans and animals in cities and the subsequent accumulation of excrement and waste, led to the nineteen-century being infamous for its filth, squalor and disease. Early reform groups reasoned that cleaning the offal and excrement from streets, alleys and tenements would resolve the hygiene and disease problems[13]. The lower classes - and not the "economic polarisation of the new industrial economy" (Rogers, 2005: 42) - were blamed for the moral decay of society and the unsanitary conditions.

Wars[14] had significant impacts on the amounts and types of wastes produced. Technological advances made during these periods significantly influenced new methods of production and subsequent consumerism. The US Civil War between 1861 –1865 helped to reshape industrialisation. Fewer companies now produced commodities on a larger scale and as industry developed and consolidated, goods were produced with increasing variety and at lower costs and "cheaper materials and new synthetics flooded the postwar market" (McDonough and Braungart, 2002: 97).

The manufacturing of soap provides an example of this shift. Up to this point in history, households made their own soap from leftover cooking fat. When soap became mass produced, readily available and affordable, it became easier to purchase it than laboriously make it at home. As more and more goods were mass produced, items such as household fat were no longer perceived as useful or needed and thus became part of the waste stream. As Strasser (1999:32) explains:

[13] Rogers (2005:62) states that "sanitation engineers, local governments and business owners understood that clean streets meant ease of movement" and new street cleaning methods facilitated the flow of commerce allowing people and goods could move freely between businesses and markets.

[14] Although resources and materials were supposedly utilised optimally during times of war, this was not always the case. "During the Second World War, when Americans and Britons on the home front sorted and saved enormous quantities of tin, aluminium, rubber, paper, scrap and other commodities: the government collected all this material, supposedly for the use of the war effort … much of the material was stockpiled … and unbeknownst to the public, was quietly landfilled when the war was over" (Rathje and Murphy, 2001:195).

> "Commercial soap production doubled between 1870 and 1890, with fewer companies. The biggest manufacturers – Colgate, Procter and Gamble, and Enoch Morgan's Sons …developed into national giants. Mass production in their factories required immense amounts of fat, which they bought not from households or peddlers but from other large and expanding companies."

Industrialisation changed society and the waste stream. As cars replaced horses, less dung was found on city streets and as homes became electrified, ashes from households diminished. Rathje and Murphy (2001) observe that the nineteenth century gave us tin cans, cardboard, ready made clothes and refrigerators[15]. These products, and many more, had significant impacts on society, the economy, the environment and the waste stream.

In 1885, to manage the subsequent increases in waste caused by the industrial revolution, increased consumerism and increased population numbers, the first incinerator was constructed from technology imported from England. (Rogers, 2005; Rathje and Murphy, 2002).

1.4 Twentieth Century

At the turn of the twentieth century, the science of bacteriology led to a paradigm shift regarding waste management. Bacteria, and not the waste itself, was identified as the cause of disease, causing a shift from waste being managed as a health issue, to waste being viewed as a technical issue. "Sanitation workers took a highly rationalised approach to garbage, viewing discards less as a resource and more as a logistical problem …a substance that needed to be put in its proper place" (Rogers, 2005: 61).

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[15] Due to refrigeration, freezers and chemical preservatives, food waste was reduced by approximately 50 percent, although packaging waste increased. (Roythe, 2005:21).

➢ 1930s and 1940s

Rogers (2005), Royte (2005), Rathje and Murphy (2001) and Strasser (1999) document the various methods that were used to manage the ever increasing volumes of waste.

Most waste was dumped into holes on the outskirts of towns with open dumps breeding maggots, flies, rodents, and cockroaches, and causing water and soil contamination. The dumps often caught alight and surrounding residents complained of odours. During the 1930's and 40's, waste continued to be dumped into holes in the ground and was often used to reclaim land and make it useable. Landfilling was cheap and touted as advantageous as the process would fertilize the soil.

Dumping in seas or rivers was common. Negative impacts included polluted communities downstream from the dump site, waste being washed back up along waterfronts and water pollution.

By the 1930s there were over 600 incinerators in the USA due to government funding and subsidies. Some incinerators were used to recover energy from the burning process and create additional revenue but the incinerators were capital intensive and waste with high organic content did not burn well. Large amounts of ash residue had to be dumped.

Less waste went through reduction processes although composting and grinding of food wastes were still common practice. Feeding waste to swine continued to be a popular method of dealing with food waste.

The first sanitary landfill was constructed in 1934. It consisted of digging a hole, unloading the waste into it and then compacting and covering the waste with a layer of soil to minimise odours, fires and vermin. "By 1945, about a hundred

American cities had created sanitary landfills. Within fifteen years the figure was fourteen hundred" (Rathje and Murphy, 2001:86).

The infrastructure necessary to manage large amounts of waste was instituted. Rogers (2005) discusses how concerns regarding public health implications of incineration, and other disposal methods were dismissed. She documents how the American public began to accept growing quantities of waste without contemplating its implications because it was efficiently removed from households by professionals. It had become invisible and was no longer their responsibility.

The act of wasting became easier, logistically and aesthetically, and there was a growing disconnect between waste and the larger system of industrial production. "Manufacturers began hyping disposable products – sanitary napkins, paper towels, plastic cups – as scientific, modern and hygienic. Tapping into class prejudices, ad campaigns suggested that the old ways, linked to poverty and immigration, were dirty" (Royte, 2005:21).

By the mid 1930s plastic production had become extremely efficient and versatile. Injection moulding revolutionised how goods were produced and plastics could be made cheaply, anywhere and into anything. The Society of Plastics Industries, worked directly with the American government during World War 2, to safeguard against war time raw material shortages. With the support of the American government, plastics manufacturing flourished with plastic production "tripl[ing] between 1940 and 1945" (Rogers, 2005:121). After World War 2, the plastics industry had developed super-efficient production systems and needed consumers for items such as "Tupperware, Formica tables, Fiberglas chairs, … disposable Bic pens …and pantyhose" (Ibid, 121)

- **1950s and 1960s**

Rogers (2004) and Strasser (1999) discuss how a disposable society had to be "cultivated" in the 1950s and 1960s. Paradigms had to be shifted from one of frugality to that of mass consumption. One method employed by producers was to deem consumerism patriotic and noble - purchasing goods meant job creation and prosperity for all.

When the market became saturated and sales for goods began declining in the late fifties, producers began building in obsolescence (Rogers 2005, Royte 2005, McDonough and Braungart 2002). Products would become obsolete for many reasons:

- New technology created a superior product.
- The quality of goods was inferior so that they would break down more rapidly. It was cheaper to replace products than to repair them.
- New fashions and designs would be more desirable to consumers[16]

For manufacturers to convince consumers of their perceived needs, advertising was utilised. The advent of the television had a dramatic effect on consumerism. Products could now be advertised through an extremely powerful medium.

> "More than 35 million families were glued to the tube by the mid-1950s[17]. Correspondingly, between 1950 and 1955 spending on TV advertising jumped from $177 million to over $1 billion[18] … Vigorously deployed in the post war era, marketing based on desire, anxiety and envy was highly effective. This strategy produced a consuming class that did not look into the structural problems of industrial society as the source of it's ills, but instead turned to industrially produced commodities as the solution …[and] connected social status and human value with the ability to

16 Rathje and Murphy (2001:215) warn against oversimplifying obsolescence and claim that it is "inevitable and essential" They argue that certain disposables are necessary for hygienic purposes and that per capita, packaging waste has decreased as packaging has been streamlined to use the least possible amount of resources by comparing old waste samples with new.

17 Victor Lebow, "Forced Consumption- The Prescription for 1956," p. 169

18 Keep, Hollander, and Dickinson, "Forces Impinging on Long –Term Business to Business Relationships."

> consume … bonds between humans and ecological systems were recast according to the contours of the market" (Rogers, 2005:124 - 125).

In 1953, a non profit organisation Keep America Beautiful (KAB), was set up and funded by companies including the American Can Company, Coca-Cola, and the Dixie Cup Company delivered a message that transferred the responsibility of waste onto the consumer.

> "KAB wanted to turn any stirrings of environmental awareness away from industry's massive and supertoxic destruction of the natural world, telescoping ecological disaster down to the eyesore of litter and singling out the real villain: the notorious 'litterbug'. Taking this tack, the group could defend disposability and obsolescence; the problem wasn't rising levels of waste, they explained, it was all those heathens who failed to put their discards in the proper place" (Rogers, 2005:143).

By 1960, the approximate waste produced per person in the USA was 2.5 pounds per day (EPA, 2005). Contributing to this increase, as Rogers observes, was the amount of packaging used on consumer goods. Packaging was functional: it provided protection while having the added benefit of being disposable. It became a means of advertising for companies and was perceived as indispensable. The packaging industry claimed that the shift to disposable packaging was due to customer demand. Rogers argues that the real reasons for the shift included the huge profit to be made from a disposable market, the advertising potential of the containers and the consolidation of the beverage industry.

- **1970s, 1980s and 1990s**

The first photo of the Earth from Apollo 8 afforded humans the opportunity to see the planet from a distance. When viewed from afar, the Earth could be seen as a as a closed, finite system, sparking concerns regarding the impact of humans on the environment. The initial ‘Earth Day’ in the USA on 22 April, 1970 began addressing environmental issues and at this time, the introduction of the concept of “source reduction” and the waste hierarchy was introduced. Programmes “were initiated not just as a way to establish a solid waste management alternative, but as a kind of cultural rejection of the ‘throwaway’ market” (Bloomberg and Gottlieb, 1989:19).

In the US, legislation such as the Clean Air Act, the Clean Water Act and the Resource Conservation and Recovery Act (RCRA) were passed and the Environmental Protection Agency (EPA) was formed in 1976. One of the functions of the EPA was to oversee landfill standards. New environmental groups proposed regulations that would restrict or ban certain types of packaging. However, it was not until the 1980’s and 1990’s that the RCRA required leachate and methane collection systems (Royte, 2005:51).

Rogers (2005) discusses subversive political lobbying by the packaging industry during the 1970s that prevented legislation against the industry being passed. Many legislative battles between the packaging industry and government and the public have been fought and “packaging, food, and petrochemical industries have quietly spent tens of millions of dollars fighting existing and proposed bottle bills. And they have done it at exactly the same time that they are very publicly promoting recycling” (Ibid,184). Packaging lobbyists often had bills and legislation successfully squashed before they came up for review and would use the argument that banning or reducing packaging production constituted unfair trade restrictions, which would cause a loss of jobs and harm recycling programmes. [19]

The amount of waste in the States quadrupled between 1960 and 1980 (Rogers, 2005:156) and by 1980, waste requiring disposal and incineration had increased

[19] It is beyond the scope of this paper to explore data on the histories of all industries and their associated wastes but it is important to establish that all manufacturing industries have used similar tactics of lobbying to avoid responsibility for the wastes they produce.

to 3.5 pounds of waste per person, per day (EPA, 2005). To dispose of these wastes was becoming increasingly expensive as disposal fees increased dramatically in the USA during the mid eighties. Legislation required existing dumps to be remediated and converted into sanitary landfills causing the closure of many sites. Royte (2005:51) notes that "In 1988, there were nearly 8,000 landfills across the country; in 1999, there were 2,314; and by 2002, there were only 1,767". However, she notes that many of the closed sites consisted of smaller "dumps", with newly established or remediated landfills tending to be mega-landfills several hundred acres in size.

In addition to more stringent landfill regulations, transport costs increased as public pressure moved landfills further away from urban areas. Many states turned to incineration as the answer to ever increasing volumes of waste, less landfill space and increased transport costs. During the 1980's incineration was widely supported and subsidised by institutions such as the EPA and the Department of Energy as energy could be captured during incineration. Rogers (2005) observes that significant amounts of energy would be conserved, if the waste was not produced in the first place.

The link between the placement of incinerators and the lower socio – economic classes is discussed by Royte (2005) and Rogers (2005). Incinerators were usually situated in low socio-economic areas, as these communities were considered to have fewer resources with which to object to new developments. However, a new form of environmentalism arose and environmental justice groups emerged to protect the rights of disempowered groups. "By linking toxicity with escalating consumer wastes and social and economic injustice, this new incarnation of environmentalism expanded to include issues of class, race and labo[u]r" reports Rogers (2005:165). Hundreds of proposed incinerator plans, worth billions, were cancelled as a result of public opposition. Since 1996, no new incinerators have been built in the USA.

The decrease in available landfill space, with a concomitant ban on incinerators and public pressure for recycling systems, resulted in a surge in recycling efforts to deal with increasing waste volumes. Seldman (1995:2356) reports that "[b]y the late 1980s, there were more than 5 000 municipal recycling programs in the United States, up from just 10 in 1975."

- **Present day**

Frosch (1998) estimates that the USA produces approximately 10 billion tons of waste a year, with 200 million tons becoming MSW. According to the EPA (2005), MSW[20] generation has increased 60 percent between 1980 and 2005. Waste generation per capita in the USA has stabilised to approximately 4.5 pounds per person per day. The total MSW generated in 2005 amounted to approximately 246 million tons, with 79 million tons being recovered through composting and recycling while 33 million tons of waste was incinerated and 133 million tons landfilled. Of this total of MSW, the Container Recycling Institute (CRI, 2006) estimates that in the USA in 2006, approximately 42 million PET bottles, 4 billion HDPE bottles, 51 billion cans and 24 billion glass bottles were discarded.

Waste management is an $80 billion dollar per annum industry in the United States (Waste Age 100, 2007), run mostly by governments and large corporations. Billions of dollars have been invested in sanitary landfills, incinerators and collection systems. The large investment in the waste industry coupled with the powerful multinational corporations involved in the extraction and manufacturing processes, makes reducing waste a global challenge as the principle of waste reduction confronts the basic premise of the consumer society.

[20] There is a wealth if info on MSW in the states but not of the quantities and categories of industrial, mining and agricultural wastes which make up 98 percent of the waste in the USA.

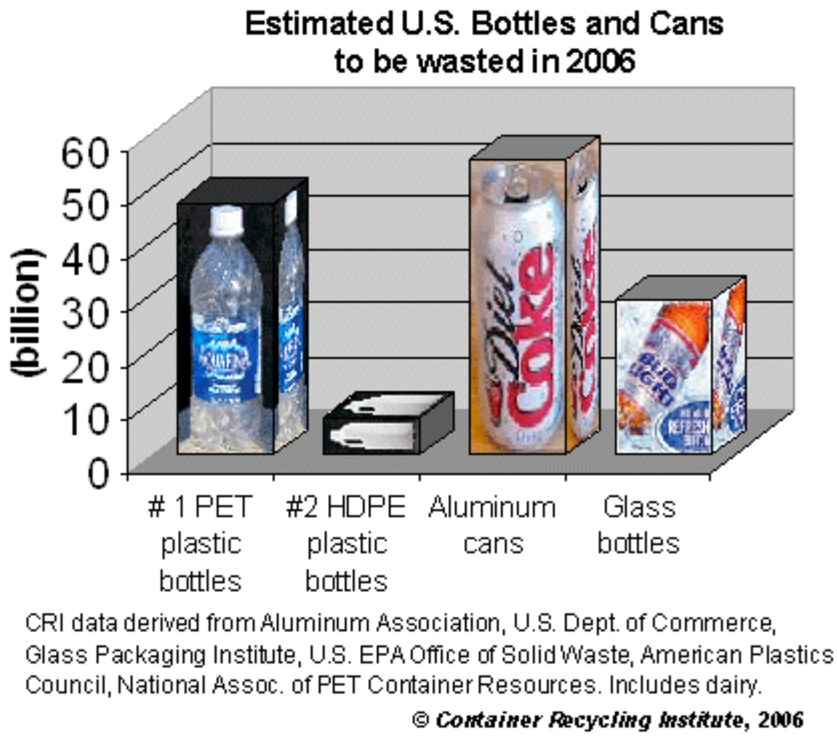

Figure 1: Estimated amount of bottles and cans discarded of in the USA in 2006 (CIR, 2006)

In addition to subsidies preventing optimum resource management are market forces that do not acknowledge waste and environmental degradation in financial terms. As Hawkin et al (1999) observe that "while technology keeps ahead of depletion, providing what appear to be ever-cheaper metals, they only appear cheap, because the stripped rainforest and the mountain of toxic tailings spilling into rivers, the impoverished villages and eroded indigenous cultures – all the consequences they leave in their wake- are not factored into the cost of production" (Hawkin et al, 1999:3).

Industrialisation has had significant social and environmental impacts. Waste generation and complexity is directly linked to increasing production processes and increasing population numbers. Efforts to reduce, reuse and recycle waste face many obstacles that limit significant reductions of the waste stream.

McDonough and Braungart (2002:18) take a critical step back and describe the Industrial System created retrospectively over the last two centuries from a design viewpoint. It:

- "puts billions of pounds of toxic material into the air, water, and soil every year
- produces materials so dangerous that they will require constant vigilance from future generations
- results in gigantic amounts of waste
- puts valuable materials in holes all over the planet, where they can never be retrieved
- requires thousands of complex regulations – not to keep natural systems safe, but rather to keep them from being poisoned to quickly
- measures prosperity by how few people are working
- creates prosperity by digging up or cutting down natural resources and then burying or burning them
- erodes the diversity of biological species and cultural practices"

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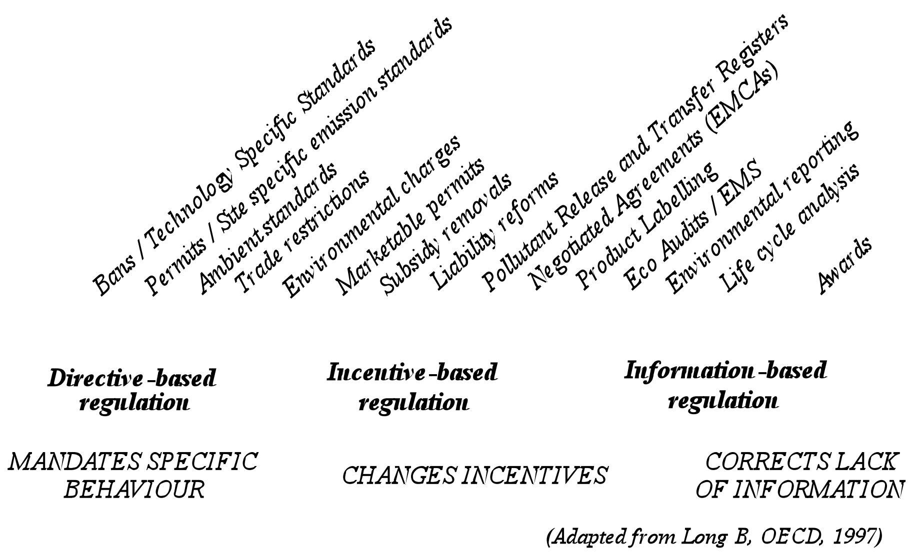
Appendix 7: Legislation and initiatives guiding waste management globally and regionally within the Caribbean

7.1 Legislation guiding waste management globally

Global legislation influencing environmental and waste management policy is guided by a spectrum of regulatory tools ranging from directive based regulation that mandates behaviour change through to incentive and information based regulation that encourages behavior change. Examples of the range regulatory instruments and associated tools are depicted in figure 14:

Figure 13: Range of instruments for environmental policy
(Adapted from Long,1997 by Dittke, 2007)



Listed below are three policies and regulatory frameworks guiding waste management worldwide:

7.1.1 Agenda 21

At the Earth Summit in 1992, 182 nations adopted Agenda 21 framework “a non-binding policy document containing forty chapters of actions, and objectives, believed necessary to affect sustainability at the local, national and international level” to encourage local action with global consequences. (Georges, 2002:24). According to the UN’s Agenda 21 (UNDESA, 2004a) policy document, sustainable development is built on three inter-related pillars of economics, society and the environment, and it is the interplay and balance between the three that permits a good, affordable standard of living for all, whilst preserving the environment.

Chapters 19, 20, 21 and 22 of Agenda 21 refer to waste management as a key area to be addressed in pursuing sustainable development detailing IWM, hazardous waste and the transportation of hazardous waste.

7.1.2 United Nations Environmental Programme (UNEP)

UNEP provides information on environmentally sound technologies (ESTs) and information on waste management strategies, Environmental Management Tools for Decision Analysis, the IWM Scoreboard, Cleaner Production information, Research on Ecotowns and Best Practice Database, Improving the Living Environment (UNEP, 2008).

The ***Basel Convention,*** created through UNEP, is an international treaty ratified by over 170 participant countries, developed to control the transportation of hazardous wastes, with particular focus on hazardous waste being transported from developed countries for disposal in developing countries where less stringent environmental laws apply (UNEP, 2006).

7.1.3 MARPOL 73/78

MARPOL is the International Convention for the Prevention of Pollution from Ships, created in 1973, and modified by the Protocol of 1978 consists of six annexes that govern the prevention of pollution from oil, noxious liquid substances, harmful substances in packaged forms, sewage, solid wastes and air pollution from ships (IMO, 2007).

7.2 International guidelines, policies and initiatives influencing waste management in the Caribbean

International policy frameworks and initiatives guiding waste management that are relevant to the Caribbean are identified in this section. It is important for islands to determine which international conventions, policies and frameworks apply and incorporate these into actionable national policy and legislation that are specific to the island concerned. Many of the islands are governed by the jurisdiction of other countries such as the EU, US or the British Commonwealth and are required to legislate accordingly.

7.2.1 Agenda 21

Stemming from Agenda 21, the Barbados Plan of Action (BPoA), initiated in 1994 by the UN for Small Island Developing States (SIDS), focused on sustainable development on islands with waste being a key area to be addressed. At the World Summit on Sustainable Development in 2002, a review of the BPOA was set. In 2004, an international meeting in Mauritius known as BPoA + 10, it was found that many islands were unable to meet the objectives set due to various combinations of constraints that impeded progress (UNDESA, 2005).

The Mauritius Strategy recommitted SIDS to meet the objectives of Agenda 21, acknowledged the vulnerability of SIDS and affirmed that SIDS are a special case for sustainable development. With regards to waste management specifically, the Mauritius Strategy highlights many objectives that include:

- To form regional partnerships to improve solid waste management practices;
- To utilise the Basel convention to monitor hazardous waste by ship;
- To identify cost-effective and environmentally sound practices;
- To explore funding options;
- To promote the 3 R’s;
- To encourage appropriate projects that utilise waste as a resource;
- To reduce pollution and waste from ships. (UN, 2005)

7.2.2 UNEP

UNEP are involved in numerous projects throughout the Caribbean. Those directly related to waste include:

- Partnering with the Caribbean Environmental Health Institute to develop ESTs for waste management technologies in the Caribbean. See section 7.3.2 for details on this initiative.
- The Basel convention has been ratified by Antigua and Barbuda, Barbados, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines and Trinidad and Tobago (UNEP, 2006).

7.2.3 MARPOL 73/78

The MARPOL convention, as described in section 7.1.3, has been ratified by Antigua and Barbuda, Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines and Trinidad and Tobago are signatories of MARPOL. The International Maritime Organization (IMO) has established a regional centre in Trinidad to assist Caribbean nations in implementing the objectives of MARPOL (IMO, 2007).

7.3 Regional Caribbean policies and initiatives influencing waste management

Within the Caribbean region itself, policies and initiatives are underway that focus specifically on waste management and should be considered in local strategies and policies.

7.3.1 The Caribbean Community (CARICOM) and the CARICOM Single Market and Economy (CSME)

The Caribbean Community (CARICOM) is attempting to move toward a CARICOM Single Market and Economy (CSME) as a method of integration to improve trade, employment and production rates. Key elements include:

- Free movement of goods and services

- Ability to establish CARICOM businesses in any member state
- A common external tariff to be applied by all members to imported products
- Free movement of goods imported
- Free movement of capital by eliminating exchange controls and creating one currency
- A common trade policy
- Free movement of labour
- Harmonisation of laws

(CARICOM, 2007)

Although not directly linked to waste, CSME could be an important player in the potential of minimising waste at source using certain waste reduction and resource management tools as described in chapter seven.

7.3.2 Caribbean Environmental Health Institute

The Caribbean Environmental Health Institute (CEHI) has been appointed by the Organisation of the Eastern Caribbean States (OECS) as the lead agency for WM in the Caribbean SIDS.

CEHI, in partnership with UNEP, have developed a document entitled *Environmentally Sound Technologies for the Integrated Management of Solid, Liquid, and Hazardous Waste for SIDS in the Caribbean Region* (CEHI, 2004). The document notes that waste minimisation is limited on Caribbean Islands in part to the rapid development of islands, a general lack of awareness amongst the general public regarding waste management issues and the "lack of waste minimisation legislation and policies, plans and programmes" (CEHI, 2004:6). CEHI (2004) make recommendations for waste minimisation on islands and these considerations are included in chapter 7.

To further the objectives of waste minimisation CEHI have a ***Cleaner Production and Eco-efficiency*** initiative and have prepared a draft ***Waste Diversion Strategy***. Projects to minimise waste through Cleaner Production and Eco-efficiency are underway. The waste diversion strategy (CEHI, 2006) is in the early stages of development and currently resources are being sought to begin small scale implementation projects on certain islands. The waste diversion strategy addresses issues such as diversion goals and objectives, status quo analysis, risk analysis, programme components such as policy and legislation, economic instruments, information, awareness and training programmes, financing mechanisms, administrative and physical infrastructure, marketing, public/private partnerships, activities and stakeholder roles and responsibilities (CEHI, 2006).

7.3.3 The Caribbean Environmental Programme

Created in 1981, the Caribbean Environmental Programme (CEP) is a UNEP Regional Seas Programme that addresses environmental issues within the wider Caribbean area through the Caribbean Action Plan. The ***Cartagena Convention*** legally supports the implementation of the Caribbean Action Plan and aims to protect and develop the marine environment (CEP, 2007).

The Cartagena convention covers pollution from ships, dumping, sea bed activities, air pollution and marine pollution from land based activities and has been ratified by 23 UN member states. The Convention has been supplemented by three protocols namely:

- oil spills
- protected areas and wildlife
- land-based sources and activities or marine pollution

(CEP, 2007).

7.3.4 Organisation of the Eastern Caribbean States (OECS), Environment and Sustainable Development Unit, Solid and Ship Generated Waste Management Project

Between 1997 and 2003, the Caribbean Development Bank, Global Environmental Facility (GEF) and the World Bank jointly funded the OECS Solid and Ship Generated Waste Management Project (SSGWMP) and focused on improving SWM in St. Vincent and the Grenadines, St. Lucia, Dominica, Grenada, St. Kitts/Nevis and Antigua and Barbuda (Burke, 2003).

The project provided funding, technical assistance and training aimed to strengthen institutional capacities, collection and disposal facilities, establish appropriate legal and institutional frameworks to enable effective waste management, improve the collection, treatment and disposal of ship-generated solid wastes and identify regional opportunities for reduction, recovery and recycling of solid waste.

As part of the SSGWMP, regional markets for recyclables were identified and a strategy for the 4R's prepared. However, due to a project flaw, with certain regional components being completed before national components, the strategies remain unused (Burke, 2003).

7.3.5 St. George's Declaration

The St. Georges Declaration of Principles for Environmental Sustainability in the OECS was signed by member states in 2001 and "sets out a broad framework to be pursued for environmental management in the OECS region" (OECS, 2006:v). The declaration makes specific reference to the Basel convention and the management of hazardous waste in addition to the integrated waste management of solids and liquids.

7.3.5 Recaribe

Recaribe is the Wider Caribbean Solid Waste and Recycling Alliance and organises an annual waste conference for Caribbean States through Clean Islands International. Recaribe aims to develop a network for collaboration and coordination to share information and technologies regarding waste management and has recently hosted the thirteenth annual Recaribe conference. Twenty eight Caribbean countries are active participants within this forum (Recaribe, 2007).

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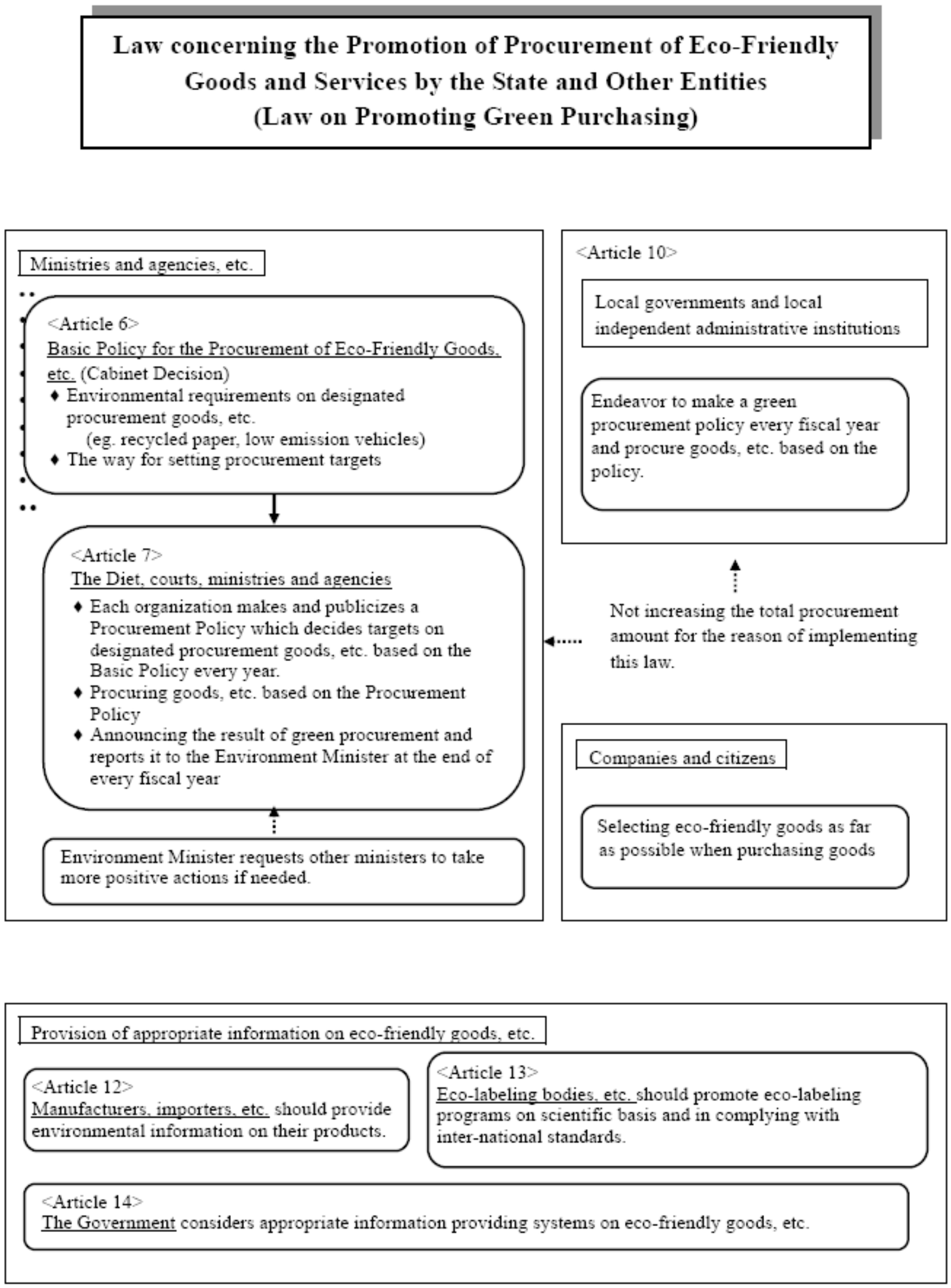
Appendix 8: Overview of Japan's green procurement legislation

Available online at: http://www.env.go.jp/en/laws/policy/green/4.pdf.



Appendix 9: Local economic development: using waste as a resource

Taken from Institute for Zero Waste in Africa, 2005. Local Economic Development. Project Ideas for consideration. Workshop in Ethekwini, South Africa.

Products from scrapped tyres.

Tyres are a known problem, even at rubbish dumps, and include being a potential breeding place for mosquitoes, etc. Dumping or burning them does not make sense, as burning tyres releases much higher levels of toxic pollution than even coal, and the energy and raw materials are lost to the economy, with negative health impacts.

A proven solution is to crumb the tyres, and make a whole host of products. A simple one to start with, would be that 20% to 30% of tar for road construction / repair can be safely replaced by crumbed tyres, which also has the effect of making better roads that last well. This is positive for the city, and the city could specify this in its purchasing policy, ensuring that local communities reap the major benefits. This will lower costs for maintenance of roads, as well as make roads last longer. This will be resisted by companies that make money from roadbuilding currently.

Rubber material (both tyres and conveyor belting) can be used to make a variety of products:

Road and Rail Applications

- Rubber modified bitumen
- Hot mix bitumen
- Reflective crack sealant
- Waterproof membranes
- Gap seals
- Stress absorbing membranes
- Acoustic barriers
- Road base
- Portable traffic control devices
- Ripple strips and speed bumps
- Rail crossings, sleepers and buffers
- Roadside safety railing

Construction & Industrial

- Foundation material Industrial flooring & footpaths
- Anti-static computer mats Acoustic barriers
- Sprayed up roofing, insulation and waterproofing
- Adhesive sealants

- Mounting pads and shock absorbers
- Membrane protection
- Airfield runways
- Shoe soles
- Carpet underlay
- Children's playground surfacing

Compounding with a wide range of plastic such as:

- ABS
- Thermoplastic rubbers of ethylene and propylene
- Flexible foam
- Rollers
- Pond liners
- Compression moulding compound
- Extrusion compounding for rubber products
- Injection moulding compound
- Solid tyres for industrial equipment
    - Conveyor belts

- Packaging Filler
- Bag

- Recycling bins

▲**Bases for Traffic Signs**

Bulk Products & Mining

- Filter for landfill leachate ponds
- Erosion control landfills
- Road base / stone replacement
- Leachate pond liners
- Oil spill absorber
- Aggregate surfacing
- Mulches and perma-mulches

Automotive

- Filler in new tyre manufacture
- Tyre retreads
- Solid and pneumatic tyres
- Oil spill absorber
- Floor mats, mud flaps, moulded protection strips
- Special friction brakes
- Automotive door and window seals
- ALLTRACK segmented earthmoving tyres
- Gaskets
- Adhesive sealants
- Sprayable sealant for automobile wheel housings
- Vehicle bumper bars
- Flooring for truck trays and tipper bodies

Marine

- Wharf buffers
- Floating docks
- Non slip flooring

Sporting

- Flooring
- Sporting fields, athletic tracks, tennis courts, etc
- Gymnasium flooring and matting
- Equestrian surfaces and workout areas

◄Hosepipe made from scrapped tyres!

Rural and Landscaping

- Flooring
- Turf and horse training tracks
- Watering systems, rubber hosing & low pressure irrigation drip hoses
- Agricultural pipes
- Flower pots, wall hangers, pot plants
- Animal bedding
- Protective fencing
- Sprayable linings for grain silos, storage tanks, etc
- Mitigation of floods from rivers
- Tyres for agricultural machinery

The majority of the above applications rely on a crumbing process, which separates the waste into three streams: rubber, steel and in certain cases, fibre. The crumb is used in production, the steel generally sold to a recycler, and the fibre composted, or other uses can be found for non-cotton fibre.

A needs analysis should be carried out, to identify which products of the above will prove the most viable and sustainable, and then implemented. The projects could supply existing businesses with raw material; replace imports; and set up further projects that would use the raw material, as well as satisfy many current needs of government at all levels.

Wood Waste

A great many products can be made from organic material and wood waste, so for a start, all Municipality organic / garden waste can be either made into products listed below, or made into compost. The organic material going into one landfill alone has the potential to make R2 million per annum from composting alone, as well as generating methane gas for local use. Further details of the following available.

- Animal Bedding and Litter

- Boiler Fuel
- Compost Amendment
- Erosion Control
- Ethanol
- Hardboard/Fiberboard
- Landfill Cover
- Landscape Mulch
- Methanol
- Oriented Strandboard/Waferboard
- Packaging Filler
- Particleboard
- Pet Litter
- Playground/Handicapped Acce Groundcover
- Potting Soil
- Pulp and Paper
- Road Stabilization
- Soil Amendment
- Topsoil

Glass and Ceramic Wastes

Value Adding to Waste Glass

Glass, and ceramic waste in particular, in the City have been problematic waste streams, with erratic markets for the collected glass material, due to lack of deposits and re-use, and no Extended Producer Responsibility, as well as problems with separation of different colours and qualities, with no after market at all for broken ceramics. This could be resolved by firstly, developing a market for whole bottles (deposit system, return to wine industry, adding value within organic and other agriculture, pickling, re-use by fillers, etc. amongst other things), then recycling, and for the non-recyclable residue, to crush the glass into various levels of particle size for different applications, such as for addition to road-building material, or cement and septic tanks.

"From Glass to Sand; The Benefits Abound
The transformation of discarded glass into a substance resembling sand is now being performed at the Council Bluffs Recycling Center in Council Bluffs, Iowa with the introduction of new pulverizing equipment. Iin the past, discarded glass had been difficult to recycle because bottles and jars often were contaminated with residues of their previous contents, and it was cost-prohibitive to bring some of the material to a condition where it was acceptable to glass remanufacturers.

With the pulverizer, the recycling center can now accept all types of glass - mirror, ceramic and plate glass, in addition to ordinary container glass. Because the machine can crush all categories of glass, it represents a major step forward in recycling items that at one time were routinely thrown away and ended up in landfills. But the equipment provides another benefit.

By turning the glass into an aggregate, the pulverizer creates a reliable supply of raw material that the city can use in public works projects - thereby eliminating the need to purchase a comparable product from an outside vendor. "Expenses can be lowered by using the crushed glass," Ingham said, noting that the material will become part of the "glassphalt" that will be put down on city streets during improvement projects scheduled this year. Pieces with diameters of three-eighths of an inch are used for seal coating work on streets, while pieces with diameters of one-eighth of an inch or less are used for sand. Ingham said the material would be suitable for commercial landscapers and individual homeowners. He said that in some places in New Jersey, the pulverized glass is spread on beaches near the ocean.

At present, all the aggregate produced at the recycling center is scheduled to be used by the city's public works department. But Ingham said once the output capacity of the pulverizer has been increased, plans are *to offer the material for sale to businesses and area residents. By adding a sifting unit to the equipment, he said, "we'll be able to make sandblast grade material. There's a good market for this, so it would be a way to generate more revenue. "The pulverized glass is also now being incorporated into septic systems of rural homes - a use that represents another viable market. "Studies have shown that water flows better through the glass granules," Ingham said. Along with crushing bottles and jars brought in by consumers, the equipment will be in operation breaking up and converting ceramic drain tiles that are being replaced in the city with metal pipes.*

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Products from crushed Glass:

Bricks

Powdered glass can be used as a 'fluxing agent' during brick and tile manufacture, leading to significant savings in energy and reduction in harmful emissions.

Water filtration

Potentially the most exciting application, recycled glass filter media can outperform traditional sand filters to conform with ever-tightening legislative standards.

Grit Blasting

"Glass grit" is a totally inert material that will match, or perform better, than existing abrasive performance at far less risk to the environment.

Cement & concrete

As a natural sand replacement, recycled glass has many potential applications in cement and/or concrete based products.

Sports turf

The use of 'processed sand' is a popular and efficient means for this industry to meet the challenge of reducing its environmental impact.

Fibreglass insulation

Already used extensively by this industry, there is still room for market growth where colour sorting is less critical than other applications.

Container glass

Largely centred on clear (or 'flint') glass, the re-melting of glass is highly efficient without any adverse effects on quality or physical property.

It must be remembered that converting USABLE bottles and other containers into 'sand' must be seen as a last resort, as the most efficient (materials, labour and energy) approach is to re-use the container in its original form. It is worth investigating how this can be achieved, as it will provide the highest use and highest benefit to the poor and unemployed.

Food value adding (jams, pickles, pesto, tapenades, preserved fruit, wine, naturally flavoured vinegars, relishes, sauces, etc.) would be one option – this could link up with community gardens, and be sold to city (or other) conference and catering operations, for example. City operated food businesses would also be a potential market.

Appendix 10: BVI waste images

Hilly terrain of Tortola making landfill engineering difficult and expensive

Entrance to incinerator at Pockwood Pond, Tortola

Incinerator on Tortola (BVI, 2007a)

Smoke from burning dump behind incinerator during incinerator downtime

Examples of skips, used by residents and many businesses, to dispose of waste.

Managed skip (BVI, 2007a)