A SOLID WASTE PILOT STUDY AND PROPOSED MANAGEMENT RECOMMENDATIONS FOR EZEMVELO KWAZULU-NATAL WILDLIFE PROTECTED AREAS

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"Man has reached a turning point
in his history..... Now he has reached a point
where these [natural] processes can no longer cope
with his demands. So it is not a question of
whether he wants to assume control;
he is obliged to..."

(Taylor (1972), in The Doomsday Book)

ABSTRACT

Ezemvelo KwaZulu-Natal Wildlife (KZN Wildlife) needed to develop a solid waste management policy and strategy for their protected areas, as well as specific solid waste management plans for existing and new developments within these areas. These had to be in keeping with the principles of sustainable development, protected area conservation objectives, best practice and legislative requirements.

A pilot study was thus undertaken at two large KwaZulu-Natal protected area visitor facilities, Hilltop Rest Camp in Hluhluwe Game Reserve and Sodwana Bay Rest Camp, to investigate the types and amounts of solid waste generated. In addition, the solid waste disposal methods employed in 1984 and 2000, the disposal options available and the constraints and impacts of solid waste disposal throughout the protected area system were investigated. A comparison was made with solid waste production and management at Skukuza Rest Camp in the Kruger National Park as well as with various international waste sources. The information was presented in the form of histograms for comparison and tree cluster analysis was used as a heuristic tool to discuss the results.

Hilltop and Sodwana Bay Rest Camps produced similar waste although its composition varied according to the specific source of production within the visitor facility. The waste produced at KZN Wildlife protected area visitor facilities had a similar composition to that produced at Skukuza Rest Camp. Audits of waste management practices at Hilltop, Sodwana Bay and Skukuza indicated that KZN Wildlife was not adequately managing the solid waste at their two protected area visitor facilities. However, solid waste was being responsibly disposed of at Skukuza Rest Camp.

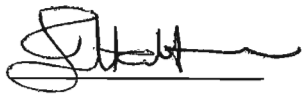
The type of waste produced at protected area visitor facilities in a number of other African countries and Australia, was similar in composition to that produced in South African protected areas; all were similar to that produced in developed, westernised countries.

A survey in 1984 of waste disposal methods in 32 KZN Wildlife protected areas, indicated that disposal to municipal landfill was only practised by protected areas less than 5 000 ha in size and less than 30 km from a municipal landfill. The current (2000) survey showed that disposal directly to landfill without reduction within protected areas had been discontinued, and that there was an increased proportion of waste disposal to municipal landfill. Such disposal was primarily limited to areas of less than 10 000 ha and less than 40 km from such a landfill. The main constraints on the choice of waste disposal method were the cost of transport and limited budgets.

A draft solid waste management policy and strategy were developed. The policy set out the legal requirements, ecological objectives and constraints of solid waste disposal in protected areas and also the preferred disposal options. The strategy set out the waste disposal methods available and their associated risks, likely impacts, opportunities and implications for management. The use of a simple matrix, that combined transport costs (represented by distance to a municipal landfill site); the size of the protected area (assumed to reflect the amount of solid waste generated); and the environmental risk of leachate production (as indicated by the climatic water balance), with suitable waste disposal options, was recommended. This matrix was designed to assist in the objective implementation of the draft waste management policy and in selection of an appropriate waste disposal method for each protected area. The draft policy and strategy were applied to produce a solid waste management plan for a new development in Umfolozi Game Reserve.

DECLARATION

I declare that this project is my own, unaided work. It has not been submitted before in any other form for any degree or examination in any University. Where use has been made of the work of others, it is duly acknowledged in the text.



Signed

27th March 2002

Date

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1 INTRODUCTION

Wastes are inevitable products of the functioning of both natural and artificial systems, either as by-products of production processes or as discarded materials. When functioning without interference from humans, natural systems have the ability to assimilate their own wastes (Bradshaw *et al.*, 1992). Proclaimed protected areas, such as those managed by Ezemvelo KwaZulu-Natal Wildlife (KZN Wildlife), are considered benchmark areas for biodiversity conservation and ecological functioning in that they are maintained with the minimum possible impact by modern man.

Sustainable development requires that development and its potential impacts within protected areas are fully considered and only implemented when it is certain that negative impacts arising from the activity or development can be mitigated to the extent that the protected area objectives are not compromised. In order to maintain this status, solid waste produced by both ecotourism and park management activities requires careful management. With increasing visitor numbers and increased management activities, additional volumes of solid waste are being produced. The natural systems are often unable to assimilate the additional volumes and concentrations of foreign substances produced by human activities, and thus pro-active solid waste management is required.

Wastes in protected areas are produced by visitors and at visitor facilities such as rest camps and picnic areas, as well as by management activities such as game capture, research, workshops, staff accommodation and offices. A variety of both biodegradable and non-biodegradable products are imported into the KZN Wildlife managed areas where a proportion becomes solid waste that, in turn, may lead to unacceptable negative impacts if not actively and responsibly managed.

Given the activities related to protected area management, it is unlikely that hazardous wastes will be produced. Traditionally, protected area wastes have not

been removed to registered landfills, but have been collected for burial or burning at informal disposal sites, such as abandoned road-making quarries, close to the source of the solid waste generation. Such disposal is both easy and economic, but may have negative impacts on the environment, e.g. leachates entering the local groundwater, the pollution of stormwater runoff, the attraction of, potentially, disease bearing animals and scavengers, as well as aesthetic and overall detraction in the value of the protected area through landfill activities (Zeller, 1994). Improved understanding of these risks, increasingly stringent waste management legislation and growing public awareness of the value of protected areas and compatible land-use practices, has caused KZN Wildlife to reconsider existing waste disposal policy and practices and to seek the most practical and environmentally compatible ways to manage their solid wastes. This need has arisen for both existing and new facilities within protected areas.

As the provincial nature conservation authority, KZN Wildlife has a particular responsibility to comply with the principles and legal requirements of good waste management practice. This means that solid waste generated within protected areas must be disposed of in an environmentally responsible manner, so that the organisation serves as a role-model and sets benchmark standards for sustainable development in other ecologically valuable areas and similar tourism developments.

The responsibility for the generation of a solid waste management policy and its implementation was delegated from national to provincial level and in 1996 the KwaZulu-Natal Waste Management Policy Process was initiated. This led to the KwaZulu-Natal draft policy on waste management in 1997. This policy is currently being reassessed (Department of Agriculture and Environmental Affairs, 2001). A strong drive by KZN Wildlife to make the protected areas more economically viable by increasing the number of tourists visiting the protected areas, and the recent proclamation of both the Greater St Lucia Wetland Park World Heritage Site in December 1999 and the uKhahlamba-Drakensberg World Heritage Site in November 2000, in KwaZulu-Natal (UNESCO, 2001), has made the development

of a policy, a linked strategy, and individual waste management plans to address solid waste management in protected areas, urgent requirements.

This pilot study aims to investigate the types and amounts of solid wastes generated at KZN Wildlife protected area facilities (as represented by Hilltop and Sodwana Bay Rest Camps) and the best management alternatives. The pilot study comprises a phase of quantitative investigation of current and past waste management practices and compliance, both within and beyond KZN Wildlife protected areas, mostly utilising primary sources of information. These results are then compared to other protected area and national waste production data and disposal methods, both South African and international, so that common issues and possible solutions could be identified. In order to develop a policy and strategy for KZN Wildlife the principles of integrated environmental management and other secondary sources of information are considered. Existing legislative requirements, constraints and environmental best practice principles are then applied to alternative waste management options. Following this the solid waste management policy and strategy is developed for KZN Wildlife protected areas and applied to an individual waste management plan for a new development in Umfolozi Game Reserve.

2 WASTE GENERATION AND DISPOSAL WITHIN PROTECTED AREAS

Wastes are generally considered to be of no use to the producer, with little or no value for sale, productive use or recycling (Bradshaw *et al.*, 1992). However, in the natural world, a waste by-product from one organism, may be a raw material or resource for another organism (Frosch and Gallopoulos, 1992). This is the basis of maintaining nutrient and energy cycles in natural ecosystems. Human activities produce additional wastes which, if not actively managed, may jeopardise the continued healthy functioning of the natural system. It is this negative impact that KZN Wildlife is attempting to address, and to do so, an overall understanding of waste and its management is required.

Although a great variety of solid waste types and their individual management requirements are discussed in the literature, they originate predominantly from commercial, industrial and large scale municipal sources (Porteous, 1997; Smith Korfmacher, 1997). As this pilot study only considers protected area visitor facilities, this review, discussion and classification of wastes has been limited to the types and amounts of solid wastes likely to be found within such protected areas.

2.1 SOLID WASTE CLASSIFICATION

Solid waste in South Africa is classified and regulated according to its potential impact on the environment, particularly groundwater. Legislation governs its handling, treatment and disposal requirements. Internationally, the Basel Convention of 1989 classified hazardous wastes (Appendix I) for the purposes of international waste disposal. In South Africa, wastes are divided into "hazardous" and "general" wastes according to the definitions contained in the "Minimum Requirements" set of guideline documents for waste management, published in 1994 by the Department of Water Affairs and Forestry in terms of section 24 of the Environmental Conservation Act 73 of 1989 (Department of Water Affairs and Forestry, 1994) (Appendix II).

2.1.1 Hazardous wastes

There are no significant differences between the definition contained in the Basel Convention and the Minimum Requirements Guideline Documents definition of hazardous waste that is as follows:

"an inorganic or organic element or compound that, because of its toxicological, physical, chemical or persistency properties, may exercise detrimental acute or chronic impacts on human health and the environment. It can be generated from a wide range of commercial, industrial, agricultural and domestic activities and may take the form of liquid, sludge or solid. These characteristics contribute not only to degree of hazard, but are also of great importance in the ultimate choice of a safe and environmentally acceptable method of disposal." (Department of Water Affairs and Forestry,1994).

Activities that generate hazardous wastes, e.g. certain industrial processes, are unlikely to be compatible with protected area uses. Hazardous wastes require disposal at permitted hazardous waste disposal landfills according to the requirements of the Minimum Requirements Guidelines (Department of Water Affairs and Forestry, 1994). However, hazardous solid wastes that may be produced by visitor and staff facilities within protected areas are likely to be limited to small quantities of flourescent light tubes, discarded medicine bottles and old batteries (Zeller, 1994). The Minimum Requirements Guidelines allow for small quantities of hazardous solid wastes to be mixed with non-hazardous wastes and included with general waste for disposal. Hazardous solid wastes requiring specialised disposal are most likely to originate from veterinary sections (R Porter, 2001, pers. comm.).

2.1.2 General wastes

The Minimum Requirements Guideline Documents' definition of general solid waste is as follows:

"General waste is a generic term applied to all urban waste that is produced within the domain of local authorities. It comprises rubble, garden, domestic, commercial and general dry industrial waste. It may also contain small quantities of hazardous substances dispersed within it, for example, batteries, insecticides, weed-killers and medical waste discarded on domestic and commercial premises." (Department of Water Affairs and Forestry,1994).

Although protected areas are not considered to be urban environments, the visitor and management facilities are similar in type and activities to small-scale suburban and urban areas. Most solid wastes produced within protected areas are from households and offices, and are comprised of food wastes, tins, plastic, glass, paper and miscellaneous items (A Blackmore, 2001, pers. comm.). These are classified as non-hazardous general waste in terms of the above definition. However, when these wastes have a negative impact on any component of the protected area environment, they are considered to be pollutants.

2.2 SOLID WASTE MANAGEMENT AND DISPOSAL

2.2.1 Objectives of solid waste disposal

Responsible waste disposal is the wise utilisation, proper management and integrated control of all waste material in a defined system. It includes environmentally responsible and cost-effective management of surrounding environments that may be affected by these wastes i.e., soil, water, air and biota. The principle of Best Practicable Environmental Option is applied, and is defined as *"that option that provides the most benefit or results in the least damage to the environment as a whole, at a cost acceptable to society, in both the long-term and short-term"*. (Republic of South Africa, 1989; 1998a).

In order to reduce the potential negative impacts of waste disposal, a combination of the following options is needed i.e.,

- to reduce the mass or volume of the waste before disposal;
- to change the nature of the waste to a more environmentally acceptable form;
- to reduce transport costs of waste;
- to separate and recover recyclable materials;
- to reduce the area required for final waste disposal; and
- to encourage the most resource efficient and effective waste management system (Brownlie, 1990; Porteous, 1997; Department of Environmental Affairs and Tourism, 2000b).

Management of solid waste follows a number of discrete stages, each of which may have impacts on the environment according to the nature of the waste and the manner in which it is managed (Cock and Koch, 1991). The life-process shown in Figure 1.1 traces the possible paths of waste from production to disposal.

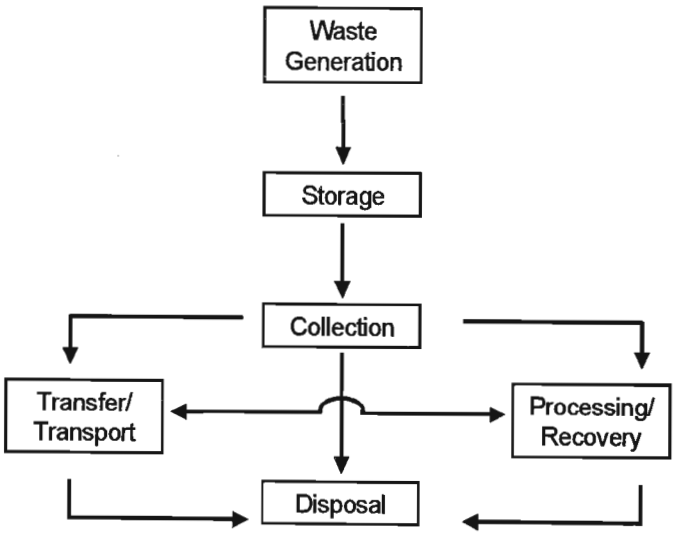


Figure 1.1 Solid waste life-process (Tchobanoglous *et al.*, 1993).

It is widely accepted that the choice of the final disposal method is likely to have the greatest influence on the long-term behaviour and impacts of a particular waste on the environment (Sillito, 1994; Westlake, 1997).

2.2.2 Storage, collection, transport, and handling of solid waste

Each stage of the waste management process (Figure 1.1) has the potential to create negative environmental impacts. At visitor facilities within KZN Wildlife protected areas, there are unlikely to be serious negative impacts created by general wastes during storage and immediately after generation, as waste is secured within containers and disposed of regularly (C Freer, 2001, pers. comm.). Negative impacts, such as poor aesthetics, smells, attraction of pests and health risks, would impact directly upon the appeal and viability of the visitor facility if storage and collection were not adequately managed.

Waste spillage during collection and transfer of waste from KZN Wildlife protected area visitor facilities to a disposal point could result in negative impacts on the environment (C Freer, 2001, pers. comm.). While the likely impacts arising from spillage of general waste in an already modified environment are considered to be small (Agumwamba *et al.*, 1998), the risks of adverse impacts on a protected area environment are greater due to the great sensitivity of the surrounding natural environment.

Waste processing and recovery may be undertaken either at source or immediately prior to disposal. Turner (1992) notes that material recovery or sorting prior to it entering the waste stream reduces the potential for negative environmental impacts by reducing the waste stream and potential waste interactions. Despite the fact that sorting increases the complexity and cost of collection and transport, Turner (1992) considers this preferable to sorting after collection at the disposal point as this may allow wastes to become contaminated during collection and transport so that they cannot be recycled, e.g. paper may become contaminated by foodstuffs. The additional costs of sorting at the disposal point (either by dedicated personnel or a specialised mechanical sorting system) must be balanced against the costs of sorting at source, and the best solution chosen for

each situation. In the context of a protected area, the costs of waste separation and recycling are considered justified when compared to the potential environmental impact costs of not sorting waste (R Porter, 2001, pers. comm.).

2.2.3 Disposal of solid wastes and associated impacts

The primary methods of solid waste disposal are:

- recycling (composting of some organic materials; reuse of tins, glass etc.);
- incineration; and
- landfill (Cock and Koch, 1991; Anderson and Pescod, 1992; Porteous, 1997; Wei *et al.*, 1997).

2.2.3.1 Recycling and composting

Recycling is the process whereby materials considered as waste, are recovered and re-used (Turner, 1992). This includes re-use of the recovered item for the same or for a different purpose without a change in form, as well as recycling where an item is recovered, processed, and either resold or re-used after a change in form. Approximately 5% of the solid waste stream in South Africa is domestic and non-hazardous general waste. Of this, 64% of the waste paper, 48% of the multi-trip glass bottles and 36% of the aluminium is recycled (Smith Korfmacher, 1997). These figures must be interpreted against the background that only about 3% of solid waste in South Africa is recycled, compared to the 95% that is landfilled (Department of Environmental Affairs and Tourism and Department of Water Affairs and Forestry, 1997).

In human-modified environments the recycling of organic wastes is primarily through deliberate composting. Composting is the aerobic, biological decomposition of organic material to form water, carbon

dioxide and stable residues (compost). This process is carried out by naturally occurring microorganisms which spontaneously begin to grow and decompose organic matter when temperature, oxygen and other chemical conditions are suitable (Cock and Kock, 1991). Ideal conditions for initiating composting include a temperature range from 35°C to 60°C, a moisture content from 40% to 50%, freely available oxygen (15 - 18%), a pH of 5 - 8.5, and an initial carbon:nitrogen ratio of from 25:1 to 35:1 (Anderson and Pescod, 1992; Fleming, 1993). This suggests that unaided composting would initiate and function more rapidly in warm, wet climates than in cooler and drier ones. Composting may initiate spontaneously year-round in sub-tropical areas such as parts of KwaZulu-Natal. J Hughes (pers. comm., 2001) noted that as the process itself is exothermic, once started and provided with sufficient water, organic material and oxygen, it can continue with little regard of the external ambient temperatures. During the exothermic process, temperatures in the active composting mass may exceed 60°C and the mass of the compost may reduce by up to 50% (Lefebvre *et al.*, 2000).

The primary benefits derived from recycling include:

- a reduction in the demand for raw materials by optimising the use of existing, processed resources;
- the assignment of a secondary value to although the value of recycled materials may be lower due to a reduction in the material quality;
- a higher cost can be asked for source materials, due to the availability of secondary materials, again reducing demands on raw materials;
- the creation of small business opportunities; and
- a reduction in the total waste stream, with a resulting decrease in the likely impacts of waste disposal (Turner, 1992; Parkin, 1995; Smith Korfmacher, 1997).

2.2.3.2 Incineration and open-fire burning

These processes reduce the mass and volume of waste to be disposed of by approximately 80% and 90%, respectively (Backman and Lindhqvist, 1992; Lu, 1996; Wei *et al.*, 1997). Given combustible materials and sufficiently high temperatures, a sterile ash with minimal fats and carbon content is produced. This can then be disposed of safely to landfill, by scattering (in very limited amounts over a wide area) or by mixing into a recycling system such as composting (Anderson and Pescod, 1992). Westlake (1997) argues that the impacts of such co-disposal of wastes are difficult to predict and may have significant negative impacts.

However, complete combustion is seldom achieved by open fires that generally have temperatures below 500°C (Littergon KwaZulu-Natal, 1997). Cock and Koch (1991) indicate that the products of incomplete combustion may be toxic if inhaled or ingested. Incineration within a purpose-built incinerator provides a controlled environment where very high temperatures can be achieved (McEldowney *et al.*, 1993) and wastes are fully combusted to a sterile ash. The minimum temperature required for the incineration of municipal waste is 850°C (Department of Environmental Affairs and Tourism, 1997). Double burning incinerators may reach 1300°C in the second chamber, and thereby convert potentially hazardous gases to water vapour and carbon dioxide (Department of Environmental Affairs and Tourism, 1997).

Incineration was seen as the waste disposal solution of the 1980's, but in the 1990's there was increasing public concern about the impacts of incomplete combustion and potential emission of hazardous substances such as dioxins, didenzofuranes, polyaromatic hydrocarbons and heavy metals from smoke-stacks, leading to polluting "fallout" in the surrounding environment (Cock

and Koch, 1991; Backman and Lindhqvist, 1992; McEldowney *et al.*,1993). Incompletely combusted ash derived from hazardous wastes such as organometallic compounds may contain heavy metals and other hazardous elements (McEldowney *et al.*,1993) which could pollute groundwater if the ash is not properly disposed of at a specialised landfill site (Lu, 1996; Westlake, 1997). Recently, improvements in incineration technology have led to a reduction or eradication of hazardous emissions and it is again considered to be an environmentally responsible waste disposal option by some (Porteous, 1997; Wei *et al.*, 1997).

The main benefits of incineration are considered to be that:

- waste volume for landfill disposal is drastically decreased;
- transport costs to the final disposal site decrease; and
- there is a reduction in pollution risk if suitable waste is incinerated at sufficiently high temperatures (Lu, 1996; Porteous, 1997; Wei *et al.*, 1997).

2.2.3.3 Landfill

This is the engineered burial or infilling of both treated and raw wastes, that concentrates and manages the disposal impacts at a single point (Cock and Koch, 1991). Historically, this has been considered the most cost effective manner of disposing of large quantities of mixed solid wastes (Anderson and Pescod, 1992). However, Turner (1992) questions the real cost of landfill and argues that if the costs of the long-term environmental impacts were internalised, the cost of landfill would be raised so as to become comparable with other disposal options such as energy-from-waste schemes.

Some European countries have banned landfills due to the risk of negative impacts, particularly on groundwater (McEldowney *et*

al.,1993), but it remains the principal formal solid waste disposal method in the United Kingdom (Rae and Campbell, 1992), and also in South Africa (Cock and Koch, 1991). KwaZulu-Natal has 51 permitted landfill sites and 21 pending approval (Department of Agriculture and Environmental Affairs, 2001). About 95% of waste in South Africa is disposed to landfill (Department of Environmental Affairs and Tourism and Department of Water Affairs and Forestry, 1997) compared to only 70% in the United States (Rathje, 1991). Since 1980, landfill design and construction has improved so decreasing the potential for negative impacts (Westlake, 1997; Akesson, 1998). Other waste reduction technologies such as incineration or recycling still leave a residue that has to be disposed of, usually at a landfill facility (Mayet, 1993). Economy of scale is particularly applicable to disposal by landfill, unless a small scale sanitary landfill or a *"general small waste disposal site"* is being considered (Turner, 1992).

Sanitary landfill is intended for the disposal of non-hazardous wastes. These are simply compacted and covered daily with a layer of inert material, such as sand. When the landfill has reached capacity, it is covered with a final layer of material, usually partially waterproofed to prevent excessive leaching, and revegetated (Wei *et al.*, 1997).

Decomposition in a landfill occurs in three main phases i.e., aerobic, acid phase anaerobic, and methanogenic anaerobic decomposition. Each phase produces different types of leachates and more than one phase may be present in different parts of the same landfill (Flyhammar *et al.*, 1998). Most landfill decomposition is anaerobic due to the compaction and exclusion of air by the regular layering (Lefebvre *et al.*, 2000). Methane is produced and must be vented from the site. While potentially a health risk, methane gas is not

commercially viable as a fuel source in small landfills (Rae and Campbell, 1992). Aerobic decomposition occurs where oxygen is freely available, such as in the exposed and disturbed upper layers of a landfill (Lefebvre *et al.*, 2000).

One of the major concerns in waste disposal is leachate (Senior, 1995; Flyhammar *et al.*, 1998), defined as liquid that has passed through or emerged from solid waste (United States Environmental Protection Agency, 1979). It may carry suspended or dissolved materials such as organic acids, inorganic salts, heavy metals and gases, in concentrations potentially 100 times that of raw sewage (Cock and Koch, 1991). It may also be caused by chemical and biochemical reactions within the decomposing solid waste. Chemicals washed from the decomposing waste may interact, and the composition and toxicity of leachate becomes difficult to predict as it varies over time with the breakdown of different wastes and different environmental conditions, especially temperature, and the availability of water and oxygen (Sillito, 1994; Senior, 1995; Abu Qdais *et al.*, 1997; Blight *et al.*, 2000). Senior (1995) records a ten year old landfill in Johannesburg where no leachate was recorded due to the perennial climatic water deficit. When the amount of rainfall or moisture entering the landfill exceeds the evaporation for that area, such as in northern coastal KwaZulu-Natal, i.e., where the climatic water balance is positive for several months of the year, leachate will be produced (Sillito, 1994; Senior, 1995; Blight *et al.*, 2000). Leachate must be controlled so that it does not pollute surface waters or groundwater (Department of Environmental Affairs and Tourism and Department of Water Affairs and Forestry, 1997; Republic of South Africa, 1998b).

Certain wastes, although not initially hazardous, may change form during decomposition and move from the landfill into the surrounding ecosystem, affecting components of the system or accumulating elsewhere, e.g. mercuric compounds transform easily to methyl mercury, which is highly toxic and easily taken up by living organisms (Bradshaw *et al.*, 1992; Haarstad and Maehlum, 1999). The co-disposal of hazardous wastes in landfills may be problematic unless they are first treated to make them harmless. However, reactions between harmless substances may also form harmful leachates (Westlake, 1997). Even naturally occurring materials in abnormal quantities or concentrations may have a local and direct impact or a derived effect, e.g. nitrogen and phosphorus resulting from the breakdown of organic wastes may leach into a water body causing a local nutrient overload and eutrophication (Haarstad and Maehlum, 1999). Landfill sites are often areas where potentially hazardous substances are concentrated and they must be properly planned, constructed and managed in order to minimise negative impacts (Cock and Koch, 1991; Department of Environmental Affairs and Tourism and Department of Water Affairs and Forestry, 1997; Westlake, 1997).

The toxicity of some heavy metals is well documented (McEldowney *et al.*,1993). Although metals are released continuously into the environment through natural processes and serve important biological functions (McEldowney *et al.*,1993), elevated metal concentrations may move through an ecosystem and accumulate at particular points, such as sediments in estuaries or pans (Flyhammar *et al.*, 1998; Haarstad and Maehlum, 1999). They may also be deposited at, or mobilised from, collection points through a change of chemical environment. Food chains and webs account for a significant part of the movement of materials in ecosystems, and there is often an opportunity for pollutants to become

concentrated at higher trophic levels. Such bio-accumulation usually occurs if the materials become stable and are not excreted by the organism. An example of this is the accumulation of chlorinated hydrocarbons in birds of prey, leading to thinning of eggshells and population decline (Bradshaw *et al.*, 1992).

Hunter *et al.* (1987) showed that different metals accumulate differently in different species. In an area of grassland contaminated with both copper and cadmium, bio-accumulation levels were examined in voles (herbivores) and shrews (insectivores). Copper was not retained by either species as it is easily excreted. However, cadmium was retained and concentrated by insects and then further concentrated by the insectivorous shrews that led to noticeable kidney damage. Retention time of heavy metals may also differ from specie to specie e.g. the half-life for methyl mercury was about 8 days in a mouse, 70 days in a human and over 1000 days in certain fish (Bradshaw *et al.*, 1992).

The disposal of wastes by landfill is regulated through a "Minimum Requirements" Waste Management Series of documents that include the "Minimum Requirements for Waste Disposal by Landfill" and the "Minimum Requirements for the Handling and Disposal of Hazardous Wastes" documents (Department of Water Affairs and Forestry, 1994). These state that any solid waste that is not able to be recycled or re-used must be properly disposed of, either through landfill or incineration, after classification. Domestic and non-hazardous wastes may be disposed of at a licensed landfill site. The classification of the site is based upon the volume of the waste stream, rainfall and the average evaporation of the area. Although the Minimum Requirements are not enforceable, they can be made a condition of any waste disposal permit so that their violation will invalidate the permit, without which the landfilling activity must cease immediately.

The requirements for a sustainable landfill appear to be in conflict with the objectives of protected areas for the following reasons:

- new areas of disturbance would have to be created for landfill;
- there is a potential for the uncontrolled production of harmful leachates that may enter the surrounding natural environment; and
- mining or importation of inert material is required for covering layers (Sandwith and Toucher, 2000).

2.3 PROTECTED AREAS AND CONSERVATION OBJECTIVES

2.3.1 Protected area objectives

Protected areas are an effective method of conserving biodiversity and functioning ecosystems. The International Union for the Conservation of Nature (IUCN) defined a protected area as *"an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means"* (IUCN, 2001). In accordance with this definition, twelve primary conservation objectives were identified for protected areas i.e., to:

- maintain essential ecological processes and life-support systems;
- preserve genetic and biological diversity;
- protect the habitat of representative, rare and endangered species;
- provide opportunities for recreation and ecotourism;
- protect aesthetic values and natural ecosystems;
- maintain air quality;
- control erosion, sedimentation and soil depletion;
- conserve watersheds and their production;
- provide opportunities for research, monitoring and education;
- protect the natural and cultural heritage;
- contribute to sustainable use and eco-development; and
- retain future options (IUCN, 2001).

2.3.2 International recognition of protected areas

To achieve the above objectives, a number of different types of protected areas, each with specific management and conservation objectives, are recognised. The IUCN (2001) has categorised these into six groups that range from strict wilderness reserves to managed resource protected areas, in order to allow for flexibility in management options and for international conservation bodies to work more effectively with national departments throughout the world. The United Nations Educational, Scientific and Cultural Organisation added the concept of "biosphere reserve" which is a core conservation zone, a buffer zone for research, recreation and tourism, and a transition zone for settlements, agriculture and uses (UNESCO, 1995).

Areas meeting the specified criteria are protected through international agreements, such as the Ramsar (Wetlands) Convention, and additional international recognition may be awarded to areas qualifying as World Heritage Sites (areas of outstanding universal value) through the World Heritage Commission. These may be cultural or natural sites. KwaZulu-Natal has two such sites, one of which is the Greater St Lucia Wetland Park World Heritage Site (natural site) that incorporates several northern KwaZulu-Natal coastal protected areas, including Sodwana Bay National Park (one of the areas used in this pilot study).

2.3.3 National and KwaZulu-Natal protected areas

The classification of protected areas in South Africa is largely in accordance with the IUCN categories. Both Hluhluwe Game Reserve and Sodwana Bay National Park (the two study areas) and the Kruger National Park, are classified as South African category II protected areas i.e., national parks and equivalent reserves (Appendix III) (Republic of South Africa, 1994).

The management criteria for category II protected areas specify that *"Preservation of the natural environment will at all times receive the highest priority. Only development which is reconcilable with the objectives of the area [to protect . . . . for spiritual, scientific, educational, recreational or tourism purposes] will be allowed."* (Republic of South Africa, 1994).

KwaZulu-Natal protected areas are proclaimed in terms of either the KwaZulu Nature Conservation Act of 1975 (former KwaZulu areas) or the Nature Conservation Ordinance of 1974 (former Natal areas). The KwaZulu-Natal Nature Conservation Act, once promulgated, will supercede these two pieces of legislation and apply to the whole Province. Other South African protected areas are proclaimed in terms of the National Parks Act 57 of 1976. While this affords them greater legislative protection, e.g. the Minerals Act 50 of 1991 recognises that only proclaimed national parks are excluded from becoming potential mining areas, the management objectives and responsibilities of the respective nature conservation authorities towards these protected areas are identical.

KwaZulu-Natal Wildlife protected areas must be managed according to the organisation's Mission Statement, as well as in accordance with international and national protected area objectives, international waste management principles and national waste management objectives (see Appendix IV for the full mission statement and supporting statements) (KZN Wildlife, 2000). Such areas and sensitive sites are to be considered benchmark areas for provincial biodiversity conservation and ecological functioning (A Blackmore, 2001, pers. comm.). They remain among the few areas that are not noticably negatively impacted upon by modern man.

2.3.4 Sustainable development

Conservation and development have traditionally been considered to be in conflict (Yeld, 1997). This was largely due to the view that development implied the exploitation of resources and relied upon the consumption of

ever increasing amounts of energy and resources, even to the point of depletion of the resource i.e., unsustainable use of the resource. Conservation on the other hand was viewed as protecting resources from exploitation, thereby denying development opportunities.

In 1980 the United Nations recognised the need for both development and conservation to take place and appointed the World Commission on Environment and Development. By 1987 the concept of sustainable development was defined as:

> *"meet[ing] the needs of present generations without compromising the ability of future generations to meet their own needs."* (World Commission on Environment and Development, 1987).

This concept recognises that development and conservation are not necessarily mutually exclusive, and aims at improving the quality of human life while living within the ecological means of the planet (Yeld, 1997). Costanza (1991) expands upon this concept as follows:

> *"A relationship between dynamic human economic systems and larger dynamic, but normally slower-changing ecological systems, in which . . . . effects of human activities remain within bounds, so as not to destroy the diversity, complexity, and function of the ecological life support system."*

While this required a change in the approach to development to take environmental concerns into account, it also required that conservation and protected areas consider development when it constitutes appropriate use of the natural resources being protected (World Commission on Environment and Development, 1987).

A number of tools were designed to assist in the implementation of sustainable development practices, including integrated environmental management. Integrated environmental management includes environmental impact assessment and environmental auditing, and is used to identify, understand and avoid the potential negative environmental consequences of proposed developments in their planning, implementation and operational phases, while enhancing potential positive aspects (Yeld, 1997). This is particularly applicable to activities and developments proposed in sensitive environments such as protected areas, where negative environmental consequences arising from uncontrolled development would be incompatible with the objectives of such protected areas (Section 2.3.1).

A variety of protected area management and visitor activities and developments result in the production of waste that may have negative environmental impacts if not properly managed. A number of waste management alternatives exist, each having different impacts, risks and costs. Development and thus waste management within protected areas (including policies, strategies and individual management plans) has to meet the requirements of sustainable development so that short-term economic cost saving does not impact negatively upon the ecological life support systems that are being protected.

2.3.5 The value of protected areas and changing conservation strategies

2.3.5.1 The value of protected areas

The value of protected areas can be considered under a number of headings i.e.,

- **Ecological:** The integrity of the natural ecosystem/s within the protected area must be protected as they provide an essential life-support role in maintaining nutrient cycles, producing oxygen and other gases, moderating climate,

regulating and purifying water supplies, and providing a pool of biodiversity to restock other areas where the biodiversity has already been deplted (Taylor, 1972; Millar, 1994; Theron, 2000). In addition, all species have scientific and research values which are often still unknown.

- **Genetic and food resources:** The World's crops are domesticated varieties of wild plants. Genetic engineers need existing wild varieties of these plants in order to develop new strains that are disease-resistant or that have certain characteristics (Yeld, 1997). Birds and insects pollinate food crops worldwide. Source populations of these pollination agents are maintained in protected areas.

  The fish stocks of the world are a natural resource of great economic value that appear to be suffering overutilization. Several of these fish species, e.g. slinger (Van der Elst, 1981) are restocked from spawning grounds in protected marine and estuarine areas or coral reefs (Theron, 2000).

- **Medicinal:** The active ingredient of more than 25% of current medicines comes from wild plants and only a small percentage of plants have been studied for their medicinal uses. Penicillin and tetracyclines are among more than 3000 antibiotics developed from microorganisms. In South Africa, there is a flourishing industry in medicinal plants and animals through traditional healers (Cunningham, 1989; S McKean, 2001, pers. comm.).

- **Ecotourism and community benefits:** Visitors to KwaZulu-Natal protected areas are an important part of the province's economy. This is even more important on a local scale,

bringing trade and investment to remote regions. As ecotourism relies on the natural resources of the area, their protection and sustainable development is required (D Frandsen, 2001, pers. comm.).

- **Recreational:** Many recreational hobbies, such as fishing and hunting, rely on natural resources. Protected areas prevent certain species, e.g. the much sought after fish, the seventy four and dusky cob (Van der Elst, 1981), from being depleted by restocking areas of intensive use from these marine protected areas. Hiking and photography are among other recreational pursuits that draw people to natural areas.

- **Aesthetic:** It is difficult to place a value on the scenic beauty of an area. However, tourism routes, expensive real estate and a variety of environmental economic tools provide possible ways of placing real economic values on this intangible (Department of Environmental Affairs and Tourism, 1996).

- **Ethical and spiritual:** There is a view that every specie has an equal right to life and that human and technocentric approaches to life are resulting in irreversible loss of biodiversity and damage to the World's life support systems. In contrast, an ecocentric worldview places importance on conserving biodiversity and ecosystems, rather than individual species. The ethical value of protected areas is that humans are behaving as caretakers of the planet and its systems, treating all living beings as equally important and conserving these for future generations (Fuggle and Rabie, 1992). This approach includes the concept of sustainability.

2.3.5.2 Changing conservation strategies

Conservation strategies of the past concentrated on protecting species and restricting human access to protected areas. While some parts of protected areas are often still restricted in terms of access, the value and use of these areas for recreation is increasing, attracting more visitors annually and creating additional impacts on these areas, e.g. increased waste production (D Frandsen, 2001, pers. comm.). Conservation management is adapting to the economic, socio-political and physical climates, in order to enhance the value of protected areas for all sectors of society. At the same time there has been a shift from species and habitat conservation to systems conservation that was first documented in the World Conservation Strategy of 1980 (Yeld, 1997). This recognises the finite nature and limited carrying capacities of natural resources, while accepting the twelve IUCN objectives of protected areas (Section 2.3.1).

2.3.6 Impacts of solid waste disposal in protected areas

With increasing visitors to protected areas, wastes are imported into these areas and accumulate at visitor and management facilities, such as rest camps, picnic areas, research offices, maintenance workshops, staff accommodation, shops, restaurants and offices. This waste may lead to unacceptable impacts, even threatening the integrity of the protected area, unless actively and responsibly managed.

Although a great deal of literature on waste management in urban and peri-urban situations exists, published work on waste management and its impacts in protected areas is almost non-existent. An internet search led to several policies and undertakings on waste management from Australian, Canadian and United States protected area authorities, but no detailed information on actual management practices or strategies. E-mail

communication and discussions with staff from protected areas in Africa and Australia revealed that the same concerns and constraints exist for their protected areas. Most Australian protected areas have strictly enforced waste management at visitor facilities where waste is sorted and removed to registered waste disposal facilities. However, isolated protected areas in the Northern Territory tend to practice only a limited amount of recycling before solid waste is burnt and buried in pits within the protected areas (A Bowland, 2001, pers. comm.). In African parks such as those in Uganda, Kenya, Tanzania, Botswana and Zimbabwe where distances make transport of waste prohibitively expensive, wastes are burnt and buried within the protected areas, usually close to the visitor or staff facility (I Achoka, B Gebre, E Gobuamang, J Kazembe, M Mutabilwa, V Nyirenda, E Tarimo, and J Warutere, 2001, pers. comms.) .

Bradshaw *et al.*(1992) consider an ecosystem as the most convenient unit in which to consider the impacts of waste disposal. An ecosystem is a particular group of plants and animals, the physical world they exist in, and their interactions. The components of ecosystems interact so that a change to one component may effect changes of varying degrees on other components. A flow and cycling of energy, nutrients and materials occurs since energy may not be created or destroyed, only changing its form, so no solid waste entering an ecosystem disappears. It may, however, change its form and move within the system, so affecting an entirely different section of the ecosystem.

The impacts of a specific waste can only be evaluated in the context of the ecosystems that it may affect, taking into account the properties of the waste and the proposed disposal technique. The most common problems that arise from general solid waste disposal within protected areas include the following:

- ecologically valuable land set aside for nature conservation is permanently degraded by its use for waste disposal;

- leachates can form from waste decomposition and water entering the waste. These leachates may then pollute surrounding ground and surface water;
- the decomposition and burning of wastes may cause air pollution and harmful gases;
- wastes may provide breeding sites for pathogenic organisms and other pests;
- animals may modify their feeding habits due to the supply of waste food at a disposal site;
- waste dumps may be a potential fire hazard; and
- landfill and waste management sites are aesthetically displeasing (Brownlie, 1990; Lombard and Associates, 1992; Zeller, 1994; Department of Agriculture and Environmental Affairs, 2001).

These impacts threaten the ecological integrity of the protected area and are contrary to the objectives of conservation, both nationally and internationally.

2.3.7 Constraints on solid waste management in protected areas

The following factors can be constraints on the way in which solid waste is managed, as well as its potential impacts.

2.3.7.1 Economics

The cost of transport is the main economic constraint on the disposal of solid wastes. The costs of transporting domestic solid wastes over long distances makes waste management as practised in urban areas difficult and often economically impractical. For example, current costs are greater than R2/m^3 of solid waste/km, including operational and maintenance costs (C Freer, 2001, pers. comm.). It would therefore cost Sodwana camp R1680 per 6m^3 truck delivery to the closest registered waste disposal site, at Hluhluwe, that is approximately 70km away. This is prohibitively expensive for

a partially state-subsidised organisation with limited funding, where the selected waste disposal system must be economically viable. Even Hilton (a suburb of Pietermaritzburg) is proposing a separate waste disposal site to the main Pietermaritzburg site (12km from Hilton) on the basis of the transport costs being prohibitively expensive.

2.3.7.2 Climate

Prevailing winds, rainfall, average and temperature extremes, as well as seasonal variations must be taken into account when selecting a waste management system. Higher rainfalls and temperatures may increase the rate of decomposition and the risk of leachate, making it necessary to have rapid final disposal of solid waste (Blight *et al.*, 2000). Drier, cold climates may make it possible to store waste for longer periods, allowing more cost effective periodic collection and transport from low volume waste sources.

2.3.7.3 Site sensitivity

Sites in water catchment areas and those in areas with high water tables, or sites that have specific conservation zonations or sensitivities (Appendix V), are more sensitive to the effects of pollution (Department of Water Affairs and Forestry, 1994). This makes it essential to locate waste management sites so as to remove any risk of pollution.

2.3.7.4 Attitude of staff and visitors

Attitude directly influences behaviour, while knowledge influences attitude. The priority accorded to solid waste management depends upon staff attitudes and knowledge. As staff become increasingly aware of the risks and impacts of incorrectly managed solid waste, together with the availability of cost-effective management alternatives, responsible solid waste management will gain real

support and become effective. Similarly, visitor attitude is able to influence the effectiveness of the waste management system. This applies particularly to the sorting of waste and the types of waste brought into the protected areas, either directly by visitors or by service structures to supply perceived visitor demands.

2.4 SOLID WASTE MANAGEMENT POLICY AND LEGISLATION

2.4.1 International context

South Africa is a signatory to several international conventions that influence waste management practices. The Basel Convention of 1989 is a global environmental treaty that calls for international co-operation in environmentally sound hazardous waste management by regulating the transboundary movement of hazardous wastes. South Africa subscribes to the procedures of this convention through permits issued by the Department of Environmental Affairs and Tourism (Department of Environmental Affairs and Tourism, 2000a), but has not yet included it into legislation.

The World Conservation Strategy of 1980 and the follow-up Earth Summit in 1992, recognised the dangers of pollution, including the fact that pollution does not recognise boundaries and requires an integrated international approach. At a local level, Agenda 21 promotes a sustainable and integrated lifestyle approach that incorporates responsible waste reduction and management principles (Yeld, 1997).

The Convention for Biological Diversity, held in Rio de Janeiro in 1992, also deals with pollution control and sets biodiversity objectives in this regard. South Africa is a signatory to this convention and a green paper on the Conservation and Use of South Africa's Biological Diversity was published in 1996. Objectives set out in this convention are included in many of the principles of South African environmental legislation and in the objectives of conservation organisations.

2.4.2 South African legislative context

South Africa has extensive waste management legislation, fragmented across a number of departments and levels of government (Department of Environmental Affairs and Tourism and Department of Water Affairs and Forestry, 1997; Department of Environmental Affairs and Tourism, 2000b). Prior to 1980 there were 36 Acts affecting waste disposal, but only the Water Act provided for the protection of the environment. In 1980, the Environment Conservation Act made provision for the registering and permitting of landfills, and this was implemented with the revised Environment Conservation Act of 1989 (ECA) (Republic of South Africa, 1989). However, legislation was still piecemeal, e.g. Act 122 of 1984 prohibits dumping and scattering of litter in a forest, but contains no other provisions for solid waste management. In 1998, the National Environmental Management Act (NEMA) (Republic of South Africa, 1998a) and National Water Act (NWA) (Republic of South Africa, 1998b) consolidated much of the waste management legislation.

2.4.2.1 Guiding principles of waste management legislation

The Constitution of the Republic of South Africa Act 108 of 1996 (section 24) guarantees everyone the right to a clean and safe environment that is not harmful to their wellbeing or health. It goes on to state that this includes the prevention of pollution and ecological degradation.

A Discussion Document for the White Paper on Integrated Pollution and Waste Management in South Africa was published in May 1997 and defined "Integrated Pollution and Waste Management" as:

"a holistic and integrated system and process of management, aimed at pollution prevention and minimisation at source, managing the impact of pollution and waste on the receiving environment and remediating damaged

environments." (Department of Environmental Affairs and Tourism and Department of Water Affairs and Forestry, 1997).

The NEMA (Republic of South Africa, 1998a) replaced sections of the ECA (Republic of South Africa, 1989) and attempts to embody both the Constitutional rights and objectives of integrated waste management by subscribing to the principle of sustainable development and setting out sub-components required in order to achieve these objectives. Internationally recognised principles such as "cradle-to-grave" responsibility, "care of duty", "polluter pays", and "waste avoidance and minimisation" are translated into various pieces of legislation and policy such as the "Minimum Requirements" waste management document series. The NEMA (Republic of South Africa, 1998a) also sets out the national environmental standard, the "Best Practicable Environmental Option" (BPEO) (Section 2.2.1).

The White Paper on Integrated Pollution and Waste Management in South Africa, released for discussion in May 2000, states as its aim the establishment of an integrated national pollution and waste management system which will, in turn, achieve a variety of objectives, namely to:

- assist the government in attaining its sustainable development goals;
- ensure that the quality, quantity and accessibility of information are improved;
- facilitate strong partnerships between the government, private sector, labour, non-governmental organisations and communities;
- facilitate compliance with environmental laws and reduce the amount of bureaucratic delays; and

- build capacity and awareness (Department of Environmental Affairs and Tourism, 2000a).

2.4.2.2 Environment Conservation Act 73 of 1989 (ECA)

Authorisation is required to conduct any activity which may have a substantial detrimental effect on the environment, such as solid waste management, in terms of sections 21 and 22 of this Act (Republic of South Africa, 1989). In addition, this Act prohibits any form of littering.

Section 20(1) of the ECA (Republic of South Africa, 1989) further applies to general waste management, where the operation of a disposal site (a site used for more than 90 days for the accumulation of waste for the purpose of disposing or treatment of such waste) requires a permit to be issued through the Department of Water Affairs and Forestry (DWAF). This particular piece of legislation is currently under revision.

2.4.2.3 National Environmental Management Act 107 of 1998 (NEMA)

This Act (Republic of South Africa, 1998a) specifies that a person or company has a duty to take reasonable measures to prevent significant pollution or degradation of the environment from occurring, continuing or recurring. "Pollution" is deemed to have occurred when:

> *"there is any change in the environment caused by, inter alia, substances emitted from any activity, including the storage or treatment of waste or substances, where that change has an adverse effect on human health or wellbeing; on the composition, resilience and productivity of natural or managed ecosystems; or on materials useful to people, or will have such an effect in the future." (Section 1(1) of NEMA).*

If the pollution or degradation is authorised in terms of other legislation, or cannot reasonably be avoided, section 28 of NEMA (Republic of South Africa, 1998a) requires that it be minimised or rectified. This duty extends to the person or organisation in control of the land and would be KZN Wildlife for provincial protected areas.

2.4.2.4 Atmospheric Pollution Prevention Act 45 of 1965

While this legislation is primarily aimed at specialised medical waste incineration, the construction of a general waste incineration site may fall under the scheduled processes listed in the Second Schedule of this Act (Republic of South Africa, 1965), which deems that a scheduled process certificate may be required if noxious or offensive gases are likely to be produced by any of the seventy two scheduled processes (e.g. incineration). This certificate is granted by the Chief Air Pollution Officer in terms of section 10, once the officer is satisfied that the requirements for BPEO of preventing or reducing the escape of any noxious or offensive gases are met. The standards for class 3 incinerators (small general waste incinerators, burning less than 100kg of waste per hour at 850°C or higher) are contained in a guideline document (Department of Environmental Affairs and Tourism., 1997). Medical and veterinary wastes are classified as hazardous and require specialised handling practices, and incinerators where the minimum temperature attained is 850°C in the primary chamber and over 1000°C in the secondary combustion chamber. If no incinerator is available, hazardous wastes must be pre-treated by sterilization, direct irradiation or microwaving, before they may be landfilled at a registered hazardous waste disposal site.

2.4.2.5 National Water Act 36 of 1998 (NWA)

Water leaving a waste site, whether contaminated surface run-off or leachate, which may pollute any water resource, must be treated according to the "Minimum Requirements" standards (Section 2.2.3.3) before being released to the environment. The discharge of such water requires a licence from DWAF.

The disposal of liquid wastes is provided for through the NWA (Republic of South Africa, 1998b) and regulations stipulate the allowable levels of pollutants and permit requirements for polluting activities. While landfilling or incineration of wastes is permitted under specified conditions, the pollution of ground or surface water in any form or quantity is deemed unacceptable. All disposal sites must be situated above the water-table and any water passing through the waste must be collected and treated to legislated standards before it may be released to the environment.

2.4.2.6 Occupational Health and Safety Act 85 of 1993 (OHSA)

Solid wastes require a variety of types of handling during their collection, sorting, storage and disposal stages. The OHSA (Republic of South Africa, 1993) stipulates that every employer has a duty to establish what risks exist in dealing with a particular waste and then to provide the necessary safety and precautionary measures to avoid risk of injury or damage to health, and to ensure compliance. The Act further provides for the health and safety of employees through regulations such as the General Administrative Regulations, General Safety Regulations and Environmental Regulations for Work Places, amongst others.

For example, although the waste in a protected area may be classified as general or non-hazardous, if waste management staff should be required to sort the small quantities of hazardous waste

(e.g. flourescent tubes and batteries) from the general waste stream, the Regulations for Hazardous Chemical Substances, under the Act, will apply and precautions must be taken to ensure that the staff member is trained and that risk of exposure to the hazardous waste is prevented.

2.4.2.7 Health Act 63 of 1977

In terms of this Act (Republic of South Africa, 1977), every local authority is required to take all necessary and practical measures to ensure that its area of responsibility is maintained in a clean and hygienic condition. They must prevent the pollution of clean water and purify any polluted water. KZN Wildlife is recognised as the local authority in terms of many of the areas proclaimed under its protection.

2.4.2.8 Municipal Systems Act 32 of 2000

This Act (Republic of South Africa, 2000) devolves the responsibility of provision and management of waste services and facilities to local and district municipalities. This must be in compliance with the prevailing national and provincial waste management legislation. KZN Wildlife is considered to be the *de facto* local authority in most of the protected areas that it manages.

2.4.3 Applying the legal requirements within the framework of protected area management

A common factor in the above legislation is that it has largely been designed with waste-human interactions and the urban, modified and built environments in mind. In category II protected areas, such as many of those managed by KZN Wildlife, a primary objective is to conserve the natural ecological functioning of the protected area by minimising human impact and intervention. A practical and successful waste disposal strategy must therefore consider and apply both biodiversity and waste

management objectives. For example, while the management and disposal of diseased animals and carcasses within protected areas is regulated through the State Veterinarian and the animal disease control legislation, waste legislation requires that carcasses be considered hazardous waste and immediately disposed of at a registered facility. In the case of a disease-free carcass, such as a "kill", this would be in direct conflict with the proper management and conservation of the protected area.

It was therefore proposed that protected areas should be considered as controlled environments where naturally functioning systems are promoted and human interaction with natural wastes is minimised (Hatton, 2000). This would mean that the proper disposal of a disease-free carcass would be to allow it to naturally decompose or be scavenged.

2.4.4 KZN Wildlife and the need for this study

Ezemvelo KwaZulu-Natal Wildlife is the successor to the recently amalgamated (1997) Natal Parks Board and KwaZulu Department of Nature Conservation. It is the provincial nature conservation authority, managing 96 protected areas throughout KwaZulu-Natal. Thirty-eight of these provide overnight visitor facilities and approximately 308 500 overnight visitors visit these protected areas annually (KZN Wildlife, 1998). The two selected study sites i.e., Sodwana Rest Camp at Sodwana Nature Reserve and Hilltop Rest Camp at Hluhluwe Game Reserve, account for approximately 9% and 8% of these visitors, respectively (KZN Wildlife, 1998).

As early as 1984, an unpublished Natal Parks Board document indicated that *"refuse loads are reaching alarming proportions in some areas, and that pollutive effects might be higher than permitted in a conservation area."* This historical situation, together with the following factors i.e.,

- the recent increases in visitors to the economically important nature-based facilities of the tourism industry;

- the lack of registered disposal sites near most of the larger protected areas in KwaZulu-Natal, combined with the often prohibitively expensive cost of transport to these sites;
- an increased awareness of staff and visitors of waste management impacts and requirements together with the requirements of sustainable development; and
- the upgrading or extension of existing rest camps, and the development of new rest camps, staff and game capture facilities, which require approved waste management plans,

made this study an urgent requirement.

Despite a number of policies indirectly related to solid waste production and its impacts within protected areas (Appendix VI), there was no specific solid waste management policy to guide KZN Wildlife field staff in their management of such waste.

To design a functional and appropriate waste management policy and strategy, one must know what wastes are being produced, from where and in what volumes. Mayet (1993) states that it is important to know the amount of waste that will be generated so that adequate resources can be allocated to appropriate collection, storage, management and disposal of the waste. This will also provide a set of baseline data against which future waste generation and management trends can be monitored.

Accordingly, the key objectives of this pilot study were to:

- investigate the types and amounts of solid waste generated at two KZN Wildlife protected area visitor facilities;
- investigate the various disposal methods employed throughout the protected areas system;
- compare these results to waste production and disposal methods employed in other biodiversity protected areas and to international waste production and disposal methods;

- develop a draft solid waste management policy and strategy for KZN Wildlife to ensure that the negative impacts of this solid waste are avoided or mitigated in relation to the ecological functioning of the protected areas; and
- apply the draft policy and strategy to a new development within a KZN Wildlife protected area, by producing a solid waste management plan for that development.

3 AREAS OF STUDY AND METHODS

The objectives of this pilot study were to investigate solid waste composition, management and disposal alternatives at KZN Wildlife protected area visitor facilities, both in the past and at present, and to make comparisons with both national and international waste composition and its management. This required the collection of quantitative data and consideration of primary information obtained through interviews, sampling and audits, as well as the use of secondary sources of information in the form of journal articles and reports.

To develope the required solid waste management policy, strategy and individual plans for KZN Wildlife protected areas, existing waste management knowledge, legislative requirements and Integrated Environmental Management principles were applied to the information collected in the earlier stages of the pilot study. While primary information was applied to aspects of the strategy such as the waste management option selection matrix (Section 5.3.2), secondary information was sourced from books and legislation in order to provide the contextual and legal framework in which the policy, strategy and management plans were developed.

Two KZN Wildlife visitor facilities were selected for the pilot study, one coastal, Sodwana Bay Rest Camp, and one inland, Hilltop Rest Camp. Both are large visitor facilities that cater for different sectors of the market, and both have a diverse range of facilities and functions, such as reserve management, research offices, shops, restaurants, chalets, camping, and day visitors. In addition, Skukuza Rest Camp in Kruger National Park was selected for comparison with these KZN Wildlife camps as it is a South African example outside KwaZulu-Natal that is operated by the national nature conservation authority (South African National Parks) and for which there was existing waste production and management information.

A survey of current (2000) solid waste disposal practices throughout KZN Wildlife controlled areas was also conducted as part of this study. This is only the second survey of waste management in KZN Wildlife protected areas. The previous survey (Natal Parks Board, 1984) was conducted prior to any perceived need to develop an organisational solid waste management policy and strategy. As in the 1984 survey, the current survey included coastal, midland and mountainous protected areas that provide a range of different visitor facilities and perform a variety of management functions. This information was gathered to test the hypothesis that smaller protected areas with easy access to regional or local authority waste disposal facilities are more likely to use these facilities, whereas those areas that are larger or more remote will dispose of wastes within their boundaries. The relationship between waste volume and waste reduction (e.g. by burning or recycling) before landfilling was also investigated.

The existing methods of waste disposal were then compared to acceptable waste disposal techniques and the requirements for legislative compliance and sustainable development principles in order to develop a solid waste management policy and strategy.

3.1 STUDY AREAS

3.1.1 Hilltop Rest Camp

Hilltop Rest Camp in Hluhluwe Game Reserve in northern KwaZulu-Natal is located at 28°01'00"S and 32°01'30"E (Figure 3.1) and has a diversity of facilities including offices and a curio shop, day visitor facilities, KZN Wildlife chalets, a restaurant and bar, and staff accommodation. Hluhluwe Game Reserve covers an area of 25 633 ha and is linked to the 47 753 ha Umfolozi Game Reserve by the 21 598 ha Corridor Game Reserve, creating the largest "big five" game viewing area within KwaZulu-Natal (94 984 ha). The park attracts over 81 000 visitors per annum, 30% of whom stay overnight and 55% of whom are from abroad (KZN Wildlife, 1998).

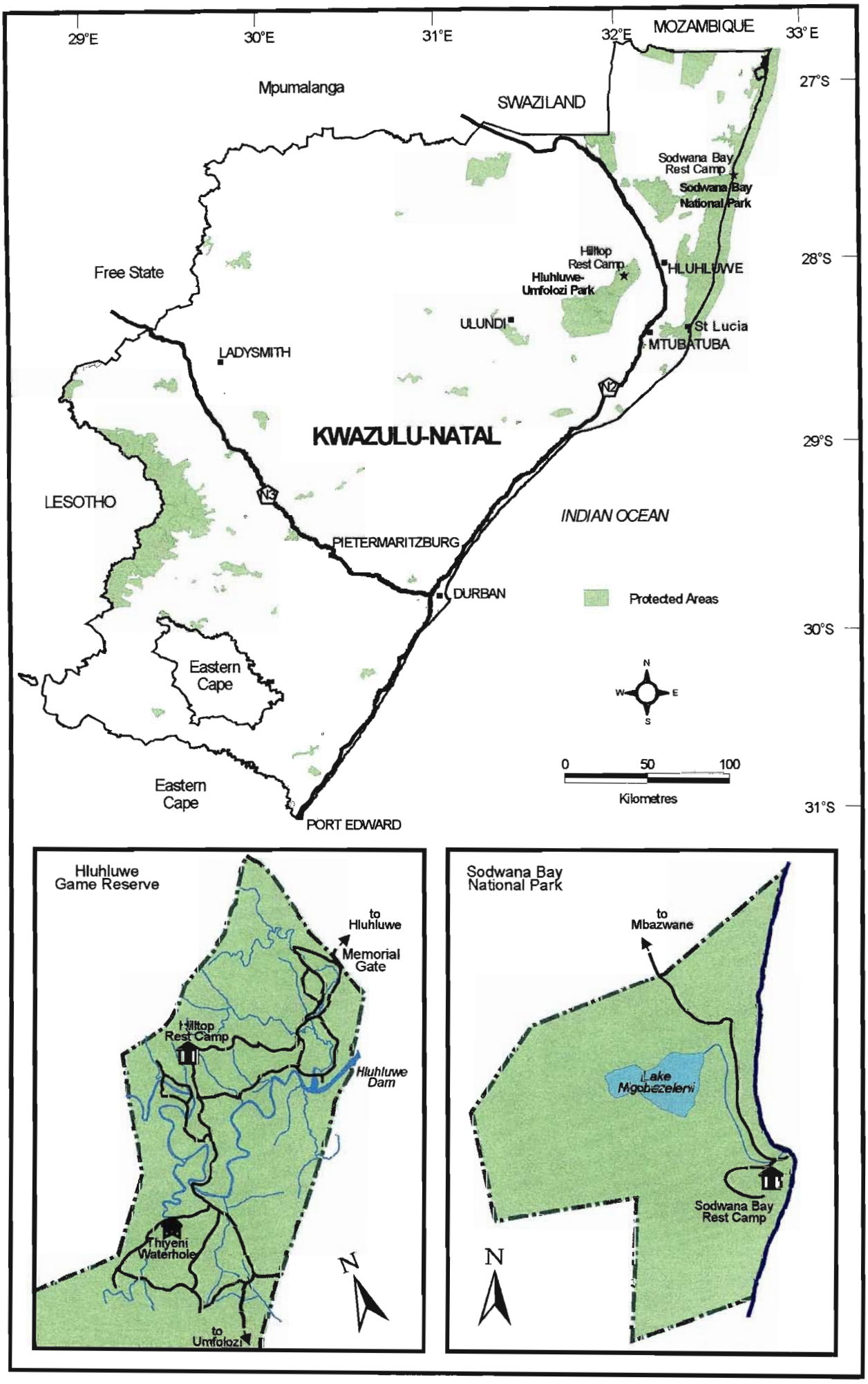


Figure 3.1 Location of Hilltop and Sodwana Bay Rest Camps within KwaZulu-Natal

Visitor accommodation at Hilltop Rest Camp at the time of the current waste survey (Section 3.2.3) consisted of 120 beds in rondavels and 80 beds in luxury chalets, with access to the restaurant for both overnight and day visitors. There are no camping facilities. Staff accommodation for 65 people is provided adjacent to the Rest Camp.

The waste from Hilltop Rest Camp is currently disposed of in a pit, 3km from the camp, within the protected area. The closest town with a registered domestic landfill site is Hluhluwe (27km away).

3.1.2 Sodwana Bay Rest Camp

The Sodwana Bay Rest Camp is in Sodwana Bay National Park which is a part of the Greater St. Lucia Wetland Park World Heritage Site (Figure 3.1). It is located on the north coast of KwaZulu-Natal at 27°32'45"S and 32°39'00"E and has facilities that include offices, a shop, camping grounds, KZN Wildlife chalets, private chalets with restaurants, and staff accommodation. It comprises a relatively small terrestrial reserve (1 155 ha) adjacent to a large marine reserve (47 127 ha).

Approximately 55 000 visitors visit the protected area annually, attracted by fishing, diving and turtle viewing opportunities. Fifty percent stay overnight and most are South African (KZN Wildlife, 1998). Visitor accommodation at the time of the current waste survey (Section 3.2.3) consisted of 100 beds in wooden chalets, a private 60 bed chalet development with a restaurant, a 120 bed rustic dive resort development and a large 600 bed camping facility. Staff accommodation for 80 people is provided adjacent to the Rest Camp.

Mbazwane is the closest town (13 km) but it does not have a registered landfill site. The closest registered domestic landfill is 75 km away at the town of Hluhluwe. Sodwana Bay Rest Camp disposes of its waste at a landfill within the protected area, less than a kilometre from the camp.

3.1.3 Skukuza Rest Camp

Skukuza Rest Camp in the Kruger National Park has facilities that include chalets, camping, staff accommodation, research and administration offices, shops, and restaurants. Visual, verbal and unpublished information was gathered so that the overall waste composition could be compared with that of Hilltop and Sodwana.

Skukuza Rest Camp is within the Mpumalanga section of the Kruger National Park at 24°58'45"S and 31°34' 00"E and is managed by South African National Parks. The Kruger Park provides 1 962 362 ha of game viewing and Skukuza Rest Camp caters for approximately 550 overnight visitors at any one time. Skukuza has a total of approximately 350 visitor beds in chalets, a camping facility of 200 beds, three restaurants and an adjacent 500 bed staff village. The closest town with a registered landfill site is Nelspruit (112 km away). Solid wastes are disposed of within the protected area at an approved incineration and sanitary landfill site that is adjacent to the camp.

3.2 DATA COLLECTION

A variety of data collection techniques were employed, chosen according to the availability of existing data for comparative purposes, the type of data and degree of detail required, and practical time, technology and budgetary constraints.

3.2.1 Historical and unpublished data

Historical data were collected from long-serving individuals in KZN Wildlife and South African National Parks. These took the form of results from an earlier survey (Natal Parks Board, 1984), unpublished reports on KZN Wildlife protected area and Kruger National Park waste management (Brownlie, 1990; Lombard and Associates, 1992; Zeller, 1994; KZN Wildlife, 1998) and personal interviews (see general personal communications section in References). As there was little or no co-

ordination in the past to collate information relating to waste production and management, and because much of the information has been lost during various organisational amalgamations, the information is fragmented with differing levels of accuracy, and was seldom useful for comparative purposes.

3.2.2 Questionnaire

An overview of waste management practices in KZN Wildlife protected areas throughout the province was obtained either telephonically or through face-to-face interviews with senior field staff, according to the questionnaire format included as Appendix VII. The volumes of wastes produced are the estimates of experienced field-based management staff. Staff with the most protected area management experience and knowledge were selected where possible, in order to obtain the most reliable information and experienced opinions available within the nature conservation authority (see 2000 waste survey: personal communications section in References for full list of interviewees). The questionnaire was structured in an unbiased manner and was strictly adhered to during data collection in order to prevent interviewer bias that could have influenced the respondent. Broadly, for each KZN Wildlife protected area, the questionnaire required information on the volume of waste generated, how it is disposed of, and why that method was chosen.

3.2.3 Sampling of solid waste

Solid waste generated over a consecutive three day period (Friday, Saturday and Sunday) was collected at Hilltop and Sodwana on Monday 29th May and Monday 26th June 2000, respectively. Waste was separated at each site into the following waste source categories:

- offices (including research facilities) and shops;
- staff accommodation;
- day visitors site;
- private fully catered chalets;

- KZN Wildlife visitor chalets / self-catering rondavels;
- camping area; and
- restaurant (including take-away and bar areas).

The volume and mass of the solid waste from each source was measured using a 35dm^3 bucket calibrated in quarter dm^3 intervals, and weighed on a digital scale that was accurate to 50g. Due to the small quantities of waste measured each time, there was very little compaction. Within each waste source category, the waste was then further separated into the following components:

- plastics;
- food wastes;
- paper;
- tins (including cans);
- glass; and
- miscellaneous waste.

Each waste component was then measured as before and the weights and volumes recorded. Volumes are non-compacted volumes and weights are wet weights for all samples. The occupancy of each of the camps, including staff, over the period when the waste was generated, was also recorded.

3.2.4 Waste management and compliance audits

A broad assessment of compliance with legislative requirements and of the likely impacts of the waste management disposal sites was carried out at Hilltop and Sodwana Bay Rest Camps in KZN Wildlife protected areas and Skukuza Rest Camp in the Kruger National Park as per the form in Appendix VIII, which was adapted from the assessment form designed by Lombard and Associates (R Lombard, 2000, pers. comm.). Environmental auditing is a useful tool to assess, how well an activity is currently being conducted, using objective and key criteria. It is used in this pilot study to identify where the waste management activities are not meeting the

minimum criteria required to achieve the objectives of sustainable development and to indicate the priority remedial actions that must be addressed through the solid waste management policy and strategy.

A site visit was made to Skukuza Rest Camp in the Kruger National Park in September 1999, to study the solid waste disposal management facilities. Visual observations, interviews with National Parks Board staff (B du Plessis, 1999, pers. comm.; S Freitag-Ronaldson, 1999, pers. comm.) and information from unpublished reports (Zeller, 1994) on the types, amounts and management of solid waste were gathered for comparison with the information collected by observation and interviews at the two KZN Wildlife visitor facilities (T Dale, 2000, pers. comm.; M Bouwer, 2000, pers. comm.).

3.2.5 International waste information

Solid waste production from cities and countries, both per capita and by component, were obtained from other studies (Parkin, 1995; Blight, 1996; Abu Qdais *et al.*,1997; Smith Korfmacher, 1997; Blight *et al.,* 1999).

An internet search using the search engines AltaVista, Aardvark, MSN, and Yahoo, with combinations of the following key words: national, protected, areas, waste, management, parks, garbage, and policy; led to policies and undertakings on waste management from Australian, Canadian and United States protected area authorities, but no detailed information on actual management practices or strategies.

Due to the scarcity of published information, additional information on international waste management practices and subjective assessments of the composition of protected area wastes were obtained by e-mail and personal communication with representatives of protected areas in Australia, Uganda, Kenya, Tanzania, Ethiopia, Zambia, Malawi, Botswana

and Zimbabwe (Section 2.3.6)(I Achoka, T Bowland, B Gebre, E Gobuamang, J Kazembe, M Mutabilwa, V Nyirenda, E Tarimo, and J Warutere, 2001, pers. comms.).

T Bowland in Australia was selected for his knowledge of both protected area management in Australia and his previous experience of KZN Wildlife protected area management. I Achoka (Uganda), B Gebre (Ethiopia), E Gobuamang (Botswana), J Kazembe (Malawi), M Mutabilwa (Tanzania), V Nyirenda (Zambia), E Tarimo (Tanzania), and J Warutere (Kenya) were selected for their perspectives and information on waste management within protected areas in Africa. They are experienced, knowledgeable conservation staff, and were available for discussion while attending a course on sustainable development planning within protected areas, and following the course, accessible by e-mail.

3.3 DATA ANALYSIS

3.3.1 Hilltop, Sodwana and Skukuza Rest Camps, and international waste composition comparisons

3.3.1.1 Comparison of histograms

The composition of the solid waste from the various sources within Hilltop and Sodwana Bay Rest Camps, and the volume and mass produced per visitor or staff member per day, were calculated. These component volumes were converted to percentages and plotted as histograms.

The Skukuza Rest Camp waste composition data and the information on solid waste composition from both first and third world countries were similarly treated.

It should be noted that using data collected at a specific point in time as an estimate of the volumes and character of the solid waste

generated does not allow for sampling to be necessarily representative. It also does not allow a statistical assessment or comparison of the samples or factors that may be contributing to variations within and between the sample results. Ideally, samples should have been collected at the same camp several times, over a period of a year or more, to give greater confidence when calculating the composition of the solid waste produced. Within the time constraints of this project, such detailed sampling was not possible and therefore only single samples were gathered at each facility in order to test the methodology and the general assumptions of this pilot study.

3.3.1.2 Cluster analysis

In order to assist in comparing the similarity of the various waste compositions, cluster analysis was applied (Hair *et al.*, 1998). Cluster analysis methods are mostly used when there are no *a priori* hypotheses and the research is still in the exploratory phase so that statistical significance testing is not yet appropriate. In this pilot study it is used as a heuristic tool, without assigning any statistical significance to the results, in order to organise waste samples according to their apparent similarity in composition.

A horizontal tree clustering technique was used which progressively links clusters together that have a similar waste composition, the clusters becoming increasingly dissimilar along the horizontal axis (denotes the linkage distance) until all the clusters are joined together. When there is a clear structure in the clustering, it will often be reflected in a hierarchical tree with distinct branches, which can then be interpreted.

Tree clustering uses the dissimilarities or distances between sample groups when forming clusters. Squared Euclidean distance has

been used in this study. This is the geometric distance between samples in a multidimensional space and squaring the distance simply emphasises the differences between samples. As differences in scale can greatly affect this type of cluster analysis, the samples are all represented according to the same scale, i.e., kg or dm^3 per person per day.

Unweighted pair-group centroids were used to determine whether two samples or clusters were sufficiently similar to be linked together. The centroid of a cluster is the average point in multidimensional space and the distance between two samples or clusters is determined by the distance between the centroids (Hair *et al.*, 1998). Those clusters having the least squared geometric distance between samples in a multidimensional space (i.e., those clusters that are most similar in character) are indicated on the tree cluster as the first order of amalgamation. The second order of amalgamation indicates the next closest grouping of clusters, and so on until all the cluster relationships are indicated in order of amalgamation.

3.3.2 Relationship between KZN Wildlife protected area size and distance from waste disposal facility

The relationship between reserve size and increasing visitor and staff numbers was examined using visitor statistics (KZN Wildlife, 1998) and reserve proclamation data. Using information available from the 1984 and 2000 surveys, each reserve's size was plotted against its distance from the nearest town that has a waste disposal facility. By the use of selected symbols to indicate different waste management and disposal methods, the relationships between size of protected areas, ease of access to a waste disposal site and choice of disposal method were investigated.

The legality and impacts of the disposal methods are briefly discussed in terms of current legislation, using the results of the assessments at Hilltop and Sodwana Rest Camps.

3.3.3 Policy, strategy and solid waste management plan formulation

Prior to this study, KZN Wildlife had no solid waste management policy, strategy or management plans, although related organisational policies such as the Integrated Environmental Management Policy, Precautionary Principle and Ecotourism Policy (Appendix VI) were being implemented. Recommendations arising from assessment of results obtained in this study from KZN Wildlife protected areas in terms of solid waste composition, management and disposal, were considered together with the organisation's mission and strategic objectives, national and provincial policy, and legislative requirements. A solid waste management policy was then drafted in the accepted KZN Wildlife format, followed by an implementation strategy, in accordance with the key policy statements. A solid waste management plan was then developed, based on the policy and strategy, for the new Centenary Centre in Umfolozi Game Reserve.

4 RESULTS AND DISCUSSION

4.1 WASTE COMPOSITION AT HILLTOP AND SODWANA BAY REST CAMPS

4.1.1 Assumptions and limitations

Similarities were anticipated in the composition of waste produced at Hilltop and Sodwana Rest Camps. Each waste sample (i.e., Hilltop and Sodwana), although representing a three day period, was taken at a single point in time and additional samples over a representative period of time will be required to increase the confidence level in any findings. It is anticipated that waste production may also vary with changes in visitor income, visitor culture, season and climate (e.g. more cans may be produced in hot weather), during holiday periods when more children are present, and with deliveries to restaurants and shops. Sampling would have to include all such periods in order to be fully representative and so that it can be determined whether these factors significantly affect the per capita waste composition and volume. For the purposes of this pilot study, where similarity is detected between the composition of two waste source samples and is indicated in the tree cluster analysis, it has been assumed that there is a real correlation.

The Hilltop day visitor's waste sample was small and whether it can be considered representative will need to be investigated in future studies. It was also difficult to be certain of the number of day visitors using the facility over the three day period, rendering the waste calculation for that particular waste source, in kg person^{-1}day^{-1}, potentially inaccurate. The data collected are given in Appendix IX.

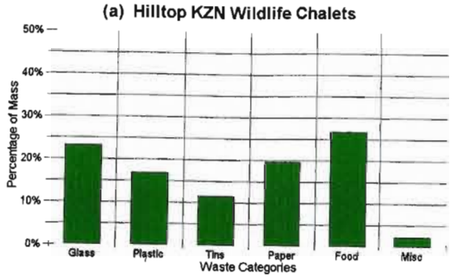
Mass has been measured using wet weights for all samples and care has been taken to avoid comparison with other studies where it is stated that kg

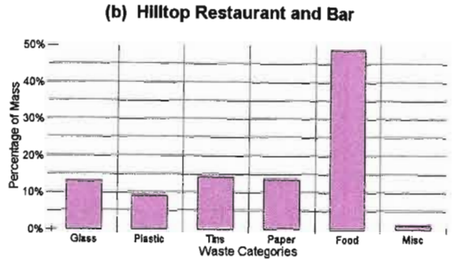
person^{-1}day^{-1} or percentage waste composition have been calculated using dry weights. It is, however, likely that this mostly affects the biodegradable wastes as glass, tins and plastics do not absorb moisture.

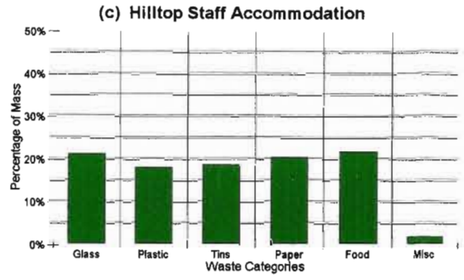
4.1.2 Solid waste composition from sources within Hilltop and Sodwana Bay Rest Camps

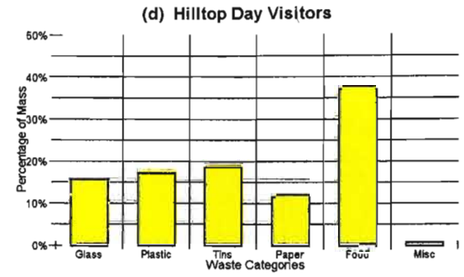
The composition of solid waste from each point source at both Hilltop and Sodwana Bay Rest Camps is represented as a percentage of each source's total mass in Figure 4.1, and as a percentage of the total volume in Figure 4.2. Lists of actual wastes noted while sampling Hilltop and Sodwana Bay are given in Appendix X. Samples were further compared using a tree cluster analysis method (Hair *et al.*, 1998) to confirm the results obtained from the histograms.

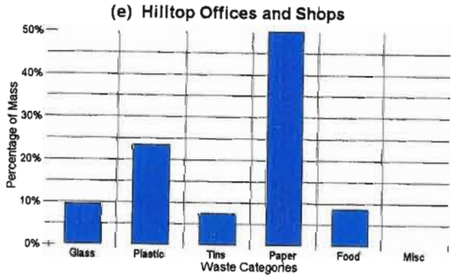
It was anticipated that the KZN Wildlife Chalets waste source at both camps would have a relatively high per capita waste production, consisting largely of waste foods and packaging due to their self-catering facilities and the availability of take-away meals from the restaurant facilities at Hilltop Rest Camp. Tables 4.1 and 4.2, however, indicate that the per capita waste production is about average, although Figures 4.1(a) and 4.1(f) do show that food wastes make up the major portion of the waste stream by mass (27% and 33%, respectively). Packaging, such as cereal boxes and plastic bottles, makes up the bulk of the volume and this can be clearly seen in Figures 4.2(a) and 4.2(f) (plastic is 27% and 26%, and paper is 26% and 31%, respectively). There is thus a high degree of similarity between the overall waste compositions from the KZN Wildlife Chalets at both Hilltop and Sodwana Bay Rest Camps. This is further indicated by the tree cluster analysis in Figures 4.1(k) (mass) and 4.2(k) (volume) where their high degree of similarity is indicated by their first and third order similarity, respectively.

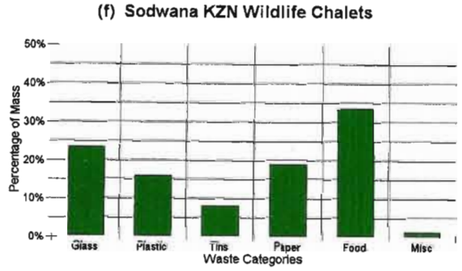


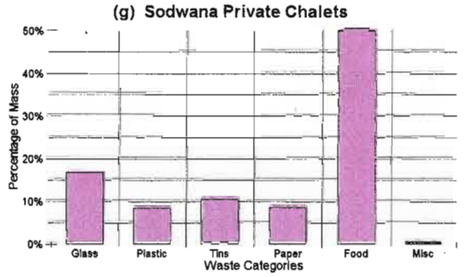


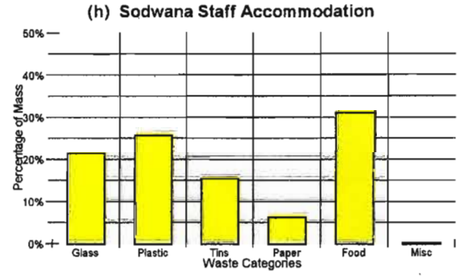


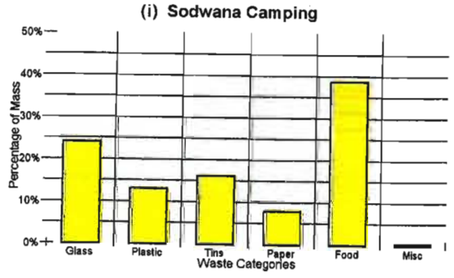












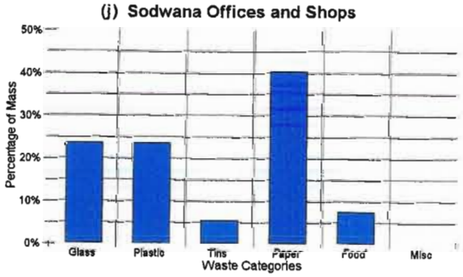
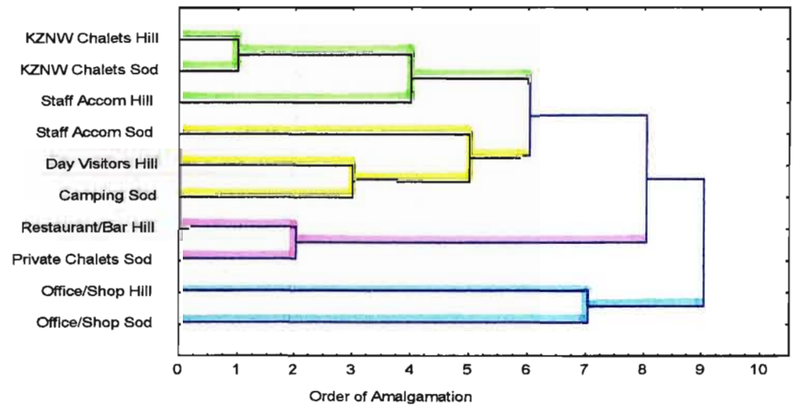
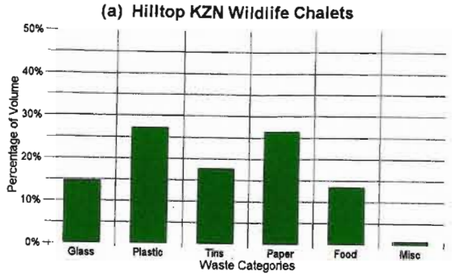
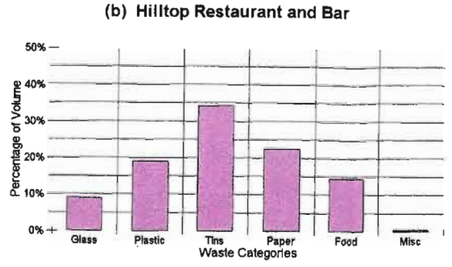


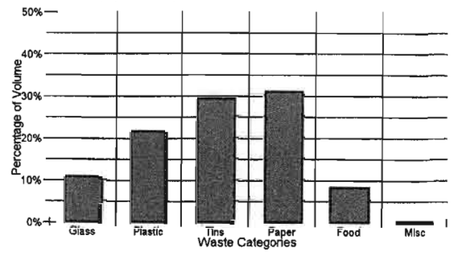
Figure 4.1 **(a) to (j) Solid waste composition (% mass/mass) from various sources at Hilltop and Sodwana Bay Rest Camps.**

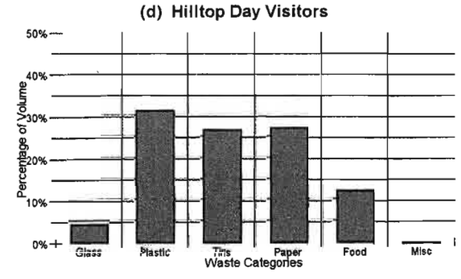


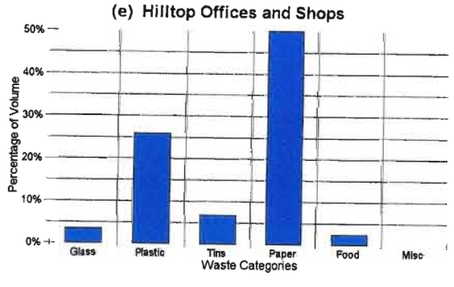
(k) Cluster analysis tree diagram of solid waste composition by mass from various sources at Hilltop and Sodwana Bay Rest Camps.

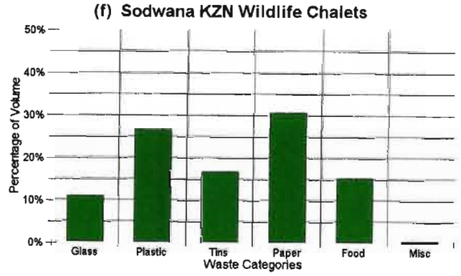


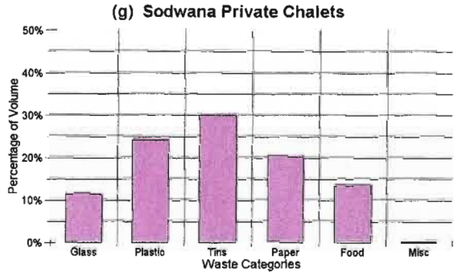


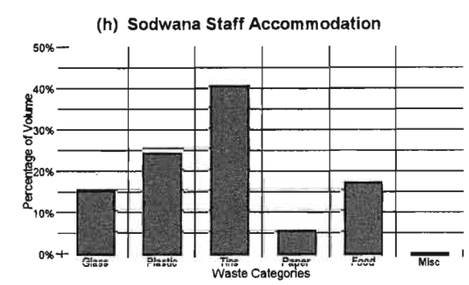


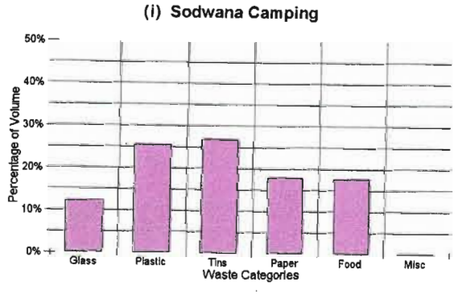












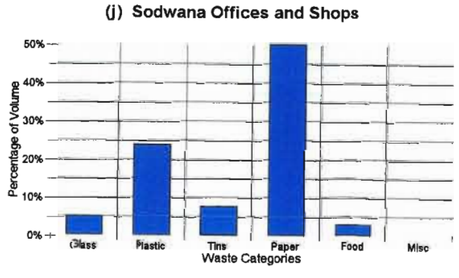
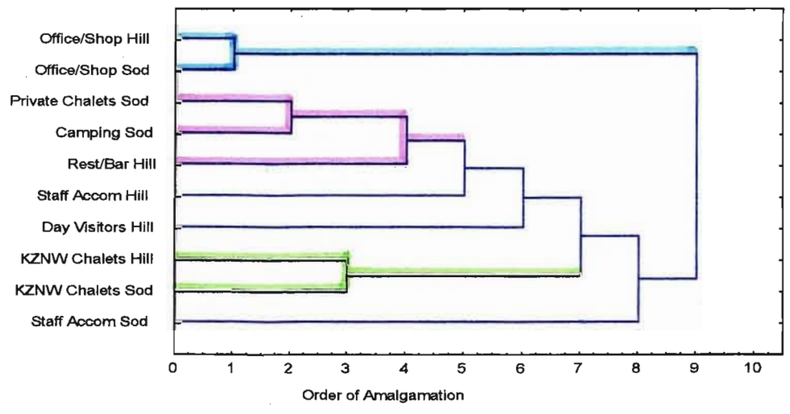


Figure 4.2 **(a) to (j) Solid waste composition (% volume/volume) from various sources at Hilltop and Sodwana Bay Rest Camps.**



(k) Cluster analysis tree diagram of solid waste composition by volume from various sources at Hilltop and Sodwana Bay Rest Camps.

Table 4.1 Mass and volume of waste produced per person per day at various sources at Hilltop Rest Camp.

SOURCE (Hilltop Rest Camp)	Mass ($kg\ person^{-1}day^{-1}$)	Volume ($dm^3\ person^{-1}day^{-1}$)
KZN Wildlife Chalets	0.30	1.58
Restaurant and Bar	0.33	1.40
Staff Accommodation	0.09	0.58
Day Visitors	0.06	0.46
Offices & Shops	0.43	3.88

Table 4.2 Mass and volume of waste produced per person per day at various sources at Sodwana Bay Rest Camp.

SOURCE (Sodwana Bay Rest Camp)	Mass ($kg\ person^{-1}day^{-1}$)	Volume ($dm^3\ person^{-1}day^{-1}$)
KZN Wildlife Chalets	0.50	2.27
Private Chalets	0.79	2.49
Staff Accommodation	0.29	0.95
Camping	0.63	2.30
Offices & Shops	0.67	5.35

The proportion of glass is the second highest (after food) for the Hilltop and Sodwana KZN Wildlife Chalets (23% for both), the Hilltop Staff Accommodation (21%), the Sodwana Private Chalets (17%), and the Sodwana Camping wastes (24%) (Figures 4.1(a), (c), (f), (g), and (i)). On site it was noted that this was largely comprised of wine bottles in Hilltop KZN Wildlife Chalet's waste, and beer and liquor bottles in the Sodwana KZN Wildlife Chalet's, the Sodwana Private Chalets and the Sodwana Camping waste. The difference in glass types may be a reflection of the

different visitor groups, but may also reflect the purchasing habits of the respective camp restaurants and shops as the Sodwana restaurants serve beer in both cans and bottles while the Hilltop restaurant serves beer in cans only. Thus tins are the second highest waste type by mass (14%) (Figure 4.1(b)) and highest by volume (34%) (Figure 4.2(b)) for the Hilltop Restaurant and Bar waste samples. Sodwana Private Chalets include private restaurant facilities and Figures 4.1(b) and (g), and 4.2(b) and (g) reflect the input of beverage cans from the bar section of the restaurants at Hilltop and Sodwana Rest Camps (14% and 11% by mass, and 34% and 30% by volume, respectively). The cluster analysis (Figure 4.2(k)) indicated that Sodwana Camping waste composition by volume is very similar to that of the Hilltop Restaurant and Bar and the Sodwana Private Chalets (Figures 4.2 (i), (b) and (g), respectively). This is due to the high content of tins from the camping wastes, although on site inspection of the tins indicated a higher proportion of food tins to beverage tins than was found for the wastes from restaurants and bars.

The Hilltop Restaurant and Bar and the Sodwana Private Chalets (Figures 4.1(b) and (g), respectively), and the tree cluster analyses in Figure 4.1(k) indicate this same similarity in overall waste composition. As explained above, this may be due to the restaurant and bar facilities that form a part of the private operator chalet facilities at Sodwana Bay. Restaurant wastes at Sodwana Bay also reflected a shellfish component not evident at Hilltop.

Staff Accommodation sources Hilltop and Sodwana do not appear to produce similar waste compositions by mass (Figures 4.1 (c) and (h)), although by volume (Figures 4.2 (c) and (h)), they appear more similar. The high proportion of tins indicated by percentage volume (Figures 4.2(c) and (h) (29% and 40%, respectively)), is possibly due to the isolation of staff accommodation from inexpensive shops (such as supermarkets), resulting in food often being bought in bulk and in a form that doesn't

require refrigeration facilities, such as tinned foods. This is reflected in the wastes produced. Camping activities have similar needs for foods that can be stored without refrigeration and this is also reflected in the high proportion of tins in the waste stream (27%) (Figure 4.2(i)), as discussed above.

The overall Hilltop and Sodwana Staff Accommodation waste composition histograms (Figures 4.2(c) and (h), respectively), differ most obviously in their waste paper volumes (31% and 5% of their respective waste compositions). It is possible that this is due to the fact that staff at Sodwana make open fires at their accommodation, disposing of combustible material; while at Hilltop Rest Camp, open fires are prohibited. Largely due to this difference, the cluster analysis indicates that waste produced at the staff accommodation sources is highly dissimilar in its overall composition by volume (Figure 4.2(k)).

As anticipated, waste from the Office and Shops at both Hilltop and Sodwana Bay Rest Camps, contains high amounts (by both mass and volume) of packaging materials such as plastic and paper (Figures 4.1(e) and (j) and Figures 4.2(e) and (j). By mass plastics are 23% at both camps; paper is 51% at Hilltop and 40% of the waste stream at Sodwana. By volume plastics are 26% and 24% at Hilltop and Sodwana, respectively, while paper constitutes 51% by volume at both camps. The high degree of similarity in the waste composition is demonstrated both by mass and volume tree cluster analyses (Figures 4.1(k) and 4.2(k)). These cluster trees also clearly indicate the dissimilarity between the Office and Shop waste and all other sources of waste, as in both trees they occupy a separate branch until the last linkage. Enquiries at the time of sampling revealed that a large amount of stock had been delivered to the Sodwana Bay shop the previous week, resulting in a large number of boxes entering the waste stream. At Sodwana Bay, the shop also sells beverages in glass

bottles. Some of these are drunk outside the shop and disposed of with waste from the shop, explaining the percentage mass of glass being equal to that of plastic at the Sodwana Bay shop (Figure 4.1(j)).

The waste produced by the Hilltop Day Visitors is low in both mass and volume per person (Table 4.1) and is comprised mostly of food by mass (37%) and plastic by volume (31%) (Figures 4.1(d) and 4.2(d)). Although the cluster analysis (Figure 4.1(k)) indicates that the Hilltop Day Visitor waste is most similar to the Sodwana Camping waste, as noted earlier (section 4.1.1) the Day Visitor waste sample was very small and the number of day visitors could not be determined with certainty, making it impossible to draw valid conclusions from information gathered from this waste source.

In conclusion, KZN Wildlife Chalets at both visitor facilities appear to produce waste having the same basic composition, while the waste sources having restaurant and bar facilities produce a distinctive waste that has a large food and tins (including cans) component. Likewise, Offices and Shops at the two KZN Wildlife protected areas produce the same types of wastes in similar proportions.

4.1.3 Comparison of total solid waste composition between Hilltop and Sodwana Bay Rest Camps

Figures 4.3(a) and (b), respectively, represent Hilltop and Sodwana Bay Rest Camps' total waste composition as a percentage of the total mass. This waste composition by volume is reflected in Figures 4.4(a) and (b), respectively. These data are given in Appendix XI. While Hilltop and Sodwana wastes appear quite different when their respective mass compositions are compared (Figure 4.3(a) and (b)), the two camp's waste distribution by volume appears very similar (Figure 4.4(a) and (b)).

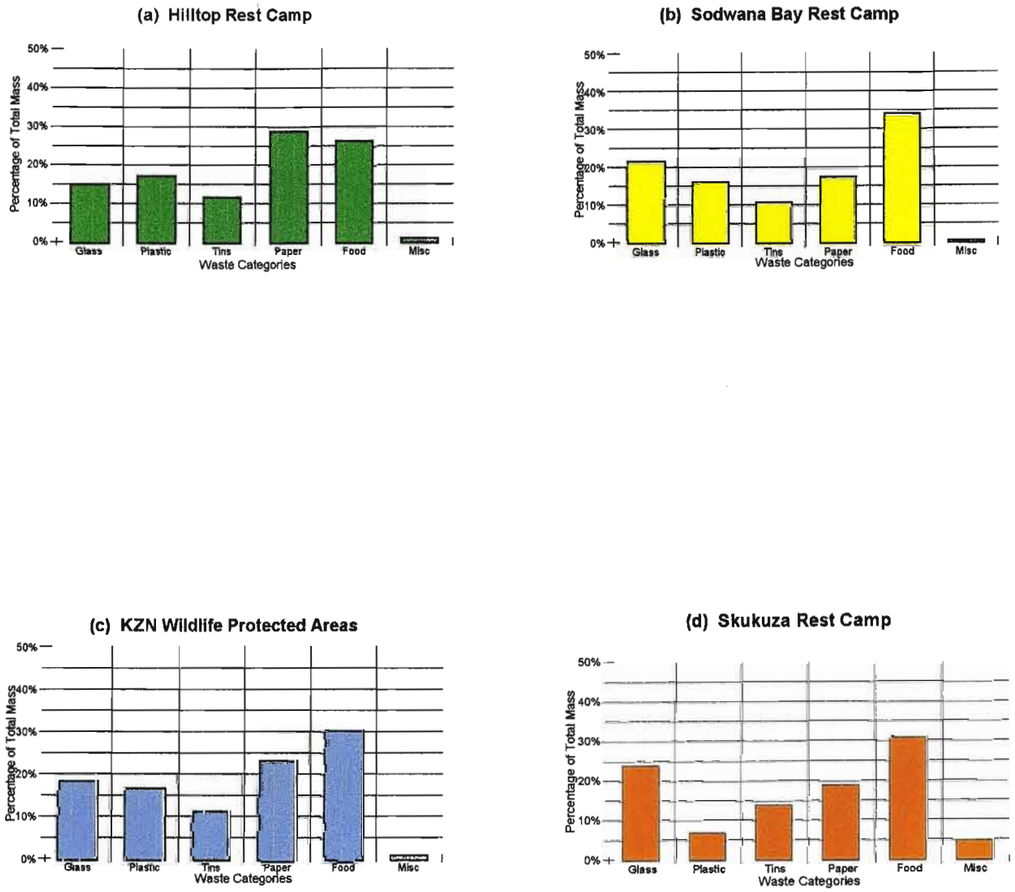


Figure 4.3 **(a) to (d) Solid waste composition (% mass/mass) from Hilltop, Sodwana Bay, KZN Wildlife Protected Areas and Skukuza Rest Camps.**

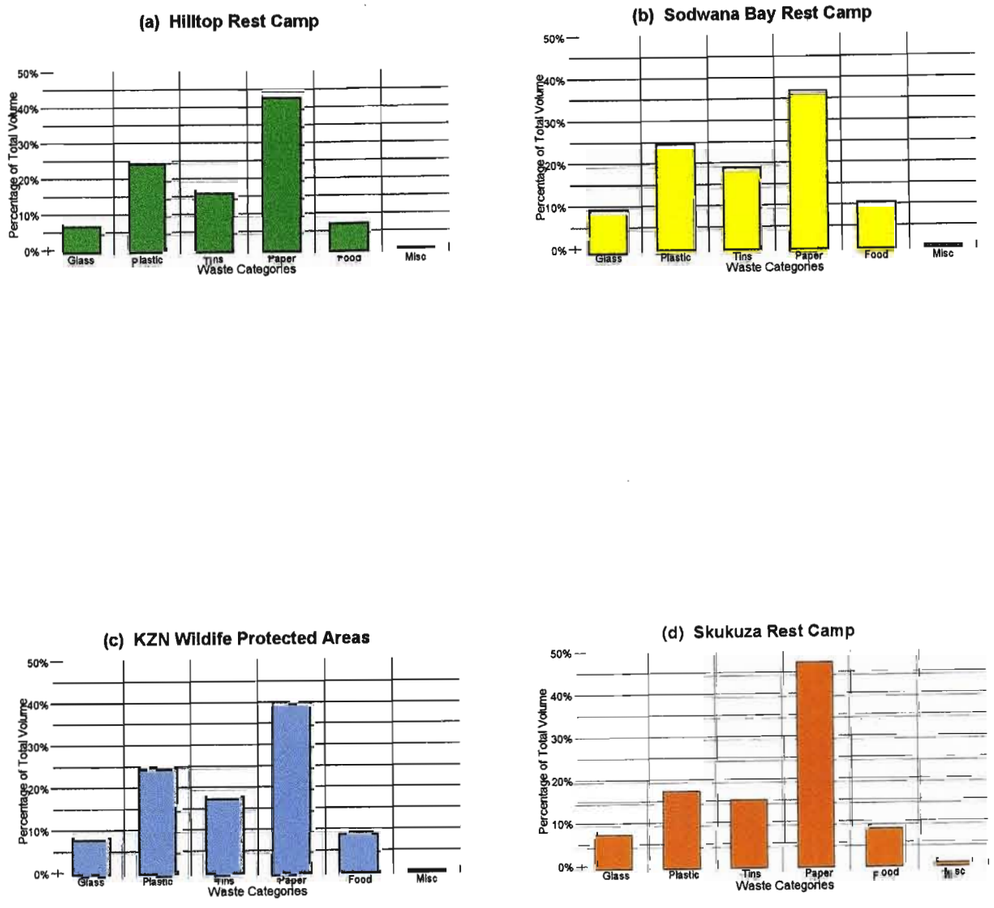


Figure 4.4 **(a) to (d) Solid waste composition (% volume/volume) from Hilltop, Sodwana Bay, KZN Wildlife Protected Areas and Skukuza Rest Camps.**

4.2 WASTE COMPOSITION AT KZN WILDLIFE AND SKUKUZA REST CAMPS

4.2.1 Assumptions and limitations

As these are protected areas within South Africa, similarities were anticipated between the waste composition from the KZN Wildlife visitor facilities and that produced at Skukuza Rest Camp in the Kruger National Park. Skukuza Rest Camp was assumed to be representative of visitor facilities in protected areas outside KwaZulu-Natal. Representivity was assumed due to the high occupancy rates, the mix of visitors, the variety of facilities within the camp, the large size of the facility and the collection of data over a period of time. The total solid waste produced at Hilltop and Sodwana Bay Rest Camps was summed and converted to unweighted average percentages by mass and volume (Appendix XI). Zeller (1994) conducted a waste management study at Skukuza Rest Camp, as South African National Parks were addressing their waste management and technical services delivery within the Kruger National Park at that time. A set of waste composition figures by volume and mass resulted from that study and are given in Appendix XI. These data were converted to percentage compositions and are represented graphically in Figures 4.3(d) and 4.4(d) to allow comparison with the KZN Wildlife waste composition histograms. As stated in Section 4.1, when similarity is detected between the proportional composition of two waste samples, it has been assumed that there is a real correlation. However, this cannot be statistically proven without additional sampling.

4.2.2 Comparison of solid waste composition by mass and volume

Figures 4.3(c) and 4.4(c) are the combined waste compositions by mass and volume, respectively for KZN Wildlife protected areas, obtained by summing the percentages for Hilltop and Sodwana and halving this in order to obtain an average waste composition for KZN Wildlife protected areas. Figures 4.3(d) and 4.4(d) are the waste compositions for Skukuza Rest Camp in the Kruger National Park, as a percentage of its total waste mass and volume, respectively. A comparison of Figures 4.3(c) and 4.3(d) reveals a difference in percentage plastic waste by mass (17% and 7%, respectively). However, this difference is not considered to be of importance as the comparison by volume in Figures 4.4(c) and (d) shows the same waste composition for KZN Wildlife visitor facilities and Skukuza Rest Camp. It may be that the plastics disposed of in KZN Wildlife protected areas are comprised of more heavy plastic bottles than lightweight plastic bags, than wastes disposed of at Skukuza Rest Camp. However, this would require further investigation. Both by mass and volume, Sodwana Bay Rest Camp has a similar waste composition to Skukuza Rest Camp. This may be due to the waste produced at the large camping facilities at these two camps.

In summary, after comparing the histograms of the various wastes compositions, it would appear that protected area visitor facilities within South Africa produce waste with high proportions of paper (17% to 29% by mass) and food (26% to 34% by mass). A comparison by volume between the waste produced at KZN Wildlife visitor facilities and that produced at Skukuza Rest Camp (Figures 4.4(a) to (d)) indicates very small differences in the proportional composition i.e., glass proportions range from 7% to 9%; plastic from 18% to 25%; tins from 16% to 19%; paper from 37% to 48%; food from 8% to 10%; and miscellaneous from 0% to 1%.

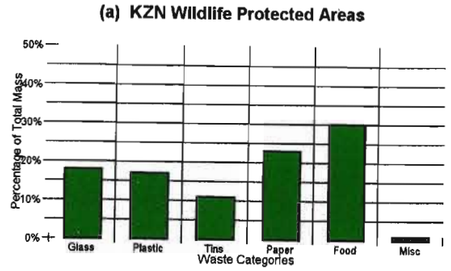
4.3 KZN WILDLIFE AND INTERNATIONAL SOLID WASTE COMPOSITION

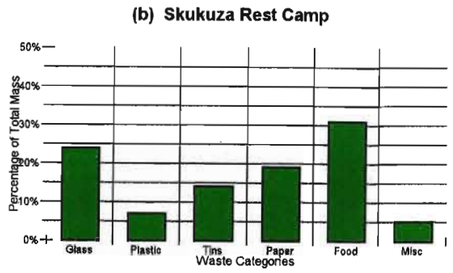
4.3.1 Assumptions and limitations

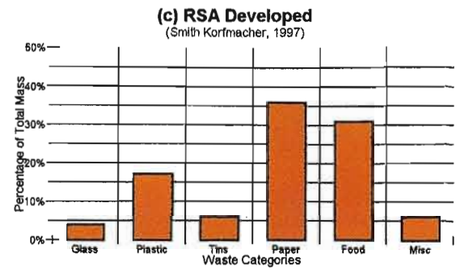
It was assumed that waste production figures from other countries include wet weights for waste foods and where dry weights were indicated, these figures were not used. In several instances, waste type categories contained in the literature had to be combined in order to produce the same six waste categories that were used for the Sodwana Bay and Hilltop Rest Camp waste comparisons.

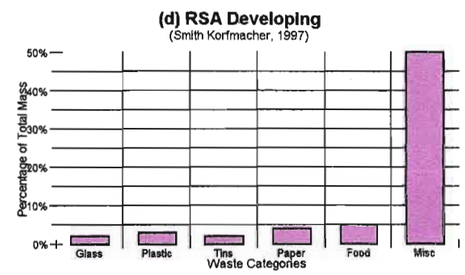
4.3.2 Comparison of solid waste composition

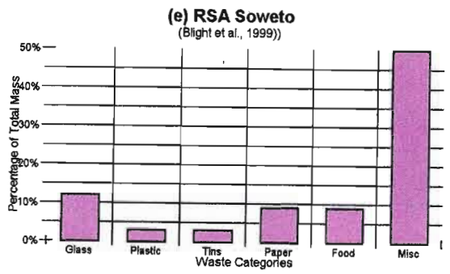
Data for the histograms (Figures 4.5 (a) to (l)) are given in Appendix XI. The sources of the data are provided on Figures 4.5(a) to (l). A comparison of Figures 4.5(a) to (l) reveals that firstly paper and secondly food wastes dominate the waste composition for the first world components of countries such as RSA Developed (36% and 31%, respectively) (for the purposes of Smith Korfmacher's study (1997) this comprised the urbanised component of South Africa having a relatively high per capita income and including commercial, processing and production industries, and urban residential) (Figure 4.5(c)), USA residential (42% and 36%, respectively) (Figure 4.5(f)), and the United Kingdom (30% and 25%, respectively) (Figure 4.5(h)). In Holland (Figure 4.5(g)), Kuwait (Figure 4.5(i)), Peru (Figure 4.5(j)), and Mexico (Figure 4.5(k)), the percentage food component is greater than the paper component, although in Kuwait this difference is small (37% and 34%, respectively). KZN Wildlife Protected Areas (Figure 4.5(a)) shows this same pattern of food and paper wastes dominating the waste composition (30% and 23%, respectively). The smaller paper component in Holland's waste (24% paper compared to 48% food) could be due to a conscious reduction of packaging materials and the impact of recycling nationally or possibly the use of paper wastes as fuel in the former eastern Germany areas, which are still in the process of economic development. In contrast, paper is likely to be used as a fuel source in Peru and Mexico, leaving very little to enter the waste stream (14% and 17%, respectively).

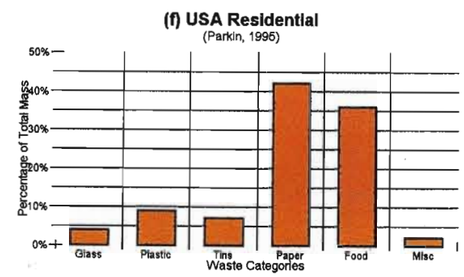


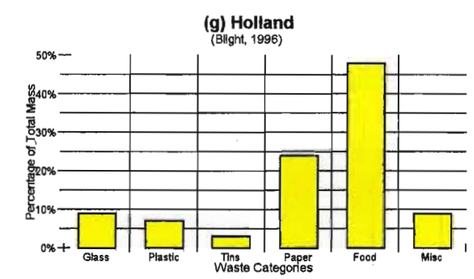


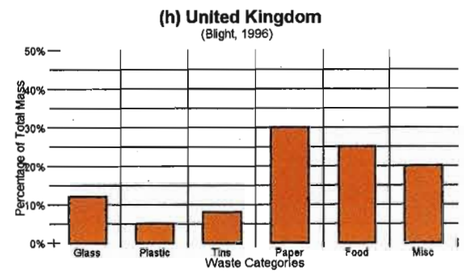


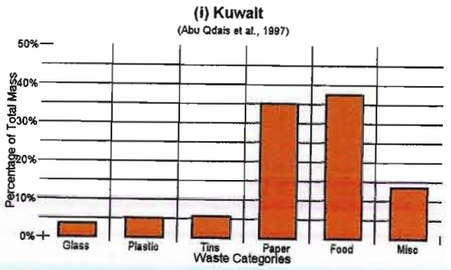


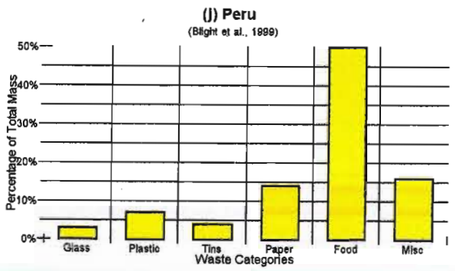


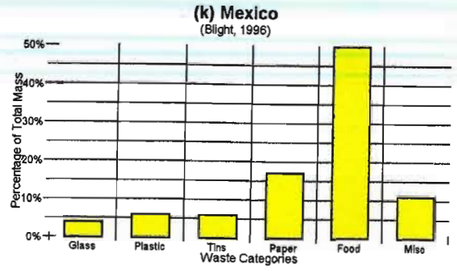












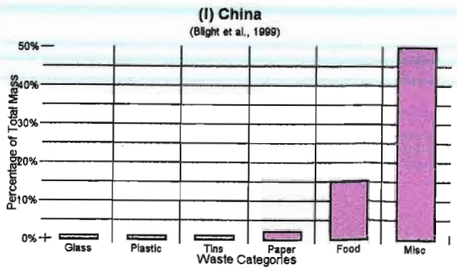
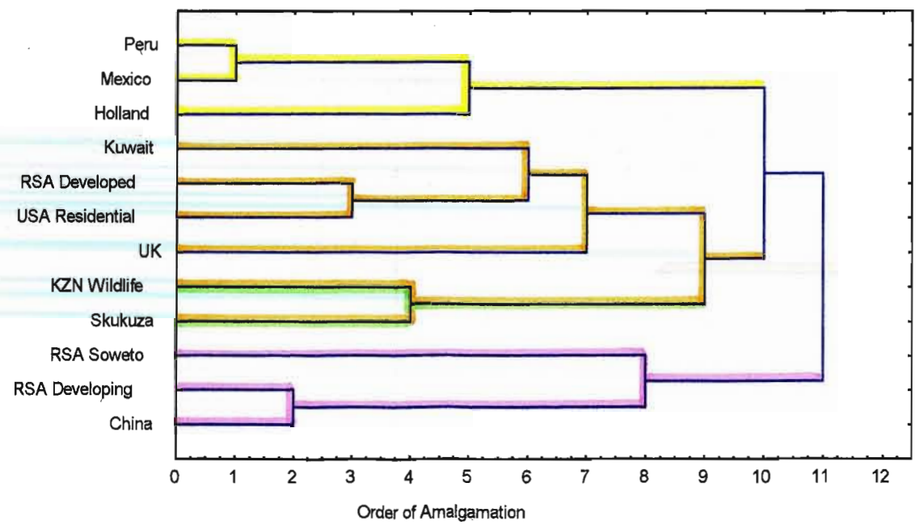


Figure 4.5 **(a) to (l) Solid waste composition (% mass/mass) from KZN Wildlife Protected Areas, Skukuza Rest Camp and international sources.**



(m) Cluster analysis tree diagram of solid waste composition by mass from KZN Wildlife Protected Areas, Skukuza Rest Camp and international sources.

Skukuza Rest Camp (Figure 4.5(b)) is dominated by food (31%) and glass (24%) waste, with paper the third most prevalent waste type (19%). The KZN Wildlife Protected Areas histogram (Figure 4.5(a)) shows a high proportion of glass (18%) and plastic (17%) waste. It is possible that due to the vacation type activities, combined with dry winters and very hot summers, more liquids, contained in glass and plastic bottles, are consumed than in residential, non-vacation situations.

There are clear differences between RSA Developed (Figure 4.5(c)) and RSA Developing (for the purposes of Smith Korfmacher's study (1997) this comprised the non-urbanised component of South Africa having a low per capita income and including extractive industries and agriculture, as well as areas of urban sprawl) and RSA Soweto (Figures 4.5(d) and (e), respectively) in that the latters' wastes are dominated by the production of waste ash and coal, included in the miscellaneous component.

In contrast, the composition of KZN Wildlife Protected Areas waste (Figure 4.5(a)) appears similar to waste from developed countries and having dissimilar proportions of waste compositions to developing economies, such as the developing portion of RSA or China (Figures 4.5(d) and (l), respectively). Peru and Mexico's waste (Figures 4.5(j) and (k), respectively), appear similar to each other (supported by the results of the cluster analysis in Figure 4.5(m)), but have no similarity to the solid waste production at KZN Wildlife visitor facilities nor to the protected area rest camps indicated in Figures 4.3 (a), (b) and (d).

The cluster analysis in Figure 4.5(m) shows three distinct clusters of waste composition, supporting the results of the comparisons made from the histograms. The first is the developing countries of China, RSA Developing and RSA Soweto, indicated through the high proportion of miscellaneous waste (waste ash and fuel). The second grouping consists of Peru, Mexico and Holland, with food waste dominating the waste composition. The third and largest category is the protected area facilities and developed

countries. Skukuza and KZN Wildlife Protected Areas waste compositions are a separate sub-branch within this third category, indicating that while there are similarities in the character of waste produced at protected area visitor facilities and the waste compositions of developed countries, these protected area visitor facilities produce a more specific waste composition within the broader category. These similarities in waste composition have implications for the planning for, and management and disposal of, such solid wastes (Section 5.2.2).

Information obtained during discussion with representatives from Kenya, Uganda, Tanzania, Ethiopia, Zambia, Malawi, Botswana and Zimbabwe (Section 3.2.5. and see international personal communications section in References) indicated that the types of wastes produced at visitor and staff facilities in protected areas in these African countries, may be similar (i.e., high proportions of paper, tins and plastic packaging) to those produced in South African protected areas, although quantitative comparison was not possible. Possible differences include the high ash content of waste produced at certain protected areas facilities in Africa which do not have electricity, e.g. camps in Chobe National Park, Botswana (E Gobuamang, 2001, pers. comm.). Waste bottles and plastic containers are often removed from the waste streams before disposal in other African countries as they have a use-value for rural people. Australian protected area waste composition is likely to be very similar to that of South Africa as the visitors have similar needs, a similar range of facilities and a similar range of products requiring disposal are available (A Bowland, 2001, pers. comm). No quantitative information was available for comparison, however.

4.4 SOLID WASTE DISPOSAL METHODS IN KZN WILDLIFE PROTECTED AREAS IN 1984 AND 2000

An unpublished Natal Parks Board solid waste disposal survey was conducted in 1984 as the need to properly manage waste within protected areas was

recognised. By 2000, this need had become urgent, and a revised survey was required to present the current practices, changes in practices and to consider reasons for changes in disposal options.

4.4.1 Assumptions and limitations

It was assumed that:

- as protected areas increase in size, more staff will be required to manage them;
- the greater the size and variety of habitats within a protected area, the more visitor opportunities that are available;
- as more visitor opportunities become available, more visitor facilities are provided;
- increased numbers of staff and visitors will result in increased amounts of waste produced in a relatively linear relationship. A study of residential area waste production in the United States (Alter, 1991) found that there was a linear relationship between the number of people in an area and the amount of waste produced. As KZN Wildlife waste was found to be broadly similar in composition to that of USA Residential waste (Section 4.3.2), this relationship is assumed to hold true for waste produced in KZN Wildlife protected areas; and
- for the purposes of this study, protected area size is directly related to the amount of solid waste produced.

It should be noted that the 1984 survey (Natal Parks Board, 1984) did not record the amount of recycling taking place and so this component cannot be compared with the results from the 2000 survey.

4.4.2 Methods of solid waste disposal

4.4.2.1 **1984 Survey** (Natal Parks Board, 1984)

In 1984, three methods of waste disposal were used by the 32 protected areas sampled. These methods were to remove waste to

a municipal dump (25% of protected areas sampled); to burn waste and bury the remainder in a pit within the protected area (44% of protected areas sampled); or to simply bury the waste in a pit within the protected area without reduction of the waste (31% of protected areas sampled) (see Appendix XII). Figure 4.6(a) clearly indicates that the use of municipal landfill facilities was limited to only relatively small protected areas of less than about 5 000 ha and no more than 30 km from a municipal landfill. This was probably due to the smaller amounts of waste produced in small protected areas, and the lower cost of transporting waste for disposal over short distances. Disposal to a pit together with burning was conducted by eight of the 14 protected areas (57%) that were either more than 30 km from a municipal landfill, or were larger than 5 000 ha (Figure 4.6(b)).

Disposal to a pit without burning, was carried out in 10 of the 32 protected areas (31%) sampled in 1984 (Natal Parks Board, 1984) and comprised a range of protected areas of differing sizes (41ha to 29 653 ha) and distances from municipal landfills (from 4km to 35 km) (Figure 4.6(c) and Appendix XII).

4.4.2.2 2000 Survey

In 2000, a survey of nine of the above 10 protected areas that disposed of wastes to a pit without burning in 1984, indicated that four of these were now disposing to municipal landfill and the other five were burning before disposal to a pit within the protected area. Figures 4.7(a) to (c), 4.8(a) to (c) and Appendix XII show that while many protected areas are conducting pit and burn disposal, no protected area sampled in 2000 is landfilling their waste without first reducing it. This change in disposal technique appears to be due to the realisation that space within a protected area is limited and that,

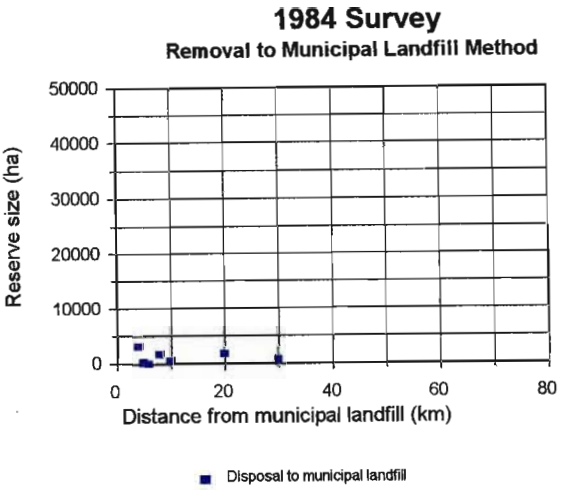


Figure 4.6 (a) Waste disposal by removal to municipal landfill in 1984, plotted against the distance to the nearest municipal landfill and protected area size.

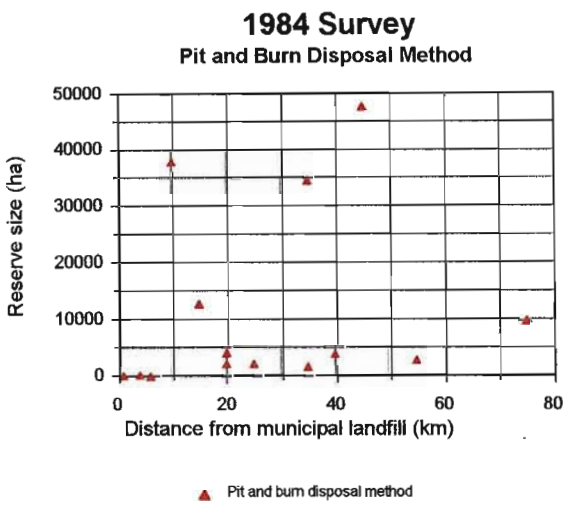


Figure 4.6 (b) Waste disposal by pit and burn method in 1984, plotted against the distance to the nearest municipal landfill and protected area size.

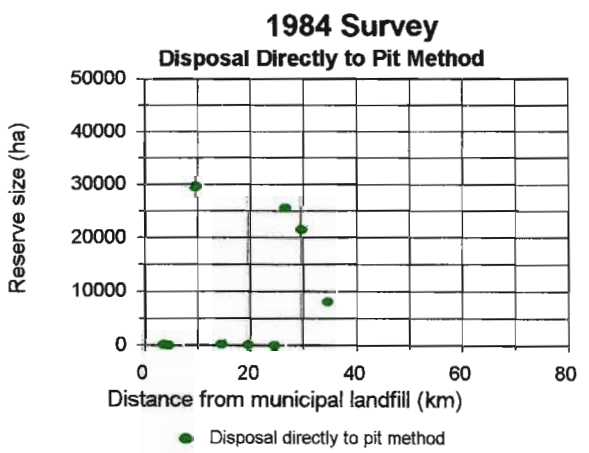


Figure 4.6 (c) Waste disposal to pit in protected area without waste reduction in 1984, plotted against the distance to the nearest municipal landfill and protected area size.

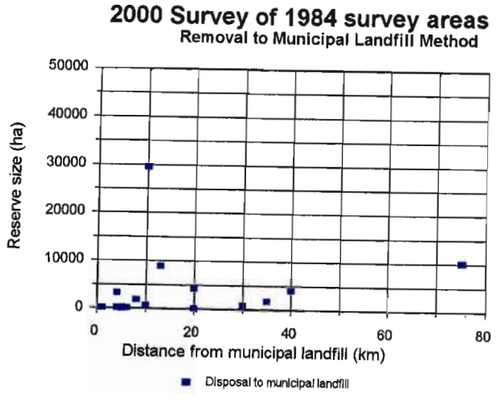


Figure 4.7 (a) Waste disposal by removal to municipal landfill in 2000, plotted against the distance to the nearest municipal landfill and protected area size.

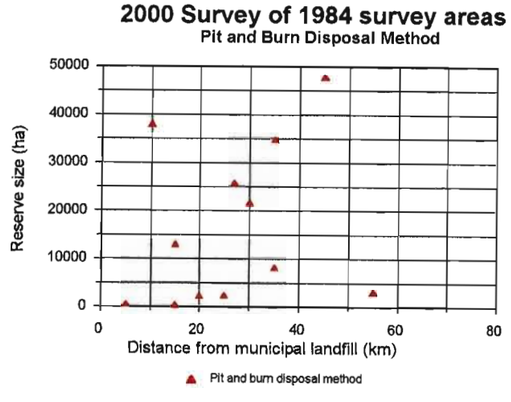


Figure 4.7 (b) Waste disposal by pit and burn method in 2000, plotted against the distance to the nearest municipal landfill and protected area size.

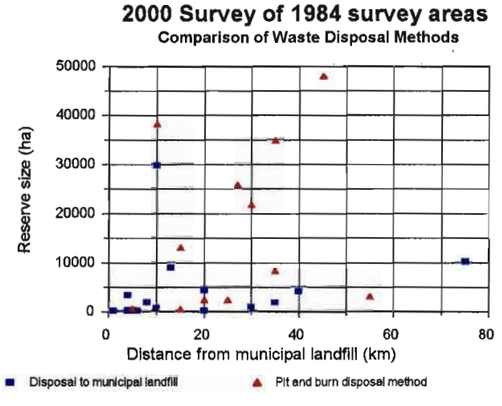


Figure 4.7 (c) Waste disposal methods in 2000, plotted against the distance to the nearest municipal landfill and protected area size, for protected areas sampled in 1984.

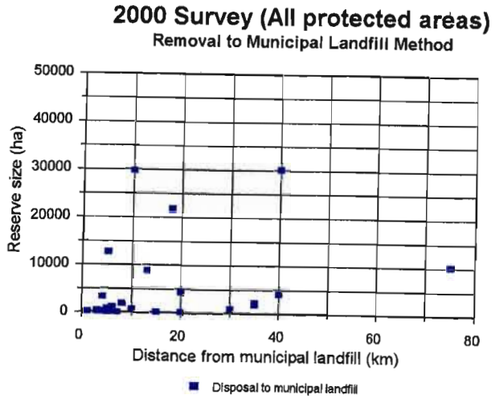


Figure 4.8 (a) Waste disposal by removal to municipal landfill in 2000, plotted against the distance to the nearest municipal landfill and protected area size.

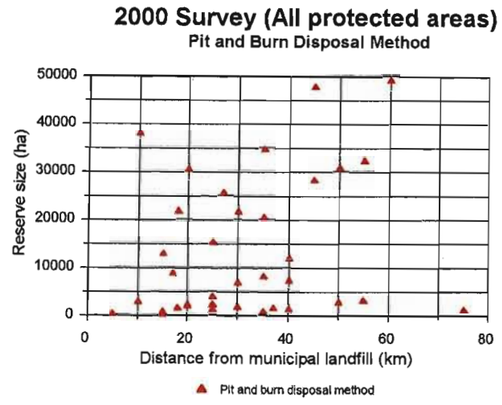


Figure 4.8 (b) Waste disposal by pit and burn method in 2000, plotted against the distance to nearest municipal landfill and the protected area size.

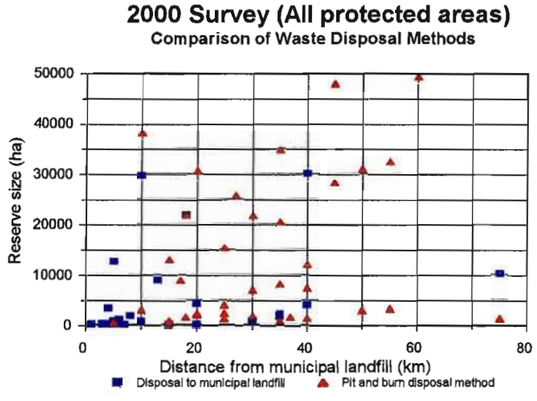


Figure 4.8 (c) Waste disposal methods in 2000, plotted against the distance to the nearest municipal landfill and protected area size, for all protected areas sampled in 2000.

if waste is not reduced before being landfilled, new landfills will have to be created. This change in the percentage of reserves practicing this waste disposal method from 1984 to 2000 is from 31% to 0%, for the reasons already discussed.

With the notable exception of Ithala Game Reserve (29 653 ha) which is adjacent to the town of Louwsberg, larger protected areas such as Royal Natal National Park, Corridor Game Reserve and Hluhluwe Game Reserve chose the pit and burn method, while smaller protected areas close to municipal landfills chose to change to the municipal landfill disposal option.

Thirty one of the 32 protected areas that had been surveyed in 1984 were surveyed in 2000 (Figure 4.7(c) and Appendix XII). In 2000, all of the protected areas that dispose of their waste to municipal landfills are smaller than 10 000 ha and less than 40 km from a landfill, with the exceptions of Ithala Game Reserve as explained above, and Ndumo Game Reserve (Figure 4.7(a)). Ndumo Game Reserve can be explained as it produces less refuse than expected from its size (10 117 ha) due to limited visitor facilities in this high malaria risk area. This refuse is collected and stored for disposal when reserve management travels into a town with a municipal landfill.

The incidence of pit and burn in small protected areas close to municipal landfill sites indicated in Figures 4.7(b) and 4.8(b) is a combination of lack of awareness regarding the impacts of landfilling within protected areas and an unwillingness by several smaller municipalities, such as Himeville and Howick, to accept the solid waste as their landfill sites are already over-subscribed.

The 2000 survey included 70 of KZN Wildlife's 96 protected areas

(Figure 4.8(c) and Appendix XII). Thirty of these 70 (i.e., 43%) in 2000, compared to only 25% of protected areas sampled in 1984 employing this method. 55% of the protected areas sampled in 1984 and then again in 2000 dispose of their solid waste to municipal landfill sites, indicating that this sub-sample is not properly representative of the larger 2000 survey (Appendix XII). This may be due to the fact that proportionally, more large sized reserves were sampled in 2000 and it is shown that protected area size is one of the factors influencing the choice of waste disposal method.

The other 40 (57%) of the 70 protected areas sampled in 2000 reduce their waste by burning, before landfilling within the protected area. In 1984, 44% of that sample disposed of wastes by this method. As explained above the increased proportion of large size protected areas sampled, as well as the shift of several protected areas from pit disposal in 1984, may have influenced this change. Of these 40, 24 (60%) first separate out the glass and tins for recycling. Only eight of the 30 (27%) that dispose to municipal landfill separate recyclable material before disposal. This is possibly due to the small amounts of waste produced at these protected areas that makes recycling appear uneconomic on an individual basis. In addition, municipal waste collection services do not allow for the collection of separated waste.

Of the 30 protected areas that dispose of their solid waste to municipal landfills, only four are either larger than 15 000 ha or more than 40 km from a landfill site (Figure 4.8(a)). Apart from Ithala and Ndumo Game Reserves (described above), Thembe Elephant Park (30 013 ha), adjacent to Ndumo Game Reserve and the Coastal Forest Reserve are the two other exceptions. Thembe Elephant Park has a private operator running the visitor facilities and the

waste is stored in a skip until it can be removed from the protected area to the municipal landfill. There appears to be little explanation for the Coastal Forest Reserve except that there are very limited visitor and staff facilities and management have chosen to store the waste until it can be taken to a municipal landfill when staff are going into a local town for other business.

Figure 4.8(c) shows that, with the exceptions discussed above, as distance from a landfill increases, there is a tendency for protected areas of similar size to choose the pit and burn disposal option over the municipal landfill option. The most likely factors in this decision are the cost of transport and the charges for waste disposal at the municipal landfill. Eight of the protected areas smaller than 10 000 ha indicated that there was no allowance made in their budgets for the disposal of solid waste to a municipal landfill site.

4.4.3 Methods of disposal of solid waste at international protected areas

Personal communications with conservation staff from the African countries (Section 3.2.5), indicate that, with the exception of the Simen Mountains in Ethiopia (B Gebre, 2001, pers. comm.) where very small amounts of waste are produced and taken to a municipal landfill, all other large volumes of solid waste produced at visitor facilities are reduced by burning and then placed in a pit, before covering with soil. A certain amount of recycling may take place, but this appears to be for materials that have a secondary use rather than recycling back to primary materials for production. Fuggle and Rabie (1992) note that this "frontier attitude" of limitless resources is commonly found in developing countries.

Australian protected areas are managed by the nature conservation authority in the particular state or territory. Very little if any recycling takes place in protected areas in Northern Territory and waste is simply burnt in a pit within the protected area (A Bowland, 2001, pers. comm.). There are

stringent waste management controls in protected areas in Queensland and New South Wales, however, and these include separation of waste at source, recycling and the removal of remaining wastes from protected areas for disposal at a recognised, legal landfill site. (A Bowland, 2001, pers. comm.). Budgetary constraints, existing infrastructure and distances between protected area visitor facilities and recognised landfill facilities appear to be the constraining factors in Northern Territory, compared to Queensland and New South Wales (A Bowland, 2001, pers. comm.).

4.5 WASTE SITE AUDITS AT HILLTOP, SODWANA BAY AND SKUKUZA

At the time of sampling of the solid waste produced at Hilltop and Sodwana Bay Rest Camps, a brief audit was conducted of each waste disposal facility. A similar audit of the Skukuza waste site was conducted during a site visit on 14th September 1999. The full details of these audits are contained in Appendices XIII, XIV and XV, respectively.

4.5.1 Summary of waste site management at Hilltop, Sodwana Bay and Skukuza, and impacts on the surrounding protected areas

4.5.1.1 Hilltop waste site

This waste site poses a likely threat of leachate being produced and entering the surrounding natural environment. This was due to the pit being unlined, the partly combusted nature of the waste, the co-disposal of nickel-cadmium batteries with the general wastes, the collecting of water in the pit with the waste during consecutive months in which the climatic water balance is positive (rainfall exceeds evaporation) (Schulze *et al.*, 1997), and the failure to cover the decomposing waste with a soil layer after waste had been placed in the pit (Plate 4.1(a)).

The presence of scavengers that have free access to the site is a further concern, particularly within a protected area where the behaviour of these animals is being affected by the waste site.

Plate 4.1 (a) Waste disposal pit near Hilltop Rest Camp, showing rainwater collected in the pit, smouldering waste in the water, uncovered wastes, the open entrance to the site and piles of sorted tins and glass.

Plate 4.1 (b) Community member sorting recyclable materials from the waste, without suitable protective clothing or facilities.

Plate 4.1 (c) Waste disposal site in relation to the surrounding protected area, showing only a partial fence that does not exclude scavengers and no fire break.

Members of the community, who sort waste on the site (Plate 4.1(b)) have no protective clothing or access to first aid, communications or ablution facilities. Wind blown waste is able to pollute the protected area from the site and there is a high likelihood of noxious gases being produced through the uncontrolled burning and smouldering of the waste (Plate 4.1(a) and (c)).

The open burning poses a potential fire hazard to the protected area (Plate 4.1(c). There is no waste plan or pollution prevention plan in place. No permits and approvals are in place. Recyclable materials, such as glass and tins, are separated out before burning, but have not yet been recycled (Plate 4.1(a)).

4.5.1.2 Sodwana Bay waste site

This site is managed in a similar manner to that at Hilltop (Plate 4.2(a)). Due to the unlined pit and high summer rainfall which creates a positive climatic water balance for several months of the year (Schulze *et al.*, 1997), the partly combusted nature of the waste, the co-disposal of large numbers of nickel-cadmium batteries with the general wastes, and the failure to compact or cover the decomposing waste with a soil (Plate 4.2(a)), it is likely that leachates may be polluting the surrounding natural environment.

Scavengers such as monkeys, jackals and crows have access to the site and waste can be blown from the site into the surrounding protected area. There is a high probability of noxious gases being produced through smouldering of the waste (Plate 4.2(c)). Staff have no access to first aid, communications or ablution facilities while working on the waste site. In addition, members of the public appear to be accessing the site and dumping wastes without permission, as parts of boats, fishing nets and other waste not collected by KZN Wildlife staff, were evident on the dump. There is

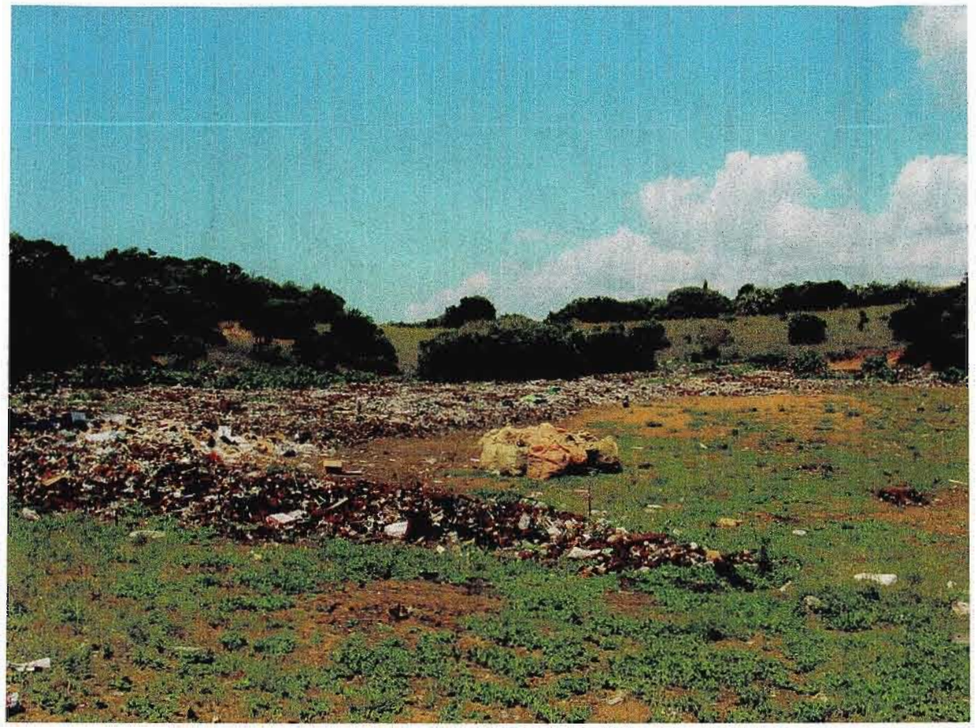


Plate 4.2 (a) Waste disposal pit near Sodwana Bay Rest Camp, showing uncovered wastes and the surrounding protected area.

Plate 4.2 (b) Cans and glass separated out from the waste in the past and remaining as part of the waste disposed of at this site. The lack of compaction is clearly evident from the condition of the cans and bottles.

Plate 4.2 (c) Waste disposal site in relation to the surrounding protected area, showing the lack of a fence or suitable fire break. The uncovered waste shows clear signs of having been partially burnt.

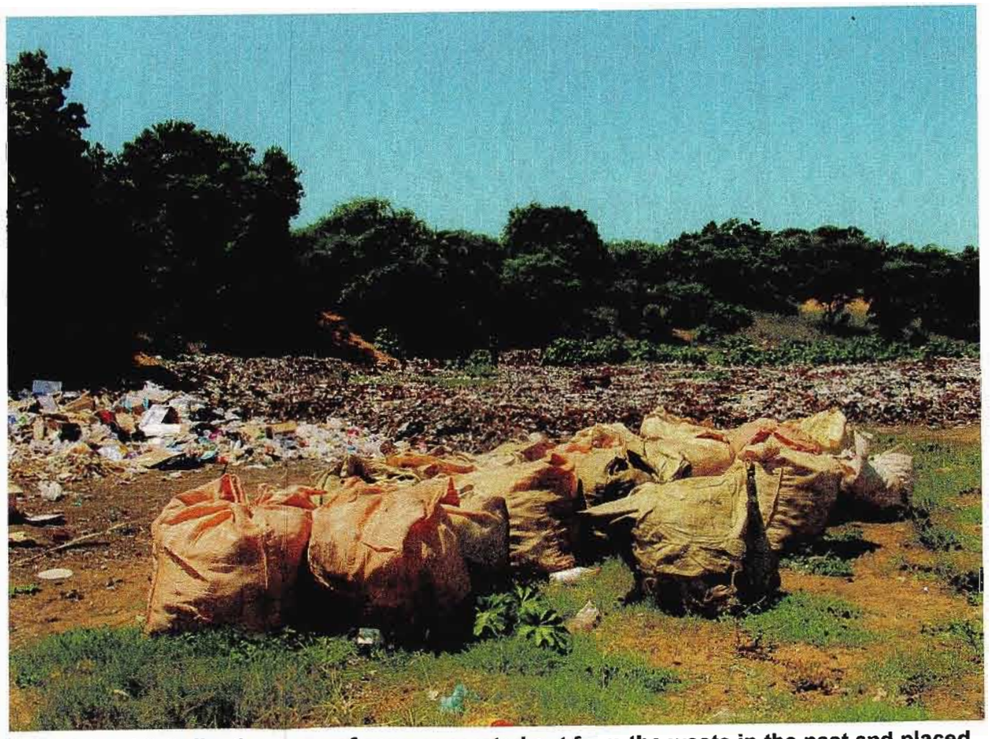


Plate 4.2 (d) Collection bags of cans separated out from the waste in the past and placed ready for collection.

no waste plan or pollution prevention plan in place and the formerly effective recycling programme has stopped after the equipment and sorting shed was vandalised and parts stolen (Plates 4.2(b) and (d)). The required permits and approvals for a waste disposal site have not been obtained.

4.5.1.3 Skukuza waste site

This waste site is intensively managed (Plate 4.3(a)). The site has a scavenger-proof fence with a lockable gate (Plate 4.3(b)), an on-site toilet (Plate 4.3(c)) and first aid facilities. Staff are trained to sort and incinerate waste, and are provided with suitable protective clothing (Plate 4.3(d)).

Recyclable wastes and potentially hazardous waste such as batteries, are separated and stored in designated containers, while the remaining waste is burnt in purpose built incinerators that reach temperatures of over 850°C, as required for a class three general waste incinerator (Department of Environmental Affairs and Tourism, 1997). The ash is disposed of in a pit directly adjacent to the incinerators and covered with a thin layer of soil (Plate 4.3(c)). Solid waste is sorted on a concrete surface, under a roof (Plate 4.3(d)). It is unlikely that Skukuza has a positive climatic water balance for any period exceeding a month. The vegetation indicates a relatively dry climate and the disposal of only ash results in a very low likelihood of any leachate being formed and entering the natural environment, as in the case of a Johannesburg landfill monitored and reported on by Senior (1995), where no leachate was produced over a ten year period due to the negative climatic water balance.

Plate 4.3 (a) Waste disposal site near Skukuza Rest Camp, showing a purpose designed waste management site, with a hardened, covered sorting area, a series of purpose-built incinerators and clearly designated areas for the storage of recyclable materials.

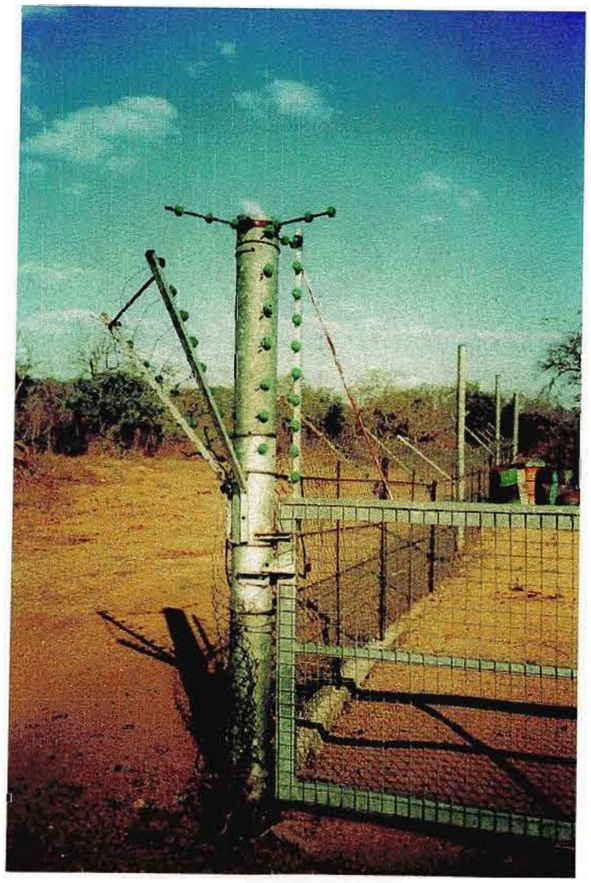


Plate 4.3 (b) Solar powered electric fence with a lockable steel gate, designed to exclude potential scavengers from the waste site and prevent waste from blowing into the surrounding protected area. A fire break is clearly visible adjacent to the fence.

Plate 4.3 (c) Ash disposal pit directly behind the row of incinerators. Incinerators are operated by trained staff members, one of whom can be seen loading the closest incinerator. Toilet facilities are visible at the far end of the waste disposal site.

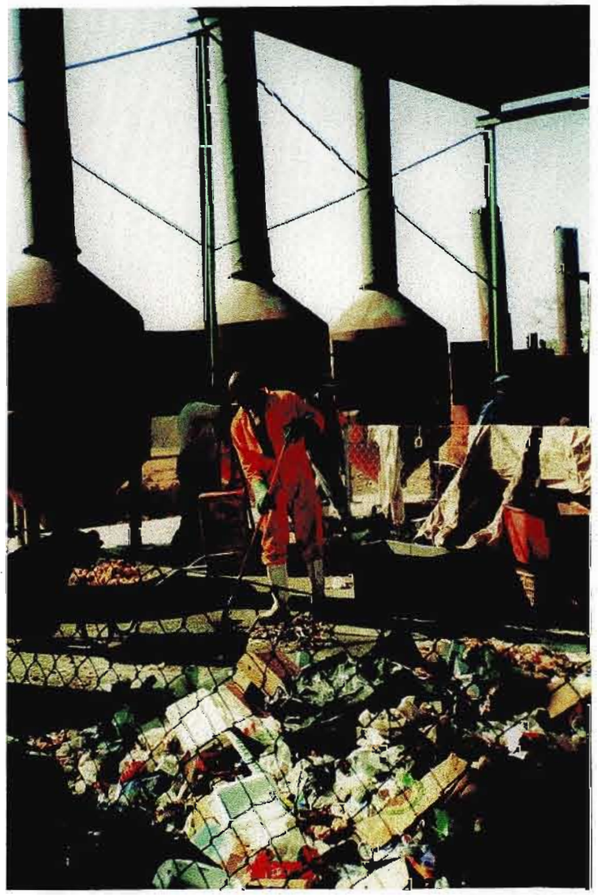


Plate 4.3 (d) Trained staff member wearing suitable protective clothing and properly equipped. Note recycling bins in the sorting bay and mesh fence to prevent waste spilling or blowing between sorting bays or from the concrete sorting surface.

The concrete sorting area is washed down at intervals and this contaminated water is directed into a wastewater disposal system. The operation of the waste disposal site and the incinerators have been approved by the Department of Environmental Affairs and Tourism.

4.5.2 Comparison of impacts and management

The positive climatic water balance, that exists for several months of the year at the two KZN Wildlife protected area waste sites (Schulze *et al*, 1997), greatly increases the likelihood of leachate production (Blight *et al.*, 1999). This increased risk to the surrounding protected area therefore requires that intensive management of waste be undertaken to mitigate the impacts. As can be seen from the Skukuza waste site inspection, the potential impacts of solid waste disposed of within the protected area can be greatly reduced through the design and operation of a relatively simple waste site that includes the following components, i.e., a carefully selected location, a scavenger-proof fence, lockable gate, covered and hardened waste sorting area, ablution facility, first aid kit and means of communication, incinerator (purpose-built class three), a clear waste site management plan, and trained staff with adequate protective clothing.

5 DEVELOPMENT OF A SOLID WASTE MANAGEMENT POLICY AND STRATEGY FOR KZN WILDLIFE

Following the investigation of waste composition and waste disposal practices in KZN Wildlife protected areas (Chapter 4), a solid waste management policy, strategy and implementation plan were developed. This was done by creating a framework for policy and strategy development after considering the legislative requirements and best practice principles (Sections 2.4.2 and 2.4.3), protected area objectives (Section 2.3.1) and principles of sustainable development (Section 2.3.4), and then applying this framework to the waste information available for KZN Wildlife protected areas.

5.1 PAST AND PRESENT PRACTICES AND CONSTRAINTS

Historically, as is evident from the results of the 1984 survey, larger protected areas (over 5 000 ha) that produced more waste, and those over 30 km from a municipal landfill disposed of their solid waste through burning and landfilling within the protected areas. In the current 2000 survey, it can be seen that, with few exceptions, disposal to municipal landfill is only undertaken by protected areas smaller than 10 000 ha and those less than 40 km from a landfill. Many protected areas are now recycling their glass and tin waste. Limited budgets and high transport costs are still the most important constraints to disposing of large amounts of solid waste, especially from remote protected areas. Despite these constraints, an increasing awareness of the risks and negative impacts of solid waste disposal within sensitive environments has led the management staff of certain protected areas to make efforts to recycle wastes and to transport their wastes over large distances to municipal landfill sites.

This approach is flawed from an organisational point of view, as, (i) the waste management strategy for each protected area changes as both management staff and budgetary constraints change; (ii) the choice of waste disposal option is not according to a clear policy and strategy and does not form part of the reserve

management plan; and (iii) the appropriate waste disposal option is seldom possible within the allocated budget and with the current level of organisational support.

5.2 KZN WILDLIFE SOLID WASTE AND DISPOSAL OPTIONS

5.2.1 Waste composition and generation

The waste from Hilltop and Sodwana Bay Rest Camps has been analysed for its composition by both mass and volume, while considering the sources within the camps and the amount produced per capita per day (Section 4.1). Comparisons made between these KZN Wildlife camps, Skukuza Rest Camp (Section 4.2) and international waste sources indicate that similar wastes are produced by the three visitor facilities within protected areas, and that this closely approximates general solid waste generated in developed, westernised countries. While further sampling will be required in order to determine the accuracy of extrapolating waste production results over seasonal peaks and to other and smaller visitor facilities, these results provided a basis on which a draft policy and strategy could be developed.

5.2.2 Disposal options, risks, opportunities, impacts and implications

In accordance with the principles of sustainable development, the impacts associated with waste disposal need to be assessed and mitigatory measures implemented, so that the ecological integrity of the protected areas are not threatened.

The waste options available for disposal of protected area general solid wastes are:

- the removal of all wastes from the protected area to a municipal or regional landfill site;
- reducing the amount of waste requiring disposal through:
  - reducing the amount of waste entering or remaining within the protected area;
  - recycling (glass, tins, paper, composting);

- incineration of appropriate wastes; and

- landfilling of waste, before or after reduction, within the protected area.

These same options are available for solid waste disposal in urban areas of westernised countries and they could be read as such by simply substituting the word "urban" wherever "protected" occurs. Options such as energy recovery from waste and industrial incineration, which would also be considered in large urban areas, have been discounted as inappropriate for protected areas due to the relatively low volumes of waste produced and the capital and operational cost implications. The risk, potential impact and implications of each of the options considered are set out in Table 5.1, below.

Table 5.1 Risks, opportunities, potential impacts and implications of various solid waste disposal and reduction options available for protected areas, assessed on the basis of long term sustainability, BPEO, applicable legislation and available knowledge.

Disposal option	Risk / opportunity / potential impact	Implication
Landfill wastes within protected area.	Sterilisation and non-sustainable use of land intended for conservation purposes.	This is not in accordance with conservation and protected area objectives.
	Co-disposal of wastes may result in pollution of soil and water through leachate production (organic acids, inorganic salts, heavy metals).	In a positive water balance climate, the site would require a permit and management as a small communal landfill. Leachate control measures are expensive to implement. In a negative water balance climate, the site would only require a permit and management as a small general landfill as leachate production would be small or non-existent.

Disposal option	Risk / opportunity / potential impact	Implication
(Landfill wastes within protected area continued.)	Disposal of large volumes of waste reduces the landfill's lifespan.	Will need to reduce the volume of waste in order to extend the operational life of the landfill. Reduction can be achieved through methods such as recycling and incineration prior to landfilling, and *in situ* compaction. The impacts of these reduction processes must also be considered.
	Scavenging by animals such as baboons, and breeding of pests and disease vector animals such as rats and flies.	Scavenging may affect natural habits of protected area animals and would have to be prevented through scavenger-proof fencing of the entire waste management and disposal site. Pests and disease vector animals would need to be controlled.
	An apparently cheap disposal option due to reduced transport costs and no landfill charges.	Costs of proper management of disposal site, dedicated staff and permit requirements must be calculated for comparison.
	May require regular soil covering as sanitary landfill requirement.	May be required to mine or import soil for this purpose, with related cost and legal implications.
	Landfills are visually displeasing.	The site may require screening.
	Unpleasant odours and noxious gases may be produced by decomposing waste or smouldering landfill.	There may be a risk to staff living adjacent to the landfill and those working at the waste disposal facility. This would need to be assessed and prevented.
	Wastes may be blown into the protected area, causing visual pollution and risk to animals.	The waste management and disposal facility must be fenced and covered to prevent wind scatter of wastes.

Disposal option	Risk / opportunity / potential impact	Implication
(Landfill wastes within protected area continued.)	A fire risk may exist if non-combusted waste is disposed to landfill or if wastes are burnt *in situ* in the landfill.	The fire risk to the surrounding protected area must be minimised. The burning of wastes *in situ* has impacts on leachate and production of noxious gases. This practice is unacceptable and must be discontinued.
Remove waste to a municipal landfill site.	No negative impact on protected area, although there is a risk of spillage while transporting waste.	Disposal must be at a recognised, legal landfill.
		Transport costs to the landfill.
		Landfill charges for the waste disposal.
		May require an upgrade of interim waste storage facilities within the protected area.
Reduction of waste by burning *in situ* (usually in landfill pit).	Temperatures are not as high as in controlled incinerators and only partial combustion of wastes may take place, leading to a high likelihood of leachate and noxious gas production. The fallout of noxious gases in the protected area may impact upon ecological processes. Hazardous wastes unsuitable for this type of burning may be included in the wastes.	Burning of mixed and general wastes in this manner is not permitted and exposes the organisation to risk of prosecution. There may be associated health risks to staff working on the site. Leachates may pollute the groundwater supplies and require costly preventative and rehabilitation measures.
	Partly combusted wastes, combined with water that enters the landfill and the decomposition of mixed wastes will lead to leachate production.	No pollution of groundwater supplies is permitted and landfills producing leachates are subject to rigorous and expensive permit requirements.

Disposal option	Risk / opportunity/ potential impact	Implication
Reduction of waste by burning *in situ* (usually in landfill pit), continued.	A fire risk may exist in windy conditions.	This has management implications.
	Volume of waste for disposal is greatly reduced.	This extends the life of landfills and reduces transport costs.
Reduction of waste by controlled incineration.	Sufficiently high temperatures can be attained and complete combustion of wastes occurs.	A permit is required for a class 3 small general waste incinerator. This allows for the co-disposal and incineration of mixed domestic and general waste. The construction or purchase and operating cost of the incinerator must be considered.
	Sterile ash remains that may contain high concentrations of heavy metals. Disposal to landfill in positive water balance climate may result in these leaching into the protected area.	Sterile ash may be mixed into composting systems or disposed of to landfill in negative water balance climates. In positive water balance climates the ash will need to be stored and removed to a municipal landfill which has the appropriate pollution controls (this has cost implications).
	Operation of incinerator requires trained staff.	Appropriately trained staff are required.
	Incinerator chimney and smoke may be visually obtrusive.	Suitable screening may be required. Reaching maximum burning temperature as quickly as possible will reduce visual impacts of smoke.
	Volume of waste for disposal is greatly reduced.	This extends the life of landfills and reduces transport costs.

Disposal option	Risk / opportunity/ potential impact	Implication
Reduction of waste by recycling/composting.	Only certain wastes are suitable for this option.	Remaining wastes still require disposal.
	Volume of waste for disposal by incineration or landfill is greatly reduced.	This option is sustainable practice and extends the life of landfills, reduces transport costs, reduces pressure on raw materials, provides opportunities for community partnerships, and provides earnings from wastes with resale value.
Reduction of waste by compaction.	Volume of waste for disposal is greatly reduced.	This extends the life of landfills and reduces transport costs. However, appropriate equipment and an operating budget are required.

5.3 SOLID WASTE MANAGEMENT POLICY, STRATEGY AND IMPLEMENTATION PLAN

Based on the results of the pilot study (Chapter 4) and after consideration of the options, risks, impacts, opportunities and constraints presented in Table 5.1, a solid waste management policy was drafted. This policy needed to be designed for, and adopted by KZN Wildlife, supported by a clear management strategy, and enabled by an adequate budget and appropriate staff training. Penalties for non-compliance with current waste management legislation are set out in Appendix XVI.

5.3.1 Draft solid waste management policy

The following factors were considered while designing the policy and strategy:

- the type of wastes produced within KZN Wildlife protected areas, as different wastes present different constraints and opportunities for

waste disposal (e.g. cans are non-combustible, but present opportunities for recycling);

- the amounts of wastes produced, as small volumes may be stored and transported without requiring separate waste disposal vehicles and high transport costs;
- the waste disposal options available, taking legislative requirements such as the prevention of groundwater pollution, and best practice principles such as BPEO (Section 2.2.1) into account;
- the impacts of the waste disposal options, taking protected area management objectives into account (Table 5.1); and
- the constraints and opportunities of the various waste disposal options, including factors such as economic viability, local climate, and biophysical and social constraints.

The aim was to ensure that the impacts of solid waste generation and management within protected areas under the management of KZN Wildlife are at a level at which the negative impacts do not affect the ecological functioning of these areas.

The draft policy (Appendix XVII) was set out in the format used by KZN Wildlife and discussed the objectives of protected area management, the reality of solid waste production within protected areas, the ethical and legal requirements for its management and disposal, and the constraints on solid waste management and disposal. It then set out the options for solid waste disposal in the preferred order so as to minimise potential negative impacts on the protected area and stated the organisation's commitment to responsible solid waste management.

5.3.2 Recommended solid waste management strategy

When interpreting the policy and drafting an appropriate and successful solid waste management strategy for KZN Wildlife, the strategy had to meet the requirements, of being:

- environmentally acceptable;
- socially responsible;
- practical;
- cost effective; and
- well planned (incorporating integrated waste handling and waste disposal systems, and based on waste minimisation) (Lombard and Associates, 1992).

From a consideration of Table 5.1, it appears that the ideal waste disposal option is an initial reduction of waste, followed by removal of any remaining waste from the protected area. However, evaluation of the option best suited to each protected area's waste disposal needs must take into account economic, social and environmental considerations. Purely economic considerations of immediate costs, without considering risk and potential environmental cost, have been used to make these decisions in the past. Internationally, the United Kingdom has tended to follow this approach (Powell, 1996), hence the dominance of landfilling as their waste disposal choice. Within KZN Wildlife protected areas, high transport costs together with budgetary constraints has often led to the same option being selected in the past.

However, this ignores the social and environmental costs. Social costs and risks within protected areas are limited in comparison to those in residential and urban areas, as there are few or no immediate residential neighbours and access is restricted, but staff or community members working at the disposal site may be at risk. Costs and risks to the natural environment, however, need to be given a high priority when considering waste disposal options within KZN Wildlife areas, which are proclaimed specifically for the protection of their biodiversity, natural features and their continued healthy ecological functioning. Any activity which threatens that protection or functioning is clearly not acceptable within the protected area.

A complex multicriteria evaluation formula and matrix designed by Powell (1996), in which *inter alia* the variables of transport costs, land used for waste disposal, amount of recycling, amount of energy recovery from waste, incineration benefits, air pollution costs, and water and soil pollution costs are considered, can be used to choose the best waste disposal option. However, this matrix was designed for application in an urban environment, and requires complex information not readily available within protected areas. It also does not take the ethics and objectives of protected area management into account. For these reasons, it was impractical to use such a model for the selection of the most appropriate protected area waste management option. To obviate this problem a much simpler matrix was designed (Figure 5.1), specifically for use in protected areas.

This matrix (Figure 5.1) takes into account the leachate risk (represented by climatic water balance) as well as cost-effectiveness of waste transport (represented by distance to municipal landfill), and the amount of waste produced (represented by protected area size). The scheme is based on the results of the 2000 survey of waste disposal practices within KZN Wildlife protected areas and reflects the minimum standards that are required to be met.

It must be noted that almost the whole of South Africa has a negative climatic water balance when considered over the entire year (Schulze *et al.*, 1997). However, due to the fact that leachates may be produced during in a relatively short period during high rainfall months, it is recommended that any KZN Wildlife protected area that has a positive water balance over any three month period, must use the positive water balance side of the matrix to guide its waste disposal.

Should a protected area wish to select an option not recommended or provided for by the matrix, it must be specifically motivated. KZN Wildlife,

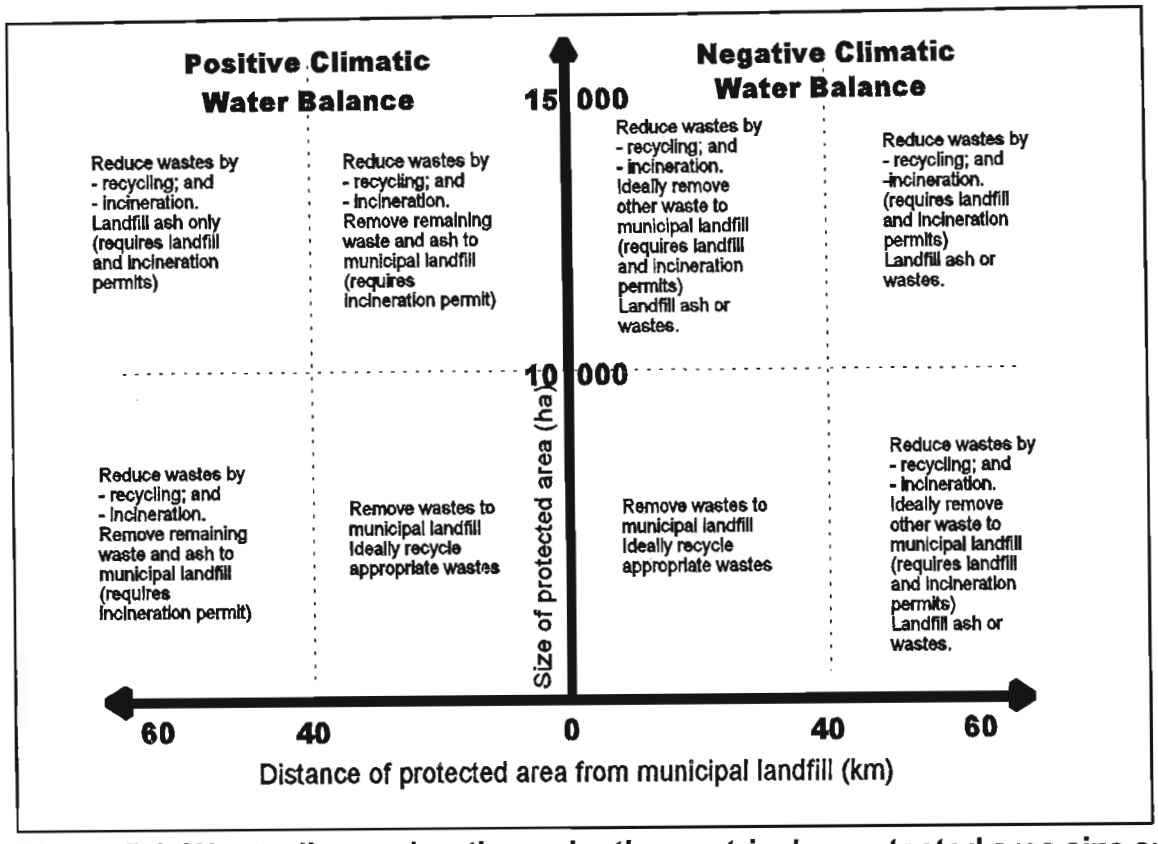


Figure 5.1. Waste disposal option selection matrix, by protected area size and distance from nearest municipal landfill.

on the other hand, must be prepared to provide the required staff, equipment and operational budget for the waste disposal options indicated by the matrix.

As it would be impractical to implement this matrix throughout all protected areas in the same financial year, it is recommended that this be tackled as a five year project and that new projects and larger protected areas be prioritised for immediate action. The solid waste management plan for the Centenary Centre follows from the policy and strategy recommendations and is briefly set out in Section 5.3.3 and more fully in Appendix XVIII.

Approval of the five year plan should be sought from the regulatory authorities so that the transition to good solid waste management practice in all KZN Wildlife protected areas can proceed without delay or departure from the agreed priorities.

5.3.3 Solid waste management plan for the Centenary Centre

5.3.3.1 Background to the Centenary Centre

Environmental approval was granted for the development of the Centenary Centre in Umfolozi Game Reserve. A condition of this approval was the submission of a plan to manage solid, liquid and veterinary wastes for the Centenary Centre to the Department of Environmental Affairs and Tourism (DEAT). Only the solid waste component of the plan is considered in this discussion.

The Centenary Centre includes a "Game Capture" section, comprised of game holding pens, a veterinary facility, helipad, workshop area, canteen, ablution facilities, feedsheds and administration buildings; and a "Tourism and Information" section, comprised of parking facilities, an auditorium, a curio sales outlet, ablution facilities, take-away food kiosks and an exhibition centre. Staff accommodation is provided adjacent to the development and a series of dormitories for visiting school groups is proposed for a later development phase.

The Centre is less than a kilometre from the disused Mambeni Gate in Umfolozi Game Reserve. The closest approved municipal landfill is 36 km away, at Mtubatuba. The eight kilometres of gravel road from Mambeni Gate to the tarred district road, is in poor condition. The climatic water balance is negative when considered on an annual basis. However, during the months of December, January and February, the monthly water balances can be positive (Schulze *et al.*, 1997).

5.3.3.2 Application of the draft solid waste management policy and strategy

The solid waste management plan considered the relevant legislation, and predicted the composition of the waste according to

the components and activities of the development. Appendix XIX sets out the predicted solid wastes, and the minimum legal disposal options for these are given in Appendix XX.

The solid waste (excluding the veterinary component) was predicted to be similar in composition to that produced at Hiltop and Sodwana Bay Rest Camps and was therefore classified as general solid waste. Application of the solid waste disposal option matrix in Figure 5.1, places the Centenary Centre on the "Positive Climatic Water Balance" side of the matrix, in the quadrant with a protected area larger than 10 000 ha and the closest municipal landfill less than 40 km distant. The condition of the gravel road may be a factor that requires further consideration. However, it was assumed that the road would be upgraded during the course of provincial service and infrastructure provision to local communities that live adjacent to the protected area.

The minimum waste disposal requirements set out in this quadrant (top right quadrant on the "Positive Climatic Water Balance" section) of the matrix require that:

- wastes must initially be reduced through recycling;
- remaining wastes must be incinerated; and
- ash and wastes unsuitable for incineration must be removed to a municipal landfill.

5.3.3.3 The implementation plan for the Centenary Centre

The recommended minimum waste disposal requirements meant that a waste management area had to be selected and designed. The plan aimed to ensure that solid wastes are responsibly managed so that the effective ecological functioning of the protected area is not affected by their production, management and disposal.

Site selection and design : The waste management site was selected so that it is in an environmentally acceptable position, that minimises potential negative impacts on the surrounding protected area, while remaining functional. It was required to be in accordance with the Minimum Guideline Requirements Documents for Waste Disposal by Landfill (Department of Water Affairs and Forestry, 1997). A site was selected close to the Centenary Centre and near Mambeni Gate, on almost flat land, visually unobtrusive, away from water bodies, having easy access for services, and employed members of the community. The only concern was the proximity of staff accommodation, although this was upwind of the site and can be mitigated.

The waste management site needed to be designed in accordance with BPEO principles (Section 2.2.1) so that potential negative impacts were minimised while the site remained both functional and cost-effective. Accordingly the design included animal-proof fencing, which also provides staff sorting the waste with security, prevents scavenging and acts as a partial barrier to wind-blown wastes. A lockable steel entrance gate was required.

The sorting area is hardened and covered. The concrete floor was to prevent spillages soaking into the soil and to provide a stable area for an incinerator. The roof was to allow sorting of waste to take place regardless of weather conditions and to prevent rain washing through the wastes. Another mesh fence was recommended to prevent any wind blown pollution.

The incinerator needs to be capable of disposing of general wastes that are not able to be reduced, reused or recycled. The design for

a purpose-built class three incinerator, of the type approved at Skukuza, which attains temperatures in excess of 850°C was attached to the plan.

Suitable collection facilities are planned in designated areas for all sorted recyclable wastes. Ablution facilities are to be provided for staff on the site. A water containment pond, to collect polluted run-off water from the waste management area, was designed at the downslope end of the area so that sediments suspended in the run-off water can settle out before the water enters the grey-water treatment system. Clean rainwater entering the site is channelled away from pollution points by berms before being released to the environment.

Site management: The objective was to ensure that potential impacts of waste handling, storage, and disposal on the surrounding natural environment were mitigated. Staff need to be provided with safe and healthy working conditions, suitable protective clothing, and access to first aid, communication and ablution facilities. The staff need to be properly trained to handle wastes, particularly hazardous wastes and those requiring incineration. A record of waste volumes and types, particularly unusual wastes needs to be maintained by the responsible waste site manager.

Waste management on site: General waste brought to the site has to be deposited on the hardened area, and sorted into suitable containers for hazardous waste (e.g. batteries and fluorescent tubes), glass, tins, plastics, and biodegradable wastes. Glass and tins are stored for collection by recycling companies, while plastics are stored for removal to a municipal landfill. Initially, all biodegradable wastes were intended for incineration or, if suitable,

foodstuffs were to be removed by a local pig-farmer. The possibility of composting these wastes, together with ash from the incinerator still requires investigation.

The incinerator is to be operated only by trained staff who follow strict safety procedures. It will be loaded with paper wastes at the bottom and other wastes above, in order to generate the maximum heat in the shortest time. The ash grid would be cleared before the next load of waste was burnt. Burnt wastes and ash are to be placed in a watertight bin and removed to a municipal landfill periodically. Any soils that become contaminated through spillage, must be collected and disposed of at an appropriate facility.

Waste minimisation: In order to reduce the potential negative impacts of waste generation and disposal on the environment, a reduction of both waste production and of wastes entering the disposal stream (recycling) is recommended.

It is also recommended that restrictions be placed on the amount of non-recyclable goods entering the protected area, through selective buying and specific requests and requirements to distributors and staff, giving a clear preference for easily recycled goods and packaging. The potential of community-based recycling programmes and appropriate recycling skills training is also recommended for future investigation.

Specific recommendations are made for collecting, securing and storing waste at the waste generation points, such as the take-away kiosk, staff accommodation, veterinary facility, and offices.

The complete set of overall waste management objectives, waste management site selection criteria, design and management activities, as well as general and hazardous waste minimisation objectives and activities are set out in the extract from the DEAT approved Centenary Centre waste management plan (Hatton, 2000) (Appendix XVIII).

6 CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE INVESTIGATIONS

This pilot study has indicated that the overall composition by volume of waste produced at Hilltop and Sodwana Bay Rest Camps is similar and can be classified as "general waste" suitable for disposal in a domestic landfill or incineration in a class three incinerator. The facilities having restaurants and bars all produce distinctive high percentages of food and tins in their solid wastes. Offices and Shops produce similar types of wastes in similar proportions. The composition of the wastes from Offices and Shops, facilities with Restaurant and Bars, and KZN Wildlife Chalets are distinct from each other.

The comparison of solid waste production at KZN Wildlife protected area facilities with that at Skukuza Rest Camp in the Kruger National Park shows that the waste produced has similar characteristics. Further comparison with international solid waste composition indicates that solid waste produced in South African protected area visitor facilities has a similar composition to waste produced in developed, westernised countries, such as the developed sector of South Africa, and residential areas in the USA, Kuwait and the United Kingdom. Personal communications with conservation staff in Australia, Kenya, Tanzania, Uganda, Malawi, Ethiopia, Zambia, Botswana and Zimbabwe indicate that the types of waste produced at protected area visitor facilities in these countries is essentially the same as that produced in South African protected areas. Several waste disposal constraints and disposal options exercised in these countries that have to dispose of waste of a similar composition may be applicable to protected area solid waste disposal and the mitigation of its impacts in South Africa.

The main constraints on the management of solid waste produced within protected areas, that differ from those experienced within urban environments are, (i) the cost of transporting waste on a very limited budget; (ii) the remote nature of many protected area facilities from registered landfill sites; and (iii) the lack of a solid

waste policy and strategy with an appropriate allocated budget. These constraints make waste management as practised in urban areas, difficult and often economically non-viable.

A 1984 survey of waste disposal methods in 32 KZN Wildlife protected areas, indicated that disposal to municipal landfill was only practised by protected areas that were less than 5 000 ha in size and less than 30 km from a municipal landfill. It was assumed that protected area size was directly related to visitor and staff numbers and thus to the amount of solid waste produced.

The practise of disposal directly to landfill within protected areas was evident in 1984, but by 2000, there was increasing awareness amongst KZN Wildlife management staff of the impacts and unsustainability of waste disposal within protected areas. This, together with improved road access to municipal landfills, led to the discontinuation of landfilling without reduction of waste, either by burning or recycling, and to an increased proportion of waste disposal to municipal landfill, even by large protected areas and at distances over 40 km. Despite this, the approach to solid waste management in KZN Wildlife is still on the basis of individual protected areas, their management staff opinions, and the amount of non-dedicated budget that staff manage to redirect for waste management activities.

An audit of waste management practices at Hilltop and Sodwana Bay Rest Camps, as well as at Skukuza Rest Camp in the Kruger National Park, indicated that KZN Wildlife was failing to adequately manage the solid waste at the two KwaZulu-Natal protected areas i.e., waste management was not meeting the criteria of sustainable development. In contrast, the solid waste at Skukuza Rest Camp was being responsibly managed through the implementation of a number of simple, yet effective, measures.

The major outcomes of this pilot study have been the drafting and recommendation of a solid waste management policy and implementation strategy

for KZN Wildlife protected areas. The suggested phased implementation of this strategy over five years will allow for prioritisation of high risk protected areas for immediate attention, within the current financial constraints. Acceptance of the policy and strategy by senior KZN Wildlife management and the Board will create an organisational commitment to responsible solid waste management, that will include an adequate and dedicated budget.

The policy proposed as a result of the present study, is developed within the framework of sustainable development objectives and sets out the waste disposal options available, together with the waste management objectives within the confines of a protected area, and the constraints which apply. The proposed strategy follows from the policy and first sets out the waste disposal methods available and their associated risks, likely impacts, opportunities and implications for management. It then recommends the application of a simple matrix that combines the variables of (i) distance from a municipal landfill site; (ii) the size of the protected area (this is assumed to reflect the amount of solid waste generated); and (iii) the likelihood of leachate production using the climatic water balance (a high pollution risk would require rigorous legal enforcement), with suitable waste disposal options. The matrix was designed to assist in the objective implementation of the draft waste management policy and in the selection of an appropriate waste disposal method for each protected area, taking the constraint of transport costs into account while minimising the impacts of waste disposal on the protected area's ecological functioning.

The draft policy and matrix have been applied to a new development, the Centenary Centre in Umfolozi Game Reserve, and a solid waste management plan designed. This plan has been approved by the Department of Environmental Affairs and Tourism and is in the process of being implemented.

6.1 RECOMMENDED FUTURE INVESTIGATIONS

As this pilot study only sampled two visitor facilities at a single point in time, the results are not statistically comparable. It is recommended that future

investigations sample a range of visitor facilities of various sizes and in other locations such as the Ukhahlamba-Drakensberg Park. Sampling needs to be conducted at regular intervals throughout the year so that the effects of differences in visitor numbers, climate, South African and international holiday seasons and other variables on waste composition and production can be assessed. It is recommended that sampling only measure the total weight and volume for each waste type from each waste source, as weighing out and measuring sub-samples is a time-consuming activity and the sub-samples were summed for comparative purposes.

A study of the number of day visitors using waste facilities that are to be sampled, needs to be conducted. The uncertainty over the number of day visitors using facilities at Hilltop Rest Camp, together with the small sample, made it impossible to draw conclusions from results obtained from that source. Similarly, it is recommended that shop size and office space, rather than the number of staff working in an office or shop, should be used to predict waste production as the waste packaging is likely to be more closely related to the volume of goods stocked and sold.

There appeared to be a similarity between the Staff Accommodation at the two protected areas and the Camping source by mass, but not by volume. This requires further investigation in order to determine whether such a similarity really exists.

The assumption that, as protected areas increase in size more staff are required to manage them, should be investigated. This could be done through a comparison of staff numbers and protected area size, coupled to a management study on the need for the staff complements found.

Another assumption made in the present study was that as more visitor opportunities are available, more visitor facilities will be provided and this

should be investigated through the protected area tourism plans that are currently being compiled by KZN Wildlife ecotourism staff, in which visitor opportunities and facilities are listed.

As more waste information is collected, it will become possible to test the assumption that increased numbers of staff and visitors result in a linear increase in the amounts of waste produced. By conducting the above studies, it will be possible to test whether protected area size is directly related to the amount of solid waste produced, as assumed in this pilot study.

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APPENDIX I BASEL CONVENTION CLASSIFICATION OF HAZARDOUS WASTE

According to the Basel Convention of 1989, toxic wastes are defined as those that meet one or more of the following criteria:

a. *explosive;*
b. *flammable (liquid or solid);*
c. *likely to spontaneously combust under normal conditions encountered during transport or disposal;*
d. *capable of emitting flammable gases on contact with water;*
e. *oxidizing (capable of giving off oxygen so as to cause or contribute to the combustion of other materials);*
f. *organic peroxides (thermally unstable and capable of emitting large amounts of heat during decomposition);*
g. *poisonous (causing acute damage to health, or even death if swallowed, inhaled or in contact with the skin);*
h. *infectious;*
i. *corrosive;*
j. *capable of emitting poisonous gases on contact with air or water;*
k. *toxic (causing chronic or delayed effects on health if they are inhaled, swallowed or in contact with the skin - this includes carcinogenic substances);*
l. *ecotoxic (toxic to the environment or ecosystem);*
m. *capable of producing any substance after disposal which displays any of the above characteristics.*

For the purposes of KZN Wildlife protected area management, these would include but not be restricted to:

- fluorescent light tubes,
- biocides and their containers,
- fertilisers and their containers,
- medicines and their containers and packaging,
- paint and varnish remains and their containers, and
- a variety of batteries such as those used in torches and radios.

APPENDIX II MINIMUM REQUIREMENTS GUIDELINE DOCUMENTS' CLASSIFICATION OF HAZARDOUS WASTE

The following text has been taken directly from the "Minimum Requirements Guideline" series of documents (Department of Water Affairs and Forestry, 1994).

WASTE TYPE

There are two categories of waste type, General and Hazardous. These are defined as follows:

(i) **General waste (G)**

General waste is a generic term applied to all urban waste that is produced within the domain of local authorities. It comprises rubble, garden, domestic, commercial and general dry industrial waste. It may also contain small quantities of hazardous substances dispersed within it, for example, batteries, insecticides, weed-killers and medical waste discarded on domestic and commercial premises.

General waste may be disposed of on any permitted landfill. However, certain General waste sites must have leachate management systems, since General waste can produce leachate with an unacceptably high pollution potential. This is the result of waste decomposition, together with the infiltration and/or percolation of water.

(ii) **Hazardous waste (H)**

A Hazardous waste can be defined as "an inorganic or organic element or compound that, because of its toxicological, physical, chemical or persistency properties, may exercise detrimental acute or chronic impacts on human health and the environment. It can be generated from a wide range of commercial, industrial, agricultural and domestic activities and may take the form of liquid, sludge or solid. These characteristics contribute not only to degree of hazard, but are also of great importance in the ultimate choice of a safe and environmentally acceptable method of disposal."

The definition does not include the quantities or level of danger of Hazardous waste materials offered for transport or disposal. This is, however, taken into account in the detailed classification of Hazardous waste, by the principle of an Estimated Environmental Concentration (EEC).

In more detail, Waste can be defined for South African purposes as:

Any material, whether solid, liquid or gaseous which is:

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(i) to be discarded, discharged or emitted in any form, with or without means of control, treatment, reduction or compositional change;

(ii) no longer to be used for its original purpose and which is likely to be stored or accumulated for three months or longer, with or without the eventual intention of its being treated, disposed of, discharged or emitted.

(iii) sent off site for re-use, recycling, regeneration, alienation, treatment or disposal, or for processing so as to produce other re-usable, recyclable or disposable substances.

"Hazardous waste" will be taken, for South African purposes, to be any waste that directly or indirectly represents a threat to human health or to the environment by introducing one or more of the following risks:

- infections, pathogens, parasites or their vectors
- chemical instability, reactions or corrosion
- acute or chronic toxicity
- cancer, mutations or birth defects
- toxicity, or damage to the ecosystems or natural resources
- accumulation in biological foodchains, persistence in the environment, or multiple effects

to the extent that it requires special attention and cannot be released into the environment or be added to sewage or be stored in a situation which is either open to air or from which aqueous leachate could emanate.

The basic definition that identifies a waste as "Hazardous", therefore, hinges on whether the waste material could cause danger to humans or to the environment. This is a very broad definition, since wastes vary substantially in nature, composition, size, volume, appearance and degree of harmfulness. Waste must therefore be analyzed for all hazardous components and classified according to the classification system, to distinguish those wastes that are harmless or only slightly hazardous from those which may be harmful or extremely hazardous.

The following types of waste should be regarded as potentially hazardous:

Inorganic waste

- Acids and alkilis

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- Cyanide waste
- Heavy metal sludges and solutions
- Waste containing appreciable proportions of fibrous asbestos

Oily waste

- Primarily from the processing, storage and use of mineral oils

Organic waste

- Halogenated solvents residues
- Non-halogenated solvents residues
- Phenolic waste
- PCB waste
- Paint and resin waste
- Biocide waste
- Organic chemical residues

Putrescible organic waste

- Waste from the production of edible oils, slaughter houses, tanneries and other animal and vegetable based products.

High volume/low hazard waste

- This waste, which contains small quantities of highly dispersed hazardous substances, presents a relatively low hazard. Examples are harbour dredge spoils, sewage, sludge, and contaminated soil or builders' rubble.

Miscellaneous waste

- Infectious waste such as diseased human/animal tissues, soiled bandages and syringes
- Redundant chemicals or medicines
- Laboratory waste
- Expolosive waste from manufacturing operations or redundant munitions.

Hazardous waste is further classified in terms of **Hazard Ratings**. The Hazard Ratings are based on Acute Mammalian Toxicity, Eco-toxicity, Environmental Fate and Chronic Toxicity.

[Ref. Department of Water Affairs & Forestry: Minimum requirements for the Management and Handling of Hazardous Waste, Pretoria, 1993]

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Hazardous waste is thus classified into:

Hazard Rating 1	:	Extreme Hazard
Hazard Rating 2	:	High Hazard
Hazard Rating 3	:	Moderate Hazard
Hazard Rating 4	:	Low Hazard

These ratings have different disposal requirements. Consequently, they are recognised and addressed in the Landfill Classification System.

In situations where significant quantities of Hazardous Waste are identified, the abovementioned document, "Minimum Requirements for Management and Handling of Hazardous Waste", must be consulted in order to determine the Hazard Rating. Once this has been determined, the class of landfill and the applicable Minimum Requirements for the disposal of this waste can be determined.

APPENDIX III SOUTH AFRICAN PROTECTED AREA CLASSIFICATION

The following is an abstract from the Government Gazette of 9 May 1994, Notice 449 of 1994.

SCHEDULE CLASSIFICATION OF TERRESTRIAL AND MARINE PROTECTED AREAS

1 INTRODUCTION

The development of nature conservation and specifically the establishment and management of protected areas has moved away from the traditional concept that all protected areas were to be preserved solely as sacrosanct wildlife sanctuaries. The accommodation of the lifestyles, aspirations and needs of local communities as part of the overall conservation ethic has become a globally accepted principle. The protected areas, managed for a variety of purposes. To provide for the classification of protected areas on the basis of management requirements, and in keeping with international trends, the following system shall be applied.

2 CATEGORY I : SCIENTIFIC RESERVES AND WILDERNESS AREAS

2.1 DEFINITION

A scientific reserve is an area of land and / or sea possessing some outstanding or representative ecosystems, natural features and / or fauna and / or cultural resources of scientific importance, available primarily for scientific research and / or environmental monitoring.

A wilderness area is a large area of unmodified land, or land and water; retaining its natural character and influence, without permanent physical structures of significant habitation, which is protected and managed to preserve its natural conditions. The area may contain ecological, geological, cultural or other features of scientific, educational, scenic or historic value.

2.2 OBJECTIVES

2.2.1 Scientific reserves

To maintain essential ecological processes, to preserve biological diversity and to protect special cultural resources in an undisturbed state in order to have representative examples of the natural environment and / or special cultural resources available for scientific study, environmental monitoring, education, and for the maintenance of genetic resources in a dynamic and evolutionary state.

Research activities need to be planned and undertaken carefully to minimise disturbance. Public access is limited to accredited research scientists engaged in strictly supervised projects.

2.2.2. Wilderness areas

To protect a largely undisturbed natural area which serves human physical and spiritual well-being. In order to achieve that a wilderness area must be an enduring natural area of sufficient size to retain its natural character. It is an area where little or no persistent evidence of human intrusion is permitted, so that natural processes will take place largely unaffected by human

intervention. Cultural resources which may occur in these areas, will also be protected.

Non-mechanised and strictly controlled access to wilderness areas should be stressed. Adds pristine natural areas they should be established to ensure that future generations will have an opportunity to seek solitude and understanding in largely undisturbed areas.

2.3 CRITERIA FOR SELECTION AND MANAGEMENT

2.3.1 Scientific reserve

It contains an outstanding ecosystem particularly susceptible to degradation or species of fauna and flora in imminent danger of extinction, or areas or features of particular biological, cultural or other scientific importance.

The minimum size of the area should ensure the integrity thereof and should accomplish the protection of the feature involved.

The only objective is the permanent preservation of the feature involved, and no development will be allowed which has no direct bearing on this objective.

Access is generally proscribed and in any case is limited to people directly charged with supervision of the area and accredited scientists engaged with strictly demarcated projects. It is managed by a nationally recognised authority or institution.

2.3.2. Wilderness area

An undeveloped area presently uninhabited by man and retaining an intrinsically wild appearance and character, or capable of being restored to such a condition.

It must be of sufficient size to protect the wilderness character and to provide the wilderness experience and be physically and visually separated, preferably by other protected area categories, from adjacent areas of development and habitation.

Preservation of the natural environment and wilderness character will be the highest management priority.

Controlled access for visitors seeking the wilderness experience in a natural environment, will be permitted in strict accordance with the natural carrying capacity of the area. It is managed by a nationally recognised authority or institution.

2.4 PRESENT LEGAL OR OTHER CATEGORIES WHICH COULD POSSIBLY BE CLASSIFIED AS CATEGORY 1

Special nature reserves, wilderness areas.

3 CATEGORY II : NATIONAL PARKS AND EQUIVALENT RESERVES

3.1 DEFINITION

A national park or equivalent reserve is a relatively large, outstanding natural area of land and/or sea designated to protect the ecological integrity of one or more ecosystems for this and future generations to exclude exploitation or intensive occupation of the area and to provide a foundation for spiritual, scientific, educational, recreational and cultural opportunities for visitors.

3.2 OBJECTIVES

To protect a natural and scenic areas of national or international significance for spiritual, scientific, educational, recreational and tourism purposes. The area should perpetuate, in a natural state, representative samples of physiographic regions, biotic communities and genetic resources and species, to provide ecological stability and diversity. Cultural resources which may occur in these areas, will also be protected.

3.3 CRITERIA FOR SELECTION AND MANAGEMENT

National parks and equivalent reserves encompass outstanding and extensive examples of at least one of the recognised biomes of the country in a near natural state or which has potential to be rehabilitated to such a state.

These are of sufficient size to sustain viable, free-living populations of all wild plant and animal species which occur naturally or which occurred in historical times, including predators, without requiring unrealistic control measures to safeguard adjacent farming practices or other development.

Preservation of the natural environment will at all times receive the highest priority. Only development which is reconcilable with the objectives of the area, will be allowed.

These areas are open for controlled access by all members of the public.

These areas are managed by either the National Parks Board or a competent nationally recognised authority.

3.4 PRESENT LEGAL OR OTHER CATEGORIES WHICH COULD POSSIBLY BE CLASSIFIED AS CATEGORY II

National parks, provincial parks and nature reserves, indigenous state forests.

4 CATEGORY III : NATURAL MONUMENTS AND AREAS OF CULTURAL SIGNIFICANCE

4.1 DEFINITION

A natural feature or a feature of cultural significance or both or an area of outstanding or unique scenic, scientific, educational or inspirational value.

4.2 OBJECTIVES

To protect outstanding natural and cultural features and places because of their special interest, unique or representative characteristics and, to the extent consistent with this, provide opportunities for interpretation, education, research and public appreciation.

4.3 CRITERIA FOR SELECTION AND MANAGEMENT

This category normally contains one or more features of outstanding significance which, because of uniqueness, rarity or representivity, should be protected. These areas are not of the size, nor do they contain a diversity of features which would justify their inclusion as a Category II area.

Generally, these sites are not extensive.

They may be established to protect natural ecosystems and cultural resources, but usually they protect specific phenomena related to larger systems.

These sites may be state-owned and managed by either central or other government agencies, or owned and managed by non-profit trusts, corporations or private landowners as long as there is assurance that they will be managed to protect their inherent features for the long term.

4.4 PRESENT LEGAL OR OTHER CATEGORIES WHICH COULD POSSIBLY BE CLASSIFIED AS CATEGORY III

National monuments, monuments, botanical gardens, zoological gardens, natural heritage sites, sites of conservation significance.

5 CATEGORY IV - HABITAT AND WILDLIFE MANAGEMENT AREAS

5.1 DEFINITION

Habitat and wildlife management areas area areas subject to human intervention, based on research into the requirements of specific species for nesting, feeding and survival. Maintaining sustainable plant and animal population as well as protecting rare and threatened species, is an integral function.

5.2 OBJECTIVES

To assure the natural conditions necessary to protect significant species, groups of species, biotic communities, or physical features of the environment where these may require specific human manipulation to ensure their survival. Scientific research, environmental monitoring and educational use are the primary activities associated with sustainable resource management of this category. Cultural resources which may occur in these areas, will also be protected.

5.3 CRITERIA FOR SELECTION AND MANAGEMENT

A Category IV area is desirable which protection of specific habitats is essential to the continued well-being of indigenous flora and resident or migratory fauna.

Although a variety of areas fall within this category, each would have, as its primary purpose, the protection of nature and the survival of species. The production of harvestable, renewable resources and the protection of cultural resources may play a role in management.

The size of the area is dependant on the habitat requirements of the species to be protected. These areas may be relatively small, but should incorporate nesting areas, marshes, or lakes, estuaries, forest or grassland habitats, or fish spawning areas or seascapes including feeding beds for marine mammals. On the other hand, some bird sanctuaries may be very extensive.

The area may require habitat manipulation to provide optimum conditions for the species, vegetation community or feature according to individual circumstances, For example, a particular grassland or heath community may be protected and perpetuated through grazing; a marsh for wintering waterfowl may require continual removal of excess reeds and supplementary planting of waterfowl food; or a reserve for an endangered animal may need protection against predators. Limited areas may be developed for public education and appreciation of the work of wildlife management.

Ownership may be by any level of government, non-profit trusts, corporations, private individuals or groups.

5.4 PRESENT LEGAL OR OTHER CATEGORIES WHICH COULD POSSIBLY BE CLASSIFIED AS CATEGORY IV

Provincial, local and private nature reserves, conservancies.

6. CATEGORY V - PROTECTED LAND/SEASCAPES

6.1 DEFINITION

Areas which are a product of the harmonious interaction of people and nature. They may demonstrate cultural manifestations such as customs, beliefs, social organisation or material traits as reflected in used patterns. These areas are often scenically attractive or aesthetically unique patterns of human settlement. Traditional practices associated with agriculture, grazing or fishing are evident.

6.2 OBJECTIVES

To maintain significant areas which are characteristic of the harmonious interaction of nature and culture, whilst providing opportunities for public enjoyment through recreation and tourism, and supporting the accepted life-style and economic activity of these areas. These areas also serve scientific and educational purposes and maintain biological and cultural diversity.

6.3 CRITERIA FOR SELECTION AND MANAGEMENT

The scope and character of areas in this category are necessarily broad because of the wide variety of natural, cultural or scenic areas that occur.

These areas may demonstrate certain cultural manifestations such as customs, beliefs, social organisation or material traits as reflected in use patterns. They are characterised by either scenically attractive or aesthetically unique patterns. Traditional practices associated with agriculture, grazing and fishing dominate. The area would be large enough to ensure the integrity of the use patterns.

Natural or scenic areas along coastlines and lake shores, or in hilly or mountainous terrain, or along the shores of rivers, or inland adjacent to important tourist highways or population centers, offering scenic views are often included. Many will have the physical qualities and potential to be developed for a variety of outdoor recreation uses.

In some cases the area would be privately held and the application of either central or delegated planning control would likely be necessary to assist in the perpetuation of both the use and life-style. Means of subsidisation or other government assistance might be required. Efforts would be made to maintain the quality of landscape through appropriate management practices. In other instances the areas are established and managed under public ownership.

6.4 PRESENT LEGAL OR OTHER CATEGORIES WHICH COULD POSSIBLY BE CLASSIFIED AS CATEGORY V

Protected natural environments, natural resource areas, scenic landscapes, urban landscapes.

7 CATEGORY VI - SUSTAINABLE USE AREA

7.1 DEFINITION

It is a predominantly natural area of land and/or sea, designated and managed to ensure the long-terms protection and maintenance of its biological diversity, while providing a sustainable flow of natural products.

7.2 OBJECTIVES

To protect and maintain the biological diversity and other natural values of the area in the long term, whilst bringing benefits that contribute to the welfare and development of the local community.

7.3 CRITERIA FOR SELECTION MANAGEMENT

The area shall be predominantly natural, although it may also contain limited areas of modified ecosystems (commercial plantations are not appropriate).

The area shall be large enough to absorb sustainable resource uses without detriment to its overall long-term natural and cultural value.

Management shall be undertaken preferably in partnership with the local community or through local custom.

Sound management practices that ensure sustainable production and protect the natural resource base from being alienated for other land uses that may negatively impact on biological diversity are essential.

Also, Category VI areas provide, where necessary, additional protection as buffers and links in a network of protected areas.

7.4 PRESENT LEGAL OR OTHER CATEGORIES WHICH COULD POSSIBLY BE CLASSIFIED AS CATEGORY VI

Mountain catchment areas.

APPENDIX IV KZN WILDLIFE MISSION AND KEY OBJECTIVES

MISSION STATEMENT

TO CONSERVE THE INDIGENOUS BIODIVERSITY OF KWAZULU-NATAL WHICH INCLUDES THE LANDSCAPES, ECOSYSTEMS AND PROCESSES UPON WHICH IT DEPENDS, AND TO ASSIST ALL PEOPLE IN ENSURING THE SUSTAINABLE USE OF THE BIOSPHERE

Where:

(i) To conserve means to ensure the survival of indigenous fauna, flora and natural ecosystems and the promotion of public environmental awareness.

(ii) Biodiversity means the wealth of life on Earth, including the millions of different animal and plant types, the genes they contain and the communities, ecosystems and landscapes of which they are part.

(iii) KwaZulu-Natal means the provision of KwaZulu-Natal and adjacent territorial waters.

(iv) Sustainable use is the level of consumptive or non-consumptive use that will not threaten the long-term survival of biodiversity or its benefits to current and future generations.

(v) Biosphere means that part of the Earth which sustains living organisms.

To achieve the above mission, the KwaZulu-Natal Nature Conservation Service must:

(vii) Promote awareness of the functioning and importance of the biosphere.

(viii) (i) Prevent the man-induced extinction of any species indigenous to KwaZulu-Natal.

(ii) Ensure the survival of viable populations of all species indigenous to KwaZulu-Natal.

- Recognise the link between rural poverty and environmental degradation and promote the conservation of biodiversity and ecological processes in KwaZulu-Natal and ensure their conservation in protected areas administered by the Service and other areas where biodiversity conservation is a declared goal.
- Promote the sustainable and equitable use of wildlife resources in KwaZulu-Natal, and exercise the necessary controls to ensure sustainability and equity.
- Create conditions and incentives that support the conservation and sustainable use of biodiversity.
- Facilitate public access to protected areas and provide appropriate services including opportunities for education and scientific study.
- Participate in KwaZulu-Natal's ecotourism industry by providing visitor facilities and experiences in protected areas on a self funding basis and by developing partnerships with local communities and the private sector all of which must be compatible with the Mission of the Service.
- Conduct its activities effectively and efficiently through the employment of appropriately skilled people dedicated to service and committed to biodiversity conservation.
- Ensure the social, economic and environmental integration of protected areas locally, sub-regionally, and regionally.
- Be aware of the increasing threats to the environment as a result of pressure from rival poverty, unsustainable population growth and lack of individual responsibility and accountability, and foster sustainable living through the economic and social development of communities, especially those adjacent to protected areas.

In pursuit of its mission, and the realisation of its objectives, the KwaZulu-Natal Nature Conservation Service understands:

- that the State provides limited funding and legislative support for the conservation of wildlife

Continuation of APPENDIX IV

- resources and the promotion of public biodiversity conservation awareness in KwaZulu-Natal.

The KwaZulu-Natal Nature Conservation Service recognises:

- that the long-term survival of Man depends on the universal acceptance and understanding of the need for natural life-support systems to operate at sustainable levels;
- that the provision of natural resource-based recreation and opportunities for spiritual fulfilment in protected areas, accessible to all who desire to use them, is an indispensable contribution towards increasing public awareness of the importance of biodiversity conservation;
- that formal biodiversity conservation agencies have a leading role to play in developing an awareness and understanding of, and sensitivity to, the protection and management of the biosphere; and
- that, as the statutory custodian of the wildlife resources in KwaZulu-Natal, it also has a wider role to play through the support of local, regional, national and international biodiversity conservation endeavours.

The KwaZulu-Natal Nature Conservation Service acknowledges:

- that it holds in trust, for the benefit of all the people of KwaZulu-Natal and of South Africa, the protected areas over which it exercises custodianship;
- the IUCN World Conservation Strategy, expresses its support for its guidelines and undertakes actively to support international conservation by espousing the principles and endeavours of the World Conservation Union and its Commissions;
- that South Africa is a signatory to CITES, The Convention on Biological Diversity, the RAMSAR Convention, The Convention on the conservation of migratory species of wild animals, the World Heritage Convention and others, and pledges its support to uphold their principles and undertake the management responsibilities assigned to the Service;
- the role of the KwaZulu-Natal Department of Traditional and Environmental Affairs;
- the role of the Department of Environmental Affairs and Tourism in biodiversity and environmental conservation in South Africa.

The KwaZulu-Natal Nature Conservation Service:

- pledges its co-operation to all other local, regional, national and international biodiversity and environmental conservation authorities;
- confirms its commitment to and support for the communities and public it services and with whom it interacts; and
- dedicates its staff to the fulfilment of its mission.

APPENDIX V LIST OF ENVIRONMENTALLY SENSITIVE FEATURES

From A.C. Blackmore *(in prep)*

Defining Sensitive Features and Sites within a Protected Area System

(vii) Type Areas

a. Benchmark Area
- i. Entire protected area
- ii. Reference area (wilderness, wild areas, other park zonation)
- iii. Reference vegetation (species composition, structure, etc.)
- iv. Reference management/experimental area (area requiring special management, exclusion plots, etc.)
- v. Reference archaeological/historical scientific area

b. Original Specimen Collection Habitat
- i. Nomenclatural Type Location (including Holotype[1] and Neotype)

c. Limits and Thresholds to Acceptable Change Areas
- i. Area (limit) deemed to be the minimum or vital area required to ensure integrity of the system or feature whether it be natural or cultural
- ii. Area (limit) denoted as the minimum area beyond which change would result in a significant loss in the sense of place of the feature
- iii. Area (threshold) denoted as the minimum area once reached would trigger management investigation into whether the integrity of the system or feature is at risk.

2. Life Support Systems and Specialised Habitats

a. Life support systems
- i. An ecological system in which its outputs are vital for sustaining specialised habitats
- ii. An ecological system in which its outputs are vital for sustaining human life (e.g. water purification)

b. Specialised habitats
- i. Priority breeding habitats
- ii. Refuge area
- iii. Vital for species survival (important for part or all of its life cycle)
- iv. Essential for species performance
- v. Cryptic habitats

3. Unresearched areas
- i. Area not adequately investigated for sensitive features

4. Important Flora and Fauna

a. Community
- i. Nationally (Poorly conserved outside KwaZulu-Natal)
- ii. Provincially (Endemic to KwaZulu-Natal)
- iii. Regionally (Poorly conserved or threatened outside PA)

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[1]Holotype: Collected specimen designated against original descriptive publication.
Neotype: Designated *in lieu* of the holotype when the latter is lost or damaged.

iv. Type / population

b. Priority Species
- i. Nationally (Poorly conserved outside KwaZulu-Natal)
- ii. Provincially (Endemic to KwaZulu-Natal)
- iii. Regionally (Poorly conserved or threatened outside PA)

c. Important Structurally
- i. Structure of community that is extraordinary or vulnerable (e.g. tall forest, feather corals)

d. Important Spatially
- i. Continuous belt or expansive area
- ii. Important for landscape biodiversity
- iii. Important for migratory species
- iv. Important corridor for species movement
- v. Extreme limit of species distribution

e. Vulnerable Static Community/Population
- i. Marine
- ii. Terrestrial
- iii. Fresh Water

f. Type Community/Population
- i. Community from which a Type Specimen was collected (including Holotype and Neotype)

g. Original Genetic Stock
- i. Ecotype[2]
- ii. Ecophene[3]

h. Sensitive/Vulnerable Animal Behaviour
- i. Terrestrial
- ii. Freshwater
- iii. Marine

i. Commercially Important Species
- i. A species of animal or plant having desirable human uses (food, fuel, shelter, clothing, medicine etc.) present in sufficient numbers to make commercial collection or harvesting economically viable

5. Important Hydrological Feature

a. Wetlands
- i. Open water
- ii. Vegetated
- iii. Subterranean
- iv. Marine
- v. Estuarine

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2 Ecotype: Individuals occupying a particular habitat and forming an interbreeding population which differs genotypically from other populations

3 Ecophene: Individuals occupying a particular habitat and adapted to it phenotypically but not genotypically

Continuation of APPENDIX V

6. **Geological Feature and Landform**

   a. **Unstable or potentially unstable Areas**
      i. Steep slopes
      ii. Erodible soils
      iii. Labile formations (e.g. peat)
      iv. Rock outcrops

   b. **Unique geological features**
      i. Formations (e.g. Uloa formation)
      ii. Economically valuable minerals
      iii. Unique bio-geological features (features formed as a result of an interaction between indigenous biota and the geological substrate e.g. bio-armouring)

7. **Biodiversity Management**
      i. Areas required for successful implementation of an important management activity
      ii. Area required that would allow key biophysical processes to be sustained

8. **Archaeological Phenomena**
      i. Areas that have recorded archaeological features
      ii. Areas that have not been investigated but have a high probability of containing archaeological features

9. **Historical**

   a. **Monument**
      i. Buildings greater than 50 years old particularly if they are a remnant of architectural period or have elements of an architectural design that warrants their conservation
      ii. Areas of historical importance (e.g. battlefields)
      iii. Sites of provincial, national or cultural importance
      iv. Settings of a historical period predominantly in architecture and landscaping

   b. **Park Development/Establishment**
      i. Milestone areas crucial for the establishment of the Park
      ii. Areas representing strategic or memorable milestones in the Park's history
      iii. Landmark area for the mutually beneficial resolution of land claims

   c. **Wildlife and Tourism Development and Management**
      i. Special areas or structures that have played a documented role in the development of the Park's wildlife and its management
      ii. Special areas or structures that have played a documented role in the development of the Park's tourism industry

10. **Sense of Place/Ambience**
      i. Special areas that confer mystique and sense of awe of the natural environment
      ii. Natural areas that have historically been unchanged and have, as a result, become tradition or a trademark of the Park
      iii. Natural environment free of pollution
      iv. Developed or partially developed areas that have historically been unchanged and have, as a result, become a trademark of the Park or component thereof

Continuation of APPENDIX V

11. Visual Impact

a. Areas that form the visual landscape within the protected area

i. Buffer areas surrounding wilderness areas
ii. Buffer areas surrounding popular tourist destinations
iii. Undeveloped or unaltered land- or viewscapes

12. Cultural/Spiritual areas

i. Areas that have recorded cultural/spiritual phenomena
ii. Areas that have not been investigated but may have cultural/spiritual phenomena

13. Wildlife Disease and Control

a. Species or Populations

i. Disease free populations
ii. Vulnerable species (species/populations predisposed to particular diseases)
iii. Isolated or small populations
iv. General species or population immunity (through continued exposure)

b. Controlled areas

i. Disease free areas
ii. Disease refuge areas

c. Vectors

i. Vulnerable vectors (focus for disease control)

APPENDIX VI KZN WILDLIFE POLICIES
(i) Precautionary Principle

EZOKONGIWA KWEMVELO KZN
KZN NATURE CONSERVATION SERVICE
KZN NATUURBEWARINGSDIENS

POLICY

SUBJECT: **PRECAUTIONARY PRINCIPLE** POLICY FILE NO: **3-viii**

DATE OF BOARD APPROVAL: **30 JULY 1999** BOARD MINUTE: **8.1.2 (vii)**

The KwaZulu-Natal Nature Conservation Board **RECOGNISING** that:

* sustainable socio-economic development within KwaZulu-Natal is necessary;
* as currently utilised natural resources diminish, alternatives will be sought to meet demands;
* it is inevitable that there will be uncertainty with regard to the effects of human activities on biodiversity;
* notwithstanding uncertainty, it may be necessary to act in the absence of complete knowledge;
* IEM procedures and scientific monitoring are prerequisites for acting under uncertainty.
* the burden of proof lies with the proponents of development to show that environmental risks are not excessive;

ADOPTS the following as a statement of the Precautionary Principle:

* Where there is a probability of significant reduction in, or loss of indigenous biodiversity or a perceived opportunity to maintain, enhance or restore such biodiversity, the lack of full scientific certainty as to the consequences should not be used as a reason for failing to apply appropriate action.

UNDERTAKES:

(1) to assess the environmental risks inherent in all current and planned activities in protected areas;

(2) not to proceed with an activity where the environmental impacts are not entirely clear, but where there are likely to be serious or irreversible negative changes which threaten the indigenous biodiversity of KwaZulu-Natal and may lead to the unsustainable use of the biosphere;

Continuation of APPENDIX VI (i)

(3) where environmental impacts are able to be mitigated, to supply appropriate cost effective mitigatory measures and to evaluate their effectiveness;

(4) expedite decisions and activities where there is an opportunity to maintain, enhance or restore biodiversity; and

(5) promote the application of, the precautionary principle outside protected areas.

APPENDIX VI **KZN WILDLIFE POLICIES**
(ii) Integrated Environmental Management

EZOKONGIWA KWEMVELO KZN
KZN NATURE CONSERVATION SERVICE
KZN NATUURBEWARINGSDIENS

POLICY

SUBJECT: **INTEGRATED ENVIRONMENTAL MANAGEMENT** POLICY FILE NO: **5 - i**

DATE OF BOARD APPROVAL: 28 February 1992 BOARD MINUTE : 6(a) (ii)

The KwaZulu-Natal Nature Conservation Board **RECOGNISING** that:

In the implementation of policies, programmes and projects involving development within Board areas, there is a risk that adverse effects on both the natural and visitor environments could occur; and

REALISING that:

The application of the integrated environmental management procedure (IEM) as advocated by the Council for the Environment 1989 allows for the:

* inclusion of environmental considerations at all stages of the development process
* evaluation of alternatives to the proposed development at the initial planning stage
* design of modifications in the early stages of planning to avoid or reduce any adverse effects
* application of the appropriate level of assessment of a proposal in accordance with its potential to cause adverse environmental effects
* formulation of measures to enhance beneficial effects of a proposal and mitigate likely detrimental effects
* reviewing of the environmental report to ensure its adequacy and comprehensiveness
* consideration by decision-makers of the various consequences for nature conservation, of the proposed policy, programme or project
* monitoring of implementation of recommendations made in the environmental report.

The Board **ACCEPTS** that:

(i) it needs to be aware of the potential environmental implications of proposed policies, programmes and projects and especially if it is predicted that there may be significant adverse impacts;

Continuation of APPENDIX VI (ii)

(ii) the adoption of an IEM procedure will promote more informed decision-making and will demonstrate that the Board is being both environmentally considerate and responsible with regard to its own development policies, programmes and projects within protected areas;

(iii) by using the IEM procedure both the potential beneficial and adverse effects of all proposed policies, programmes and projects would be identified in the early planning stages, allowing for appropriate modification of each proposal prior to detailed planning thereof or decision-making thereon. Therefore the best interests of the Board, as well as the natural and visitor environments of areas controlled by the Board would be served.

The Board **UNDERTAKES** to:

1. apply the integrated environmental management procedure to all projects within Board areas and to those programmes and policies, the implementation of which has the potential to affect either the natural or visitor environments;

2. as part of this procedure, prepare a written report on the findings and recommendations of the environmental assessment.

APPENDIX VI **KZN WILDLIFE POLICIES**
(iii) Ecotourism and Protected Areas

EZOKONGIWA KWEMVELO KZN
KZN NATURE CONSERVATION SERVICE
KZN NATUURBEWARINGSDIENS

POLICY

SUBJECT: **ECOTOURISM AND PROTECTED AREAS** POLICY FILE NO: 7x

DATE OF BOARD APPROVAL: 25 June 1999 BOARD MINUTE: 4.1.2.

The KwaZulu-Natal Nature Conservation Board **RECOGNISING** that:

* the sustainable use of wildlife resources is considered to be a key strategy for the conservation of biodiversity;

* tourism is a lead economic sector in the province as a whole, and that ecotourism provides economic opportunities which are especially important in rural areas where few other opportunities exist;

* the statutorily proclaimed protected areas of the province of KwaZulu-Natal are the key attractions for domestic and international tourism to the province;

and **NOTING** further that:

* ecotourism development has the potential to create jobs and generate entrepreneurial opportunities for people with a variety of backgrounds, skills and experience, including rural communities and especially women;

* tourism can generate negative impacts on the environment and on rural communities if not developed and managed sensitively;

* successful ecotourism development is dependent on the provision of infrastructure and essential support services by the State;

and **REALISING** that:

* the provision of visitor access to protected areas is an integral component of the sustainable use of the wildlife resources of the province;

* the flow of benefits from protected areas at the local, regional, national and international level, should be equitable and sustainable;

* the provision of visitor access to protected areas provides a source of revenue to complement state funding for nature conservation, and hence to maintain the nature

conservation resource base;

* all of the people in the province and further afield have the right to benefit from the recreational opportunities presented by protected areas, including those persons who have disabilities necessitating the provision of modified access or accommodation facilities.

DEFINES ECOTOURISM TO ENCOMPASS:

Responsible tourism, based on the wildlife resources of the province, developed and managed to maintain or enhance environmental quality and to ensure that benefits accrue to society and, particularly, to communities neighbouring protected areas;

UNDERTAKES to:

1. optimise the nature and scale of ecotourism opportunities in protected areas to provide a range of visitor facilities which are attractive and affordable to a broad range of South Africans and other visitors, and which contribute to nature conservation, to the provision of visitor enjoyment, relaxation and learning, and to the economic development of the region, within limits of acceptable environmental change;

2. plan, develop and manage visitor facilities in protected areas in accordance with the principles and practice of Integrated Environmental Management (IEM), including the assessment of the environmental, social and economic impacts of proposed development opportunities, public participation and consultation, transparent decision-making, mitigation of negative impacts and environmental auditing;

3. construct visitor facilities in protected areas which maintain the integrity of the built and natural environment, which are aesthetically pleasing, and which incorporate environmentally-friendly technologies for the provision of water and energy and for dealing with waste materials;

4. enter into partnerships with community and private sector parties, where appropriate, and to assist with the planning and management of ecotourism within and adjacent to protected areas which will maximise community involvement and employment, and contribute to capacity-building and the creation of entrepreneurial opportunities among protected area neighbours;

5. provide appropriate nature conservation interpretation and information regarding the ecological, economic, historical and cultural values of the protected areas, and to promote nature conservation awareness and sustainable living among visitors to protected areas, as well as reverence for the history and culture of the region;

6. motivate to the relevant authorities the need for infrastructure and essential support services, including roads, telecommunications, international and domestic airports, tourism marketing, and safety and security measures;

7. motivate to the relevant authorities the need to consider nature conservation concerns in all economic and tourism policies, plans and programmes.

8. optimise the financial contribution which these facilities can and should provide to the conservation service of the Province.

APPENDIX VII QUESTIONNAIRE FORMAT

SURVEY QUESTIONNAIRE

SOLID WASTE MANAGEMENT IN KZN WILDLIFE PROTECTED AREAS

This is a brief survey being conducted by the Planning Division to obtain a broad picture of solid waste management practices in our protected areas and to identify areas of concern. The results of this survey will be used as grouped results and are not intended to reflect upon the individual stations or protected areas. At a future time, a more detailed, station by station inspection may be conducted.

A GENERAL INFORMATION

1 What is the size of the protected area? .....

2 Does the protected area cater for overnight/day visitors / both? .....

3 What is the average numbers of visitors per year? .....

4 Are they predominantly local or overseas tourists? .....

5 Do staff stay within the protected area (if so, how many, including family members)

6 Are there offices within the protected area? If so, how many staff work there daily?

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B SOLID WASTE COLLECTION

1 How is waste collected? *(E.g. bins are provided at the campsite, staff have communal bins outside their accommodation units, where it is stored until removed to the dump)*

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2 How often is waste collected? *(E.g. bins are emptied twice weekly by staff)* .....

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3 Please estimate how much waste is collected each removal *(e.g. four x 44 gallon drums)*

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C SOLID WASTE DISPOSAL

1 Where is the waste disposed of? *(E.g. in the protected area or at a municipal dump)*

2 If disposed of within the protected area, is it burnt, buried or otherwise reduced?

What is the distance to the nearest town that has a municipal landfill site? .....

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D RECOMMENDATIONS

1 Do you feel that the current system can / needs to be improved? .....

2 If so, what steps need to be taken? .....

.....

3 What do feel is limiting any changes you may wish to make to the system *(only ask question if the manager feels that changes are needed and knows what changes are needed)* .....

APPENDIX VIII **FORM USED IN ASSESSMENT OF LEGAL COMPLIANCE AND IMPACTS OF WASTE DISPOSAL SITES IN PROTECTED AREAS**

WASTE DISPOSAL SITE AUDIT

(Adapted with thanks from Lombard and Associates Audit Schedule)

Inspection date:

	CATEGORY	OK	COMMENTS
1.	ENVIRONMENTAL IMPACT		
1.1	Visual appearance		
	Site neatness		
	Wind scatter		
	Site maintenance		
1.2	Health & hygiene		
	Odorous		
	Pests		
	Sanitary landfill (daily covering)		
1.3	Water pollution		
	Leachate quality		
	Leachate management		
	Monitoring of groundwater		
2.	SITE MANAGEMENT		
2.1	PUBLIC INVOLVEMENT		
	Complaints register		
	Community participation programme		
2.2	DOCUMENTATION		
	Operation Management Plan		
	Closure Plan		
	Contingency Plan		
	Regular internal audits		
2.3	WASTE DISPOSAL		
	Clearly defined operational area		

Continuation of APPENDIX VIII

	Compaction of appropriate waste		
	Sorting of recyclables		
	Incineration of appropriate waste		
	Co-disposal of suitable wastes		
	Cover of waste (see 1.2)		
	Berms to control water pollution		
2.4	SAFETY MEASURES		
	Site fenced and locked gate		
	First aid training & kit		
	Fire alarm and communications		
	Fire controls in place		
	Accident reporting system		
	Staff protective clothing		
2.5	SITE FACILITIES		
	Site Office		
	Ablution facilities on site		
2.6	MACHINERY		
	Properly maintained		
	Operated according to plan		
3.	LEGISLATIVE COMPLIANCE		
3.1	WATER ACT & ENVIRONMENTAL CONSERVATION ACT		
	DWAF Permit i.t.o. ECA Sect 20 Act 73 of 1989		
	Results of leachate and monitoring available to authorities		
	ECA Sect 21 and 26 authorisation for waste disposal		
3.2	ATMOSPHERIC POLLUTION PREVENTION ACT		

Continuation of APPENDIX VIII

	Approved incineration (section 10 of Act 45 of 1965)		
3.3	OCCUPATIONAL HEALTH AND SAFETY ACT		
	Safety requirements (Act 85 of 1993)		

APPENDIX IX (i) HILLTOP REST CAMP SOLID WASTE DATA

KZN WILDLIFE VISITOR CHALETS

	Total		Glass		Plastic		Tins/Cans		Paper/board		Foods		Miscellaneous	
Sample	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³
1a	4.85	27.00	1.20	3.50	0.60	5.50	0.85	6.25	1.10	7.50	0.95	4.00	0.15	0.25
1b	3.15	14.25	0.45	1.50	0.40	3.75	0.35	2.75	0.65	3.50	1.30	3.00	negl	negl
1c	3.70	24.00	0.50	3.00	0.80	7.50	0.50	5.50	0.45	3.00	1.25	4.75	0.20	0.25
1d	3.25	15.00	0.70	1.75	0.75	5.50	0.10	0.25	0.35	3.75	1.35	3.75	negl	negl
1e	3.70	21.50	1.00	3.25	0.55	5.00	0.25	2.25	0.80	6.50	1.10	4.50	0.00	0.00
2a	3.50	20.00	0.95	3.00	0.30	2.50	0.05	0.25	1.15	8.75	1.55	6.00	0.40	1.25
2b	4.45	24.50	0.70	2.25	1.05	9.75	0.50	4.50	0.80	5.75	1.40	2.25	negl	negl
2c	2.95	16.25	0.55	3.00	0.45	3.75	0.20	2.25	0.50	4.25	1.25	3.00	0.00	0.00
2d	4.15	18.00	0.85	2.50	0.95	7.25	0.65	4.00	0.35	2.50	1.30	1.75	0.05	negl
2e	5.25	23.25	1.10	3.75	0.60	6.50	0.45	2.75	1.05	6.50	1.60	3.00	0.45	0.75
2f	3.05	10.50	1.25	2.75	0.45	4.00	0.15	1.50	0.35	1.75	0.85	0.50	negl	negl
3a	3.95	19.25	1.05	3.00	0.80	7.75	0.20	2.50	0.70	4.00	1.00	1.25	0.00	0.00
3b	4.20	17.50	1.10	3.50	0.75	4.25	0.15	2.25	1.30	5.50	0.80	2.00	0.10	negl
3c	2.45	13.50	0.90	2.50	0.35	3.75	0.35	2.50	0.55	4.00	0.30	0.75	0.00	0.00
3d	4.40	21.00	0.40	1.50	0.75	3.25	1.10	8.50	0.70	5.75	1.45	2.00	negl	negl
3e	3.90	20.50	0.95	2.75	0.70	6.75	0.45	3.00	1.20	6.75	0.60	1.25	negl	negl
3f	3.60	18.75	0.55	3.00	0.50	5.25	0.50	3.25	0.85	5.00	0.90	1.75	0.30	0.50
4a	2.55	19.50	0.20	0.25	1.00	8.00	0.25	2.50	0.60	8.00	0.65	0.50	negl	negl
4b	4.30	26.75	2.05	8.75	0.10	2.25	1.35	12.50	0.30	2.00	0.50	0.75	0.00	0.00
4c	3.55	20.25	1.00	2.75	0.45	3.50	0.20	2.25	1.05	6.25	0.65	5.25	0.20	0.25
4d	3.30	19.00	0.80	2.50	0.60	4.50	0.20	2.25	0.65	6.50	1.05	3.25	0.00	0.00
4e	2.90	16.50	0.85	2.50	0.70	5.75	0.25	2.25	0.75	4.75	0.35	1.25	negl	negl
4f	2.45	14.75	0.60	1.50	0.70	4.25	0.15	2.00	0.45	4.25	0.55	2.75	0.00	0.00
Totals	84.90	442	19.70	64.75	14.30	120.2£	9.70	78.00	16.65	116.50	22.70	59.25	1.85	3.25

RESTAURANT & BAR

	Total		Glass		Plastic		Tins/Cans		Paper/board		Foods		Miscellaneous	
Sample	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³
5a	1.90	20.25	0.00	0.00	0.55	10.75	0.50	8.25	0.30	2.25	0.95	3.00	negl	negl
5b	4.00	21.25	0.95	2.50	0.75	5.50	0.35	3.00	0.85	6.75	1.05	3.25	0.05	0.25
5c	2.75	16.25	0.20	0.75	0.25	2.25	0.55	4.75	0.65	5.50	1.10	3.00	0.00	0.00
5d	2.95	19.50	0.45	0.75	0.55	5.00	0.20	2.50	1.10	9.00	0.65	2.25	0.00	negl
5e	3.20	17.25	0.65	2.75	0.55	4.50	0.15	1.75	0.60	5.50	0.95	2.50	0.30	0.25

Continuation of APPENDIX IX (i)

RESTAURANT & BAR continued.

	Total		Glass		Plastic		Tins/Cans		Paper/board		Foods		Miscellaneous	
Sample	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³
5f	2.50	15.75	0.20	0.25	0.20	1.75	0.65	8.00	0.25	3.00	1.20	3.75	0.00	0.00
5g	2.35	13.00	0.45	1.25	0.15	2.00	0.25	3.00	0.45	2.75	0.95	3.75	0.10	0.25
5h	3.15	19.75	0.45	2.25	0.50	4.25	0.35	2.75	0.75	6.25	1.10	4.25	0.00	0.00
5i	2.45	16.25	0.85	2.50	0.35	4.00	0.40	3.50	0.55	5.25	0.30	1.00	0.00	negl
5j	3.05	20.75	0.25	0.50	0.40	4.25	0.30	2.75	1.05	3.75	0.95	3.50	0.00	negl
5k	2.70	14.00	0.40	0.50	0.20	2.75	0.40	3.75	0.70	4.50	0.90	2.25	0.10	0.25
6a	4.30	23.00	0.45	1.00	negl	negl	1.15	14.00	0.70	6.00	0.00	0.00	negl	negl
6b	2.25	14.00	0.70	2.75	0.15	0.25	0.80	8.50	0.25	1.50	0.30	1.00	0.05	negl
6c	2.35	18.25	0.30	1.75	0.30	2.25	1.20	13.50	negl	negl	0.55	0.75	0.00	0.00
6d	3.25	15.00	0.95	2.25	0.10	0.75	0.65	7.00	0.40	2.50	1.15	2.50	0.00	0.00
6e	4.04	23.25	0.15	0.50	0.75	3.25	1.40	12.50	0.75	4.50	0.80	2.25	0.20	0.25
6f	2.80	14.50	0.40	0.50	0.45	1.75	0.70	7.25	0.70	3.50	0.55	1.50	0.00	negl
7a	3.20	24.50	0.25	1.00	0.00	0.00	1.35	15.25	0.75	7.25	0.20	1.00	0.00	0.00
7b	3.25	15.75	1.25	3.00	0.10	1.25	0.70	7.50	0.45	2.25	0.70	1.75	0.05	negl
7c	2.45	18.25	0.65	3.00	0.50	3.75	0.80	8.50	0.15	1.25	0.35	1.75	0.00	negl
7d	2.60	16.25	0.30	0.75	0.45	3.50	0.95	7.75	0.60	3.75	0.30	0.50	0.00	0.00
7e	3.45	17.45	0.75	2.50	0.65	5.25	0.45	4.75	0.70	3.75	0.95	1.25	0.10	0.25
8a	39.60	20.00	0.20	0.50	0.10	0.25	0.15	1.00	0.00	0.00	38.95	17.50	0.20	0.50
9a	4.45	22.50	1.25	3.25	1.00	8.50	0.65	5.25	0.85	4.50	0.60	0.75	0.10	0.25
9b	3.60	18.25	0.80	2.50	0.40	3.75	0.60	6.75	0.35	2.50	1.45	2.75	0.00	0.00
9c	2.90	14.50	0.65	2.25	0.35	2.25	0.10	0.75	1.05	6.75	0.85	2.50	0.00	negl
9d	3.40	20.75	0.90	2.75	0.65	6.50	0.95	8.25	0.30	1.50	0.70	1.75	0.00	0.00
9e	4.05	18.00	1.05	3.25	0.50	4.75	0.35	2.25	0.65	3.75	1.25	3.25	0.25	0.75
9f	3.90	23.75	0.35	0.75	0.55	5.50	0.75	6.25	1.00	9.75	1.25	1.50	0.00	negl
Totals	124.85	529.00	16.20	48.25	11.45	100.50	17.80	181	16.90	119.50	61.00	76.75	1.50	3.00

STAFF ACCOMMODATION

	Total		Glass		Plastic		Tins/Cans		Paper/board		Foods		Miscellaneous	
Sample	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³	Kg	dm³
10a	1.75	12.00	0.40	1.25	0.35	3.00	0.30	3.75	0.30	3.25	0.40	0.75	0.00	negl
10b	2.10	15.75	0.55	1.75	0.30	2.75	0.45	3.50	0.65	7.50	0.15	0.25	0.00	0.00
10c	2.65	18.00	0.30	1.50	0.50	4.50	0.50	6.25	0.25	3.00	0.80	2.25	0.30	0.50
10d	2.70	21.00	0.85	3.50	0.45	3.50	0.65	7.00	0.40	5.50	0.35	1.50	0.00	0.00

Continuation of APPENDIX IX (i)

STAFF ACCOMMODATION continued.

	Total		Glass		Plastic		Tins/Cans		Paper/board		Foods		Miscellaneous	
11a	2.95	25.25	0.45	0.75	0.15	2.00	0.95	12.25	0.80	9.25	0.60	1.00	0.00	negl
11b	2.40	17.00	0.35	2.00	0.80	6.25	0.45	3.25	0.40	4.25	0.40	1.25	0.00	negl
11c	3.50	16.50	1.05	2.75	0.60	1.50	0.40	3.75	0.90	7.25	0.55	1.25	0.00	0.00
11d	3.70	25.00	0.70	2.25	0.45	4.00	0.70	8.25	0.70	6.75	0.95	3.50	0.20	0.25
11e	2.70	14.50	0.55	2.75	0.40	3.75	0.15	1.75	0.55	4.00	1.05	2.25	0.00	negl
12a	1.85	13.00	0.35	1.25	0.25	1.75	0.30	3.00	0.55	6.50	0.40	0.50	0.00	0.00
12b	3.20	20.25	0.90	2.50	0.85	7.50	0.60	5.50	0.20	3.00	0.65	1.75	0.00	0.00
12c	3.20	23.75	0.40	1.50	0.70	6.75	0.55	6.25	0.85	7.75	0.70	1.50	0.00	negl
Totals	32.70	222.00	6.85	23.75	5.80	47.25	6.00	64.50	6.55	68.00	7.00	17.75	0.50	0.75

OFFICE / SHOP

	Total		Glass		Plastic		Tins/Cans		Paper/board		Foods		Miscellaneous	
Sample	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3
13a	2.85	20.50	0.20	0.25	0.75	9.25	0.55	4.50	1.10	6.00	0.25	0.50	0.00	0.00
13b	2.40	19.25	0.00	0.00	0.60	7.50	0.25	2.00	0.95	8.25	0.60	1.50	0.00	0.00
13c	3.05	16.50	0.45	1.50	0.95	8.50	0.10	0.75	1.25	4.75	0.30	1.00	0.00	0.00
13d	1.35	12.125	0.15	0.25	0.70	8.00	0.05	0.25	0.45	3.75	0.00	0.00	0.00	0.00
14a	2.50	17.25	0.30	1.25	0.55	2.75	0.30	2.75	1.05	19.75	0.30	0.75	0.00	0.00
14b	2.05	21.75	0.50	2.00	0.40	3.25	0.00	0.00	1.15	16.50	0.00	0.00	0.00	0.00
14c	2.70	34.00	0.00	0.00	0.00	0.00	0.00	0.00	2.70	34.00	0.00	0.00	0.00	0.00
Totals	16.90	151.50	1.60	5.25	3.95	39.25	1.25	10.25	8.65	93.00	1.45	3.75	0.00	0.00

DAY VISITORS

	Total		Glass		Plastic		Tins/Cans		Paper/board		Foods		Miscellaneous	
Sample	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3
15a	2.40	19.75	0.60	1.00	0.40	6.25	0.15	2.50	0.35	8.50	0.95	1.50	0.00	negl
15b	2.35	20.50	0.25	0.75	0.55	6.50	0.80	7.75	0.30	4.25	0.45	1.25	0.00	0.00
15c	2.15	14.75	0.20	0.50	0.25	4.25	0.35	4.25	0.15	2.00	1.20	3.75	0.05	negl
Totals	7.00	55.00	1.05	2.25	1.20	17.00	1.30	14.50	0.80	14.75	2.60	6.50	0.05	0.00

Continuation of APPENDIX IX (i)

COMBINED SAMPLES FOR ALL HILLTOP SOURCES

	Total		Glass		Plastic		Tins/Cans		Paper/board		Foods		Miscellaneous	
Sample	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3
KZNW Chalets	84.90	442.00	19.70	64.75	14.30	120.25	9.70	78.00	16.65	116.50	22.70	59.25	1.85	3.25
Restaurant /Bar	124.85	529.00	16.20	48.25	11.45	100.50	17.80	181.00	16.90	119.50	61.00	76.75	1.50	3.00
Staff Accom.	32.70	222.00	6.85	23.75	5.80	47.25	6.00	64.50	6.55	68.00	7.00	17.75	0.50	0.75
Day Visitors	7.00	55.00	1.05	2.25	1.20	17.00	1.30	14.50	0.80	14.75	2.60	6.50	0.05	0.00
Office /Shop	16.90	151.50	1.60	5.25	3.95	39.25	1.25	10.25	8.65	93.00	1.45	3.75	0.00	0.00
Total	266.35	1399.50	45.40	114.25	36.70	324.25	36.05	348.25	49.55	411.75	94.75	164.00	3.90	7.00

Date of data collection: 29th May 2000

Note - "negl" indicates that waste was collected but that it weighed less than 50g or was less than 0.25 dm^3 in volume

Hilltop Rest Camp Staff and Visitor Numbers

	Per Day
KZN Chalets	93
Restaurant & Bar	126
Staff Accommodation	127
Day Visitors	40
Office & Shop	13

Hilltop Rest Camp Waste Composition (kg. person^{-1} day^{-1})

	Combined	Glass	Plastic	Tins	Paper	Food	Misc
KZN Chalets	0.30	0.07	0.05	0.03	0.06	0.08	0.01
Restaurant & Bar	0.33	0.04	0.03	0.05	0.04	0.16	0.00
Staff Accommodation	0.09	0.02	0.02	0.02	0.02	0.02	0.00
Day Visitors	0.06	0.01	0.01	0.01	0.01	0.02	0.00
Office & Shop	0.43	0.04	0.10	0.03	0.22	0.04	0.00
Totals	1.21	0.18	0.21	0.14	0.35	0.32	0.01

Hilltop Rest Camp Waste Composition (dm^3. person^{-1} day^{-1})

	Combined	Glass	Plastic	Tins	Paper	Food	Misc
KZN Chalets	1.58	0.23	0.43	0.28	0.42	0.21	0.01
Restaurant & Bar	1.40	0.13	0.27	0.48	0.32	0.20	0.01
Staff Accommodation	0.58	0.06	0.12	0.17	0.18	0.05	0.00
Day Visitors	0.46	0.02	0.14	0.12	0.12	0.05	0.00
Office & Shop	3.88	0.13	1.01	0.26	2.38	0.10	0.00
Totals	7.91	0.58	1.97	1.31	3.42	0.61	0.02

Percentage (mass/mass) Waste Composition

	Combined	Glass	Plastic	Tins	Paper	Food	Misc
KZN Chalets	100.0%	23.2%	16.8%	11.4%	19.6%	26.8%	2.2%
Restaurant & Bar	100.0%	13.0%	9.2%	14.3%	13.5%	48.8%	1.2%
Staff Accommodation	100.0%	20.9%	17.8%	18.3%	20.1%	21.4%	1.5%
Day Visitors	100.0%	15.0%	17.1%	18.6%	11.4%	37.2%	0.7%
Office & Shop	100.0%	9.5%	23.4%	7.4%	51.1%	8.6%	0.0%
Totals	100.0%	15.0%	17.2%	11.6%	28.8%	26.4%	1.0%

Percentage (volume/volume) Waste Composition

	Combined	Glass	Plastic	Tins	Paper	Food	Misc
KZN Chalets	100.0%	14.6%	27.3%	17.6%	26.4%	13.4%	0.7%
Restaurant & Bar	100.0%	9.1%	19.0%	34.2%	22.6%	14.5%	0.6%
Staff Accommodation	100.0%	10.7%	21.3%	29.1%	30.6%	8.0%	0.3%
Day Visitors	100.0%	4.1%	30.9%	26.4%	26.8%	11.8%	0.0%
Office & Shop	100.0%	3.5%	25.9%	6.8%	61.3%	2.5%	0.0%
Totals	100.0%	7.3%	24.9%	16.6%	43.2%	7.7%	0.3%

APPENDIX IX (ii) SODWANA BAY REST CAMP SOLID WASTE COMBINED DATA

COMBINED SAMPLES

Total Glass Plastic Tins/Cans Paper/board Foods Miscellaneous

Sample	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3	Kg	dm^3
KZNW Chalets	59.80	271.00	13.85	29.33	9.45	71.67	4.70	44.83	11.20	124.75	83.17	40.83	0.65	1.167
Private Operators	72.55	228.80	12.20	26.17	6.20	55.50	7.70	68.83	6.25	46.50	39.80	31.00	0.40	0.833
Campers	106.70	388.50	25.60	47.13	13.95	98.67	17.15	104.00	8.35	69.67	41.35	68.50	0.30	0.50
Staff Accom	100.20	321.70	21.50	47.17	25.70	76.33	15.40	128.5	6.30	16.50	31.15	53.17	0.15	negl
Office & Shop	27.00	214.20	6.35	10.83	6.35	50.67	1.45	16.33	10.85	130.20	2.00	6.17	0.00	0.00
Total	366.25	1442.00	79.50	160.60	61.65	352.80	46.40	362.50	42.95	387.60	134.25	199.70	1.50	2.50

Date of data collection: 26th June 2000

Note - "negl" indicates that waste was collected but that it weighed less than 50g or was less than 0.25 dm^3 in volume

Sodwana Bay Rest Camp Staff and Visitor Numbers

	Per Day
KZN Chalets	40
Restaurant & Bar	31
Staff Accommodation	113
Day Visitors	56
Office & Shop	13

Sodwana Bay Rest Camp Waste Composition (kg. person^{-1} day^{-1})

	Combined	Glass	Plastic	Tins	Paper	Food	Misc
KZN Chalets	0.50	0.12	0.08	0.04	0.09	0.17	0.01
Private Chalets	0.79	0.13	0.07	0.08	0.07	0.43	0.00
Staff Accommodation	0.29	0.06	0.08	0.05	0.02	0.09	0.00
Camping	0.63	0.15	0.08	0.10	0.05	0.25	0.00
Office & Shop	0.68	0.16	0.16	0.04	0.27	0.05	0.00
Totals	2.89	0.62	0.46	0.31	0.50	0.99	0.01

Sodwana Bay Rest Camp Waste Composition (dm^3 person^{-1} day^{-1})

	Combined	Glass	Plastic	Tins	Paper	Food	Misc
KZN Chalets	2.27	0.25	0.60	0.38	0.70	0.34	0.01
Private Chalets	2.49	0.28	0.60	0.75	0.51	0.34	0.01
Staff Accommodation	0.95	0.14	0.22	0.38	0.05	0.16	0.00
Camping	2.30	0.28	0.58	0.62	0.41	0.41	0.00
Office & Shop	5.35	0.27	1.27	0.41	3.25	0.15	0.00
Totals	13.36	1.22	3.28	2.53	4.92	1.40	0.02

Percentage (mass/mass) Waste Composition

	Combined	Glass	Plastic	Tins	Paper	Food	Misc
KZN Chalets	100.0%	23.2%	15.8%	7.9%	18.7%	33.3%	1.1%
Private Chalets	100.0%	16.8%	8.5%	10.6%	8.6%	54.9%	0.6%
Staff Accommodation	100.0%	21.5%	25.6%	15.4%	6.3%	31.1%	0.1%
Camping	100.0%	24.0%	13.1%	16.1%	7.8%	38.7%	0.3%
Office & Shop	100.0%	23.5%	23.5%	5.4%	40.2%	7.4%	0.0%
Totals	100.00%	21.5%	16.0%	10.6%	17.3%	34.2%	0.4%

Percentage (volume/volume) Waste Composition

	Combined	Glass	Plastic	Tins	Paper	Food	Misc
KZN Chalets	100.00%	10.8%	26.4%	16.5%	30.8%	15.1%	0.4%
Private Chalets	100.00%	11.4%	24.3%	30.1%	20.3%	13.5%	0.4%
Staff Accommodation	100.00%	14.7%	23.8%	39.9%	5.1%	16.5%	0.0%
Camping	100.00%	12.1%	25.5%	26.8%	17.9%	17.6%	0.1%
Office & Shop	100.00%	5.1%	23.7%	7.6%	60.7%	2.9%	0.0%
Totals	100.00%	9.1%	24.5%	18.9%	36.9%	10.4%	0.2%

APPENDIX X (i) SOLID WASTES NOTED AT HILLTOP REST CAMP

SOLID WASTES AND THEIR DISPOSAL OPTIONS

Waste Type	Classification	Disposal Options
Paper and office refuse	General Waste, dry non-hazardous	Recycle, Class 3 incinerator, small general landfill
Cardboard packaging	General Waste, dry non-hazardous	Recycle, Class 3 incinerator, small general landfill
Plastic packaging and packets	General Waste, inert non-hazardous	Recycle, Class 3 incinerator, small general landfill
Cans	General Waste, inert non-hazardous	Recycle, small general landfill
Plastic bottles	General Waste, inert non-hazardous	Recycle, small general landfill
Glass bottles	General waste, inert non-hazardous	Recycle, small general landfill
Food wastes	General waste, wet non-hazardous	Recycle, Class 3 incinerator, small general landfill
Miscellaneous office, household and kitchen wastes	General waste, non-hazardous	Recycle, Class 3 incinerator, small general landfill
Garden refuse	General waste, wet non-hazardous	Recycle, Class 3 incinerator, small general landfill
Scrap metal (filters, parts, appliances)	General wastes, non-hazardous	Recycle, small general landfill
Nickel-cadmium torch batteries	Hazardous wastes	Recycle, mixed or hazardous waste landfill
Fluorescent lighting tubes	Hazardous wastes	Recycle, mixed or hazardous waste landfill
Medical sharps and associated wastes	Hazardous waste, medical	Class 2B incinerator, mixed or hazardous waste landfill
Spoiled drugs and empty drug bottles	Hazardous waste, medical	Class 2B incinerator, mixed or hazardous waste landfill

APPENDIX X (ii) SOLID WASTES NOTED AT SODWANA BAY REST CAMP

SOLID WASTES AND THEIR DISPOSAL OPTIONS

Waste Type	Classification	Disposal Options
Paper and office refuse	General Waste, dry non-hazardous	Recycle, Class 3 incinerator, small general landfill
Cardboard packaging	General Waste, dry non-hazardous	Recycle, Class 3 incinerator, small general landfill
Plastic packaging and packets	General Waste, inert non-hazardous	Recycle, Class 3 incinerator, small general landfill
Cans	General Waste, inert non-hazardous	Recycle, small general landfill
Plastic bottles	General Waste, inert non-hazardous	Recycle, small general landfill
Glass bottles	General waste, inert non-hazardous	Recycle, small general landfill
Food wastes (including seafood shells)	General waste, wet non-hazardous	Recycle, Class 3 incinerator, small general landfill
Miscellaneous office, household and kitchen wastes	General waste, non-hazardous	Recycle, Class 3 incinerator, small general landfill
Garden refuse	General waste, wet non-hazardous	Recycle, Class 3 incinerator, small general landfill
Sanitary wastes, nappies	General waste	Class 3 incinerator, small general landfill
Old tyres and motor plastics	General waste, inert, non-hazardous	Recycle, small general landfill
Scrap metal (filters, parts, appliances)	General wastes, non-hazardous	Recycle, small general landfill
Nickel-cadmium torch batteries	Hazardous wastes	Recycle, mixed or hazardous waste landfill
Fluorescent lighting tubes	Hazardous wastes	Recycle, mixed or hazardous waste landfill
Oil rags and miscellaneous	Hazardous wastes	Mixed or hazardous waste landfill
Medical sharps and associated wastes	Hazardous waste, medical	Class 2B incinerator, mixed or hazardous waste landfill
Spoiled drugs and empty drug bottles	Hazardous waste, medical	Class 2B incinerator, mixed or hazardous waste landfill

APPENDIX XI KZN WILDLIFE, SKUKUZA, RSA AND INTERNATIONAL WASTE COMPOSITION COMPARISONS

KZN Wildlife, Skukuza and RSA Protected Area Waste Composition

Waste types as percentage mass/mass

	Hilltop	Sodwana	KZN Wildlife	Skukuza	RSA
Glass	15%	22%	18%	24%	20%
Plastic	17%	16%	17%	7%	13%
Tins	12%	11%	11%	14%	12%
Paper	29%	17%	23%	19%	22%
Food	26%	34%	30%	31%	31%
Misc	1%	0%	1%	5%	2%
Total	100%	100%	100%	100%	100%

KZN Wildlife, Skukuza and RSA Protected Area Waste Composition

Waste types as percentage volume/volume

	Hilltop	Sodwana	KZN Wildlife	Skukuza	RSA
Glass	7%	9%	8%	8%	8%
Plastic	25%	25%	25%	18%	22%
Tins	17%	19%	18%	16%	17%
Paper	43%	37%	40%	48%	44%
Food	8%	10%	9%	9%	9%
Misc	0%	0%	0%	1%	0%
Total	100%	100%	100%	100%	100%

International Waste Composition Comparisons

Waste types as percentage mass/mass

	KZN Wildlife	Skukuza	RSA Dev'd	RSA Dev'g	RSA Soweto	USA Res
Glass	18%	24%	4%	2%	12%	4%
Plastic	17%	7%	17%	3%	3%	9%
Tins	11%	14%	6%	2%	3%	7%
Paper	23%	19%	36%	4%	9%	42%
Food	30%	31%	31%	5%	9%	36%
Misc	1%	5%	6%	84%	64%	2%
Total	100%	100%	100%	100%	100%	100%

	Holland	UK	Kuwait	Peru	Mexico	China
Glass	9%	12%	4%	3%	4%	1%
Plastic	7%	5%	5%	7%	6%	1%
Tins	3%	8%	6%	4%	6%	1%
Paper	24%	30%	34%	14%	17%	2%
Food	48%	25%	37%	56%	56%	15%
Misc	9%	20%	14%	16%	11%	80%
Total	100%	100%	100%	100%	100%	100%

APPENDIX XII (i) 1984 SURVEY OF WASTE DISPOSAL METHODS IN KZN WILDLIFE PROTECTED AREAS AND CHANGE BY 2000

		Protected Area Size and Disposal Method			
PROTECTED AREA	Distance to Municipal landfill	Municipal landfill	Pit and Burn method	Disposal to Pit only	Change by 2000 survey
1	6 km	76 ha			No change
5	5 km	208 ha			No change
41	5 km	393 ha			Changed to Pit and Burn
12	10 km	584 ha			No change
14	8 km	1777 ha			No change
60	20 km	1917 ha			Changed to Pit and Burn
18	30 km	858 ha			No change
26	4 km	3257 ha			No change
2	6 km		45 ha		Changed to Municipal Landfill
39	15 km		12873 ha		No change
42	25 km		2247 ha		No change
45	35 km		34638 ha		No change
8	1 km		105 ha		Changed to Municipal Landfill
50	55 km		2980 ha		No change
10	35 km		1726 ha		Changed to Municipal Landfill
11	4 km		211 ha		Changed to Municipal Landfill
30	40 km		3984 ha		Changed to Municipal Landfill
54	10 km		37985 ha		No change
15	75 km		10117 ha		Changed to Municipal Landfill
67	45 km		47753 ha		No change
68	20 km		2189 ha		No change
29	20 km		4183 ha		Changed to Municipal Landfill
38	30 km			21598 ha	Changed to Pit and Burn
40	15 km			293 ha	Changed to Pit and Burn
48	27 km			25633 ha	Changed to Pit and Burn
56	15 km			264 ha	Changed to Pit and Burn
16	4 km			53 ha	Changed to Municipal Landfill
63	35 km			8094 ha	Changed to Pit and Burn
71	25 km			41 ha	No year 2000 information
24	5 km			32 ha	Changed to Municipal Landfill
7	20 km			104 ha	Changed to Municipal Landfill
9	10 km			29653 ha	Changed to Municipal Landfill

Note: Due to the sensitivity of the information, protected areas have been numbered in place of their names.

APPENDIX XII (ii) 2000 SURVEY OF WASTE DISPOSAL METHODS IN KZN WILDLIFE PROTECTED AREAS PREVIOUSLY SURVEYED IN 1984

		Protected Area Size and Disposal Method	
PROTECTED AREA	**Distance to Municipal landfill**	**Municipal landfill**	**Pit and Burn method**
1	6 km	76 ha	
2	4 km	45 ha	
5	5 km	208 ha	
7	20 km	104 ha	
8	1 km	105 ha	
9	10 km	29653 ha	
10	35 km	1726 ha	
11	4 km	211 ha	
12	10 km	584 ha	
14	8 km	1777 ha	
15	75 km	10117 ha	
16	4 km	53 ha	
18	30 km	858 ha	
24	5 km	32 ha	
26	4 km	3257 ha	
29	20 km	4183 ha	
30	40 km	3984 ha	
38	30 km		21598 ha
39	15 km		12873 ha
40	15 km		293 ha
41	5 km		393 ha
42	25 km		2247 ha
45	35 km		34638 ha
48	27 km		25633 ha
50	55 km		2980 ha
54	10 km		37985 ha
56	15 km		264 ha
60	20 km		1917 ha
63	35 km		8094 ha
67	45 km		47753 ha
69	20 km		2189 ha

Note: Due to the sensitivity of the information, protected areas have been numbered in place of their names.

APPENDIX XII (iii) 2000 SURVEY OF WASTE DISPOSAL METHODS IN KZN WILDLIFE PROTECTED AREAS

PROTECTED AREA	Distance to Municipal landfill	Protected Area Size and Disposal Method: Municipal landfill	Pit and Burn method
1	6 km	76 ha	
2	4 km	45 ha	
3	10 km	700 ha	
4	18 km	21772 ha	
5	5 km	208 ha	
6	5 km	5 ha	
7	20 km	104 ha	
8	1 km	105 ha	
9	10 km	29653 ha	
10	35 km	1726 ha	
11	4 km	211 ha	
12	10 km	584 ha	
13	3 km	51 ha	
14	8 km	1777 ha	
15	75 km	10117 ha	
16	4 km	53 ha	
17	13 km	8825 ha	
18	30 km	858 ha	
19	15 km	93 ha	
20	35 km	2124 ha	
21	7 km	15 ha	
22	5 km	12545 ha	
23	40 km	30013 ha	
24	5 km	32 ha	
25	6 km	1028 ha	
26	4 km	3257 ha	
27	3 km	267 ha	
28	5 km	720 ha	
29	20 km	4183 ha	Pit and
30	40 km	3984 ha	Burn method
31	18 km		1476 ha
32	30 km		1700 ha
33	55 km		32246 ha
34	30 km		6845 ha
35	18 km		21772 ha
36	20 km		30498 ha
37	40 km		1272 ha
38	30 km		21598 ha
39	15 km		12873 ha
40	15 km		293 ha
41	5 km		393 ha
42	25 km		2247 ha
43	37 km		1500 ha
44	50 km		30766 ha
45	35 km		34638 ha
46	45 km		28151 ha

Continuation of APPENDIX XII (iii)

PROTECTED AREA	Distance to Municipal landfill	Protected Area Size and Disposal Method: Pit and Burn method
47	25 km	1213 ha
48	27 km	25633 ha
49	50 km	2750 ha
50	55 km	2980 ha
51	75 km	1103 ha
52	25 km	15250 ha
53	10 km	2857 ha
54	10 km	37985 ha
55	35 km	20379 ha
56	15 km	264 ha
57	17 km	8759 ha
58	25 km	2216 ha
59	25 km	3904 ha
60	20 km	1917 ha
61	40 km	11917 ha
62	5 km	293 ha
63	35 km	8094 ha
64	35 km	762 ha
65	40 km	7283 ha
66	20 km	2100 ha
67	45 km	47753 ha
68	60 km	49156 ha
69	20 km	2189 ha
70	15 km	764 ha

Note: Due to the sensitivity of the information, protected areas have been numbered in place of their names.

APPENDIX XIII HILLTOP WASTE DISPOSAL SITE AUDIT

HILLTOP WASTE DISPOSAL SITE AUDIT

(Adapted with thanks from Lombard and Associates Audit Schedule)

Inspection date: 29th May 2000

CATEGORY	OK	COMMENTS
1. ENVIRONMENTAL IMPACT		
1.1 Visual appearance		
Site neatness	✖	Site boundary evident, with piles of sorted recyclable materials.
Wind scatter	✖	Plastic bags and paper blowing around site.
Site maintenance	✖	Waste placed into pit and burnt. However, rainwater collecting in pit prevents complete combustion.
1.2 Health & hygiene		
Odorous	✖	Smell of burning waste, uncovered and decomposing waste.
Pests	✖	Baboons, flies, crows and rats.
Sanitary landfill (daily covering)	✖	Not covered with soil, simply burnt *in situ*. Water collects in pit together with semi-burnt wastes.
1.3 Water pollution		
Leachate quality	?	No monitoring done but leachate production is very likely given the water entering and passing through the partially combusted wastes in the unlined, open pit.
Leachate management	✖	None.
Monitoring of groundwater	✖	Not done.
2. SITE MANAGEMENT		
2.1 PUBLIC INVOLVEMENT		
Complaints register	✖	None in place as not public access site, but would be easy to set up a complaints register at office.
Community participation programme	✖	There is still a programme in place where local women sort recyclable waste for sale. It has not been collected for some time now and the local women were scavenging rather than sorting on the day of this site inspection.
2.2 DOCUMENTATION		
Operation Management Plan	✖	Doesn't exist and is needed.

Continuation of APPENDIX XIII

CATEGORY	OK	COMMENTS
Closure Plan	✖	Doesn't exist and is needed.
Contingency Plan	✖	Doesn't exist and is needed.
Regular internal audits	✖	These need to form part of the operational management plan.
2.3 WASTE DISPOSAL		
Clearly defined operational area	✔	Area clearly defined, however, not fully fenced.
Compaction of appropriate waste	✖	None.
Sorting of recyclables	✖	Sorting does take place and most glass bottles and tins are separated out into piles. However, these are not removed from the site.
Incineration of appropriate waste	✖	Open burning, partial combustion of all wastes, including PVC's etc.
Co-disposal of suitable wastes	N/A	All wastes co-disposed (domestic type wastes).
Cover of waste (see 1.2)	✖	Not covered at time of site inspection.
Berms to control water pollution	✖	None. Pit is at lower end of a grassed slope, but water appears to collect in it. No berms below the pit either.
2.4 SAFETY MEASURES		
Site fenced and locked gate	✖	Incomplete fence and gate not closed (although reserve is fenced as a whole).
First aid training & kit	✖	At main offices approximately four kilometres away (ideally this should be on site while staff or community members are working there).
Fire alarm and communications	✖	Staff had radios when delivering waste to the site. However, community members had no communication on site.
Fire controls in place	✖	No emergency plans in place. Open burning of waste is a fire hazard to the reserve.
Accident reporting system	✔	Same system as in place for whole reserve.
Staff protective clothing	✔	Uniforms, boots and gloves are provided to staff collecting waste. However, community members sorting waste were not wearing protective gloves or boots.
2.5 SITE FACILITIES		
Site Office	✖	At main offices approximately four kilometres away.

Continuation of APPENDIX XIII

	CATEGORY	OK	COMMENTS
	Ablution facilities on site	✖	At main offices approximately four kilometres away.
2.6	MACHINERY		
	Properly maintained	?	None on site at time of inspection.
	Operated according to plan	✖	No plan in place.
3.	LEGISLATIVE COMPLIANCE		
3.1	WATER ACT & ENVIRONMENTAL CONSERVATION ACT		
	DWAF Permit i.t.o. ECA Sect 20 Act 73 of 1989	✖	Site is unlicenced.
	Results of leachate and monitoring available to authorities	✖	No leachate and ground water monitoring conducted.
	ECA Sect 21 and 26 authorisation for waste disposal	✖	No authorisation in place.
3.2	ATMOSPHERIC POLLUTION PREVENTION ACT		
	Approved incineration (section 10 of Act 45 of 1965)	✖	Open burning of wastes.
3.3	OCCUPATIONAL HEALTH AND SAFETY ACT		
	Safety requirements (Act 85 of 1993)	✖	Have not taken precautions to evaluate risks and provide all precautionary measures (e.g. noxious gases from open burning may endanger workers on the site unless suitable preventative measures undertaken).

APPENDIX XIV SODWANA BAY WASTE DISPOSAL SITE AUDIT

SODWANA BAY WASTE DISPOSAL SITE AUDIT

(Adapted with thanks from Lombard and Associates Audit Schedule)

Inspection date: 26th June 2000

CATEGORY		OK	COMMENTS
1.	ENVIRONMENTAL IMPACT		
1.1	Visual appearance		
	Site neatness	✖	Untidy site, no clear boundaries, waste scattered & dropped around site.
	Wind scatter	✖	Plastic bags and paper blowing around site.
	Site maintenance	✖	Waste compacted and burnt fairly regularly when staff and machinery available. However, site as a whole is not maintained.
1.2	Health & hygiene		
	Odorous	✖	Smell of burning waste and uncovered decomposing material.
	Pests	✖	Monkeys, flies, crows and rats.
	Sanitary landfill (daily covering)	✖	Not covered with soil, simply burnt *in situ*.
1.3	Water pollution		
	Leachate quality	?	No monitoring done but leachate production is very likely given high coastal rainfall, open, unlined pit, sandy soils and the partially combusted mixed wastes in the pit.
	Leachate management	✖	None.
	Monitoring of groundwater	✖	Not done.
2.	SITE MANAGEMENT		
2.1	PUBLIC INVOLVEMENT		
	Complaints register	✖	None in place as not public access site, but would be easy to set up a complaints register at office.
	Community participation programme	✖	There used to be a programme in place until it was vandalised. It is possible to start it up again. However, this would not be advisable until the site is properly managed as may be legal liabilities if a community member is injured /falls ill.
2.2	DOCUMENTATION		
	Operation Management Plan	✖	Doesn't exist and is needed.

Continuation of APPENDIX XIV

CATEGORY	OK	COMMENTS
Closure Plan	✖	Doesn't exist and is needed.
Contingency Plan	✖	Doesn't exist and is needed.
Regular internal audits	✖	These need to form part of the operational management plan.
2.3 WASTE DISPOSAL		
Clearly defined operational area	✔	Area clearly defined, however not fenced.
Compaction of appropriate waste	✔	Compaction of wastes in pit, however, not regularly, nor in layers.
Sorting of recyclables	✖	There was an effective sorting programme previously, however, any wastes sorted at the moment are not removed .
Incineration of appropriate waste	✖	Open burning, partial combustion of all wastes, including PVC's etc.
Co-disposal of suitable wastes	N/A	All wastes co-disposed (domestic type wastes).
Cover of waste (see 1.2)	✖	Not covered at time of site inspection.
Berms to control water pollution	N/A	Soils are sandy and waste site is excavated into these soils. There is little/no surface water flow as all rain soaks in almost immediately.
2.4 SAFETY MEASURES		
Site fenced and locked gate	✖	No continuous fence (although reserve is fenced as a whole, public are accessing site from the nearby town as is evidenced by certain wastes such as parts of boats dumped on site).
First aid training & kit	✖	At main offices approximately three kilometres away (ideally this should be on site while staff are working there).
Fire alarm and communications	✖	Staff had no communication on site.
Fire controls in place	✖	No emergency plans in place. Open burning of waste is a fire hazard to the reserve.
Accident reporting system	✔	Same system as in place for whole reserve.
Staff protective clothing	✔	Uniforms, boots and gloves are provided to staff. However, staff collecting waste from camp were not wearing protective gloves or boots.
2.5 SITE FACILITIES		
Site Office	✖	At main offices approximately three kilometres away.
Ablution facilities on site	✖	At main offices approximately three kilometres away.

Continuation of APPENDIX XIV

	CATEGORY	OK	COMMENTS
2.6	MACHINERY		
	Properly maintained	?	None on site at time of inspection.
	Operated according to plan	✖	No plan in place.
3.	LEGISLATIVE COMPLIANCE		
3.1	WATER ACT & ENVIRONMENTAL CONSERVATION ACT		
	DWAF Permit i.t.o. ECA Sect 20 Act 73 of 1989	✖	Site is unlicenced.
	Results of leachate and monitoring available to authorities	✖	No leachate and ground water monitoring conducted.
	ECA Sect 21 and 26 authorisation for waste disposal	✖	No authorisation in place.
3.2	ATMOSPHERIC POLLUTION PREVENTION ACT		
	Approved incineration (section 10 of Act 45 of 1965)	✖	Open burning of wastes.
3.3	OCCUPATIONAL HEALTH AND SAFETY ACT		
	Safety requirements (Act 85 of 1993)	✖	Have not taken precautions to evaluate risks and provide all precautionary measures (e.g. noxious gases from open burning may endanger workers on the site unless suitable preventative measures undertaken).

APPENDIX XV SKUKUZA WASTE DISPOSAL SITE AUDIT

SKUKUZA WASTE DISPOSAL SITE AUDIT

(Adapted with thanks from Lombard and Associates Audit Schedule)

Inspection date: 14th September 1999

	CATEGORY	OK	COMMENTS
1.	ENVIRONMENTAL IMPACT		
1.1	Visual appearance		
	Site neatness	✔	Site boundary clearly marked and fenced. Clearly defined areas for the storage of recyclable materials.
	Wind scatter	✔	None evident.
	Site maintenance	✔	Waste sorted under roof on concrete area. Recyclables and hazardous wastes removed. Remaining waste incinerated. Ashes removed and placed into pit adjacent to incinerators. Ash covered over with sand.
1.2	Health & hygiene		
	Odorous	✔	Not noticeable.
	Pests	✔	Site fully fenced with electric fencing to prevent scavengers. Only birds able to enter site and do not approach waste that is being sorted.
	Sanitary landfill (daily covering)	✔	Sand layered over ashes to prevent ashes blowing around.
1.3	Water pollution		
	Leachate quality	?	No monitoring done but leachate production is very unlikely given the negative climatic water budget, the covered sorting area and the fully combusted ashes disposed of to the adjacent ash pit.
	Leachate management	-	None required.
	Monitoring of groundwater	✖	None evident.
2.	SITE MANAGEMENT		
2.1	PUBLIC INVOLVEMENT		
	Complaints register	✔	There is a public complaints register at the office. Public are not permitted to access to the waste site or its surrounds.
	Community participation programme	✖	Sorting and management of incinerators and waste site is conducted by trained staff.

Continuation of APPENDIX XV

	CATEGORY	OK	COMMENTS
2.2	DOCUMENTATION		
	Operation Management Plan	✔	A clear set of technical management guidelines has been produced and is adhered to.
	Closure Plan	✔	This forms part of the operational management plan as no immediate closure is foreseen.
	Contingency Plan	?	Unsure if this exists.
	Regular internal audits	✔	These are conducted informally by technical staff on a regular basis and are part of the camp maintenance programme.
2.3	WASTE DISPOSAL		
	Clearly defined operational area	✔	Area clearly defined, fully fenced, with a lockable gate.
	Compaction of appropriate waste	N/A	Waste is incinerated.
	Sorting of recyclables	✔	Separation of glass bottles, tins and hazardous wastes takes place. Each is stored separately for collection.
	Incineration of appropriate waste	✔	Incineration of waste in approved class three incinerator, reaching 850°C. Waste is reduced to ashes.
	Co-disposal of suitable wastes	N/A	All wastes co-disposed (domestic type wastes), although batteries are sorted from the waste wherever possible.
	Cover of waste (see 1.2)	✔	Sand scattered over ashes.
	Berms to control water pollution	N/A	Waste is sorted on a raised platform and water contaminated through washing down the platform is channelled into an approved soakaway system.
2.4	SAFETY MEASURES		
	Site fenced and locked gate	✔	Yes.
	First aid training & kit	✔	There is a complete first aid kit on the waste site and staff are trained in basic first aid.
	Fire alarm and communications	✔	Staff have radio communication with reserve management.
	Fire controls in place	✔	Fire extinguishers on site. Incineration does not pose a high fire risk.
	Accident reporting system	✔	Use same system as for other protected area staff.
	Staff protective clothing	✔	Uniforms, boots and gloves are provided to staff collecting waste.

	CATEGORY	OK	COMMENTS
2.5	SITE FACILITIES		
	Site Office	✔	Container serves as a site office and a first aid kit is stored here.
	Ablution facilities on site	✔	Toilets provided on site.
2.6	MACHINERY		
	Properly maintained	✔	Incinerators appeared to be in good working order.
	Operated according to plan	✔	Yes.
3.	LEGISLATIVE COMPLIANCE		
3.1	WATER ACT & ENVIRONMENTAL CONSERVATION ACT		
	DWAF Permit i.t.o. ECA Sect 20 Act 73 of 1989	✖	Site is unlicenced.
	Results of leachate and monitoring available to authorities	✖	No leachate and ground water monitoring conducted.
	ECA Sect 21 and 26 authorisation for waste disposal	✔	DEAT has approved the incinerators and the disposal of the ashes.
3.2	ATMOSPHERIC POLLUTION PREVENTION ACT		
	Approved incineration (section 10 of Act 45 of 1965)	✔	DEAT has approved the incinerators and the disposal of the ashes.
3.3	OCCUPATIONAL HEALTH AND SAFETY ACT		
	Safety requirements (Act 85 of 1993)	✔	Staff have been trained and have required safety equipment provided on site. Only trained and designated staff are allowed to work at the disposal site and operate the incinerators.

APPENDIX XVI PENALTIES FOR NON-COMPLIANCE WITH WASTE MANAGEMENT LEGISLATION

Environment Conservation Act 73 of 1989. Activities listed in section 21 of the Environment Conservation Act 73 of 1989 (this includes waste disposal sites) must be authorised in terms of section 22. Contraventions of section 22 (either no authorisation obtained or the failure to comply with the authorisation) are liable upon conviction to a fine not exceeding R100 000 or to imprisonment for a period not exceeding ten years, or both, as well as to a fine not exceeding three times the commercial value of anything in respect of which the offence was committed (section 29). There are further penalties for the continuation of the offence on a daily basis, as well as full repair of any damage to the environment. In the event of ground water pollution, this could prove extremely costly.

The operation of a waste site without the required permit in terms of section 20 of the Act or who contravenes the conditions of such permit, is subject to the same penalties (section 29), upon conviction, as set out above.

National Environmental Management Act 107 of 1998. The costs of rectifying the pollution or degradation may be recovered from the person or organisation in control of the land and additional charges in terms of other sections of legislation may apply. A further provision is made for private prosecution (*locus standi*, sections 32 and 33) and personal liability of a director of the firm (the legal standing of a member of the executive of a parastatal organisation is unclear in this regard) that committed the pollution offence is provided for in section 34 (proof of the offence having been committed by the organisation will constitute *prima facie* evidence that the director is guilty).

Atmospheric Pollution Prevention Act 45 of 1965. Operation of a scheduled process in terms of the Atmospheric Pollution Prevention Act 45 of 1965 (such as incineration of certain substances) without a registration certificate is subject, upon conviction, to a first conviction fine not exceeding R500 or six month imprisonment, and subsequent conviction fine not exceeding R2000 or one year imprisonment.

Water Act of 1956 and National Water Act 36 of 1998. The 1998 National Water Act has repealed the offenses section of the 1956 Water Act and It is not fully clear what penalties apply. However the failure to treat effluent or purify water leaving an activity and entering the environment would remain an offence and the penalties proscribed for water pollution (section 151 of the National Water Act 36 of 1998) may apply. These are a fine and/or imprisonment not exceeding five years for a first offence and a fine and/or imprisonment not exceeding ten years for subsequent offenses.

Disposing of effluent in contravention of section 7 of the Water Services Act 108 of 1997, after conviction, is liable to a fine and/or imprisonment. Provision is made in section 82 of the Act to hold an employer liable or co-liable in instances where the offence is committed by an employee acting with the express or implied permission of the employer.

The use of and discharge of water from an incineration site can be considered a "water use" in terms of the National Water Act 36 of 1998. Failure to register such use is considered an offence and subject to the penalties described under section 151 of the Act. As before the employer may be held liable where the employee was found to be acting with permission.

Occupational Health and Safety Act 85 of 1993. Each set of Regulations according to the Occupational Health and Safety Act 85 of 1993 prescribes its own penalties for contraventions, e.g. the Hazardous Chemical Substances Regulations allow for a fine or imprisonment not exceeding six months as well as an additional R200 per day fine for continuing offences up to 90 days.

The Prevention of Environmental Pollution Ordinance (Natal) 21 of 1981. If convicted of an offence in terms of section 2 of the Ordinance, a fine not exceeding R1000 and/or twelve months imprisonment may be imposed.

APPENDIX XVII SOLID WASTE MANAGEMENT POLICY DRAFTED FOR KZN WILDLIFE (by I Hatton)

EZOKONGIWA KWEMVELO KZN
KZN NATURE CONSERVATION SERVICE
KZN NATUURBEWARINGSDIENS

POLICY

SUBJECT: **SOLID WASTE MANAGEMENT WITHIN PROTECTED AREAS.** POLICY FILE NO:

DATE OF BOARD APPROVAL: BOARD MINUTE:

REVISED:

Protected areas are benchmark areas for biodiversity conservation and ecological functioning in that they remain the few areas that are not significantly impacted upon by modern man. Ecotourism development and management of these areas leads to waste accumulation and associated unacceptable impacts through landfill and toxic waste disposal. For this reason a policy is required to ensure that their benchmark status is protected.

The KwaZulu Natal Nature Conservation Board, RECOGNISING that :

1. it is KZN Wildlife's mission to assure the environmental integrity of its protected areas;

2. solid waste is an unavoidable by-product of both protected area management activities and visitor use and has to be actively managed in order to avoid affecting the integrity of a protected area;

3. certain solid wastes may be re-usable or recyclable and may provide opportunities for partnerships, community participation projects or revenue generation;

and REALISING that :

(xiv) there are national standards, policies and principles for waste management and practice such as "care of duty", "polluter pays", "waste avoidance and minimisation", "cradle-to-grave responsibility " and "best practicable environmental option", and that these are encompassed in legislation such

Continuation of APPENDIX XVII

as the National Water Act, National Environmental Management Act and Prevention of Atmospheric Pollution Act as well as other documents such as coastal management policies and guideline documents.

(xv) different volumes and types of solid wastes, of varying toxicity, may require alternative collection, handling, transport, storage and disposal strategies for waste management;

(xvi) there are significant costs involved in managing solid wastes and the removal of all solid wastes from distant sources areas may be prohibitively expensive;

UNDERTAKES to :

- ensure that solid waste management does not challenge the environmental integrity of the protected areas;
- dispose of solid waste in accordance with the relevant legislative requirements, government policies and guidelines, and approvals;
- sort and remove all toxic solid waste from protected areas;
- sort and remove all other solid wastes from protected areas where economically realistic, failing which these wastes will be managed as efficiently and effectively as possible and in accordance with the above undertakings. This includes:
  a. reducing waste at source,
  b. recovering materials before they enter the waste stream,
  c. separating and recycling suitable materials, and
  d. ensuring safe disposal of toxic and unavoidable waste through removal to appropriate disposal sites or use of appropriate on-site technology.
- foster community participation and partnerships in waste recycling and management where opportunities exist;
- promote the ethics of responsible solid waste management among staff and visitors. This includes reduction, removal, re-use, and recycling of solid wastes.

APPENDIX XVIII EXTRACT FROM SOLID WASTE MANAGEMENT PLAN FOR THE CENTENARY CENTRE (UMFOLOZI GAME RESERVE)

(Hatton, 2000)

Overall Management Objective:

To ensure that solid wastes are responsibly managed so that the effective ecological functioning of the protected area is not affected by their production, management and disposal.

In order to achieve the above objective, a number of more specific management objectives have been set out. Each of these may have goals and actions that are required in order to achieve the objectives and goals.

4.1.1 WASTE MANAGEMENT AREA

Management Objective:

To select, design and operate a general wastes management area in such a manner that impacts on the surrounding natural environment are insignificant.

While land-filling imported wastes within a protected area is not considered acceptable practice, a waste management, sorting and storage area is required to handle wastes prior to their removal, recycling, or incineration.

In order to achieve this, three Goals, each with specific actions have been identified:

4.1.1.1 LOCATION OF WASTE MANAGEMENT AREA

Goal: To locate the proposed waste management area in an environmentally acceptable position, minimising potential negative impacts on the surrounding landscape, while enhancing functionality of the waste management area.

In accordance with the Minimum Requirements for Waste Disposal by Landfill, Volume 1, incineration requirements and the operational requirements of the KZN Wildlife waste management staff, the following criteria have been used to choose the most appropriate site. These are that the site should not be:

- within 500m from an airport or airfield boundary;
- within the 1:50 year floodline;
- in close proximity to permanent / temporary water bodies;
- in geologically unstable areas;
- in ecologically / historically sensitive areas;
- on highly permeable soils;
- on areas overlying / adjacent to aquifers;
- close to incompatible landuses, without suitable buffers;
- upwind of a residential area (prevailing wind);
- within any area that would not be able to be rezoned to permit waste disposal;

- situated on a previously undisturbed area;
- too narrow or steep to manage wastes or control stormwater runoff;
- requiring significant earthworks to allow access to the site;
- unsuitable for incineration due to prevailing winds;
- situated in a location where temperature inversions are likely, particularly if incineration is being considered;
- inaccessible to members of the community working at the site or place such persons at risk in reaching the site;
- difficult to access by recycling organisations / waste disposal contractors that may be required to remove certain waste types.

Action Plan:

a. Evaluate potential sites within a 3 km radius of the Centenary Centre according to the above criteria and select most appropriate site.

4.1.1.2 DESIGN OF WASTE MANAGEMENT AREA

Goal: To design a simple and practical waste management area in accordance with Best Practicable Environmental Option principles, so that it has the minimum negative impact on the surrounding natural areas, while remaining both functional and cost-effective.

Action Plan:

a. Study similar waste handling, storage and disposal facilities in protected areas.

- This has been undertaken for a number of KZN Wildlife managed protected areas, as well as Golden Gate National Parks and the Kruger National Park.
- These studies indicate the following essential design criteria:
  - The site must be fenced with animal-proof fencing. It is recommended that the fencing be electrified through the use of a solar panel or directly from a power source if available. This will also provide staff sorting the waste with security, prevent scavenging and act as a barrier to wind-blown wastes. A lockable steel entrance gate is recommended.
  - The sorting area should be hardened and covered, ideally with a concrete floor and covering roof. The concrete floor will prevent spillages soaking into the soils and provide a stable area for an incinerator to be placed upon, while a roof will allow sorting regardless of weather conditions and prevent rain washing through the wastes, polluting run-off water. The sorting area may further require a mesh fence/cage to prevent wind blown pollution.
- An incinerator capable of disposing of general wastes that cannot be reduced, reused or recycled, must be provided (class 3 incinerator).

This incinerator should be able to burn at temperatures in excess of 850°C.

- Bins and collection facilities should be provided for all wastes sorted. This includes concrete containers and storage areas for other waste storage containers (e.g. bags for cans).
- Ablution facilities must be provided for staff on site.
- A polluted water containment pond to collect run-off water from the waste management area, must be constructed at the downslope end of the area. Sediments suspended in run-off water will settle out in this pond before the water enters the natural environment.

b. Undertake a comparison of practical design differences and other specific local criteria, and draft a layout sketch (Appendix III).

c. Gain approval for the above sketch by management and technical staff, finalise and convert into working drawings for construction.

d. Complete waste management area so as to coincide with the commencement of the operational phase of the Centenary Centre Complex.

4.1.1.3 MANAGEMENT OF THE WASTE MANAGEMENT AREA

Goal: To manage the designed waste management area efficiently, in accordance with relevant legislation, ensuring that waste handling, storage and disposal impacts on the surrounding natural environment are insignificant.

Action Plan:

a. Safe and healthy working conditions must be provided for waste management staff. This would include the following:

- Staff in contact with wastes must be provided with protective clothing, including safety hand-and-footwear.
- Coveralls should be worn by staff handling wastes and staff should change from these clothes before leaving the disposal site each day.
- Ablution facilities must be provided for staff on site.
- A first-aid kit must be available on site.

b. Waste management area staff must be properly trained in waste handling and disposal.

- KZN Wildife staff must be adequately trained to deal with the collection, sorting, storage and disposal of all wastes entering the management area.
- Local management staff may organise for members from the local community to sort the wastes. Training is required for these members of the community and should include not only the handling and sorting of wastes, but the recycling of certain wastes, particularly glass and plastics.

- No member of staff or community member may enter the waste disposal area without the necessary training or management permission.

- Community members must not be allowed to handle medical and veterinary wastes. Only trained KZN Wildlife staff from the game capture and veterinary facility shall be allowed to dispose of medical wastes and diseased carcasses.

c. The following procedure should be followed for waste management, sorting and disposal:

- General waste brought to the site must be deposited on the hardened area, where it will be sorted into glass, tins, plastics, and biodegradable wastes.

- Bins and collection facilities will be provided for all recyclable wastes.

  - Glass should be stored in suitable concrete structures,

  - Tins should be crushed and stored in bags that can be obtained from Collect-a-Can for this purpose,

  - Plastics should be stored in packaging suitable for removal and disposal to a registered landfill site.

  - A water-tight disposal bin for the collection of soils that have become contaminated with oils and other hazardous substances must be provided on site. These soils must be removed from the site and disposed of at an appropriate facility.

- Batteries and fluorescent tubes must be removed from the wastes and disposed of in specialised containers.

- Initially, all biodegradable wastes will either be incinerated or removed by a local pig-farmer. The possibility of composting these wastes, together with ash must be investigated. The compost could then be removed and used by the neighbouring community.

- Medical and veterinary wastes must not be brought into the waste management area. Should these wastes enter the general waste management area, they and other contaminated wastes must be removed immediately and the area where such wastes have been handled must be disinfected before community members or general waste management staff return to sort other wastes.

d. The incinerator must be operated as safely and efficiently as possible.

- The incinerator will be loaded with paper wastes at the bottom and other wastes above, to generate the maximum heat in the shortest time.

- The door will be secured shut before the incinerator is lit and may on no account be opened during the incineration of a load.

- The torch used to light the incinerator will be extinguished between loads.

- A cooling period will be allowed between loads and the ash grid cleared before the next load of waste is placed.

e. Burnt wastes and ashes must be placed within a watertight bin within the confines of the disposal site on a daily basis, or mixed into the composting bin should this recycling project proceed.

4.1.2 GENERAL WASTE MINIMISATION

Management Objective:

To minimise the quantity of solid wastes produced at Centenary Centre wherever practicably possible, reducing potential negative impacts of waste generation and disposal on the environment.

In order to achieve this, two Goals, each with specific actions have been identified, namely; reduce and recycle solid wastes.

4.1.2.1 REDUCE SOLID WASTES

Goal: To reduce the quantity of potential solid wastes entering, produced and being disposed of within the protected area.

Action Plan:

a. Remove wastes from the protected area.

- Visitors could be requested to take their wastes back home with them when visiting the protected area for short periods of time. This may not be practical for some wastes and is likely to meet with resistance from public, however it should form part of a long term education project.

b. Limit the amount of non-recyclable goods entering the protected area.

- The amount and type of packaging entering the protected area can be limited through careful buying and specific requests and requirements to distributors.

- The packaging of goods being sold within the protected area should be examined and recyclable packing given preference. This includes types of container (e.g. cans vs plastics) and sales packaging (paper or biodegradable plastic packets vs ordinary plastic packets).

- Staff must also be encouraged to use recyclable goods and reduce packaging.

4.1.2.2 RECYCLE SOLID WASTES

Goal: To recycle solid wastes wherever possible in order to reduce the quantity of raw materials required to produce the item initially, and reducing the quantity of wastes that have to be disposed of in the protected area.

Action Plan:

a. As not all wastes are as easily disposed of or recycled due to limited markets and distance from such recycling depots, it is recommended that the types of waste produced be manipulated to favour those which are most easily recycled and disposed of.

- It is recommended that the kiosk sell only drinks in recyclable containers (e.g. tins), whenever possible.

- The sale of bottled water in a variety of containers needs to be investigated, as does the plastics and glass recycling markets. Distributors with a strong environmental ethic (preferably one that extends to removing their empties from the Hluhluwe Umfolozi Park, should be favoured when purchases are made.

b. A recycling programme / contract should be investigated. A representative of a recycling company (Ecosystems) has shown interest in collecting the tins cans from a waste management site at Mambeni Gate.

- The community would be involved in sorting and recycling, and funds raised would go to the community. A proposal in this regard is anticipated in the near future from the recycling company. Local management staff would organise for members from the local community to sort the wastes.

- Training is required for these members of the community and should include not only the handling and sorting of wastes, but the recycling of certain wastes (possibly to produce curios), particularly glass and plastics where a formal recycling market is not currently available.

c. An investigation into the production and uses of polywood (recycled plastic) should be undertaken. The use of polywood at KZN Wildlife facilities would be in keeping with responsible integrated environmental practices.

d. When possible, biodegradable wastes (food remains) will be removed by a local pig-farmer.

e. A composting programme for other biodegradable matter will be investigated. Manure from the pens could be used in such a project.

f. Car batteries, tyres and scrap metal should be stored at the workshop area and taken to local motor and scrap dealers for recycling.

4.1.3 GENERAL WASTE DISPOSAL

Management Objective:

To dispose of solid wastes that cannot be reduced, re-used or recycled as recommended in 4.1.2, in accordance with legislative requirements and so that potential negative impacts on the functioning of the protected area are insignificant.

Action Plan:

a. Waste must be collected at source in the following manner:

- Both the Game Capture and Tourism and Information Centre site

are fenced to prevent animals from entering. For this reason, scavenger-proof bins may not be required. Should this become an issue, due to monkeys or birds, such bins will have to be secured.

- Lidded bins must be provided for waste disposal at all kitchen facilities.

- Litter bins collecting waste foods and cans must be emptied within one hour of becoming full and the waste stored in a secure lidded bin.

b. Waste must be regularly of collected and removed to the waste management area:

- Collection of all biosolids (kitchen refuse, animal pen grass, garden refuse, remaining feed etc.) should be on a daily / every second day basis.

- Office and packaging wastes can be removed at weekly or two weekly intervals.

- Alien seeds imported in animal feeds must be controlled. Alien plants must be removed and sent with the general wastes to the management for incineration.

c. Incineration of wastes:

- Recyclable wastes and wastes not suitable for incineration must be sorted from the general wastes.

- Non-recyclable wastes must be immediately (same day) burnt in the class 3 type incinerator that will be available at the waste management area. A sketch plan for a similar incinerator used in the Kruger National Park and approved by the National Department of Environmental Affairs and Tourism is available for inspection.

- Ashes will be collected and stored in a container until they can be removed to a registered landfill site for disposal, or used in the composting project.

- A study will be also conducted into the impacts of incinerator ash dispersed into the natural environment. It may be practical to bury the ash with the diseased carcasses as instructed by the State Veterinarian or for it to be mixed in with the bio-solids.

- A record of wastes disposed of must be kept by the site manager. This will record volumes and types of waste, particularly exceptional wastes received.

APPENDIX XIX SOLID WASTE ANTICIPATED FROM SOURCES AT THE CENTENARY CENTRE COMPLEX

Extract from Centenary Centre Waste Management Plan (Hatton, 2000)

SOLID WASTE ANTICIPATED FROM SOURCES AT THE CENTENARY CENTRE COMPLEX		
Game Capture Facilities		**Wastes produced**
Game capture	Pens	Contaminated sand, grass, remaining feed, occasional dead animal, manure.
	Field capture operation	Empty drug bottles, syringes, medical sharps, spoiled drugs, batteries, miscellaneous wastes.
	Administration offices	Paper and office wastes, miscellaneous food packaging.
Veterinary facility	Laboratory and dissection area	Animal parts and carcasses (some diseased/contaminated), veterinary medicine bottles, sharps and associated wastes.
Administration offices	Administration offices	Paper and office wastes, fluorescent lighting.
Feed sheds	Feed sheds	Baling and packaging, foreign seeds.
Future workshop area	Administration area	Paper and office wastes, fluorescent lighting.
	Workshop area	Scrap metal, vehicle parts, chemicals (mostly cleaning materials), tyres, car batteries, miscellaneous wastes.
	Refuelling area	Some oil rags.
	Washing and parking bays	Solid wastes from capture crates, miscellaneous wastes, litter from vehicles.
Staff canteen	Canteen and kitchen	Small amount of domestic wastes.
Ablution facilities	Toilets and washbasins	Sanitary wastes.
Helipad	Helipad	No wastes anticipated.
Grassed areas	Grassed areas	Garden refuse.
Hardened areas	Hardened areas (gravelled)	No wastes anticipated.
	Roofs	No wastes anticipated.
Tourism and Centre Information		**Wastes Produced**
Exhibition centre	Exhibition centre	Food and beverage wastes, fluorescent lighting tubes.

Continuation of APPENDIX XIX

Tourism and Centre Information		Wastes produced
Curio centre	Curio centre shops	Packaging, food and beverage wastes.
Auditorium	Auditorium	Food and beverage wastes.
Take-away food kiosk	Take-away food kiosk	Packaging and assorted food wastes.
Day visitor ablution facilities	Ablution facilities	Sanitary wastes and disposable nappies.
Parking area	Gravelled area (50 cars and 5 buses)	Litter, food and beverage wastes, miscellaneous wastes from vehicles.

Note: The staff accommodation section was the subject of a separate application and those wastes are not included in the above table.

APPENDIX XX ANTICIPATED SOLID WASTES AND THEIR DISPOSAL OPTIONS AT THE CENTENARY CENTRE COMPLEX

Extract from Centenary Centre Waste Management Plan (Hatton, 2000)

ANTICIPATED SOLID WASTES AND THEIR DISPOSAL OPTIONS		
Waste Type	**Classification**	**Disposal Options**
Paper and office refuse	General Waste, dry non-hazardous	Recycle, Class 3 incinerator, general domestic waste landfill
Cardboard packaging	General Waste, dry non-hazardous	Recycle, Class 3 incinerator, general domestic waste landfill
Plastic packaging and packets	General Waste, inert non-hazardous	Recycle, Class 3 incinerator, general domestic waste landfill
Cans	General Waste, inert non-hazardous	Recycle, general domestic waste landfill
Plastic bottles	General Waste, inert non-hazardous	Recycle, general domestic waste landfill
Glass bottles	General waste, inert non-hazardous	Recycle, general domestic waste landfill
Food wastes	General waste, wet non-hazardous	Recycle, Class 3 incinerator, general domestic waste landfill
Miscellaneous office, household and kitchen wastes	General waste, non-hazardous	Recycle, Class 3 incinerator, general domestic waste landfill
Garden refuse	General waste, wet non-hazardous	Recycle, Class 3 incinerator, general domestic waste landfill
Spoiled animal feed	General waste, non-hazardous	Class 3 incinerator, general domestic waste landfill
Soiled grass/sand from pens	General waste, non-hazardous	Class 3 incinerator, general domestic waste landfill
Manure	General waste, non-hazardous	Class 3 incinerator, general domestic waste landfill
Sanitary wastes, nappies	General waste	Class 3 incinerator, general domestic waste landfill
Old tyres and motor plastics	General waste, inert, non-hazardous	Recycle, general domestic waste landfill
Scrap metals (filters, parts, appliances)	General wastes, non-hazardous	Recycle, general domestic waste landfill
Car batteries	Hazardous wastes	Recycle, general domestic or hazardous waste landfill
Nickel-cadmium torch batteries	Hazardous wastes	Recycle, general domestic or hazardous waste landfill

Continuation of APPENDIX XX

Waste Type	Classification	Disposal Options
Fluorescent lighting tubes	Hazardous wastes	Recycle, class general domestic or hazardous waste landfill
Oil rags and miscellaneous	Hazardous wastes	General domestic or hazardous waste landfill
Medical sharps and associates wastes	Hazardous waste, medical	Class 2B incinerator, general domestic or hazardous waste landfill
Spoiled drugs and empty drug bottles	Hazardous waste, medical	Class 2B incinerator, general domestic or hazardous waste landfill
Animal parts and tissues	Hazardous waste, veterinary	Class 2B incinerator, general domestic or hazardous waste landfill, State Veterinarian's instruction
Disease free carcasses	Hazardous waste, veterinary	Class 2B incinerator, general domestic or hazardous waste landfill, State Veterinarian's instruction
Diseased / condemned carcasses	Hazardous waste, veterinary	Class 2B incinerator, general domestic or hazardous waste landfill, State Veterinarian's instruction
Ash from incinerator	General waste, non hazardous	Recycle (compost), general domestic landfill