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Towards environmentally sound health-care waste management in the central district municipality of North West province

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DECLARATION

I declare that this research report is my own, unaided work. It is being submitted for the Degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

_____ _____

Name Date

ABSTRACT

This report presents an analysis of health-care waste management in selected hospitals in the Central District Municipality of the North West Province, with a view of making recommendations that will ensure environmentally sound and sustainable health-care waste management in the study area.

In contributing to the promotion of sustainable management of health-care waste (HCW), the study aimed to minimize waste generation and environmental impact of waste treatment and disposal, to enhance public health and safety, and to provide a safer working environment around hospitals. An assessment was carried out which involved a review of relevant literature, site visits, and interviews with key stakeholders in health-care waste management in the study area, to generate data and information on health-care waste management trends and issues.

The major findings of the study include identified gaps in terms of the policy and legislative framework for the actual management of HCW, and issues relating to the mishandling of health-care waste, poor segregation, inappropriate storage rooms, and insufficient training on health-care waste management. Sustainable health-care waste management measures are proposed to improve the current situation at the health-care facilities in the Central District Municipality of the North West Province.

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LIST OF ACRONYMS

CDM	Central District Municipality (of the North West Province)
DWAF	Department of Water Affairs and Forestry
DEAT	Department of Environmental Affairs and Tourism
DOH	Department of Health (National)
NWDOH	North West Department of Health
GDACEL	Gauteng Department of Agriculture Conservation Environment and Land Affairs
GDOH	Gauteng Department of Health
NWP	North West Province
HCWM	Health-care Waste Management
HCW	Health-care Waste
HCRW	Health-care Risk Waste
HCF	Health-care Facility
HCWMP	Health-care Waste Management Planning
NWMS	National Waste Management Strategy
WHO	World Health Organisation

DEFINITION OF KEY TERMS

Segregation	The systematic separation of waste into designated categories.
Treatment	Any method, technique or process for altering the biological, chemical or physical characteristics of waste to reduce the hazards it presents and facilitates, or to reduce the costs of disposal. The basic treatment objective includes volume reduction, disinfection, neutralization or other change of composition to reduce hazards, including removal of radionuclides from radioactive waste
Sharps	Sharps are a sub-category of infectious health-care waste and include objects that are sharp and can cause injuries, such as syringe needles, scalpels, infusion sets, knives, blades and broken glass.
Infectious health-care waste	Discarded materials from health-care activities on humans or animals that have the potential of transmitting infectious agents to humans. These include discarded materials or equipment from the diagnosis, treatment and prevention of disease,

	assessment of health status or identification purposes, which have been in contact with blood and its derivatives, tissues and tissue fluids.
Disinfectant	Chemical agent that is able to reduce the viability of microorganisms.
Incineration	The controlled burning of solid, liquid, or gaseous combustible wastes to produce gases and residues containing little or no combustible material.
Recycling	A term embracing the recovery and reuse of scrap or waste material for manufacturing or other purposes.
Storage	The placement of waste in a suitable location or facility where isolation, environmental and health protection, and human control (e.g. monitoring for radioactivity, limitation of access) are provided. This is done with the intention that the waste will be subsequently retrieved for treatment and conditioning and/or disposal.
Cradle-to-grave	Health-care waste management system that deals with waste from the point of generation, through containerisation, internal and external transport, onsite or offsite storage, to

	treatment and final disposal of the residues.
Container	A bag or a puncture resistant and leak resistant container in which health-care waste is placed. Containers may be reusable or disposable.
Health Care Facility (HCF).	Means a provincial or private hospital, community health centre, clinic, mortuary or any other health care facility that generates health-care waste.
Pathological waste.	Pathological waste includes tissues, organs, body parts, human foetuses and deceased animals infected with zoonotic diseases, blood and body fluids, but excludes teeth, hair and nails.
Sharps container.	A disposable puncture resistant container which, when sealed, cannot be opened without great difficulty, and which is spill proof under normal conditions.

CHAPTER ONE

INTRODUCTION

1.1 Background

The World Health Organization defines health-care waste (HCW) as a by-product of health-care that includes sharps, non sharps, blood, body parts, chemicals, pharmaceuticals, medical devices and radioactive materials and general waste. Alvim-Ferraz and Afonso (2003) further define HCW as any solid waste that is generated in the diagnosis, treatment or immunization of human beings or animals, in related research, biological production or testing. However the current study focused on the sharps, infectious and human tissue components of the HCW. The hazards to the human health and to the environment, posed by healthcare waste, justify a high level of concern with its management.

The lack of policies, strategies and enforcement of legislation for handling and disposing of health-care waste in South Africa has resulted in poor management of such waste. As a result, most of the health care facilities in the country are handling and disposing off health care waste in an unsustainable manner, with negative implications for the environment and health of the public and health personnel (Mohee *at al.,* 2005).

Improper management of health-care waste is witnessed in many hospitals in the country. An investigation was carried out in selected hospitals of the Central District Municipality of North West Province to assess the status of health-care waste management at "ground level", identify and define any

problems, and suggest feasible solutions and recommendations which promote environmental sound healthcare waste management in the study area. Mato *et al.,* (1997) conducted a study in the hospitals of Dar es Salaam from which they concluded that in order to minimise problems arising from proper health-care waste management, it is important to have a workable and proper waste management system as pre-requisite in the hospitals. This essentially involves the determination of the sources, waste characterisation, generation rates, handling practice, storage transportation and final disposal.

The most important factor underlying effective programmes for the management of health-care waste include, firstly, the assignment of legal and financial responsibility for safe management to the waste producer, and secondly, the responsibility of duty of care principle as stipulated in South Africa's National Environmental Management Act,(Act 107 of 1998).

It is essential that policies and plans for the safe management of health-care waste address the following three elements:

1. The establishment of a comprehensive system of health-care waste management, which ensures that HCW is managed in a sustainable manner from the point of generation to ultimate disposal.
2. Training of all those involved and increasing awareness (Blenkharn 2005).
3. The selection of safe and environmentally friendly options for the management of health-care waste.

In order to achieve environmentally sound health-care waste management it is essential that everyone concerned with health-care waste understands that health-care waste management is an integral part of health-care, and that

creating harm through inadequate waste management reduces the overall benefits of health-care services.

1.2. Aim of the Study

The main aim of the research is to promote sustainable management of health-care waste, to minimize waste generation and environmental impact of waste treatment and disposal, to enhance public health and safety and to provide a safer working environment around hospitals in the Central District Municipality in the North West Province.

To fulfil the above aim, the research focused on the following objectives:

- Carry out a waste assessment survey of the health-care facilities. This involved a walk through audit and completion of the survey questionnaires in an interview with the relevant stakeholders.
- Conduct a literature review of the current management policies and analyse the health-care waste management practices in the health care facilities of the study area.
- Examine the local and national policies and international laws in relation to health-care waste management.
- Assess the current status and trends of health-care waste management at ground level, identify and define any problems, and recommend feasible solutions for improving the management of health-care waste in the area.

1.3 Problem Statement

Improper management of waste generated in the health-care facilities can have a direct health impact on the community, the personnel working in health-care facilities, and on the environment (Daschner and Dettenkofer, 1997). In addition, environment polluted by inadequate treatment of waste can cause indirect health effects in the community. The problems experienced in the North West Province at large include the following:

- Poor management of health care waste at the facility level, which includes poor segregation, improper handling, inappropriate transport system and storage areas.
- Most of the hazardous medical waste is dumped in the general waste disposal sites.
- There is no provincial policy or guideline for management of HCW.
- There is fragmented legislation that has created problems in terms of ultimate responsibility for monitoring and evaluating the management of medical waste in health care facilities.
- No proper segregation of different categories of HCW.

Generally, the absence of environmentally sound or sustainable management practices of health-care waste management leads to pollution of the environment, hence potentially causing harm to human health.

Considerable improvements can however be achieved by management options such as health care waste management plans, segregation of different categories of waste and proper handling and treatment of waste.

1.4 Description of the Study Area

This section presents the key characteristics of the area of study, including demography, topography, geology and biodiversity, defining the setting within which health-care waste is generated and managed.

1.4.1 Location and Topography

The specific area of the study is the Central District Municipality (CDM), located in the North West Province of South Africa. The area is characterized by mainly flat topography. CDM is predominantly rural, consisting of both commercial farmlands (both crops and livestock) and communal lands. The study area is comprised of five local municipalities which are: Ratlou, Tswaing, Mafikeng, Ditsobotla and Zeerust.

1.4.2 Geology

The study area is overlain by sands and calcretes of the Kalahari Group. To the east, outcropping andesites of the Ventersdorp supergroup are found. The general geological profile comprises a capping horizon of windblown Kalahari fine sand overlying alluvial terrace gravels and, in turn, decomposed basement bedrock. Within these three horizons, variations of thickness, material properties and parent rock type are minor.

1.4.3 Climate

The area experiences a mean annual rainfall ranging from over 600mm in the north-east to less than 450mm in the west. About 68% of the district municipality's rainfall occurs in the November to March period, with January

being the month with the highest rainfall. The maximum temperature of about 36°C and minimum temperature of 7°C are typical of the study area.

1.4.4 Biodiversity

The Central District Municipality is situated within the Savannah biome. This biome is characterized by grassland interspersed with Acacia trees and small shrubs.

1.4.5 Demographics

The 2001 national census revealed that about 763000 people live in the Central District Municipality **(Table 1.1).**

Table 1.1: Local municipalities in the Central District Municipality of North West Province. (**Source:** National census, 2001).

Local Municipality	**Population 2001**
Ratlou	104 323
Tswaing	114 146
Mafikeng	259 484
Ditsobotla	147 605
Zeerust	137 442
Total	**763000**

A household survey performed in 1994 in the North West Province, found that 43% of the province's population above 15 years are not economically active, and of the economically active portion which is 57%, only 37% were employed and 20% unemployed. The current poor economic growth is not expected to create sufficient new employment opportunities.

1.5 The Scope of the Study

The study dwelled on assessing the health-care waste management (HCWM) situation and practices in the selected hospitals of Central District Municipality of North West Province. Fundamental issues examined include the effectiveness of HCW segregation, in-house transportation of waste, storage areas, the actual handling of HCW and policy issues. The study focused on infectious waste, sharps and anatomic waste, as these were seen to be the main component of HCW produced in the study area. The study ignores the chemical, pharmaceutical and radioactive components of HCW.

In order to get the necessary data or information on the health-care waste management (HCWM) setting, the rapid assessment questionnaire developed by the World Health Organisation was adopted and used. This questionnaire was completed in an interview with the relevant personnel in the hospitals as well other stakeholders in the study area. These were coupled with the site visits undertaken to the selected health-care facilities (HCFs) in the area.

1.6 An Overview of Subsequent Chapters

Chapter 2 explores different legislation in relation to HCW and further analyses the relevance and applicability of national laws to the current situation of HCW.

Chapter 3 presents a review of literature pertinent to health-care waste management. The fundamentals of health-care waste management such as health-care waste management plans, waste segregation and minimisation, waste management hierarchy and waste treatment technologies are also discussed.

Chapter 4 outlines the methodology used to gather and analyse HCWM data in the area of study. Data was collected through the site visits made to the selected health-care facilities, completing the waste assessment questionnaires by interviewing stakeholders and personnel in the HCFs and personal observation while visiting the hospitals.

This chapter also describes the analysis done to determine the actual situation of HCW in the Central District Municipality. The analysis involved examination of the information gathered during the data collection phase, in view of identifying areas of concern with regards to HCWM.

Chapter 5 is the presentation of the key findings of the study, focusing on the actual situation of health care waste management practices in the HCFs, which include handling and segregation of HCW, transportation, storage areas and transportation training of health-care personnel. Furthermore, the actual volume of HCW and the analysis of the existing policies at facility level and government level are also discussed in this chapter.

Chapter 6 is the concluding chapter and it draws together the important results and recommendations for improving the management of health-care waste in the study area.

CHAPTER TWO

LEGISLATIVE AND POLICY FRAMEWORK FOR HEALTH-CARE WASTE MANAGEMENT

2.1 South African Context

There are a number of laws, policies and guidelines administered by different spheres of government, which relate to the management of health-care waste. This situation results in fragmented and uncoordinated approach to managing health-care waste. The most important act, regulations, policies and strategies relating to health-care waste management are briefly discussed below:

2.1.1 Constitution of South Africa (Act 108 of 1996)

In terms of the Constitution, a number of functional areas relating to integrated pollution and waste management are a concurrent national and provincial legislative competence. These include environment, health services and pollution control. In the event of a conflict between national and provincial legislation, the national legislation will prevail.

Provincial planning and abattoirs fall within the functional area of exclusive provincial legislative competence, as does the regulation of certain local government matters, including control of public nuisances; refuse removal, refuse dumps and solid waste disposal; facilities for the burial of animals; and municipal abattoirs.

The local sphere of government consists of metropolitan councils, regional services councils and municipalities, which have legislative and executive

authority over the following matters relating to the management of waste: air pollution; cemeteries; control of public nuisances; municipal planning; refuse removal, refuse dumps and solid waste disposal; and sanitation services limited to domestic waste water and sewage disposal systems.

The Constitution contains a Bill of Rights that guarantees certain fundamental rights. Environmental rights are set out in the Bill of Rights in Section 24 of the Constitution. The Bill of Rights also guarantees other fundamental rights, such as the right to access to information and the right to administrative justice. These rights strengthen the environmental rights guaranteed in the Constitution.

Section 24 of the Constitution guarantees everyone the right:

a) To an environment that is not harmful to their health or well-being; and

b) To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that:

(i) Prevent pollution and ecological degradation;

(ii) Promote conservation; and

(iii) Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

Therefore, HCW management related legislation must therefore be in compliance with the Constitution.

2.1.2 Environment Conservation Act (Act 73 of 1989)

In terms of Section 20 of the Environment Conservation Act (ECA) (Act 73 of 1989), no person may "establish, provide or operate any disposal site

without a permit issued by the Minister of Water Affairs and Forestry". Permits are issued subject to certain conditions.

The Department of Water Affairs and Forestry has developed the "Minimum Requirements" guidelines to set environmentally acceptable standards for (i) waste disposal by landfill; (ii) the handling, classification and disposal of hazardous waste; and (iii) water monitoring at waste management facilities. The standards set in the Minimum Requirements are based on a classification system described in the documents.

The Minimum Requirements are enforced through the landfill permitting system. The classification system for hazardous waste is based on the SABS Code 0228: Identification and Classification of Dangerous Substances and Goods, which in turn is derived from the International Maritime Dangerous Goods Code. A significant proportion of health care wastes would fall into Class 6 of SABS Code 0228: Toxic and infectious substances. It is a Minimum Requirement that infectious waste be destroyed and any residue such as ash be evaluated in terms of the Minimum Requirements and be given a hazard rating.

In addition, disposal of waste in terms of Section 20 was identified under Section 21 of the ECA (Government Notice 1182 of 5 September 1997) as an activity "which may have a substantial detrimental effect on the environment". As a result, the Regulations regarding environmental impact reports (Government Notice 1183 of 5 September 1997) are applicable to the disposal of waste, and written authorisation in terms of Section 22 of the ECA must be obtained, usually from the provincial environmental departments, before the activity may be undertaken.

The Department of Environmental Affairs and Tourism is in the process of developing the new regulations which are expected to address the shortcomings of the existing regulations.

2.1.3 Health Act (Act 63 of 1977)

In terms of Section 20 of the Health Act, local authorities have a responsibility to maintain their district in hygienic conditions. These powers also pertain to sewage purification and sewage sludge treatment, storage, processing, utilisation and disposal of HCW. These powers and authority were assigned to the Provinces in a Government Gazette Notice No R 152, 1994.

Section 33 provides for regulations relating to communicable diseases, which may address the disposal of any waste or other matter that may cause the development of a communicable disease. In terms of Section 34, regulations relating to conditions dangerous to health may be made.

Section 38(1) (a&g) grants the Minister of Health power to make regulations to control a number of health-related solid or liquid waste aspects. Proposed Regulations for the Control of Environmental Conditions constituting a Danger to Health or a Nuisance were published in the Government Gazette on 4 February 2000, for comment. The proposed regulations contain definitions of, inter alia, “biomedical material” and “medical waste”, and would regulate certain aspects of health care waste management, if promulgated in their present form.

2.1.4 Hazardous Substances Act (Act 15 of 1973)

HCW may include chemical waste, such as all types of discarded chemicals, including pharmaceuticals and cytotoxic substances that may pose a special risk to human health and the environment.

The objective of the Hazardous Substances Act 15 of 1973 is to provide for the control of substances which may cause injury or ill health to or death of human beings by reason of the toxic, corrosive, irritant, strongly sensitising or flammable nature or a generation of pressure in certain circumstances and for the control of certain electronic products.

The Hazardous Substances Act categorises certain groups of hazardous substances. Groups I and II relate to substances of a toxic, corrosive, irritant, strongly sensitising or flammable nature. Group III relates to electronic products and Group IV relates to radioactive materials. It is possible that chemical waste may contain Group I and II hazardous substances.

This being the case, the Hazardous Substances Act, and Regulations promulgated there under, should be considered relevant to HCW management, and, in particular, regulations relating to the disposal and transportation of such substances.

Section 3A (1) relates to Group IV Hazardous substances; permission is required to produce, acquire, dispose, import or export such substances. This provision also relates to the "use of radioactive substances in industry, research and medicine (non-nuclear applications)", and would thus be relevant to the management of health care waste containing such substances.

2.1.5 Human Tissue Act (Act 65 of 1983)

The Human Tissue Act 65 of 1983 provides that the Minister of Health may make regulations regarding the disposal of human bodies and tissue no longer required. The Human Tissue Act does not expressly provide for the disposal of HCW.

2.1.6 Atmospheric Pollution Prevention Act (Act 45 of 1965)

The Atmospheric Pollution Prevention Act 45 of 1965 sets out the procedure for the certification of, what is referred to in the Act, as "Scheduled Processes". A Scheduled Process is defined under Section 1 of the Act to mean any works or processes specified in the Second Schedule to the Act. For the purposes of the Atmospheric Pollution Prevention Act (APPA), waste incineration is considered a Scheduled Process. That is to say processes for the destruction by incineration of waste that contains chemically bonded halogens, nitrogen, phosphorus, sulphur or metal, or any waste that can give rise to noxious or offensive gases. Accordingly, the incineration of HCW is a process that is controlled under the Atmospheric Pollution Prevention Act.

The effect of this is that any person operating on a Scheduled Process in or on any premises is prohibited from so doing unless the owner is the holder of a Registration Certificate issued under the Act. In addition, there are emission guidelines for HCW incinerators that were developed by the Directorate: Air Pollution Control, Department of Environmental Affairs and Tourism (DEAT). Any emissions resulting from HCW treatment must comply with the atmospheric pollution prevention act.

On implementation of the APPA, emission standards were defined in guidelines using international experience and taking into consideration the size and number of facilities in South Africa. However, since these emission standards could not be achieved on any of the incinerators in South Africa, the following decisions were taken:

a) All existing incinerators must be upgraded or replaced to meet the required two-stage incineration temperatures and residence time by December 2001.
b) New incinerators, with a capacity of less than 1 000 kg/hour, must operate at the required temperatures and residence time. If the emission standards cannot be met, an acceptable dispersion model may be used to determine whether the incinerator is acceptably located.
c) All incinerators with a capacity of more than 1 000 kg/hour must be fitted with pollution control equipment.

2.1.7 Integrated Pollution and Waste Management Policy

The over-arching goal of the Integrated Pollution and Waste Management IP&WM policy is to move from a previously fragmented situation of uncoordinated waste management to that of integrated waste management. The Government's White Paper on Integrated Pollution and Waste Management, which was published in March 2000, defines government's approach to the management of waste and pollution. It includes a holistic and integrated management approach extending over the entire waste cycle from cradle to grave including the generation, storage, collection, transportation, treatment and final disposal of waste.

The IP&WM policy represents a paradigm shift in South Africa's approach to waste management. Historically, pollution control focused primarily on

impact management and remediation of pollution, although in the case of water quality management, the historical end-of-pipe control approach was replaced with a hierarchical approach, commencing with pollution prevention, as far back as 1992.

However, to ensure sustainable development, the focus has moved to pollution prevention. The National Waste Management Strategy process was undertaken to ensure that the IP&WM policy is translated into practice. Central to the development of the strategy for integrated waste management has been:

- The pollution avoidance/prevention and waste minimisation approach that focuses on the source of waste and moves away from "end-of-pipe" solutions.
- The need to extend an acceptable level of waste management services to all communities.
- To ensure that public health and occupational health issues receive due attention in all waste management practices.
- To ensure that Department of Environmental Affairs and Tourism develops a framework within which all waste can be managed correctly. This includes ensuring that appropriate legislation, guidelines and regulations are developed, promulgated and enforced so that all unavoidable hazardous wastes are managed, treated and disposed in an acceptable manner (DEAT 2000).

2.1.8 Code of Practice for the Handling and Disposal of waste Materials within Health Care Facilities

Code of Practice for the Handling and Disposal of Waste Materials within Health Care Facilities (SABS 0248), provides guidelines on the handling of waste materials within health facilities. While there are some important issues that need attention, this code of practice, which is in line with international standards, forms a strong base for the development of regulations on the management of health-care waste. However the new edition of standard has replaced this Standard, which is SANS 10248 National Standard on Management of HCW.

2.1.9 National Standard on Management of Health-care Waste

National Standard on Management of Health Care Waste (SANS 10248), are new standards which will help health-care facilities to manage HCW better, and reduce the risks which hospital workers are exposed to when handling HCW. The standards will enable better usage of scarce public funds in health care and help protect less skilled personnel working with HCW.

This new edition of standards outlines the following new requirements which were not dealt with in the existing standards:

- Identifying the types of HCW and determining the hazard rating, which indicates the class of disposal site at which the waste stream or its residue can be disposed.
- Marking and labelling of HCW for transport purposes.
- Management responsibilities, including the formulation of a documented waste management policy, waste plans, assigning the necessary responsibilities, training, supervision and workplace hygiene

- Storing hazardous HCW, either in a temporary store or in the central store.
- Segregating and packaging the waste, prior to removal from the HCF.
- Collecting the waste for offsite transport, including contractual requirements.
- Guidelines in case of spilling hazardous HCW.
- Treatment and disposal methods, including incineration or alternative technologies.

2.1.10 National Environmental Management Act 107 of 1998 (NEMA)

The National Environmental Management Act 107 of 1998 (NEMA) requires that waste be avoided, minimized, reused or recycled where possible or as a last resort be disposed of in a responsible manner. The Act requires for environmental management to be integrated in all the activities which result in environmental damage. In terms of NEMA a duty-of-care is placed on every person who causes, has caused or may cause significant pollution or degradation of the environment to take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring. These measures may include ceasing, modifying or controlling any act, activity or any process causing the pollution or degradation; containing or preventing the movement of pollutants or cause of the degradation; and eliminating any source of the pollution or degradation. It is possible that if incorrectly managed, HCW may cause such pollution or degradation of the environment.

It should be highlighted that for the purposes of NEMA, “environment” includes the surroundings within which humans exist and that are made up of properties and conditions that influence human health and well being. In addition, the definition of “pollution” in the Act includes a change in the

environment caused by amongst others, substances emitted from any activity including the storage and treatment of waste or substances where that change has an adverse effect on human health or well being.

The regulatory problems associated with health care waste management are connected both to the lack of compliance with the existing legislation and to the lack of adequate legislation to meet the environmental requirements for managing health care waste.

Looking at the above outline of the legislations pertaining to health care waste management, one can conclude that there is a need for the harmonisation of all existing legislation with a view of coming up with robust legislative framework to deal with the prevailing problems or challenges associated with HCWM.

2.2 International agreements in relation to Health-care Waste Management

South Africa is a signatory to international multilateral agreements which determine how HCW should be managed. A need exist to translate these instruments into national legislation and/or practical guidelines and codes of practice at HCF level to ensure that national legislative framework and practice comply with such international agreements.

2.2.1 The United Nations Conference on the Environment and Development (UNCED)

The United Nations Conference on the Environment and Development (UNCED) in 1992 led to the adoption of Agenda 21, which recommends a set of measures for waste management. The recommendations may be summarized as follows:

• Prevent and minimize waste production.
• Reuse or recycle the waste to the extent possible.
• Treat waste by safe and environmentally sound methods.
• Dispose of the final residues by landfill in confined and carefully designed sites.

Agenda 21 also stresses that any waste producer is responsible for the treatment and final disposal of its own waste; where possible, each community should dispose of its waste within its own boundaries.

2.2.2 The Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted in 1989 and entered into force on 5 May 1992. This environmental treaty strictly regulates the transboundary movements of hazardous wastes and obligates its parties to ensure that such wastes are managed and disposed of in an environmentally sound manner.

The Secretariat to the Basel Convention is based in Geneva (Switzerland), is administered by UNEP and it facilitates the implementation of the Convention and related agreements. It also provides assistance and guidelines on legal and technical issues, and conducts training on the proper management of hazardous waste.

The key objectives of the Basel Convention are:

- to minimize the generation of hazardous wastes in terms of quantity and hazardousness;
- to dispose of them as close to the source of generation as possible;
- to reduce the movement of hazardous wastes.

A central goal of the Basel Convention is "environmentally sound management" (ESM), the aim of which is to protect human health and the environment by minimizing hazardous waste production whenever possible. ESM means addressing the issue through an "integrated life-cycle approach", which involves strong controls from the generation of a hazardous waste to its storage, transport, treatment, reuse, recycling, recovery and final disposal.

The Basel Convention makes specific reference to control of special HCW: sharps, pathological infectious waste, hazardous chemical waste, and pharmaceutical waste. Annex I of the Basel Convention includes the following waste categories that specifically refer to health-care waste:

- Clinical wastes from medical care in hospitals, medical centers, and clinics.
- Wastes from the production and preparation of pharmaceutical products.
- Waste pharmaceuticals, drugs, and medicines.

- Waste from the production, formulation and use of biocides and phytopharmaceuticals.

The following principles underlie the Basel Convention:

1. Duty of care principle

This principle stipulates that any organisation that generates waste has a duty to dispose of the waste safely. Therefore, it is the HCF that has ultimate responsibility for how waste is containerized, handled on-site and off-site and finally disposed of.

2. Polluter pays principle

According to this principle all **waste producers are legally and financially responsible for the safe handling and environmentally sound disposal of the waste they produce**. In case of an accidental pollution, the organisation is liable for the costs of cleaning it up. Therefore if pollution results from poor management of health-care waste then the HCF is responsible. However, if the pollution results because of poor standards at the treatment facility then the HCF is likely to be held jointly accountable for the pollution with the treatment facility. Likewise this could happen with the service provider. The fact that the polluters should pay for the costs they impose on the environment is seen as an efficient incentive to **produce less** and **segregate** well.

3. Precautionary Principle

Following this principle **one must always assume that waste is hazardous until shown to be safe**. This means that where it is unknown what the hazard may be, it is important to take all the necessary precautions.

4. Proximity principle

This principle recommends that **treatment and disposal of hazardous waste take place at the closest possible location to its source** in order to minimize the risks involved in its transport. According to a similar principle, any community should recycle or dispose of the waste it produces, inside its own territorial limits.

2.2.3 The Stockholm Convention on Persistent Organic Pollutants

This Convention is a global treaty to protect human health and the environment from persistent organic pollutants (POPs). POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife.

This convention has been ratified by South Africa and identifies waste incinerators as the principal source of dioxin and furans, which belong to the initial 12 substances being targeted for continuing minimization and ultimate elimination by the global community. POPs circulate globally and can cause damage wherever they travel. In implementing the Convention, the

Government of South Africa is expected to take measures to eliminate or reduce the release of POPs into the environment.

CHAPTER THREE

LITERATURE REVIEW

3.1 Definition of Health-care Waste

Prüss *et al.,* (1999) describes health-care waste (HCW) as the total waste stream from a health-care establishment, research facilities, laboratories, and emergency relief donations. HCW includes several different waste streams, some of which require more stringent care and disposal.

HCW is made up of a number of components such as infectious waste (including sharps), chemical waste (including pharmaceutical waste), radioactive waste and general waste (domestic waste). However, this research will concentrate on infectious waste, sharps and human tissue. Chemical and radioactive waste will be ignored since they do not constitute a significant proportion of HCW produced in the study area. The generators of HCW are generally grouped into two categories that represent major generators like hospitals and clinics, as well as minor generators like health practitioners, dentists and pharmacies (GDACEL, 2001).

3.2 Management of Health-care Waste

WHO (2003) defines health-care waste management as a process to help ensure that health care waste is managed from cradle to grave, meaning from health care facility, to grave, the disposal facility where the waste itself or residues are disposed off. This is illustrated in **Figure 3.1**, whereby the HCW flow is depicted from the point of generation up to the point of final disposal.

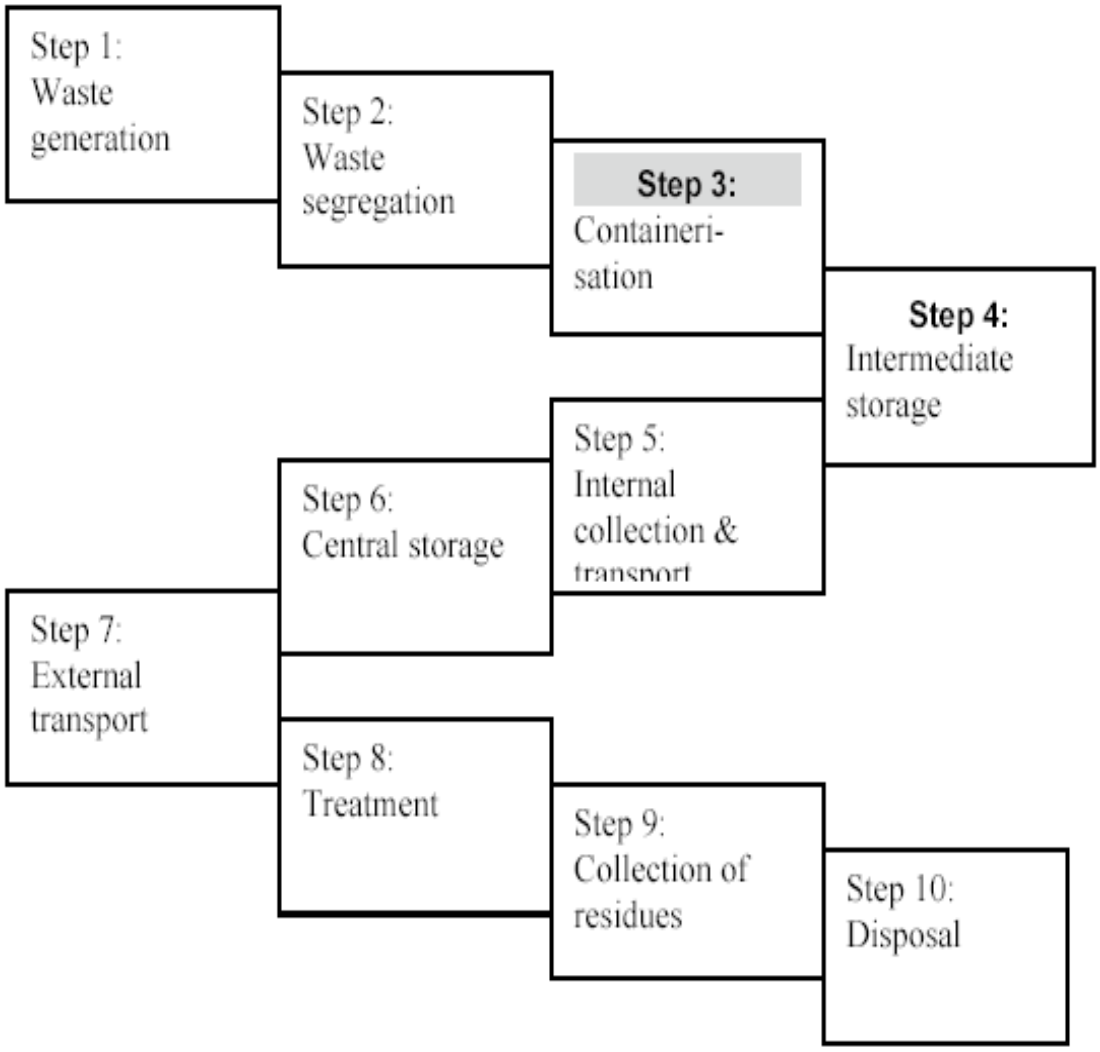


Figure 3.1: HCW flow in the Health-care facility.
(**Source:** GDACEL, 2002).

An earlier study on HCW management in South Africa concluded that the state of HCW management in the country is poor (Leonard, 2003). Contributing to this state of affairs is a lack of training and awareness, inadequate legislation, limited financial resources, particularly at the provincial health-care facilities, coupled with a lack of capacity at the

authority level. Disposal of health care waste to inappropriate landfills and informal dumps is common in most parts of South Africa (Department of Environmental Affairs and Tourism, 2000).

Patil and Shekdar (2001) conducted a study on health-care waste management in India and revealed various types of hazards associated with the management of HCW. This is illustrated in **Figure 3.2.**

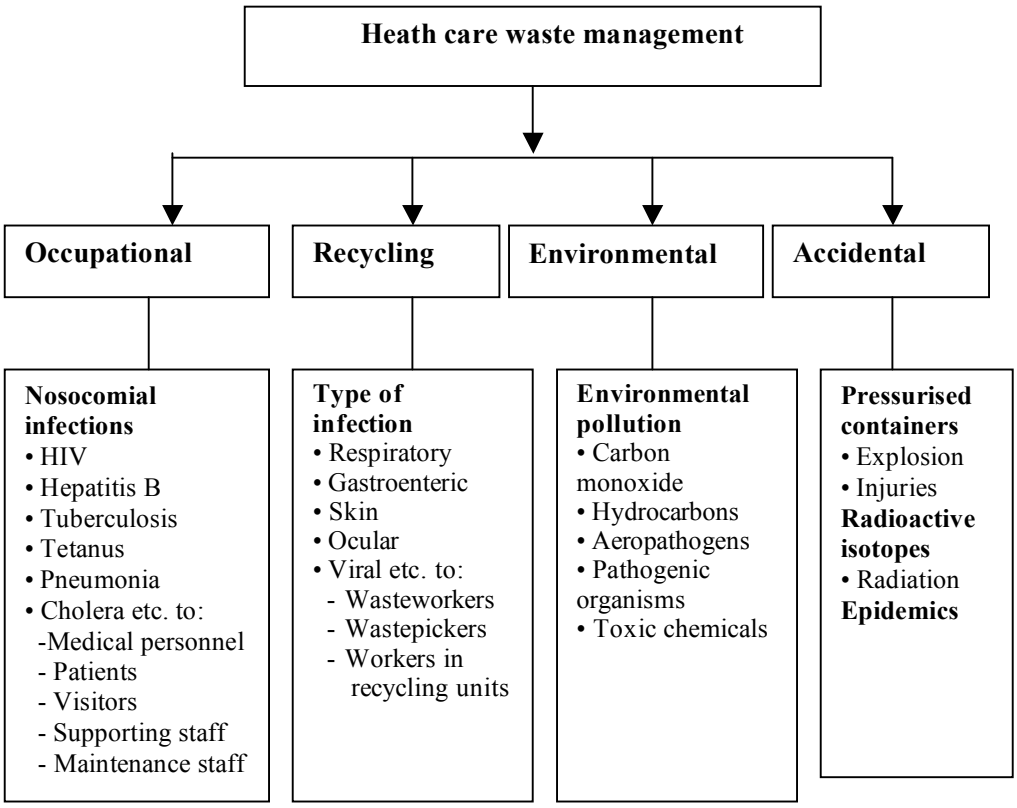


Figure 3.2: Hazards associated with health-care waste management.
(**Source:** Patil and Shekdar, 2001**)**

Garcia (1999) highlighted that in order to improve the management of health-care waste, it is important that a systematic planning approach be adopted. This necessitates establishing a practical and understandable policy,

standardizing waste container usage and location, increasing knowledge and motivation of employees, and controlling costs. Although each hospital is unique, utilization of this model can assist in the improvement of health-care waste management in the hospitals of the Central District Municipality of North West Province.

3.2.1 Waste Segregation and Minimisation

The first priority in proper management of hospital waste is to segregate waste into reusable or non-reusable hazardous or non-hazardous components including reusable and safe storage in the appropriate containers (Suwannee, 2002). Waste segregation refers to the process of separating waste at the point of generation (also known as separation at source), and keeping them apart during handling, accumulation, interim storage and transportation. This forms an integral part of sustainable health care waste management in the health care facilities. Correct segregation in the health-care facility will ensure correct disposal of waste either at the landfill (for non hazardous HCW) or treatment facility (for hazardous HCW).

The current waste management practice observed at many hospitals is that all wastes, potentially infectious, office, general, food, construction debris, and hazardous chemical materials are all mixed together as they are generated, collected, transported and finally disposed of. As a result of this failure to establish and follow segregation protocols and infrastructure, the waste leaving hospitals, as a whole, is both potentially infectious and potentially hazardous (chemical). At greatest risk are the workers who handle the wastes (hospital workers, municipal workers and ragpickers) (Hagen *et al.,* 2001).

DEAT (1999) anticipated that the promotion of the sorting of HCW will reduce the amount of medical waste that requires treatment and reduce the risk to the general public in South Africa. The risk to the general public is secondary and occurs in three ways:

(1) Accidental exposure from contact with wastes at municipal disposal bins;

(2) Exposure to chemical or biological contaminants in water;

(3) Exposure to chemical pollutants (e.g., mercury, dioxin) from incineration of the wastes.

No matter what final strategy for treatment and disposal of wastes is selected, it is critical that waste is segregated (preferably at the point of generation) prior to treatment and disposal. This most important step must be taken to safeguard the occupational health of health-care workers

World Health Organisation (2003) found that imposing segregation practices within hospitals to separate biological and chemical hazardous wastes will result in a clean solid waste stream which can be easily, safely and cost-effectively managed through recycling, composting and landfilling the residues. This resulting waste stream has a high proportion of organic wastes (food) and recyclable wastes (paper, plastic, metal) and actually very little that is truly disposable, especially given the high percentage of reprocessing and reuse of materials.

Health Care Without Harm (2001) proved that waste segregation is an important step in reducing the volume of waste. This is because it offers the ability to make more accurate assessment on the composition of hospital waste, and position the needs of the facility in terms of HCW management. Segregation practices also enable the HCF to design and practice waste

management strategy that incorporates waste reduction, reuse and recycling measures.

The waste segregation programme implemented in 1992 at a Saudi Arabian hospital resulted in the reduction of total amount of infectious waste by 65% from the 1991 volume. Consequently an incinerator operation was reduced from daily to 3 days a week, resulting in a significant reduction in incinerator stack emissions (Hagen *et al.,* 2001).

Secretariat to Basel Convention & WHO (2004) recommends that segregation should follow the following principles:

- Always take place at the source, which is at the ward bedside, operation theatre, medical analysis laboratory, or any other room or ward in the hospital where the waste is generated.
- Be simple to implement for the medical and ancillary staff and applied uniformly throughout the hospital.
- Be safe and guarantee the absence of infectious HCW in the domestic waste flow.
- Be well understood and well known by the medical and ancillary staff of the Chefs.
- Be regularly monitored to ensure that the procedures are respected.

National Health and Medical Research Council (1999) outlined the following underlying principles for waste minimisation:

- **Product substitution**

Products should be assessed before purchase in terms of their potential to generate problematic waste, result in toxic emissions, or be detrimental to the

operation and maintenance of treatment facilities. Product selection and purchasing criteria should incorporate controls to ensure that less toxic/hazardous products are selected, without compromising product performance.

Products such as polyvinyl chloride (PVC) plastic compounds should be progressively replaced by products made from ethylene vinyl acetate copolymer. Organic pigments should replace heavy metals pigments, commonly used for colouring waste bags and sharps containers. The types of substitutes to be considered include biodegradable cleaning compounds and safer chemicals.

Product changes

Management should liaise and work with the manufacturers/ suppliers to change or modify products to incorporate both product performance and waste disposal requirements. Examples of change of product includes, change from solvent-based products to water-based or from lead-based paints to less hazardous alternatives.

Procedural changes

Simple changes to patient care procedures can be made to minimise the waste generated, for example:

- Where it is not necessary to use dressing packs for minor procedures e.g. in the removal of sutures, practitioners should use alternative equipment so the minimum amount of material is used;

- When preparing for dressings, and clean and sterile procedures, practitioners should critically assess materials required. When 'setting up', unwanted extra materials should be removed for re-sterilisation or re-use. This should occur before commencing the procedure, so as to minimise the potential for contamination,
- Small, colour-coded containers should be accessible at the site of the procedure so that recyclable materials can be segregated, and
- Facilities should review frequency of waste collection, size and location of containers and bags.

Reusable items

Reusable items should be preferred to disposable items whenever it is clinically appropriate, environmentally sound and practical to do so. When assessing the suitability of the product for reuse, life cycle assessment can assist in determining the overall cost (beyond the purchase price) of the disposable versus a reusable product (Daschner and Dettenkofer, 1997).

3.2.2 Handling, Collection, Transportation and Onsite storage

Handling

It is very important that great care be taken when handling HCW as this could pose serious health risks associated with needle injuries as well as spills that can occur causing serious pollution on the environment. The manual guiding National Health Care Waste Management plans in Sub-Saharan Countries guidance manual prepared by Secretariat to Basel Convention and WHO, (2004), recommends that workers responsible for handling HCW should always wear protective clothing such as aprons, boots, and heavy duty gloves.

This was discovered to be missing at most of the hospitals visited in the Central District Municipality of North West area.

Collection and Transportation

Coulson and Magner (2004) highlight that it is the responsibility of the HCF to make sure that HCW is transported from the wards to the storage area for collection by the service provider. It is recommended that this collection be done daily to avoid accumulation of waste in the wards.

UNEP and the Secretariat to the Basel Convention (2003) indicate that trolleys used for moving health-care waste through the health-care facility should be designed to prevent spills, and should be made of materials able to withstand exposure to common cleaning agents. They should have the following attributes:

(a) Easy loading and deloading.

(b) No sharp edges that could damage waste bags or containers during loading and deloading.

(c) Easy to clean to prevent odour that might occur if ever there is spillage.

In order for one to de able to identify the origin as well as the content of the HCW containers, it is always sensible that containers be marked of the content and also the name of the hospital as well as the department of origin in that particular department (Coulson and Magner, 2004).

Storage

From the point of generation which is the wards and different departments, HCW is transported to the temporary storage facility, where it is stored before being treated / disposed of on-site or transported off-site. The guidance manual of the Secretariat for Basel Convention and WHO, 2004, advises that the maximum storage time should not exceed 24 hours.

Secretariat to Basel Convention and WHO (2004) further recommend that a storage facility should meet the following criteria

- Sized according to the volume of waste generated as well as the frequency of collection and must be found inside all Chefs.
- The facility should not be situated near food stores or food preparation areas and its access should always be limited to authorised personnel.
- It should also be easy to clean, have good lighting and ventilation, and designed to prevent rodents, insects or birds from entering.

3.2.3 Health-care Waste Management Planning

Safe and proper management of HCW is the key to ensure that there are no infections as well as to minimise the environmental pollution resulting from mismanagement of HCW. The current situation encountered in the hospitals of the study area does not comply with the international and the national requirements to guarantee a safe and environmental sound HCW management. In order to improve the situation it is crucial that government develop a medium to long term strategy to address this problem. The strategy should reflect the integrated effort that is necessary to set up a safe and environmental sound health-care waste management planning (HCWMP) (Secretariat of the Basel Convention and WHO, 2004).

The guidance manual for the preparation of national health-care waste management plans (Secretariat of the Basel Convention and WHO, 2004) suggest, that the strategy should focus on the following issues:

- At each administrative level, clear institutional and individual responsibilities should be established. Moreover, specific monitoring and administrative procedures should be set-up and adequate resources allocated to ensure a proper management of the HCW;
- Adequate awareness and training programmes for health officers and planners, hospital administrators, medical staff and environmental health officers should be developed;
- Appropriate, environmental-friendly and affordable technologies should be selected for the treatment and the disposal of HCW, taking into consideration both technical and financial resources available in the country.

WHO (2000) and Tudor *et al.,* (2004) describe the following activities as important for the development of the national strategy in order to achieve safe health-care waste management:

- Identification of key partners, including but not necessarily limited to: Ministry of Health, Ministry of Environment, non-governmental organizations, waste producers and waste disposal companies or services.
- Designation of the responsible authority for policy formulation, implementation and evaluation.
- Initial assessment and analysis of problems leading to unsafe handling or disposal.

- Development of the national policy framework stating that the management of waste is part of the health care system, and that health care service should be assigned legal and financial responsibility for safe waste management and should manage waste applying the duty of care principle.
- Development of a regulatory framework and national guidelines, based on a comprehensive approach, including training, occupational health and safety issues and sound choices of waste management options, according to local circumstances.
- Development of an enforcement mechanism.
- Setting of practical targets or objectives over a specified time period.
- Establishment of a national and regional infrastructure for health care waste disposal.
- Integration of waste minimisation into national purchasing policies.
- Routine monitoring of impact through process indicators (number of health care facilities with safe waste management systems) and outcome indicators (e.g. number of accidents involving heath care waste).

In trying to implement the strategy, it is critical that a HCWM plan be developed. Almuneef and Memish (2003) explain that the objective of the HCWM plan is to reduce the amount of infectious waste by segregating it at its point of generation from general waste. The introduction of a well-formulated plan that incorporated written policy, mandatory in service education, continuous waste audit, and the cooperation of all staff in a Saudi Arabian hospital was capable of achieving a 58% reduction in the amount of infectious waste incinerated (Almuneef and Memish 2003).

Introducing a process of health-care waste management planning within health care establishment may reduce the impact of HCW on the environment, hence promoting sustainable HCWM in the study area. However HCWM planning does not cover only the technical aspects related to waste management, such as waste handling, storage, transportation, treatment and disposal, but also human resources development, financial aspects, staff responsibilities and role, surveillance and control, all of which are essential components in sustaining the operation of HCWM systems (World Health Organisation, 2002).

According to Prüss *et al.,* (1999), HCWM planning requires the definition of a strategy that will facilitate careful implementation of the necessary measures and the appropriate allocation of resources according to the identified priorities. Secretariat of the Basel Convention and WHO (2004) further highlight that planning requires the definition of a strategy that takes into account the given constraints and opportunities, appropriate allocation of resources, clear formulation of objectives, practical indicators of achievement and a well structured time frame.

This is important for the motivation of authorities, health-care workers, and the public, and for defining further actions that may be needed. Surveys on the generation of waste will be the basis for identifying opportunities and setting targets for waste minimization, reuse and recycling, and cost reduction. A national programme of sound health-care waste management is achievable through an action plan.

Figure 3.3 clearly depicts the planning process to be followed when developing a HCWM plan. Secretariat of the Basel Convention and WHO (2004)

emphasise that it is important to dwell much on the situational analysis, order to make informed recommendations and a clear strategy.

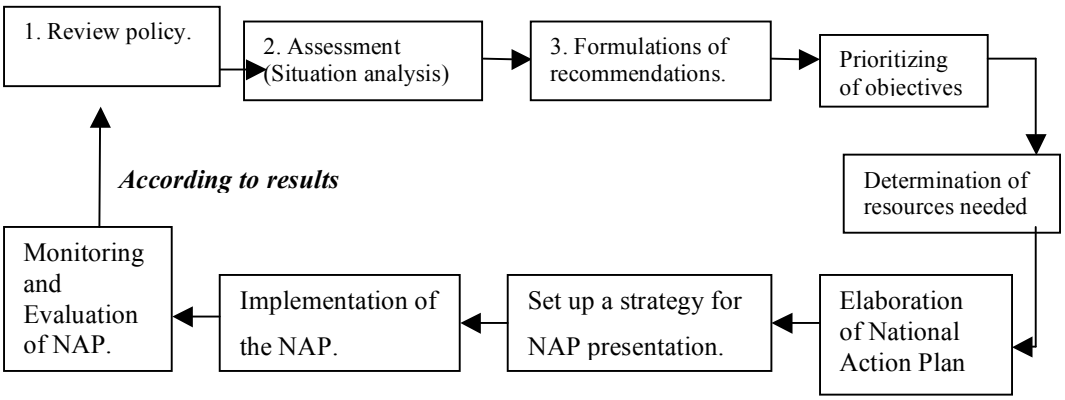


Figure 3.3: Health-care waste management planning process.
(**Source:** Secretariat of the Basel Convention &WHO, 2004).

3.2.4 Waste Management Hierarchy

The National Waste Management Strategy (DEAT, 1999) refers to the waste management hierarchy as a general guide for planning environmental sound waste management. **Figure 3.4** shows the overarching Waste Management Hierarchy was adopted for the study of HCW Management in the North West province. It is important to note that the principles outlined in the waste hierarchy do not apply to all categories of HCW; as a result this principle must be applied with great responsibility when dealing with HCW.

As indicated in the HCW management hierarchy, the first objective when trying to reduce the environmental impacts associated with HCW management is to prevent HCW from being generated. One of the possibilities of achieving this is to substitute certain environmental hazardous materials and substances, e.g. PVC (in plastic articles, e.g. urine bags) and mercury (in

thermometers). Such initiatives can be introduced through encouragement of Green Procurement procedures at HCF's.

Overall Principle	Process	Measures
Prevention	Waste prevention	Minimising use of disposable products
	Substitution of materials	Green procurement to eliminate PVC
	Waste minimisation	Improved segregation source
Re-use & Recycle	Reuse	Selected disinfection/ sterilisation
	Processing	Composting of organic materials
	Recycle	Segregation of recyclable HCW
Destruction	Incineration	Energy recovery & volume reduction
	Other treatment	Volume reduction
	Residue disposal	Final landfill of treated HCW

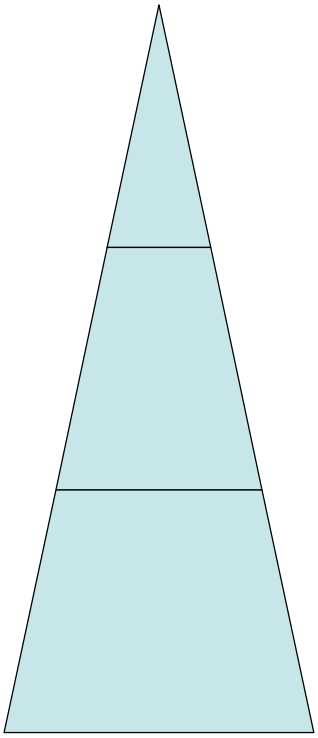


Figure 3.4: The HCW Management Hierarchy.
(**Source:** GDACEL, 2003).

Implementation of environmental management systems for all HCW generators can in turn lead to a reduction in the amount of HCW being generated, with improved HCW segregation at the Chefs resulting in a significant reduction in the amount of HCW requiring costly treatment before it can be disposed of.

Reuse and Recycling is given second priority in the Waste Management Hierarchy. This includes reuse of health care equipment (e.g. glassware, linen and utensils), reuse of HCW management equipment (e.g. general infectious waste containers), as well as recycling of certain materials recovered from the general waste (e.g. glass, metals, plastic, paper and cardboard) and processing of certain wastes (e.g. composting of organic waste). Although recycling is incorporated to varying degrees in the daily operations of HCF's, HCW does not lend itself to this as the risk of infection outweighs the advantages achieved from recycling (GDACEL, 2003).

Lee *et al.,* (2002) suggest that recycling should be undertaken as part of a broader effect to improve hospital sustainability and reduce waste. This effect would also look at substitution of reusable products and use of less toxic products that must be incinerated with improved energy efficiency.

The National Waste Management Strategy indicated that, based on the HCW hierarchy, the lowest priority is given to HCW destruction, thermal and nonthermal, before final disposal is undertaken. Although destruction is given lowest priority, it is often the only appropriate system for HCW management, as the risk of infection or injuries associated with other treatment methods is too large. However, HCW prevention and proper HCW segregation can still reduce the amounts of HCW that have to be destroyed without compromising of health and safety.

3.3 Incineration and Alternative Methods of Health-care Waste Treatment

3.3.1 Incineration process

Incineration is process **(Figure 3.5)** in which combustible materials are burnt, producing combustion gases, products of incomplete combustion and a non combustible residue or ash. DEAT (2000) found that combustion studies completed on various incineration facilities in South Africa have shown that the waste has a caloric value generally between 12 and 14 MJ/kg, which can sustain combustion without significant input of an external fuel, and is thus highly suitable for incineration.

Even though most of the incinerators in the hospitals of Central District Municipality are no longer operational, this kind of technology is still widely used in most parts of the country. Incineration has been the most widely used method of treating HCW in many HCFs in South Africa (Leonard, 2004). The growing awareness amongst the public about the hazards caused by harmful emissions produced by incineration has forced most of HCFs to start considering safer and environmentally friendly alternative technologies (Leonard, 2003).

One of the hospitals in the CDM, which is Zeerust district hospital, is in the process of setting up an autoclave system, one of non-burn technologies which are aimed at replacing the use of the incinerator.

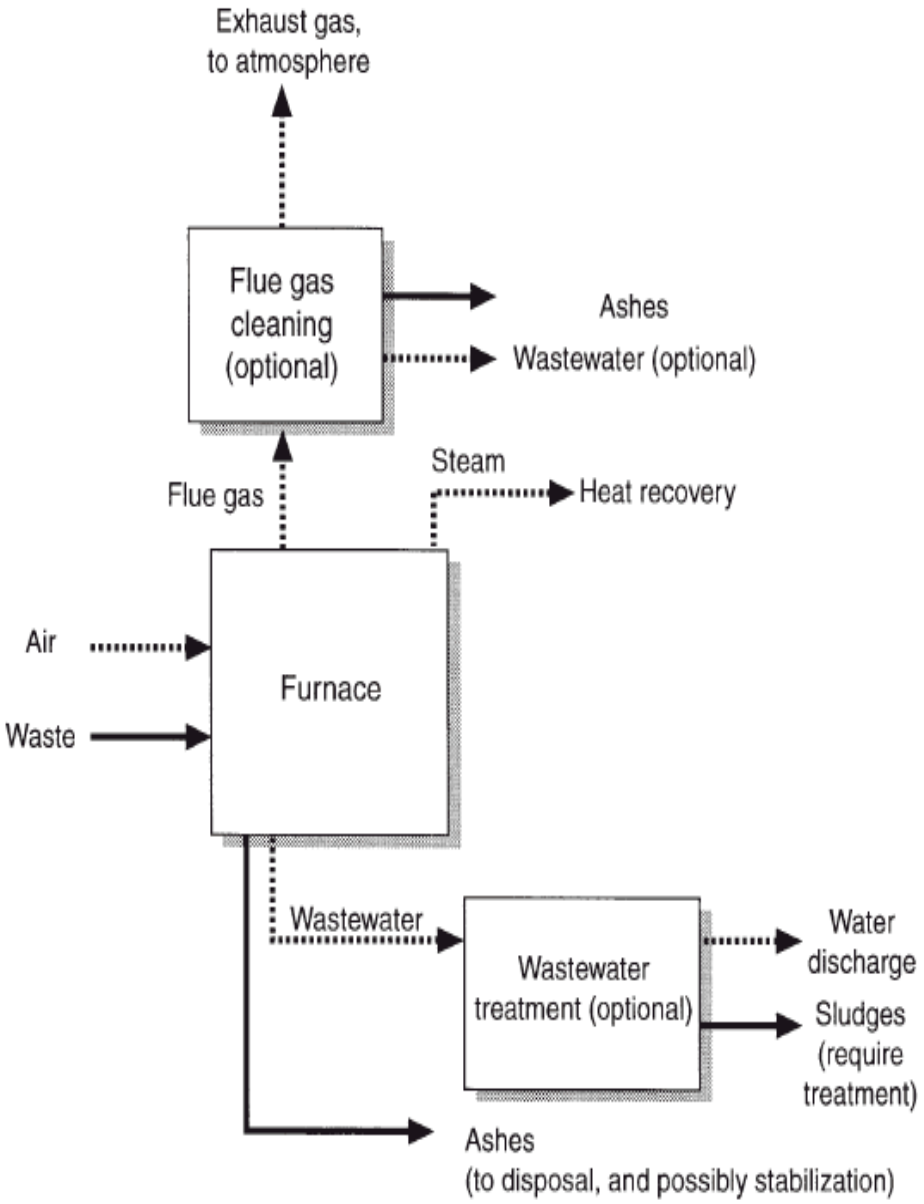


Figure 3.5: Simplified flow scheme of incinerator

(**Source:** Prüss *et al.,* 1999)

The use of incineration technology is associated with the following implications:

Incinerators emit toxic air pollutants

A medical waste incinerator releases into the air a wide range of pollutants, including dioxins and furans, metals (such as lead, mercury, and cadmium), particulate matter, acid gases (hydrogen chloride and sulphur dioxide), carbon monoxide, and nitrogen dioxides (Emmanuel, 2001). Dioxins, for example, have been linked to cancer, immune system disorder, diabetes and other health effects (Leonard, 2004). HCW incinerators are a leading source of dioxins and mercury in the environment. Incinerators are also the major sources of polycyclic aromatic hydrocarbons (Liow *et al.,* 1997 and Lee *et al.,* 2002).

Zandaryaa *et al*., (2000) undertook an experimental study which aimed at controlling nitrogen oxides emanating from waste incineration by using selective non catalytic reduction. The results of the experimentation show that the technology is only capable of achieving moderate efficiency in nitrogen oxide removal.

Incinerators ash is potentially hazardous

Incinerators do not make waste disappear; they reduce it to ash and to atmospheric emissions, both of which are potential hazards (Leonard, 2004).
A study conducted by Karademir (2004) on health risk assessment of polychlorinated dibenzofuran (PCDD/F) emissions from a medical waste incinerator revealed that such emissions are released from the incinerator and this creates a public concern due to their acute and chronic health effects, such as immune, nervous, endocrine, reproductive, and carcinogenic potential. An

attempt to measure the levels of atmospheric PCDD/F in Portugal was made and it was clear that incineration of HCW results in emission of dioxins and furans (Coutinho, 2005).

The ashes remaining at the bottom of the incinerators after burn down often contains heavy metals. Hence ashes from the incinerator must be treated as hazardous waste. However, during a visit to one of the hospitals in the study area, ashes were disposed off on the ground next to the incinerator.

Genazzini *et al.,* (2005) conducted a study which was oriented at evaluating the additions of hospital waste ash from the incinerator in cement matrices to be potentially used as construction element. The study involved the assessment of the effect of the additions (different proportions of ash and metal spiked ash) on the physico-mechanical properties of the building material and the leachability. The results of this study concluded that it is feasible to include hospital waste ash in masonry blocks or other similar products. However, it is necessary to note that hospitals waste ash composition could vary, and given the leachability of metals observed with spiked ash, it is important to analyze its composition and performance before incorporation in cementitious matrices.

Incinerators may not be cost effective

Cost is another factor which one should consider when dealing with HCW disposal issues. Emmanuel (2001) found that in evaluating the costs of incineration, decision makers should take into account, among others things the capital and operating costs of the incinerators plus scrubber and other pollution control devices; the cost of secondary chamber retrofits for old incinerators; the cost of periodic stack testing, continuous monitoring,

operator training and qualifications; and the costs for maintenance and repair especially in relation to refractory wear or failure. Most of the incinerators within the hospitals investigated are in the current no longer operational, simply because of maintenance problems which led to the incinerators not being effective enough.

Disposing of the ash residue from incinerators is also expensive as it needs to be treated as hazardous substances and in the area being studied there is no permitted waste disposal facility for disposing of hazardous waste materials.

Leonard (2004) highlighted that the use of incinerators does not create jobs in a sense that they show very little economic return. Incinerators provide little employment opportunities for the large capital investment needed.

Many communities oppose incineration

A plume of smoke from a hospital incinerator stack stands as a frequent reminder of that facility's environmental impact on the surrounding community. The public's concern for a clean environment and increasing community opposition to incineration should be paramount factors in deciding whether or not to install or continue operating a medical waste incinerator (Emanuel, 2001).

Incineration does not encourage waste minimisation

Incineration doest not encourage waste minimisation but it encourages a consumer-oriented and waste generating society (Leonard, 2004). Most of the incinerators compete with recycling and re-use schemes. In contrast with

incineration, separating and recycling waste provide opportunities for employment of local people.

Despite the above mentioned disadvantages of incineration technology, there have been attempts to explore the Maximum Achievable Control Technologies in order to reduce emissions resulting from incinerators. Van Remmen (1998) found that by utilizing well-maintained and adjusted burner systems, conventional venture/ packed tower scrubbing systems, venture/packed tower scrubbing systems with subcooling, or combination fabric filter baghouse/ packed tower equipment, virtually any existing or new incineration application can achieve low emission.

Moreover, Lee and Huffman (1996) argue that based on the current technology assessment, environmentally-safe incineration of medical waste is achievable if the state-of-art incinerators are installed, modern air pollution control equipment is used and incinerator operators are properly trained.

3.3.2 Alternative Technologies as opposed to Incineration

A number of alternative technologies are being investigated in South Africa and worldwide– these include the following technologies:

1. Chemical disinfection

Emanuel (2001) explains that this process employs disinfectants such as dissolved chlorine dioxide, bleach (sodium hypochlorite), peracetic acid, or dry inorganic chemicals. To enhance exposure of waste to the chemical agent, chemical processes often involve shredding, grinding, or mixing. In liquid systems, the waste may go through a dewatering section to remove and

recycle the disinfectant. Chemical disinfection can be readily applied to liquid waste such as blood and urine but is also applied to microbiological cultures and even sharps (DEAT, 2000). The need to shred waste adds significantly to the cost of the technology and the high cost of the chemical.

Blackman (2001) found that the ability of a chemical disinfectant to kill a targeted organism depends on many factors, including type of micro organism, degree of contamination, type of disinfectant, concentration and quantity of disinfectant.

DEAT (2000) outlined the following advantages and disadvantages of using chemical disinfectants:

Disadvantages:

- Shredding or milling of the waste is often required to ensure adequate contact of the disinfectant with the solid waste.
- The disinfectants used are potentially a significant hazard both to personnel and to the environment.
- The efficiency of disinfection depends on operational conditions and the disinfectant used.
- Only the surface of solid waste may be disinfected.
- The disposal of the residues, which include excess of the disinfectant, must be evaluated according to the minimum requirements for the Classification, Handling and Disposal of Hazardous Waste.

Advantages:

- Disinfection of infectious waste in the plastic bag or sharps container will minimize potential risk to the staff during handling.

- This method can increase the length of time a waste can be stored at room temperature and minimize the need for cold storage facilities.
- Infectious waste treated with an organic disinfectant that contains no halogen or sulphur can be incinerated without significant impact on the emissions from an incinerator.

2. Autoclaving Treatment system

Autoclaving is mainly used for sterilization of re-usable medical instruments within South Africa's health care facilities. Zeerust district hospital, which is one of the study sites in the Central District Municipality, is in the process of piloting an autoclave treatment facility. This pilot project is intended to provide an integrated cradle-to-grave HCW management system for the full HCW stream from remote rural communities, where long traveling distances limit the viability of having full HCW stream collected at regular intervals for transport to and treatment at regional metropolitan HCW treatment facilities (DEAT, 2005).

An autoclave treatment system consists of a metal chamber sealed by a charging door and surrounded by a jacket steam. Steam is introduced into both the outside jacket and the inside chamber which is designed to withstand elevated pressures (Leonard, 2004). The operating and design principle is to subject the waste to the saturated steam, in the absence of air, at prescribed temperature and pressure for a sufficient time to ensure sterilization (Blackman, 2001).

The effectiveness of the technique must be checked periodically using bacteria such as Bacillus thermophilus (DEAT, 2000). The final volume of

treated HCW is reduced to about 20% and, since dry steam is used, the product is dry to touch.

Emmanuel (2001) and Blackman (2001) outlined the following advantages and disadvantages of using the autoclave technology system.

Advantages:

- Steam system is a proven technology with a long and successful track record.
- Capital cost is relatively low compared to other non incineration technologies.
- If proper precautions are taken to exclude hazardous material, the emissions from autoclaves are minimal.

Disadvantage:

- The technology does not render waste unrecognizable and does not reduce the volume of treated waste unless a shredder is added.
- Offensive odors can be generated but are minimized by proper handling equipment.

A study on the evaluation of a steam autoclave for sterilizing medical waste in Louisiana, United States found that the steam did not fully penetrate the load, and bacteria were not killed, despite assurances from marketers of these autoclaves (Tiller and Linscott, 2004). Therefore, institutions considering this method must test autoclaves carefully to ensure safety and compliance with local health regulations.

3. Microwaving Process

The microwave process usually involves the grinding and shredding of waste materials to optimize radiation exposure (National Health and Medical Research Council, 1999). Leonard (2004) describes the microwave disinfection system as consisting of a disinfection area or chamber into which microwave energy is directed from a microwave generator (magnetron). Typically, 2 to 6 magnetrons are used with an output of about 1.2 KW each.

The microwave system consist of an automatic charging system, hopper, shredder, conveyor screw, steam generator, microwave generators discharge screw, secondary shredder and controls (Emanuel, 2001). The waste is exposed to steam after shredding, and then exposed to microwave (Lee and Huffman 1996). Microwave units routinely treat sharp wastes such as needles and waste containing pieces of metals.

This technology is considered safe and efficient, and can treat high volumes of waste; however, it appears to be more expensive than the autoclave.

Emmanuel (2001) discussed the following disadvantages and the advantages of using microwaving technology system.

Advantages:

- If proper precautions are taken to exclude hazardous material, the emissions from microwave units are minimal.
- The internal shredder reduces waste volume up to 80%.
- The technology is automated and easy to use hence it requires only one operator.

- Because many people have microwave ovens, it is easy for hospital staff to understand and accept the technology.

Disadvantages:

- If hazardous chemicals are in the waste, these toxic contaminants are released into the air or remain in the waste to contaminate the landfill.
- There may be some offensive odor around the microwave unit.
- The secondary shredder used for sharps is noisy.
- The capital cost is very high

4. Plasma Arc Destruction Technology

According to Emanuel (2001), the plasma system works as follows:

- *Waste loading*: The waste is introduced through a feed handling section which may or may not include an internal shredder, ram, or auger.
- *Plasma pyrolysis:* The waste is then exposed to very high temperatures produced by a plasma arc torch in the pyrolysis chamber operating at around 1, 650°C. At theses temperatures, the waste is destroyed, forming a product gas, at times referred to as syn gas.
- *Energy recovery:* Energy can be recovered from the gas by using it as supplemental fuel to produce steam or hot water in cogeneration. In some cases, the gases are simply burned in a flare.
- *Waste residue collection:* The solid residue from plasma technologies may include carbon black, vitrified glassy aggregates and metallic residues. In some design the metals can be recovered and some of the metals may also be encapsulated.

5. Thermal Depolymerisation Technology

Emanuel (2001) explains the following three stages of operating this system.

i) Waste loading, weighing and purging: Red bag waste on cardboard trays enters the first of three chambers. The chamber is sealed automatically and the waste is weighed. The air is then purged by replacing it with nitrogen.

ii) Reverse polymerisation: The door to the next chamber opens and the waste is moved by a conveyor into the main treatment chamber. The outer door to the first chamber is then sealed. In the second chamber tense microwave energy is applied, causing molecular bonds to break.

iii) Cooling and grinding: The resulting carbonaceous residue is moved by the conveyor into the final chamber for cooling and grinding. A heavy-duty grinder reduces the size and residue is moved to cyclone receiver where it is deposited into plastic bags for landfill disposal.

The complete cycle time is 50 to 80 minutes per load, depending on its mass. This corresponds to 1,225 kg per day.

6. Solar disinfection of infectious biomedical waste

Given the fact that the above mentioned treatment technologies are too expensive for most developing countries there have been investigations into more cost effective technologies for treating health care waste. Chitnis *et al.,* (2003) did an assessment of solar heating as an alternative technology to treating health care waste. They immersed simulated infectious waste with added challenge bacteria in water in a box-type solar cooker (**Figure 3.5)**,

which was left in the sun for 6 hours. In 24 sets of observations, the amount of viable bacteria was reduced by significantly.

Chitnis *et al., (2003*) also tested infectious medical waste with a heavy load of bacteria (108–109/g) for solar heat disinfection in 20 experiments. Their results showed a similar reduction in the amount of viable bacteria. This study concluded that solar heating thus seems to be a cheap method to disinfect infectious medical waste in less economically developed countries.

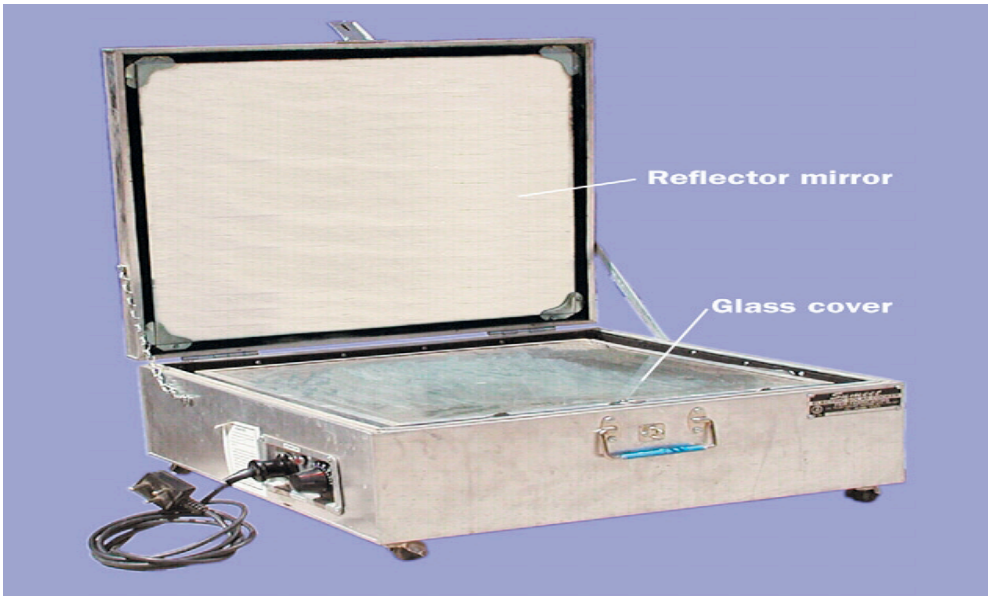


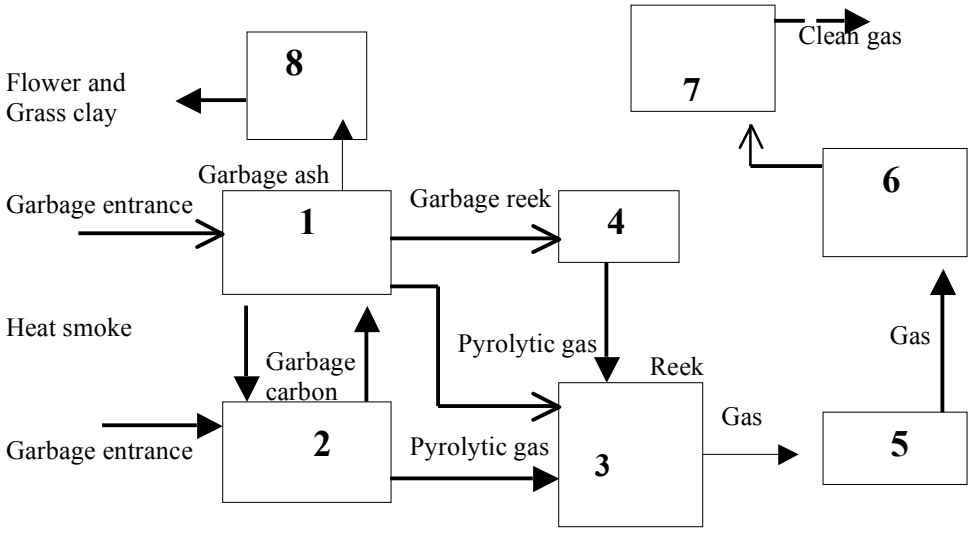
Figure 3.6: Box solar cooker used to treat infectious waste.
(**Source:** Chitnis *et al.,* 2003).

7. Refuse Pyrolysis Disposal Technology

Yufeng *et al.,* (2003) investigated and used this method in China. Basically the technology employs advanced pyrolysis to dispose of waste, produces purified combustible gas and does not discharge pollutants. It not only solves

the pollution problem of household waste and medical waste entirely, but also brings in large social and economic benefits, as well as environment protection. Using the new pyrolysis technology, dioxin emissions can be effectively reduced.

Yufeng *et al.,* (2003) highlighted a process flow chart of the municipal and medical waste management unit in **Figure 3.7**.



1= main pyrolysis boiler; 2 = secondary pyrolysis boiler; 3 = mixture gas reaction unit; 4 = water stream generator; 5 = gas cooler; 6 = gas filter; 7 = gas storage; 8 = garbage ash processor.

Figure 3.7: Flow chart of pyrolysis

(**Source:** Yufeng *at al.,* 2003)

Yufeng *et al.,* (2003) provides a description of the pyrolysis principle of the municipal and medical waste management units. The waste normally contains the element carbon (C), hydrogen (H), oxygen (O), nitrogen (N), sulfur (S) and so on. The prime waste is put into a heat-reactor retort to be heated and pyrolyzed under conditions of high temperature, low oxygen and pressure. Under these conditions, chemical bonds are disrupted. The surface water,

carbon dioxide and methane begin to phase out, and result in the generation of mixed gases consisting of methane, carbon monoxide, carbon dioxide, hydrogen, organic acid, tar oil and water vapor, among which the major component is methane.

Thus, the prime waste is changed into coke waste carbon which mainly consists of elemental carbon. Some of this waste is used to support the combustion reaction to provide heat energy for other reactions; the rest is used to react with the mixed gases mentioned above, and produce fuel gas whose major components are methane, carbon monoxide and hydrogen. A part of the clean source of energy produced in this manner is used to maintain the reaction temperature of the equipment; the rest can be supplied for consumer consumption. The whole course is operated in a recycled manner.

Therefore, no gas is wasted; the only emitted substance is innocuous solid inorganic materials which are about 5–8% of the total waste weight. Besides, this type of solid soil can still be used as soil to grow flowers and grass. The experimental results indicated that the nutrient index of this kind of solid soil is higher than that of general earth.

In order to ensure that the new technology of waste management is enforceable, the equipment is designed to contain four large parts
(Figure. 3.7), the main pyrolysis boiler, secondary pyrolysis boiler, mixture gas reaction unit and gas cleaning unit. The process of refuse management is accomplished in three stages which include pyrolyzing the waste, heat-disposing the mixture gas and purifying the fire gas as illustrated in (**Figure 3.6)**.

Tamplin *et al.,* 2005 suggested that almost all the treatment technologies listed above are suitable; however, the treatment option should be chosen according to the national and local situation. WHO (2000) has reiterated its commitment to a comprehensive approach to health-care waste management that reflects a choice of management and treatment options based on: affordability, environmental-friendliness, efficiency, workers safety, and the prevention of the re-use of disposable medical equipment.

DEAT (2000) highlighted the following issues that must be considered when choosing the method of treating health care waste:

•The sterilisation or disinfection efficiency.
•The waste should not be accessible for reuse.
•The potential impact of poor segregation of wastes, e.g. impact of chemical wastes, aerosols, etc.
•The ability to meet the requirements of the Occupational Health and Safety Act.
•The emergency procedures required, e.g. after a needle stick injury.
•Regulatory requirements, including an Environmental Impact Assessment with public scoping.
•Any gaseous emissions including fugitive emissions.
•The quantity of waste for treatment and the capacity of the system.
• The volume of waste and mass reduction.
•The residues after treatment – classification and disposal procedures.
•Infrastructure and operation and maintenance requirements.
•Training requirements.
•Available space and location.
•Capital and operating costs.
•Public acceptability.

CHAPTER FOUR

METHODOLOGY

4.1 Waste Assessment

The site visits and assessment were conducted at five public hospitals in the Central District Municipality of North West Province, and the hospitals included 1 provincial hospital, 1 private hospital and 3 district hospitals. These hospitals where selected according to size and category of structure (private, public) and the type of area (urban, peri-urban, and rural).

A walk-through audit was conducted in the selected hospitals in the study area **(Table 4.1).** The audit conducted determined the types of HCW, location of all types of HCW, approaches to management of HCW and the status of the available treatment and disposal facilities.

Table 4.1: Hospitals visited in the CDM of NW Province.

NAME OF THE HOSPITAL	TYPE	TOWN/DISTRICT
1. Thusong district hospital	District	Lichtenburg
2. Bophelong provincial hospital	Provincial	Mafikeng
3. Zeerust district hospital	District	Zeerust
5. Gelukspan district hospital	District	Tswaing/Delareyville
6. Victoria district hospital.	Private	Mafikeng

The walk-through audit also gave perspectives on the current management systems which, amongst other things, include procedures for the handling, collection, storage and packaging of waste in the health-care facility. To

facilitate the data gathering exercise, the Rapid Assessment Tool questionnaire developed by the World Health Organisation was modified and used. **Appendix A** is a collection of all this completed questionnaires.

The waste assessment exercise explained above formed the basis for identifying opportunities for improving waste collection, handling and disposal, as well as for setting targets for waste minimization, recycling and cost reduction.

4.1.1 Description of Rapid Assessment Tool Questionnaires

The assessment of healthcare waste management practices in the study area was achieved through the completion of the following questionnaire tools. The questionnaire used is divided into different tools, and each tool is designed to gather specific information from staff members at the facilities and other relevant stakeholders **(Appendix B).** The permission granted to enter the facilities and collect data and information is indicated in the letter in **Appendix C**.

Tool B1 and B2: This questionnaire is meant to answer specific questions about HCW generation, containerisation of HCWS, training of staff on HCW management issues, transportation and disposal of HCW, HCW policies and legislation, quantities of HCW, storage and treatment facilities of HCW. For the purpose of completing this questionnaire, an interview with personnel in Provincial the Department of Environment and the Provincial Department of Health in the North West Province was held. These two departments were identified as the major role players because they directly influence how the system should function from practical, technical, financial and legislative points of view.

Tool C: The questionnaire is aiming at gathering information on the demographics of the study area, HCW and domestic waste treatment, and HCW legislation and policies from the municipality point of view. An interview was held with the municipal waste manager of the Central District Municipality of North West. The municipal personnel had provided good information about waste collection, transport and final disposal, as well as eventual recycling activities.

Tool D1: The questionnaire is aimed to give a perspective on issues such as HCF characteristics, HCW offsite transport, HCW treatment facilities and training of staff on HCW management issues. The questionnaire was completed in an interview with the hospital managers as they are often caught between several conflicting requests relating to diverse national legislative requirements vis-à-vis the limited financial means at their disposal. The outcome of the interaction was very good because very useful information on how the HCF functions and how HCWM is dealt with in hospitals was revealed.

Tool D2: This questionnaire is meant to answer questions around HCW generation and segregation, HCW storage containers, HCW collection and on-site transport, and HCW legislation and policies. This questionnaire was completed through an interview with the head nurse, as such persons are normally in the best position to give information with regard to waste generation and segregation.

Tool D3: The questionnaire focuses on HCW generation rate, HCW segregation and handling waste reduction, HCW storage area, HCW collection and onsite transport and HCW treatment. The questions in this tool

were addressed in an interview with person responsible for HCWM. In most of the hospitals visited, the personnel responsible for HCWM were the best source of information regarding HCW collection, transport, treatment and final disposal.

Tool D4: The questions here are designed to capture the actual practices regarding HCW collection, transport, treatment and final disposal if done internally. The personnel handling HCW were the most relevant in providing information on these issues.

Tool E: This questionnaire was completed through the personal observation made whilst touring the hospital facilities. This is very important because one was able to confirm information on HCW storage containers, HCW storage areas, HCW treatment facilities and HCW disposal, given by HCF personnel. This exercise also made it possible to describe the situation in the HCFs.

The adoption and comprehensive use of the outlined questionnaire approach gave some baseline data on the health-care waste management practices in the selected hospitals of Central District Municipality.

4.2 Data Analysis

The data collected through interviews with relevant stakeholders in the health care facilities were fed into the questionnaire spreadsheet. The data was then processed according to the different situations in the health-care facilities, such that it was then possible to infer possible solutions and recommendations that the hospitals could follow for improved waste management systems.

The key steps followed are presented below:

a) After each interview, the answers of relevant questions to the questionnaire were translated to the excel spreadsheet for manipulation, and the comments made during the interviews were analysed and transcribed into the word processor.

b) The personal observation and notes taken during the site visits and interviews during the visit to the hospitals were also be analysed.

c) The data collected through the interviews and through personal observation was interpreted and the actual situation in the hospitals was presented in the form of text and illustrations.

d) Throughout out the hospital tour, pictures were taken and analysed to depict the actual situation in the hospitals.

e) To get the actual quantities of HCW, invoices supplied by the contractor responsible for HCW collection were obtained. However in some of the hospitals, the records on quantities of HCW were not kept. From these invoices one was able to calculate the average volume of different HCW categories collected in the hospitals per month.

4.3 Review of Related Literature

The literature survey gave a highlight on the historical and current perceptions regarding environmental impacts resulting from health care waste

management. The literature was gathered from sources such as the internet, books, journals and other information materials. This also covered the analysis of available legislation, policies and strategies in South Africa related to health care waste management, as well as a review of important international agreements to which the country is a signatory.

CHAPTER FIVE

RESULTS AND DISCUSSIONS

Using the combination of the outputs of the interviews and site visits as well as those from the completion of the waste assessment questionnaire with different personnel in the HCFs, a number of key issues can be discerned in relation to the management of health-care waste in the study area. They are discussed in the succeeding section.

5.1 Description of the hospitals visited

Thusong hospital

This is a district hospital located along the Lichtenburg / Mafikeng road in the area called Itsoseng. Thusong district hospital is approved for 300 beds but there are 175 usable beds at the moment. This hospital receives an average of 120 outpatients per day.

Zeerust hospital

The hospital is situated in the Zeerust area and it is also a district hospital. Zeerust hospital is approved for 84 beds and normally gets an average of 105 outpatients per day. The referral hospitals for Zeerust district hospital are Mafikeng and Klerksdorp/ Tshepong provincial hospitals.

Mafikeng hospital

Mafikeng hospital is a provincial hospital located in the Mafikeng area. This health-care facility serves as a direct referral hospital for many small health facilities in North West province. The area is also served a network of outlying clinics.

Victoria hospital

This is the only private hospital in the study area and is located in the Mafikeng town. Victoria hospital is one of the Afrox group private hospitals. The hospital is approved for 93 beds and gets an average of 20 outpatients per day.

Gelukspan hospital

This hospital is located at Delareyville municipality and approved for 350 beds but there are 168 active beds at the moment. The average number of outpatients visiting this hospital is approximately 22 per day.

5.2 Health-care Waste Segregation and Handling

Segregation is the critical element of responsible waste management as it ensures the most cost effective, environmentally friendly, efficient and safe way of treatment and disposal of HCW. GDACEL (2004) found that if HCW segregation is done more effectively, it is estimated that there could be a reduction in the HCW generation rate by as much as 30% during the period when improved segregation is taking place.

Generally, waste in the hospitals of the study area is segregated into sharps, infectious waste, anatomic waste and domestic waste, as illustrated in **Figure 5.1.**



Figure 5.1: Segregated HCW in the ward at Bophelong provincial hospital.

The study conducted at some European hospitals by Mühlich *et al., (*2003) emphasised that from the point of easier orientation for personnel, it is advisable to determine the sites and locations where infectious waste may and may not be expected, and to provide the appropriate waste collection bins. This practice avoids the problem of incorrect sorting but it has a consequence because more waste will be classified as infectious. However, an inherent challenge in this system is that the personnel should be trained in such a way that there is no confusion when placing and emptying the containers.

The following colour coding bags and containers are used for different waste streams in the study area:

- **Black and / Blue Plastic bags-**These colour bags are used for disposing off general waste.
- **Yellow puncture proof containers-**These are used to dispose off sharps (normally called sharps container).
- **Yellow specibinz-** These are used to dispose of human tissue, placentas, anatomic waste and the like.
- **Boxes lined with red and yellow plastics-**Infectious waste is disposed off in those kinds of boxes. These cardboxes arrive as collapsed structures, and this is advantageous because they require little space for storage before use.

  However, Neely *et al* (2003) identify the following disadvantages of using the single use cardboxes for disposing infectious waste:

  i) They require time to be folded into a box and have no lid when in use because the flaps on the top of the box are kept open by the plastic liner that folds over the top edge.
  ii) The single-use containers are not as strong as the reusable ones, are not suitable in a wet area, and are eventually added to the waste stream at disposal.

General health-care waste or domestic waste typically includes paper and packaging, drinks containers, glass, food residues, dead flowers, intravenous (IV) bottles, hand towels and tissues, and similar materials not contaminated with body fluids.

Potentially infectious waste is usually all waste items contaminated, or suspected of being contaminated, with body fluids such as bandages and gauze, swabs, IV fluid lines, maternity and incontinence pads and disposable spatulas, bowls and cups.

The specibinz containers are used to collect body parts, human tissue, placenta, blood products and the like.

Sharps containers are used to contain needle and syringe assemblies, small ampoules, razor blades, scalpel blades, infusion needles, lancets and broken glass.

During the walk-through audit, it was noticed that the containers are not labelled or marked; this makes it difficult for one to easily identify the origin of the container as well as the content. One other observation on the full HCW containers was that most of the containers were not sealed.

From observation and interviews with personnel responsible for HCW management in the hospitals visited, it was clear that even though there are containers dedicated for different HCW streams, one could still notice that there is poor segregation. Looking at **Figure 5.2** for instances, one could notice the poorly segregated HCW.



Figure 5.2: Poorly segregated HCW at Thusong district hospital.

Also, from interviews and ground observations at the hospitals, it was clear that even though there are containers designated for different categories of HCW, there is serious need to train workers to segregate HCW in a good manner, simply because there is still some confusion as to what constitutes proper segregation of HCW.

By the means of close observation in the HCW receptacles one could see that segregation is not carried out in a satisfactory manner. In the sharps containers, one could actually notice that the needles are not segregated from syringes, hence the complete unit (including the packaging material) is being

disposed off into the sharps containers instead of disposing off the needles only in the sharps container.

Brink (2003) highlighted that segregating needles from syringes and packaging material can reduce on the number of sharps containers being used, thereby significantly reducing volume of plastics to be processed

Also, Brink (2003) found that poor segregation practice implies the following:

- ***Health Risk implication***

Due to poor segregation, HCW lands up in the general waste stream, resulting in the waste being disposed of on general landfill sites. As a result, reclaimers are exposed to the physical dangers as well as a potential risk of infection.

Poor segregation can, however, also impact on the health of medical staff, cleaning staff and waste handlers, transport and disposal facility staff.

Segregation is also essential in terms of treatment technologies for treating HCW since different technologies are compatible with certain HCW streams. Failure to segregate and to process only what the technology is compatible with will result in the following consequences:

i) Exposure of employees and the public to concentrations of chemicals present in the waste or emitted by incinerator stack.
ii) The risk of explosion created by the presence of unidentified flammable substances.

- ***Financial Implication***

The cost of disposing domestic waste is far less than the cost of disposing HCW, hence the significant difference in disposal costs between the two waste categories. This should serve as an incentive for management to implement proper segregation measures in the HCF.

However, from the observation of the waste which is segregated into different HCW categories, segregation is still very poor in most of the hospitals visited during this study. There is still much to be done in terms of training the health care personnel on waste segregation techniques and procedures.

5.3 On-site Transportation of Health-care Waste

During the visits to the hospitals, it was observed that waste is generally transported from the point of generation in the wards, then temporarily stored into sluice room, and finally transported to the storage areas, to await collection by a private company called Sanumed. Evertrade medical waste contractors collect HCW produced by Victoria private hospital while the rest of the hospitals are serviced by Sanumed. In all these hospitals there are personnel dedicated to the transportation of health-care waste; in most instances, they are general workers/ groundsman and cleaners.

During the survey, it was clear that most of the HCFs in the study area have no policy or procedure for managing spills that might occur during the transportation of waste. Even though there are precautionary efforts, spills can occur in the process of moving waste from one point to another; therefore, HFCs should make an effort to put in place a documented policy and procedure to deal with a possible spill of hazardous waste.

Trolleys are used to transport HCW from the point of generation to the storage area. The trolleys used to transport HCW are partially covered on sides except for the trolley used at the Mafikeng provincial hospital (Figure 5.3), the latter hence is not suitable to effectively transport HCW**.** This kind of a trolley is not safe for transporting HCW as spills can easily occur during transportation.



Figure 5.3: Trolley used to transport HCW at Mafikeng provincial hospital

Also from **figure 5.3,** one could see that the trolley used at the Mafikeng provincial hospital is in bad condition. Spillage of HCW could result in pollution of the environment in the case where the containers are dropped during transportation.



Figure 5.4: Trolley used to transport HCW at Gelukspan district hospital.

On the contrary, the trolleys used to transport health-care waste at the Gelukspan district hospital (Figure 5.4) and Thusong district hospital (Figure 5.5) are is a much better state, reflecting improved safety in wasted transportation.



Figure 5.5: Trolley used to transport HCW at Thusong district hospital.

GDACEL (2001) outlines factors that influence safe and efficient transport of HCW which include correct and safe containerisation, packaging to prevent spillage, and that the bags/containers are labelled to ensure that the transporters are aware of the contents of the containers they are carrying.

In the hospitals visited, most of the personnel transporting and handling HCW don't have proper protective clothes. It was found that some of the personnel were handling waste without gloves, proper overalls and necessary boots. This kind of practice place staff at the risk of contracting diseases from contact with the waste in question.

5.4 Health-care Waste Storage Areas

In the HCFs visited, HCW is collected from the wards and sluice rooms to be stored in the storage room until collection by the private contractor. Most of the storage areas do not meet the minimum requirements for storage facilities for HCW.

During the site visit the storage area for Mafikeng provincial hospital was under construction, but this facility was used as a storage area for HCW even though construction was still taking place. **Figure 5.6** shows the storage area in the Mafikeng provincial hospital that was under construction during the time of the site visit. This was being built because the existing storage area was not complying with the minimum standards for HCW storage. The storage area at this hospital is not secured and is not lockable, as a result, there could be possible illegal access. However, the person responsible for HCWM pointed out that the storage area under construction will be in good condition and satisfy all the requirements for HCW storage.



Figure 5.6: Storage area under construction at Mafikeng provincial hospital

In most of the hospitals visited during the survey HCW is not stored according to specific rules **figure 5.7**. Generally, in most of the hospitals there is no systematic way of storing HCW in the storage rooms. Through the interviews with the personnel responsible for HCW, it was also gathered that waste is just placed haphazardly, not according to specific rules. However, HCW at Victoria private hospital is stored in the mortuary were it is lockable.



Figure 5.7: HCW in the storage area at Mafikeng provincial hospital.

In all the hospitals visited except Gelukspan hospital **(Figure 5.8),** there is no warning sign or marking which indicates that it is a storage area of biohazardous waste, and that no unauthorised person is allowed in the storage facility.

During the site visits, the following general problems where identified with respect to the storage areas:

- Lack of ventilation in the storage room.
- No good lighting and passive ventilation.
- Waste not stored systematically, or in other words, waste not stored according to specific rule or waste type.
- HCW not properly packaged
- No signs indicating the location of the storage area.



Figure 5.8: Warning signs at Gelukspan hospital storage area

5.5 Quantities of Health-care Waste produced in the CDM OF NWP

In order to establish a well panned health care waste management system, it is essential to know the quantity of HCW generated in the study area (Patil and Shekdar, 2001). Consequently, invoices of HCW collection were obtained from the hospitals for the purposes of calculating the approximate quantities of different HCW streams generated by the hospitals. The quantities generated vary from hospital to hospital and depend on the type of health-care facility and local economic condition.

Through the analysis of the invoices, it was picked up that Victoria private hospital uses the mass billing system; as a result, the amount of waste generated in this hospital is expressed in kg. The rest of the (public) hospitals visited in the study area use the volumetric billing system. This system allows one to calculate the amount of waste produced per hospital through counting the number of containers in each category of health-care waste (Otto and Hansen 2003). This method of billing is widely used in the public hospitals of the North West Province.

Victoria private hospital produces an amount of 911 kg of HCW per month. **Table 5.1** shows the number of different HCW containers per categories of HCW. Looking at the figures on the table, one could realise that Mafikeng provincial hospital is the major producer of all HCW types. This is attributed to the fact that it is a provincial hospital and provides health care service to the rest of NW province.

Table 5.1 further shows that the lowest producer of all categories of HCW is Gelukspan district hospital. This is due to the fact that this hospital has got only 168 active beds and it also receives an average of 22 outpatients per day,

which is on the low side. During the interview, it was also indicated that there is only one doctor servicing this hospital; as a result, very few people come for consultation to the hospital. It was witnessed during the site visit that the hospital is not very busy.

Table 5.1: Average monthly number of HCW containers per different type of HCW stream in the hospitals of the study area

Types of receptacles	Thusong hospital	Gelukspan hospital	Zeerust hospital	Mafikeng hospital
Specibinz 10L	10	4	11	47
Specibinz 1.5L	4	3	0	0
Specibinz 25L	8	0	0	49
Sharps 7.6 L	13	12	14	23
Sharps 10 L	11	5	0	0
Waste Box 50L	95	25	104	11
Waste Box 142 L	68	20	0	742

Table 5.2: Average monthly HCW volume in the study area

Type of HCW	Thusong hospital	Gelukspan hospital	Zeerust hospital	Mafikeng hospital
Human tissue	306 L	44.5 L	110 L	1695 L
Sharps	208.8 L	141.2 L	106.4 L	174.8 L
Infectious waste	14406 L	4090 L	5200 L	105914 L

Table 5.2 indicates the average monthly HCW volume for human tissue, sharps and infectious waste. In terms of infectious waste Mafikeng provincial hospital produces about 105914 litres, with Thusong hospital producing 14406 litres, Zeerust producing 5200 litres and lastly Gelukspan hospital producing 4090 litres.

In the case of the sharps, Zeerust district hospital produces a volume of 106.4 litres of sharps containers, that is the lowest out of all the hospitals visited in the study area. Mafikeng provincial hospital generates the volume of 174.8L of sharps which is the highest in the area, then with Thusong district hospital producing 208.8 L and Geluskpan district hospital producing 141.2L volume of sharps.

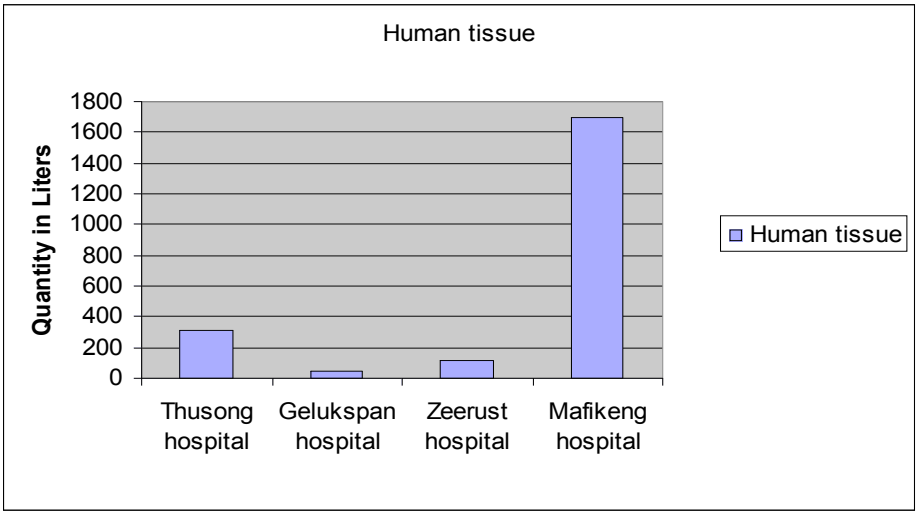


Figure 5.9: Average volume of human tissue in CDM of NWP.

For various hospitals investigated the trend of the volumes of human tissue, sharps and infectious waste is also illustrated in **Figure, 5.9, Figure 5.10 and Figure 5.11,** respectively.

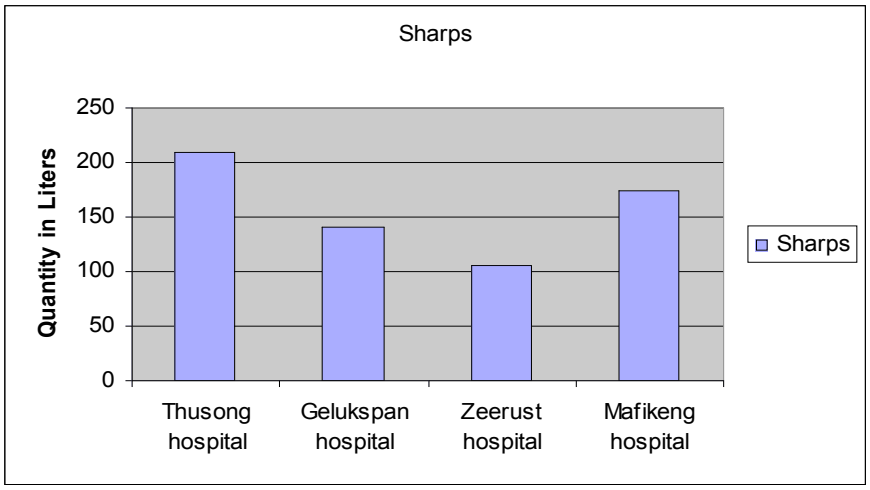


Figure 5.10: Average monthly volume of sharps in CDM of NWP.

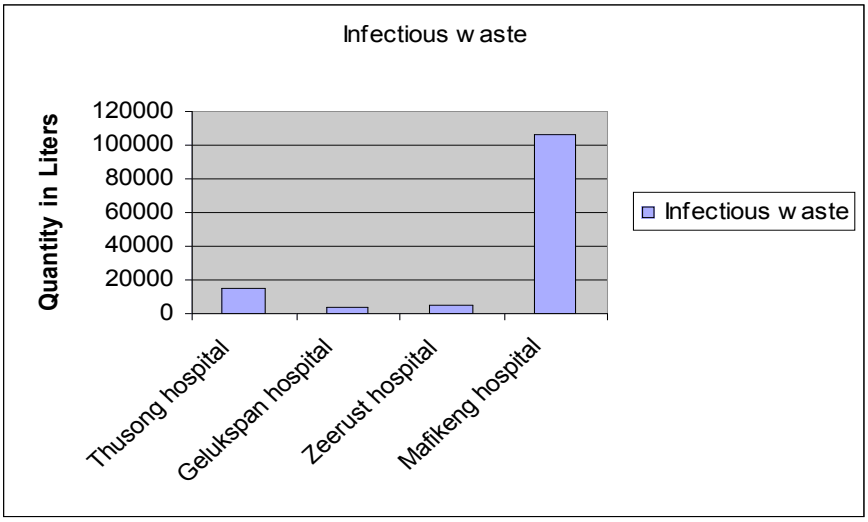


Figure 5.11: Average monthly volume of infectious waste in the CDM of NWP**.**

5.6 Treatment of HCW in the CDM OF NWP.

Treatment of HCW waste has been contracted to a company called Sanumed. This company operates incinerators in Roodepoort. Through consultation with the Department of Health, North West Province, it was highlighted that the contract with the company officially ended in September 2004, but that there was an extension from September 2004 till March 2005. And they were also looking at extending the contract until end of June 2005 when the tender was to be advertised for the appointment of a contractor.

In the past, HCW used to be treated in house in the incinerators. All the incinerators in the hospitals of the study area are no longer functional, except for the incinerator at Gelukspan district hospital which is used to treat domestic waste. The information gathered from the interviews was that these incinerators where closed down due to inefficiencies HCW treatment and plant maintenance, and also because the incinerators were not complying with the relevant environmental requirements and legislation.

The incinerators are still located at the hospitals and one could notice ashes around the non-operational plants, from which one can easily see partially treated medical waste. **(Figure 5.12)** shows the ashes from an incinerator at Thusong district hospital. The presence of these ashes poses a serious health hazard, and they consist of materials that are harmful to the environment (Mato and Kaseva, 1999).

The survey initiated in some European countries (Quab et. *al.,* 2003) revealed that incineration of health-care waste is one of the significant sources of dioxins that pose serious risks to the health of human beings. Methods of treating and stabilizing the ash from incinerators have been introduced, and

these involve stabilizing ash from the incinerator by a high temperature melting process with the final slag was proven to be non hazardous (Idris and Saed, 2002).



Figure 5.12: Ashes of HCW from the incinerator at Thusong district hospital

5.7 Treatment of Domestic Waste

In all the hospitals visited, domestic waste is collected by municipalities and dumped at the municipal landfill sites, except for Gelukspan hospital where domestic waste is incinerated and the remains or ashes transported to an unlicensed dumping site in the vicinity of the hospital.

Figure 5.13 shows he unlicensed dumping site for partially incinerated domestic waste. From the picture, one could notice burned and partially

burned domestic waste at the illegal dumping site. This practice may result in many environmental problems, including soil contamination, which may eventually lead to groundwater pollution, land degradation and air pollution (Secretariat to Basel Convention and WHO, 2004; Ibáñez *et al.,* 2000).



Figure 5.13: Unlicensed dumping site of domestic waste at Gelukspan Hospital.



Figure 5.14: Remains of incinerated domestic waste at Gelukspan hospital.

Ibáñez *et al* (2000) reported that waste incineration generates solid residues, such as fly ashes, toxins (e.g. from certain plastics), heavy metals and suspended particles (e.g. ash) into the air. These, in turn, may cause or at least aggravate respiratory problems and cause different skin diseases (Shand and Strydom 2004; Mato and Kaseva 1999).

The general waste from the incinerator of Gelukspan hospital is shown in Figure 5.14, which then feeds into the unlicensed dumping site near a school. From interviews with the person responsible for waste management at the Gelukspan hospital, there has been several complaints from the school with regards to bad odours or particulates which emanate from the dump.

The hospital personnel acknowledged the fact that they know that their practices in terms of handling and treating domestic waste are unacceptable, and indicated that it is not by choice that they are disposing off domestic waste in this manner. Hospital staff explained that they have written several letters to the municipality requesting for the services of collection of domestic waste, but that up to now nothing had been done to remove domestic refuse from the hospital.

On a positive note, in Mafikeng provincial, Thusong district, Gelukspan district and Zeerust district hospitals domestic waste gets collected by the municipality. However, in all the above hospitals there is no attempt to separate recyclable and non recyclable materials, with an exception of Thusong hospital where cardboxes are sorted for collection by a recycling company. Domestic waste is thrown into black and blue plastic bags. This waste gets transported to the storage area for collection by the municipality. At the Zeerust hospital, domestic waste gets packed into skips for municipal collection **(Figure 5.15).**



Figure 5.15: Domestic waste in the skip at Zeerust hospital waiting for municipal collection.



Figure 5.16: Domestic waste in the storage room at Thusong Hospital.

At Thusong and Gelukspan hospitals, domestic waste is stored in the same storage area with HCW; this practice is not safe because there is a chance of possible contamination of domestic waste. Unlike at the Thusong hospital **(Figure 5.16)** domestic waste from Victoria private hospital is stored outside in an open area until collection by the municipality **figure 5.17.**



Figure 5.17: Domestic waste at Victoria private hospital awaits collection by the municipality.

Generally, the storage areas of domestic waste at the hospitals are not acceptable or rather suitable for storage. There is no attempt to sort or segregate domestic waste, and waste is not stored according to any organisation or order. Thusong district hospital is the only hospital which separates boxes and cardboards for recycling purposes.

5.8 Waste Reduction and Recycling

The study showed that there is no attempt to reduce or minimise the amount of HCW that goes into the dedicated containers. This practice subsequently impacts on the efforts for handling, treatment and disposal. Most of the waste

material observed in the HCW containers can be recycled or reused, in particular, items which are not directly used for health care (packaging materials, plastics, cardboxes etc).

Thusong district hospital is the only hospital that separates cardboxes for recycling purposes, and these cardboxes get collected by a recycling company **(Figure 5.18).** At the rest of the hospitals visited, there is no promotion of sorting out different waste streams for recycling purposes, whereby by examining the waste, one could observe that opportunities for waste recycling do exist.



Figure 5.18: Segregated cardboxes for recycling at Thusong district hospital.

5.9 Training and Capacity Building

Even though the company that was awarded a tender to collect and treat health-care waste was obliged to do training on HCWM, the training conducted was not satisfactory because it was a once off activity, whereas there is a need for ongoing training of staff handling HCW on a daily basis.

The personnel responsible for HCWM in the hospitals do conduct adhoc training in a form of giving lectures and workshops on aspects of HCWM such as segregation and proper handling. There is still more work to be done in terms of systematically and regularly training and educating health-care personnel on critical aspects of HCW. The current trainings conducted only once in a long time, about once in 6 months or once in a year. This is not enough since training must be done on regular basis to keep workers informed on the principles and practice of HCWM, including segregation, waste minimisation, proper handling of waste, treatment technologies and overarching policies.

It is widely known that training is an essential component of health-care waste management. This is the case, as it is often reported that lack of adequate knowledge is the reason behind poor waste segregation practice in the health care sector (Tudor *et al.,* 2004).

From the analysis of the survey questionnaire, it is clear that the general workers and cleaners who are faced with the duties of transporting HCW and also collecting HCW receive very little training. In some instances, these workers had apparently never been trained or instructed on how to handle HCW containers during transportation, loading and offloading as well as packing in the storage rooms.

5.10 Legislative framework for Health-care Waste Management in the study area

5.10.1 Government level (National, Provincial and local)

During the interviews with the authorities in the Provincial Department of Environment and Health, it was indicated that there is no provincial policy or regulation on the management of HCW or hazardous waste. As a result, there is no policy direction in terms of HCWM in the North West, hence there is much reliance on the national policies that are fragmented and uncoordinated. And, in some cases, the national legislation which governs HCWM does not necessarily apply to the situations at the local or provincial level.

Since most of the regulations enforced by provincial authorities stem from acts promulgated by national departments, the national departments plays a leading role in guiding the framework for HCW management at the provincial level. In addition to provincial authorities, local authorities are also responsible for the enforcement of certain acts promulgated at the national level.

It was observed that coordination between health and environment officials at the provincial level is not very strong, hence there is no effort or attempt to initiate provincial guidelines or policy on health care waste management.

Constitutionally, HCW implementation is the function of local government, while planning for sustainable HCW management is the role of the province. The role of national government with regard to HCW management is to ensure

that a sustainable management system is in place, in line with the constitutional requirement and the national policies.

A clear lack of coherent HCW management legislation at all three tiers of government has been identified during the study. These include practical guidance to generators of HCW, as well as control and monitoring of generators and service providers collecting, treating and disposing off HCW. The lack of adequate legislation makes it impossible to prosecute unacceptable disposal of HCW such as poor segregation and the disposal of HCW with the domestic waste stream (Da Silva *et al.,* 2005).

5.10.2 HCF level

Mafikeng provincial hospital

This hospital has developed policy papers on handling of human tissue, disposal of sharps and also on clinical waste management. The Chief Executive of the hospital approves the policy paper and they are about one page long. The procedures of handling and disposing of various types of HCW are outlined in these policy papers.

The policy outlines look good on paper, but the in actual implementation is not satisfactory.

Gelukspan district hospital

The infection control nurse of this hospital has come up with some policy on control and disposal of clinical waste. The policy document outlines a brief overview of classification of waste, HCW containers, storage of waste

materials, and transportation to the main storage area. The general manager of the hospital endorses this policy.

Victoria private hospital has developed a document titled 'medical waste policy'. This statement contains only three paragraphs. The gap identified out of the paper is that there is no attempt to define the fundamentals of HCWM such as segregation, classification, handling and transportation. Furthermore, there is no evidence that the management endorsed the policy outline.

Thusong district hospital has developed a policy paper on disposal of waste. This policy paper briefly describes the procedures of handling different types of medical waste.

Zeerust district hospital has come up with a policy on the disposal of medical waste. The policy was developed when the incinerator was still operational; thus, the policy paper is centred on the operation of the incinerator.

An analysis of the outlined policies of the HCFs visited in the study area triggers an urgent need for the hospitals to embark on periodic audits. This approach will point to a policy direction which hospitals needs to follow to address problems of HCWM, eventually leading to real policies which are comprehensive enough to solve the prevailing problems of HCWM at the HCF level. Da Silva et al., (2005) highlight that, to ensure improvement and continuity in management practices, health-care institutions should develop clear plans and policies for the proper management and disposal of waste.

In particular, it is clear that certain gaps exist in existing policy papers. These include the omission of the following crucial elements of HCWM: the actual definition of HCW, segregation principles, handling and management of

HCW containers, transportation of HCW, waste reduction techniques, and the requirements of the storage area for HCW. The policies are also not informative, with most of the issues not described in any helpful detail.

Going forward from here, it is critical that the policies developed be participatory and inclusive of key stakeholders, and also be communicated to the staff in the HCF. This approach will encourage compliance with the policies and will ensure good HCWM practices by all concerned.

5.11 Institutional Framework for Health-care Waste.

In an ideal situation, each and every institution has to play its own role to deliver on the responsibilities or mandate pertaining to HCWM. However, this study suggests that most of the institutions interacted with may not be exercising their legitimate functions.

The Provincial Health Department has the overall responsibility to ensure that resources are made available by both private and public HCF's to have their staff members sufficiently trained and informed about the requirements for effective HCW management. In addition, the department is tasked with making sure that there is sufficient staff to fulfill the duties and responsibilities around HCWM. In general, health department has the overall responsibility to plan for all developments within the health-care sector in the North West Province.

The Provincial Environment Department has the overall responsibility to protect the environment by setting up and enforcing standards to regulate any potentially polluting activities, including collection, transport, treatment and disposal of HCW.

Local Governments are responsible for local level waste management, which may include making Bylaws for management of various waste streams, including HCW generated within the community. Moreover, Local Governments run municipal clinics and home-based care services that generate HCW.

The private and public HCFs have through their"duty-of-care", the responsibility for the appropriate daily handling of HCW, including segregation of HCW and internal collection and transport, as well as ensuring that the HCW is treated and disposed of according to the legal requirements.

The private HCW management service providers are responsible to provide an effective service for the environmentally sound, healthy and safe, collection, transport, treatment and disposal of HCW generated at the various HCFs.

Apart from the aforesaid stakeholders that are central to HCW management activities, the National Department of Labour plays an important role as it is responsible for issuing and monitoring of regulations that ensure occupationally healthy and safe working conditions during the handling of HCW.

Also, the National Department of Transport has in turn the responsibility to ensure that transport of untreated HCW, as well as the residues from treated HCW is undertaken in accordance with the relevant Transport Acts, and that such Acts address the special risks associated with the transport of HCW.

Table 5.3 summarises the key issues of note arising out of the entire study, disaggregated according to the requisite level of intervention: whether health-care facility or local and provincial government.

Table 5.3 Summary of the key issues identified during the study

Key Issues	Provincial Administration	Local Authority	Health Care Facility
1. Environmental Impacts	▪ Pollution	▪ Illegal disposal in the environment	▪ HCW spillage.
2. Occupational Health and Safety Issues	▪ Unsatisfactory enforcement of legislation.	▪ Lack of Health and Safety guidelines.	▪ Risk of infections. ▪ Risk of injury ▪ No protective clothing.
3. Institutional Issues	▪ Lack of expertise and capacity. ▪ Insufficient interdepartmental communication.	▪ Lack of human capacity. ▪ Inadequate linkages with HCFs.	▪ No firm HCWM structures.
4. Technical Issues	▪ Lack of supporting guidelines on best practices.	▪ Lack of data and information for planning.	▪ Inappropriate HCW management equipment and tools.
5. Finance and Budget	▪ Insufficient allocation of funds.	▪ Poor prioritisation.	▪ Lack of Action Plan.
6. Legal/ Policy Issues	▪ Gaps in national environmental legislation ▪ Lack of environmental regulations. ▪ Poor enforcement of existing legislation.	▪ Lack of adequate bylaws for HCWM. ▪ Poor enforcement.	▪ Lack of compliance with relevant policies and legislation.
7. Information and Awareness	▪ Adhoc training and inadequate training materials.	▪ Poor awareness ▪ Lack of trainers.	▪ Absence of structured and regular training. ▪ Insufficient awareness on handling of HCW.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Based on the findings of the study presented in the foregoing sections, a number of conclusions can be drawn. From the survey carried out at the hospitals and the interviews held with the authorities and personnel responsible for health-care waste management it is clear that there are fundamental problems pertaining to the management of health-care waste in the study area.

First a lack of clear and coherent HCW management legislation at all three spheres of government has been identified during the study. There is a serious need for formulation of policy on HCW management, both at the hospital level as well as at the local, provincial and national government level. It is particularly essential that local government comes up with the policy/ legislative guide that tackle prevailing problems pertinent to HCW management in the hospitals. The lack of adequate legislation makes it impossible to prosecute unacceptable disposal of HCW such as poor segregation and disposal of HCW with the general waste stream.

A related important finding is that most of the hospitals do not segregate their HCW in a satisfactory manner, hence contamination of general waste with HCW. These practices resulted in the disposal of untreated HCW at general waste disposal sites in one instance, and an increased risk of pollution due to more HCW being treated in the other instance.

Second, insufficient training and education was identified as one of the causes of improper management of HCW in the study area. In many cases, staff at the HCFs are not trained on issues of handling and management of HCW. In instances where training is done, it is done on an adhoc basis. To effectively manage HCW, there is need for ongoing training on segregation principles, containerization, proper handling and transportation, as well as on other aspects of HCW.

Although each of the hospitals have one personnel responsible for HCW management, this is viewed not to be enough because such persons do not look at HCW management only, but are also responsible for other occupational health and safety issues. Therefore, a need for more staff to be involved in issues of HCW management in the hospitals was also identified.

Third, a need to use trolleys that are well suited to transporting health-care waste was also identified. The trolleys used to transport HCW from the point of generation to the storage area are not covered on the sides and they are not easily movable, such that spills can easily occur. This would result in contamination of the surface areas where the incident occurred and also pose a health risk to health-care workers who handle HCW.

During the site visits undertaken to the HCFs, it was noted that most of the health-care workers responsible for transporting and packing HCW in the storage areas do not have suitable protective clothing for handling HCW. This situation poses serious consequences in terms of exposing workers to dangers of contracting diseases through contact with HCW material.

Fourth, incineration is still the most popular method of treating health-care waste in the study area. However, there is great potential for venturing into

alternative methods of treating health-care waste given the environmental hazards associated with incineration technology. It is proposed that any technology appropriate for South African conditions be used in the study area, provided the particular technology can meet all health, safety and environmental requirements including passing full environmental impact assessment and public scoping requirements.

The general conclusion of the study is that the problems associated with HCW management do not lie with the HCFs facilities only, but also with other stakeholders such the environment and health departments at the national, provincial and local levels of government. Government plays an important role in terms of setting up the regulatory framework that will enable HCFs to effectively manage HCW matters. On the other hand HCFs have got a direct responsibility to ensure that there is proper waste segregation as well as the actual management of HCW.

Finally, it is of prime importance that health-care waste management should receive higher priority at all spheres of government to protect our environment, people handling HCW at the hospitals, and the society at large.

6.2 Recommendations for Sustainable Health-care Waste Management in the Study Area

Having identified the loopholes in terms of HCWM, it is important that certain measures be taken to address the problems identified during the study. The following actions are recommended in order to ensure environmentally sound HCWM in the hospitals of the Central District Municipality in the North West Province.

1. Proposed Policy Direction

It is the responsibility of governments, national, provincial and local, to create a policy framework for the safe management of health care waste and to ensure that HCF managers take their share of responsibility to manage wastes safely. These require a national coordinating mechanism involving the Department of Health and other key stakeholders such as the Department of Environmental Affairs. It is important that a designated authority coordinates the policy formulation process and that these efforts receive sufficient political support, funding and trained staff.

As part of a strategy formulation process, it is important that the following activities be carried out: identify key role players; designate the responsible authority; assess and analyse the HCWM problems; integrate HCW as part of the health care system; develop the national regulatory framework; develop an enforcement mechanism, setting practical targets; integrate waste minimisation into national purchasing policies and set up a monitoring system. Amongst other things the strategy should include the establishment of a comprehensive system of health-care waste management, from the point of generation of waste to its final disposal.

At the local level, it is crucial that HCFs in the area investigated be supported to come up with come up with Health Care Waste Management Plans, to assist managers to put in place measures and procedures to manage their waste in compliance with environmental requirements for safe and sound handling of HCW.

The Plans should include a comprehensive baseline audit, collection and review of waste statistics, database of the transporters and waste treatment facilities, the health care waste management system, measures to implement waste reduction, enforcement mechanism and compliance monitoring.

It is recommended that clear guidelines be developed to standardize all aspects of medical waste management, namely, generation, segregation, storage, transport, incineration/treatment and disposal in the North West Province. When these guidelines are in place, the management should monitor the facility regularly to ensure full compliance. The guidelines should also include a system of internal audits, regular inspections by environment and health authorities, and possible annual external audits by accredited professionals.

2. Training and Awareness Raising

Awareness of the risks related to HCW and training in safe and sustainable practices are essential in obtaining both commitment and behaviour change by all involved in the management of HCW (Mohee, 2005). Training of the personnel responsible for handling HCW should pay attention to issues of proper segregation, procedures for safe handling of HCW, management of HCW spillage and proper transportation and storage.

One key intervention should be the inclusion of HCWM in the training curricula of nurses, doctors and other health care managers.

3. Waste Minimisation (Reuse, Recycle etc)

Reuse is one of best ways to reduce waste. It is advisable that whenever goods are purchased, they are the most durable and are easily separable. This also applies to domestic waste. Reprocessing of medical devices is another reuse activity that can reduce waste and save a lot of money. However, it is important that any reprocessing activity be reviewed and approved by specialist in infection control, risk management and other relevant areas. During the survey at the hospitals, it was found that only one hospital sends cardboards and boxes for recycling purposes. Therefore, it is important that recycling be encouraged in all the hospitals in the North West Province.

4. Storage Facilities

It is suggested that storage areas in the facilities adopt the following standards:

- A supply of cleaning equipment, protective clothing and waste bags or containers should be located conveniently close to the storage area.
- The storage area should allow easy access for staff in charge of handling waste.
- The HCW storage area door should have a signboard that clearly indicate the contents of the room, the contact details of the responsible persons, and this contact details for use in the event of an emergency.

5. On site Transportation and Handling of Waste

In order to encourage efficient and environmentally safe transportation of HCW, the following interventions are advised:

- The trolleys used for collection of HCW should be closed to prevent any potential spillage and the trolleys should be easy to load and unload (GDACEL, 2003).
- Transportation of HCW within the HCF should utilise wheeled trolleys and /or containers that are dedicated solely for that purpose.

6. Protective clothing

It was noted that most of the personnel handling HCW at the hospitals do not have adequate clothing for carrying out their tasks. There is an urgent need for the provision of protective clothing such as industrial overhalls, boots, Aprons and industrial gloves. These are very important for the protection of occupational health and safety of workers faced with the day-to-day challenges of working with health-care waste, including packaging, transporting, loading and offloading waste in the storage rooms at the hospitals.

7. Record keeping

Effective health-care waste management depends on accurate record keeping of all aspects of health care in the hospitals. This was found to be lacking in the hospitals visited during the study. Good record keeping helps to monitor effectively, document compliance, assess expenditures and evaluate minimisation efforts. Important information that should be recorded at the health-care facilities includes the following:

- The amounts and types of waste generated by each section and also levels for the whole HCF.

- Direct costs of waste collection, transportation, storage, treatment, disposal, decontamination and cleaning, including those costs for material and contracting.
- Costs of prevention and treatment of waste-related injuries and illnesses such as immunization and post exposure support.
- Type and costs of contractor services.

8. Labelling of Containers

One other important aspect of health care waste management is the labelling of containers for identification. It is important that all containers be labelled in such a way that the following information is reflected in each and every container that carries waste: waste category, name of health care facility and date containerisation.

REFERENCES

Almuneef, M., and Memish, Z.A., (2003) Effective medical waste management: It can be done, Association for Professionals in Infections Control and Epidemiology. American Journal of Infection Control, Vol: 31, pp: 188-192.

Alvim-Ferraz, M.C.M., and Afonso, S.A.V., (2003) Incineration of different types of medical wastes: emission factors for gaseous emissions, Atmospheric Environment, Vol: 37, pp: 5415-5422.

Blackman, Jr., W. C., (2001) Basic Hazardous Waste Management, 3rd Edition, Lewis publishers. United States of America, pp: 309-331.

Blenkharn, J.I., (2006) Medical waste management in the south of Brazil, Waste Management, Vol: 26, pp: 315-317.

Brink, N., (2003) Segregation of waste emanating from health care institutions in South Africa, A paper presented at the international Health Care Waste Management Conference, Johannesburg, South Africa.

Chitnis, V. S., Chitnis, S., Patil and Chitnis, D., (2003) Solar disinfection of infectious biomedical waste: a new approach for developing countries, the LANCET Vol: 362, pp: 1285–1286.

Coulson, N., and Magner, J., (2004) Guidelines for Health Care Waste Management Awareness Activities, Gauteng Sustainable Health Care Waste Management Project. GDACEL.

Coulson, N., and Magner, J., (2004) Code of Practice for Health care Waste Management, Gauteng Department of Health.

Coutinho, M., Pereira, M., Rodrigues, R., Borego, C., (2005) Impact of medical waste incineration in the atmospheric PCDD/F levels of Porto, Portugal, Science of Total Environment.

Da Silva C.E., Hoppe, A.E., Ravanello, M.M., Mello, N., (2004) Medical waste management in the south of Brazil, Waste Management, Vol: 25, pp: 600-605.

Daschner, F.D., Dettenkofer, M., (1997) Protecting the patient and the environment-new aspects and challenges in hospital infection control, Vol: 36, pp: 7-15.

Department of Health (1973) Hazardous Substances Act 15.

Department of Health (1977) Health Act 63.

Department of Health (1983) Human Tissue Act 65.

Department of Environmental Affairs and Tourism (1965) Atmospheric Pollution Prevention, Act 45.

Department of Environmental Affairs and Tourism (1989) Environment Conservation Act 73, Pretoria.

Department of Environmental Affairs and Tourism (1998) Integrated Pollution and Waste Management Policy, Pretoria.

Department of Environmental Affairs and Tourism (1998) National Environmental Management (NEMA) Act 107, Cape Town.

Department of Environmental Affairs and Tourism (1999) National Waste Management Strategy, Pretoria.

Department of Environmental Affairs and Tourism. (2000) Programme for the implementation of the national waste management strategy, Background Document on the Management of Health Care Waste. Pretoria.

Department of Environmental Affairs and Tourism (2005) Newsletter National Waste Management Strategy Implementation Project, Vol: 2, Number 1

Department of Water Affairs and Forestry (1998) Minimum Requirements for Waste Disposal by landfill, Second Edition, Pretoria.

Department of Water Affairs and Forestry (1998) Minimum Requirements for Handling, Classification and Disposal of Hazardous Waste, Second Edition, Pretoria.

Department of Protection of Human Environment (2000) Aide-Memoire for a national strategy for health care waste management, World Health Organization, Geneva, Switzerland, pp:1-2.

Emmanuel, J., (2001) Non-Incineration Medical Waste Treatment Technologies, Health Care Without Harm, Washington DC.

GDACEL: Gauteng Department of Agriculture, Conservation, Environment and Land Affairs. (2002) Draft guideline for sustainable health care waste management. South Africa, pp: 160-177.

GDACEL: Gauteng Department of Agriculture, Conservation, Environment and Land Affairs (2001) A Policy for Environmentally Sustainable Health Care Waste Management in Gauteng Province.

GDACEL: Gauteng Department of Agriculture, Conservation, Environment and Land Affairs (2003) Guidelines on Sustainable Health Care Waste Management in Gauteng Module 6: Treatment of Health Care risk Waste.

GDACEL: Gauteng Department of Agriculture, Conservation and Environment and Land Affairs (2004) Integrated Strategy and Action Plans for Sustainable Health Care Risk Waste Management in Gauteng, Final Version

Genazzini, C.; Giaccio, G., Ronco, A., and Zerbino, R., (2005) Cement-based materials as containment systems for ash from hospital waste incineration, Waste Management, vol: 25, pp: 649-654.

Garcia, R., (1999) Effective cost-reduction strategies in the management of regulated medical waste, American Journal Infection Control, Vol: 27, pp: 165-175.

Hagen D.L., AL-Humaidi, F., Blake, M.A., (2001) Infectious waste surveys in a Saudi Arabian hospital: An important quality improvement tool, Association

for professionals in Infection Control and Epidemiology, Vol: 29, Number 3, pp: 198-202.

Health Care Without Harm (2001) Going green: A Resource Kit for Pollution Prevention in health care. URL http://www.noharm.org.

Hollie Shaner, R.N. and Glenn McRae, (1999) Eleven Recommendations for Improving Medical Waste Management, Basel Action Network, *CGH Environmental Strategies, Inc.* URL:http://www.ban.org, Visited on the 20 May 2004. pp: 1-11.

Ibáñez, I., Viguri A, A., Ortiz J.R. and I. Irabien, J.A (2000) characterisation and management of incinerator waste, Journal of Hazardous Materials, Vol: A79, pp: 215-227.

Idris, A., Saed, K., (2002) characteristics of slag produced from incinerated hospital waste, Journal of Hazardous Material, Vol: B93, pp: 201-208.

Karademir., A., (2004) Health risk assessment of PCDD/F emissions from hazardous and medical waste incinerator in Turkey, Environment International, Vol 30, pp 1027-1038.

Lee, B.K., Ellenbecker, M.J. and Moure-Eraso, R., (2002) Analyses of the recycling potential of medical plastic wastes, Waste Management, Vol: 22, pp: 461–470.

Lee, C.C., Huffman, G.L., (1996) Medical waste management/ incineration, Journal of hazardous materials, Vol: 48, pp: 1-30.

Lee, W.J., Liow, M.C., Tsai, P.J., Hsieh, L.T., and (2002) Emission of polycyclic aromatic hydrocarbons from medical waste incinerators, Atmospheric Environment, Vol: 36, pp: 781–790.

Leonard, L., (2003) Health Care Waste in Southern Africa: A civil society perspective, a paper presented at Waste Conference on International Health-care Waste Management in Africa today.

Leonard, L., (2004) Managing Hospital Waste: A guide for Southern African Health Care Institutions, Groundwork.

Liow, M.C., Lee W.J., Chen S.J., Wang L.C., Chung C.H., and Chen J.H., (1997) Emission of polycyclic aromatic hydrocarbons from medical waste incinerators, Journal of Aerosol Science, Vol. 28, pp: 549-550.

Mato, R.R.A.M., and Kassenga, G.R., (1997) A study on problems of management of medical solid wastes in Dar es Salaam and their remedial measures, Resource, Conservation and Recycling, Vol. 21, pp: 1-16.

Mato, R. R. A. M., and Kaseva, M.E., (1999) Critical review of industrial and medical waste practices in Dar es Salaam City, Resources, Conservation and Recycling, Vol: 25, pp: 271–287.

Mohee, R., (2005), Medical waste characterization in health-care institutions in Mauritius, Waste Management, Vol: 25, pp: 575-581.

Mühlich, M., Scherrer, M., Daschner, F.D., (2003) Comparison of infectious waste management in European hospitals, Journal of hospital infection, Elsevier Science, Vol: 55, pp: 260-268.

National Health and Medical Research Council (1999) National guidelines for waste management in the health industry, Commonwealth of Australia, pp.4-17.

Neely, A. N., Maley, M.P., Taylor, G.L., (2003) Investigation of single-use versus reusable infectious waste containers as potential sources of microbial contamination, Association for Professionals in Infection Control and Epidemiology, Cincinnati

Otto, J. B., Hansen, M. K., (2003) Development of tender documentation for the outsourcing of Health Care Risk Waste Management services to provincial hospitals and clinics in Gauteng, A paper presented at the international Health Care Waste Management Conference, Johannesburg, South Africa.

Patil, A. D., and Shekdar, A. V., (2001) Health-care Waste Management in India, Journal for Environmental Management, Vol 63 pp: 211-220.

Prüss, A. E., Giroult, P. Rushbrook. (1999) Safe management of wastes from health-care activities, World Health Organization, Geneva Switzerland, pp: 1-50.

Quab, U., Fermann, M., Bröker, G., (2004) The European Dioxin Air Emission Inventory Project-Final Results, Chemosphere, Vol: 54, pp: 1319-1327.

Republic of South Africa. (1996) Constitution of South Africa, Act 108, Pretoria.

Rushbrook, P., Chandra, C. and Gayton, S., (2000) Starting Health Care Waste Management in Medical Institutions, *A practical Approach,* World Health Organisation, Copenhagen.

Secretariat to Basel Convention and World Health Organisation (2004) National Health Care Waste Management plans in the Sub-Saharan Countries. Guidance Manual. URL: http://www.healthcare.org. Cited on the 15 March 2005.

Shand, L., and Strydom, M., (2004) Draft Integrated Waste Management Plan for the Central District Municipality. North West Department of Agriculture Conservation, Environment and Tourism.

South African Bureau of Standards, Code of Practice for the Handling and Disposal of Waste Materials within Health Care, SABS 0248.

Suwannee Adsavakulchai. (2002) Study on waste from hospital and clinics in Phitsanulok, Online Journal, Health Allied Science Mangalore, South India, vol: 1, URL: http://www.ojhas.org/issue3/2002-3-3htm. accessed on the 14 May 2004. pp: 1-8.

Tamplin, S.A., Davidson, D., Powis, B., O'Leary, Z., (2005) Issues and options for the safe destruction and disposal of used injection materials, Waste Management, Vol: 25, pp: 655-665.

Tiller, T., Linscott, A.,(2004) Evaluation of a Steam Autoclave for Sterilizing Medical Waste at a University Health Center, Center-Shreveport, Shreveport, Louisiana. American Journal of Infection Control, Vol: E9.

Tudor, T.L., Noonan, C.L., Jenkin, L.E.T., (2004) Healthcare waste management: a case study from the National Health Service in Cornwall, United Kingdom, Vol:25, pp: 606-615.

United Nations Environment Programme and Secretariat to Basel Convention (2003) *Technical guidelines on the environmentally sound management of biomedical and healthcare wastes*, Secretariat to the Basel Convention, Switzerland

Van Remmen, T., (1998) Evaluation of the available air pollution control technologies for achievement of the MACT requirements in the newly implemented new source performance standards (NSPS) and emission guidelines (EG) for hospital and medical/ infectious waste incinerators, Waste Management, Vol: 18, pp: 393-402.

World Health Organisation (2000) Safe Health Care Waste Management, Aide Memoire for a national strategy for health care waste management, Geneva, Switzerland: URL: www.healthcarewaste.org. Cited on the 30 October 2004.

World Health Organisation (2002) Basic steps in the preparation of health care waste management plans for health care establishments, Regional Centre for Environmental Health Activities (CEHA), Amman, Jordan. pp: 1-15.

World Health Organisation (2002) Health-care waste management guidance for the development of National Action Plans, pp**:** 1-9.

World Health Organisation (2003) Health Care Waste Management at glance, URL: www.healthcarewaste.org. accessed on the 13 May 2004. pp: 1-2.

World Health Organisation (2004) Rapid Assessment Tool, URL, www.healthcarewaste.org or www.who.int/peh, accessed 13 May 2004.

Yufeng, Z., Na, D., Jihong, L., Changzhong, X., (2003) A new pyrolysis technology and equipment for treatment of municipal household garbage and hospital waste.

Zandaryaa, S., Gavasci, R., Lombardi, F., Fiore, A.., (2000) Nitrogen oxides from waste incineration: control by selective non-catalytic reduction, Chemosphere, vol: 42, pp: 491-497.

APPENDIX A

QUESTIONNAIRES

APPENDIX B

LIST OF PEOPLE INTERVIEWED

APPENDIX C

LETTER OF AUTHORISATION