MONITORING LANDFILL SITES: A CASE STUDY WITHIN THE JURISDICTION OF THE SOUTHERN DISTRICT MUNICIPALITY, NORTH WEST PROVINCE

JOHANNA ELIZABETH DE VILLIERS

Mini-dissertation submitted in partial fulfilment of the requirements for the degree Masters in Environmental Management (MEM) in Geography and Environmental Studies (School for Environmental Science and Development) at the Potchefstroomse Universiteit vir Christelike Hoër Onderwys

Supervisor: Dr. I.J. van der Walt

2002
Potchefstroom

ACKNOWLEDGEMENTS

Firstly I need to thank my Lord for granting me the opportunity to complete this study, and for giving me some understanding of His creation.

Furthermore I would like to thank the following people and institutions:

- Dr. I.J. van der Walt, my study leader of Geography and Environmental Studies for his guidance and help.

- The financial assistance from the National Research Foundation towards this research is gratefully acknowledged. Opinions expressed, and conclusions arrived at, are those of the author and are not attributed to the National Research Foundation.

- Mr. F. Labuschagne, from the Engineering Department of the Southern Districts Municipality and his staff for their support in gathering the relevant information, as well as for the honorarium.

- Mr. V. Muller, from Stilfontein Municipality, for his patience and help in gathering relevant information.

- My parents, Braam end Maria de Villiers, for their love, help, encouragement and patience during all aspects of this study both in England and South Africa.

- Tillie Burger, Loma Papadopoulos and Sharon Quin for proof-reading.

- S.J du Plooy for his love and support both in South Africa and in London.

SOLI DEO GLORIA
JOHANNA ELIZABETH DE VILLIERS
LONDON
OCTOBER 2002

SUMMARY

MONITORING OF LANDFILL SITES: A CASE STUDY WITHIN THE SOUTHERN DISTRICT MUNICIPALITY'S JURISDICTION, NORTH WEST PROVINCE

The aim of this study was to assess the current status of the landfill sites within the Southern District Municipality's jurisdiction. This was achieved by conducting a literature review with regard to:

a) The relevant legislation in South Africa regarding municipal solid waste disposal by landfill.
b) Impacts associated with the general aspects regarding waste disposal by landfill
c) Define environmental monitoring and auditing.

A monitoring plan and audit checklist was compiled from the literature. The status of the Klerksdorp, Orkney, Stilfontein and Potchefstroom landfill sites was assessed through site visits according to the monitoring plan. Compliance was tested to the audit checklist during the site visits. The trend statuses of the landfill sites were determined with regard to the findings of the different environmental audits within the environmental monitoring plan. Areas of non-compliance to the criteria of the environmental audits were identified within the study area. Lastly, recommendations to prevent further environmental despoliation were made.

OPSOMMING

MONITERING VAN STORTINGSTERREINE: 'N GEVALLE STUDIE BINNE DIE SUIDELIKE DISTRIK MUNISIPALITEIT SE JURISDIKSIE, NOORD- WES PROVINSIE

Die doel van hierdie studie is om die huidige stand van stortingsterreine binne die Suidelike Distrik Munisipaliteit se jurisdiksie te bepaal. Dit is behaal deur 'n literatuur oorsig met betrekking tot:

a) Die relevante wetgewing in Suid-Afrika wat betrekking het op munisipale vaste afval stortingterreine.
b) Die impakte wat geassosieër word met die algemene aspekte wat betrekking het op vaste afval stortingsterreine
c) Definieër omgewings monitering en ouditering

'n Moniteringsplan en ouditerings kontrolelys is saamgestel vanuit die literatuur. Die stand van die Klerksdorp, Orkney, Stilfontein en Potchefstroom stortingsterreine is bepaal deur terrein besoeke soos bepaal in die moniteringsplan. Voldoening is getoets aan die ouditeringskontrolelys gedurende die verskillende terrein besoeke. Die stand neigings van die stortingsterreine is bepaal met behulp van die bevindinge van die verskillende omgewingsouditte binne die omgewingsmoniteringsplan. Velde van nie-voldoening aan die kriteria van die omgewingsouditte is geïdentifiseer binne die studie gebied. Ten laaste is aanbevelings gedoen om verdere omgewings agteruitgang te voorkom.

List of Acronyms

MSW	Municipal Solid Waste
SDM	Southern District Municipality
DWAF	Department of Water Affairs and Forestry
SWD	Solid Waste Disposal
DEAT	Department of Environmental Affairs and Tourism
ECA	Environmental Conservation Act
NEMA	National Environmental Management Act
EPA	Environmental Protection Act
EIA	Environmental Impact Assessment

TABLE OF CONTENTS

Contents (continued)

Contents (continued)

Contents (continued

CHAPTER 1:

INTRODUCTION TO THE STUDY

1 INTRODUCTION

1.1 General

The disposal of MSW in South Africa has become increasingly costly. Problems often arise at landfill sites as a result of a lack of regard for environmental, health and safety issues related to landfills (Andrews, 2001:3). MSW can be defined as a waste stream that comes primarily from residences and small commercial enterprises, and is mostly non-hazardous, although a certain amount of hazardous substances may be present. This waste stream includes durable and non-durable goods, containers and packaging, food waste, garden waste, and miscellaneous inorganic waste from residential, commercial, institutional and industrial sources (Smith, 1994:162).

Landfills are engineered areas where MSW is placed into the land (EPA, 1999:1; DWAF, 1994:5). Modern landfills are well-engineered facilities that are located, designed, operated, monitored, closed, cared for after closure, cleaned up when necessary, and financed to ensure compliance with legislation and regulations (Andrews, 2001:1; EHSO, 2001:1; Allsopp *et al.* 2001:2). New regulations internationally, as well as locally, are imposing more stringent restrictions on waste permitted to go to landfill sites. High landfill costs and stricter regulations have spurred various technical and behavioural innovations in MSW and landfill site management. Technical innovations include incinerators with waste-to-energy capabilities, materials recovery facilities to recover high-value items and composting. Behavioural innovations include recycling programs and a variety of strategies aimed at source reduction, such as education and pay-as-you-throw disposal fees. According to Andrews (2001:2) and the EPA (1999:2) source reduction (including re-use) is the most preferred method, followed by recycling, composting and, lastly, disposal in combustion facilities and landfills.

Two of the challenges that the new democratic South African government has to deal with are the mounting problems associated with pollution control and waste management (Glazewski, 2000:189). A result of the growing population and increased urbanization is multiple waste generation, which has placed increased pressure on the environment. The need for environmentally acceptable, yet cost-effective waste disposal has become a priority in South Africa. There are regulations addressing the problems experienced with landfill sites in South Africa, the objectives being to take pro-active steps that will prevent the degradation of water quality and the environment (DWAF, 1994:11). The upgrading of the status of solid waste disposal sites in South Africa will rely to some extent on the co-operation of all participants in the field of solid waste disposal (Asmal, 1994 in DWAF, 1994:iii). It is imperative to determine the extent to which there is compliance or non-compliance with legislation regarding the general aspects associated with solid waste disposal by landfill. By determining the current status of the landfill sites, the actions necessary towards improving the status of the environment can be assessed.

Environmental problems experienced on the landfill sites within the jurisdiction of the SDM of the North West Province were detected during field visits. Signs of non-compliance with the relevant legislation as set out in the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) were identified with regard to the general aspects associated with landfill sites. The trends with regard to compliance with these general aspects (fencing, access control, covering and compaction of waste, signposting and illegal squatting) have not been assessed before in other studies. By determining these trends compliance with the general aspects could be used as an indication of whether the landfill sites within this jurisdiction show positive or negative trends – thereby determining compliance with legislation. Environmental problems experienced at these landfill sites could be identified and prioritised according to the trends observed with regard to the general aspects. Because the status of the general aspects on these landfills had not been assessed previously there was no

indication whether the sites were compliant with legislation, whether they were following a negative or a positive trend or what the main environmental problem areas were.

1.2 Conceptualisation of the problem

Andrews (2001:3) identifies the key criteria for safe waste disposal as the registration, permitting and control of all waste landfills, therefore ensuring compliance with relevant legislation. Assessing compliance with the general aspects associated with landfill sites as set out in the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) and other relevant legislation can serve to indicate what the current status of landfill sites are. The current status of the Klerksdorp, Orkney, Stilfontein and Potchefstroom landfill sites – all within the jurisdiction of the SDM - with regard to these general aspects were not known at the onset of this study.

1.3 Central theoretical statement

- The SWD sites of Klerksdorp, Orkney, Stilfontein and Potchefstroom do not comply with the relevant legislation in South Africa regarding SWD by landfill or with the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) as formulated by the DWAF.

1.4 Hypothesis

H_0 – Hypothesis The solid waste disposal sites of Klerksdorp, Orkney, Stilfontein and Potchefstroom do not comply with the relevant legislation in South Africa regarding SWD by landfill or with the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) formulated by the DWAF.

H_1 - Hypothesis The solid waste disposal sites of Klerksdorp, Orkney, Stilfontein and Potchefstroom do comply with the relevant legislation in South Africa regarding SWD by landfill or with the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) formulated by DWAF.

1.5 Goals / Objectives

In order to determine whether the landfill sites comply with legislation this study will aim to reach the following goals:

- To discuss the relevant legal aspects in South Africa focussing on the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994); to determine the environmental impacts at landfill sites and to assess these impacts on the environment.

- To discuss environmental monitoring and auditing as environmental management tools in order to compile a monitoring plan and an audit checklist in compliance with the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) so that the impacts associated with the general aspects can be assessed.

- To conduct environmental audits of the Klerksdorp, Orkney, Stilfontein and Potchefstroom waste sites at six-monthly intervals to comply with the predetermined environmental monitoring plan.

- To do a trend analysis of each general aspect to determine the level of compliance of each site with the audit checklist and thus with relevant legislation.

- To propose steps to be implemented at each site to obtain compliance with the relevant legislation.

1.6 Methodology

The methodology entails a literature study and an empirical study as set out under the goals of the study. The following specific steps will be taken:

1.6.1 Literature review

The relevant legislation in South Africa regarding solid waste disposal by landfill will be reviewed. Framework legislation of current pollution control legislation in South Africa will be discussed with specific reference to solid waste disposal. Legislation derived from the framework legislation (sectoral legislation) will also be discussed with specific reference to the Minimum Requirements for Waste Disposal by Landfill according to the DWAF (DWAF, 1994). The landfill process will be illustrated and discussed so that it will be possible to determine whether the landfill sites within the study area comply with the relevant legislation. Provincial and local level legislation with regard to solid waste disposal will also be discussed to ensure a better understanding of the legislation. The environmental impacts associated with the general aspects experienced at landfill sites in general, will be reviewed in the literature. Environmental impacts associated with the landfill site design and operational controls as part of the general aspects experienced will be discussed in further detail, to assess these impacts during site visits.

A literature review with regard to environmental monitoring and auditing will be conducted. The terms 'environmental monitoring' and 'environmental compliance auditing' will be defined. The use of these concepts as tools will be discussed in order to examine compliance with legislation and to determine the areas for corrective action. The components and aims of environmental monitoring, as

well as the environmental auditing process and its benefits will also be discussed. An integrated environmental monitoring plan will be drawn up from the literature. This integrated environmental monitoring plan will be used for the investigation of the landfill sites within the jurisdiction of the SDM, and an explanatory diagram compiled. This monitoring plan will consist of a number of environmental audits. The environmental audit process, as set out in the literature will be discussed as it applies to the study. An audit checklist will be compiled as part of the environmental audit process, with which compliance with the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) as well as the impacts associated with the general aspects will be assessed during site visits.

Site visits will be conducted to each of the sites within the study area at the predetermined six monthly intervals according to the environmental monitoring plan. During the site visits audits will be conducted as part of the environmental monitoring plan, and in compliance with the audit checklist checked and marked for each of the general aspects identified. Three site visits will be conducted according to the monitoring plan. During the three site visits, the status of each general aspect and impact identified on the audit checklist will be examined and indicated for each of the sites within the study area. Each general aspect will be awarded a rating according to its status with regard to compliance. "Compliance" "marginal compliance" and "non compliance" will be distinguished.

"Compliance" rendering the site adherence to the audit checklist with regard to the aspect identified.

"Non-compliance" implicating the aspect identified did not meet the terms of the audit checklist.

"Marginal compliance" implicating that the aspect bordered on compliance, but that it would require some attention so as not to deteriorate to the status of "non compliance".

Over the one-year study period a trend regarding the status was determined for the different aspects of each site within the study area. The compliance status of the aspects identified within the audit checklist, for each of the sites over the study period, were used to determine a trend for each aspect identified. All the site visits' (December 2000, July 2001 and December 2001') compliance status with regard to the general aspects were used to determine the trend status of the aspects identified. Distinctions were made between "positive", "horizontal" and "negative trend" status.

A "positive" trend status was awarded in a case where an aspect was "non-compliant" to the audit checklist and progressed to being "marginally compliant" on the next site visit, or "marginally compliant" on the first and "compliant"' on the second. A "positive" trend indicates areas of improvement with regard to the aspects identified in the audit checklist.

A "negative" trend status indicated the exact opposite of the "positive" trend status, and indicated areas of deterioration and problems experienced over the study period.

"Horizontal" trend status were noted where no change was observed in the status of the aspect identified between either the first and second site visit or the second and the third site visit. This could either mean no change was detected in an area between "non-compliant" and again "non-compliant" or between "compliant" and "compliant", both bringing about a "horizontal" trend status.

Proposals of steps to be implemented at each site to obtain compliance with the relevant legislation will be discussed.

1.6.2 Limitations

In this section the limitations set with regard to the number of sites, aspects studied and the duration of the study will be discussed.

1.6.2.1 Number of sites

Sites in Klerksdorp, Orkney, Stilfontein and Potchefstroom, falling within the jurisdiction of the Southern District Municipality of the North West Province were selected. These four sites needed further environmental investigation as requested by the Southern District Municipality (See Figure 1).

The Klerksdorp site is situated 8 kilometers from Klerksdorp and has been permitted in terms of section 20(1) of the Environmental Conservation Act (73/1989).

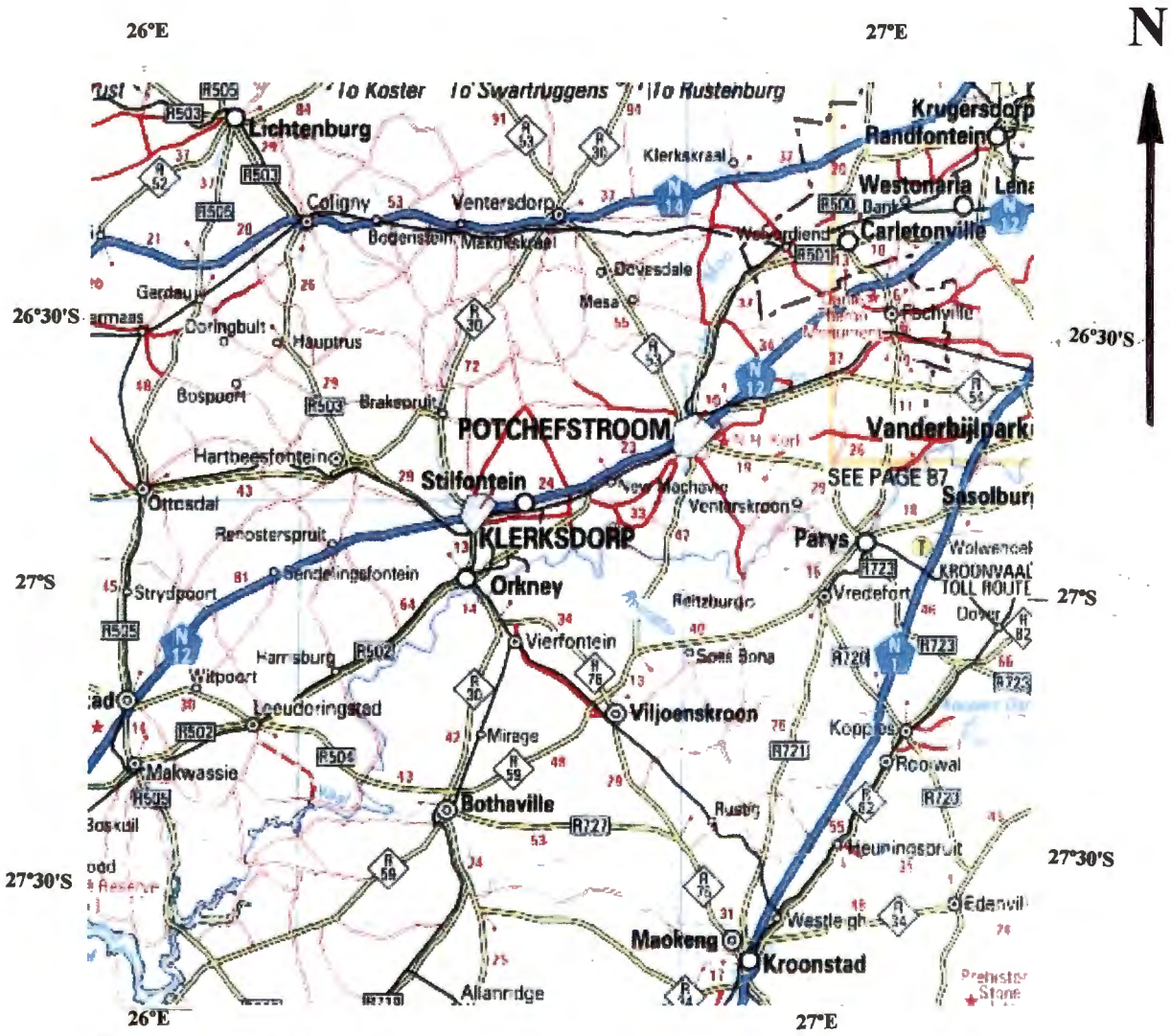
The Orkney site is situated 5.8 kilometers from town and is not permitted.

The Stilfontein site is approximately 3 kilometers from Stilfontein, and is operated by the local authority (Ball, 1997:4-8).

The Potchefstroom landfill site borders on the residential areas of town, and is due for closure.

FIGURE 1 : LOCALITY MAP OF THE STUDY AREA

Source: (Map Studio,1996:8)



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1.6.2.2 Aspects studied

A desktop study of the different physical elements with regard to each landfill site was conducted. Only the general aspects associated with landfill sites were audited because of insufficient information for more in-depth audit criteria.

1.6.2.3 Time

The monitoring plan was limited to the monitoring of the general aspects identified in the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) over the period of one year.

1.6.3 Progression of the study

In chapter one an introduction and a background to the study have been given. From this the problem statement and the hypothesis have been formulated. The methodology and the limitations of the study have been set, and the goals to be achieved specified.

In chapters 2 and 3, a brief overview of the place of environmental legislation in the broader framework of South African legislation will be given. National, provincial and local level legislation, regarding solid waste disposal by landfill with specific reference to the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) as well as general aspects associated with landfill sites will be discussed from the literature.

Subsequently an environmental monitoring plan and the audit process will be defined and discussed briefly.

The empirical research will be discussed in chapters 4 and 5. The monitoring plan and an audit checklist will be compiled from the general aspects discussed in the literature.

The landfill process with relation to the Klerksdorp, Orkney, Stilfontein and Potchefstroom landfill sites will be discussed as set out in the Minimum Requirements' process for Waste Disposal by Landfill (DWAF, 1994).

The audit findings will serve to qualify environmental impacts associated with landfill sites within the framework of the Minimum Requirements. From the audit results the trend status of the Klerksdorp, Orkney, Stilfontein and Potchefstroom landfill sites will be determined with regard to compliance with the Minimum requirements. The findings will serve to identify the areas of non-compliance and the trend status will indicate whether there was improvement or degradation of the landfill site with regard to previous audit findings.

Recommendations will be made aiming to ensure future compliance with legislation, and to prevent further environmental degradation.

CHAPTER 2:

LEGISLATION REGARDING SOUTH AFRICAN SOLID WASTE DISPOSAL (LANDFILL) SITES

2 LEGISLATION REGARDING SOUTH AFRICAN SOLID WASTE DISPOSAL (LANDFILL) SITES

The aim of this chapter is to identify the legislation in South Africa that plays an important role regarding waste disposal by landfill. The framework legislation (which is the basis for further legislation) will be discussed with particular emphasis on pollution control legislation. From the framework legislation, sectoral legislation with specific regard to solid waste disposal by landfill will be discussed in more detail. The Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) will be discussed in more detail, with specific regard to the general aspects associated with landfill sites. A brief overview of provincial and local legislation regarding solid waste disposal will also be discussed as background.

Environmental law is a young, dynamic and evolving branch of law, and is still in the process of developing its own identity (Glazewski, 2000:11). Because it is a relatively new area within the law of South Africa, a considerable proportion of legislation still needs to be developed and implemented. This is also the case with regard to legislation pertaining to municipal solid waste disposal by landfill. Legislation in South Africa has three main tiers namely National, Provincial and Local level legislation. The following legislation pertains mainly to solid waste disposal (landfill) sites in South Africa:

2.1 Framework of current pollution control legislation in South Africa

A primary function of a National Environmental Act is to further the national environmental interest by laying down the institutional structures and legal mechanisms to champion the environmental cause. A typical environmental act is broad ranging, attempting to influence and cover a wide spectrum of societal initiatives and thus governance at all levels (Glazewski, 2000:164-165). There

are a number of acts that pertain to pollution control in South Africa and by implication the control of solid waste disposal sites. Section 24 of the Constitution (1996) acts as a milestone for environmental legislation in South Africa

2.1.1 Section 24 of the Constitution of the Republic of South Africa (1996)

The Constitution (1996) is the supreme law of South Africa. According to section 24(2) any law or conduct inconsistent with the Constitution (1996) is invalid and all obligations imposed by it must be fulfilled. The Constitution (1996) is the basis for environmental legislation in South Africa. It mandates responsible environmental management to all citizens of the Republic of South Africa and specifically refers to the right to a healthy environment and states that, "everyone has the right -

- to an environment that is not harmful to their health and well-being and;
- to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that - prevent pollution and ecological degradation
- to promote conservation; and
- to secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development".

In terms of our Constitution, pollution-related legislation that was introduced after 1996 must reflect and enforce the principle of sustainable development. There is however, a multitude of older legislation which either directly or indirectly manages pollution control which is also of relevance even though it does not necessarily embrace the principle of sustainable development and its supporting principles. These acts may deal with environmental management as a whole, such as the ECA (73/1989) (discussed in a subsequent section), or deal with specific environmental aspects such as the Water Services Act (108 /1997).

The current and future developments should see a more integrated approach to pollution control and waste management. There will probably always be some aspect specific legislation, although it should be integrated in the sense that it pursues the common goal of sustainable development and other related principles (Durban Metro, 2000:5).

2.1.2 Integrated pollution control

Dissatisfaction with the prevailing fragmented regulatory system of pollution control caused the DEAT to launch a project to develop a national holistic policy on integrated pollution control. The DWAF has also begun to reassess their strategy pertaining to waste management by virtue of the ECA (Fuggle & Rabie, 1996: 829). The philosophy is that all waste management and pollution control implementation should follow a hierarchy of priorities.

The order of priority is:

- prevent waste production and pollution wherever possible;
- minimise unavoidable waste production by recycling and treatment; and
- dispose of waste that cannot be recycled or treated.

As a general strategy, the waste hierarchy must be applied to all decision-making processes and must be built into routine regulatory procedures including:

- enforcement (through licences or regulations);
- standard setting; and
- regulatory programmes (DWAF, 2000:8; Durban Metro, 2000:4).

Currently and in the future a variety of regulations will be promulgated, principally through Section 24 of the ECA (73/1989), but also through the NEMA (107/1998) (both discussed in subsequent sections). These initial regulations will relate to waste information systems, waste collection, waste minimisation and recycling as

well as waste treatment and disposal. Not only will the strategy be enforced through either amending existing legislation or creating regulations in terms thereof, but it was also intended to draft and implement an Integrated Pollution and Waste Management Act. There has been speculation that the Integrated Pollution and Waste Management Act will in fact not be formulated in a separate piece of legislation, but will rather form a chapter within the NEMA (107/1998). Nevertheless, whether this law forms part of another, or is created on its own, its intended goals, whilst laudable in streamlining a currently unsatisfactory waste management situation, will nevertheless create a multitude of obligations which organizations will be obliged to fulfil (Durban Metro, 2000:4).

2.1.3 NEMA (107/1998)

The NEMA converts the constitutional environmental right to more concrete reality by passing 'reasonable legislative measures'. It gives the term 'environment' to be a matter of concurrent national and provincial competence; it provides the framework to set in place much needed environmental norms and standards within these areas. The act describes the method for the implementation of sustainable development. It also defines the term as meaning the integration of social, economic and environmental factors into planning, implementation and decision making so as to ensure that development serves present and future generations. As part of achieving sustainable development the act imposes a duty on everyone who causes, has caused or may cause significant pollution or degradation of the environment to take reasonable measures to prevent it occurring, continuing or recurring. Where harm to the environment is authorised by law, or cannot reasonably be avoided or stopped, a duty exists to minimise and rectify the harm (Durban Metro, 2000:7; Glazewski, 2000:167). A variety of regulations will be promulgated, principally through Section 24 of the ECA (73/1989), but also through the NEMA (107/1998).

2.1.4 Section 24 of the ECA (73/1989)

The ECA (73/1989), although promulgated prior to the Constitution (1996), is still part of the environmental framework legislation of South Africa. A variety of regulations will be promulgated through this Act. In the ECA, specific reference is made to waste disposal by landfill. This section is primarily concerned with the potential contamination of underground water resources by solid waste landfill sites. The Act states that no person shall establish, provide or operate any disposal site without a permit issued by the Minister of Water Affairs and Forestry and then, subject to the conditions contained in such a permit. Although the DEAT administers the rest of the ECA, the DWAF administers this section. The DWAF has published guidelines referred to as the "Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994)". These guidelines apply to all new and operating landfill sites. This section of the ECA also states that no person may discard waste or dispose of it in any other manner save at a disposal site for which a permit has been issued. This section has not been repealed by the NEMA (107/1998) (Glazewski, 2000:189).

2.2 Sectoral legislation

2.2.1 Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994)

Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) are standards by means of which environmentally acceptable waste disposal practices can be differentiated from environmentally unacceptable waste disposal practices (DWAF, 1994:1). This set of Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) has been developed as a set of standards and procedures by which applications for a landfill permit as described in the ECA (73/1989) can be obtained.

According to these requirements the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) are enforced during the permit application procedure at a non-permitted operating site (as in the case of the Orkney and Stilfontein sites). This is because all the applicable Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) must be met before a permit can be obtained.

In the case of the Potchefstroom landfill site (an operating, non-permitted site), the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) determines that, in order to apply for closure, a closure design should be compiled in order to obtain a landfill site permit from DWAF. Only thereafter can a landfill closure report be compiled which, after acceptance from DWAF, will lead to the closure of the landfill.

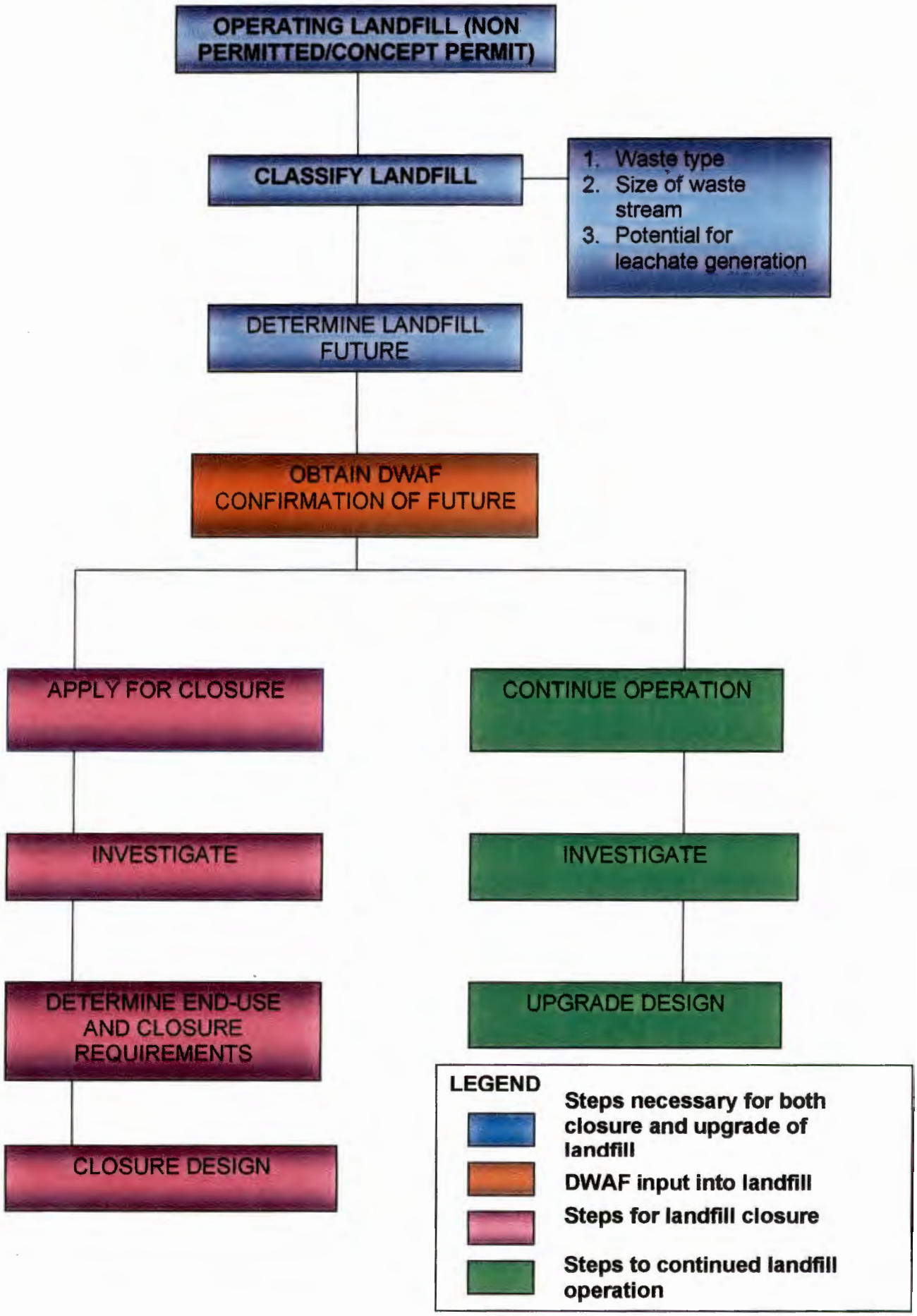
In the case of a permitted site (Klerksdorp site), the conditions appearing in the permit represent enforceable standards for that specific landfill.

Since permit conditions will always conform to, or exceed the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994), the Minimum requirements will also in effect, become enforceable standards. A flow diagram of the landfill process as described in the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) is illustrated in Figure 2.

The process will be followed in order to determine the status and the possible future of the landfill sites within the SDM's jurisdiction. This process is important in order to establish a basis for setting and applying the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994). The process determines the inherent qualities of the site, as well as the differences that characterise any existing landfill. Examples are the different types of waste involved, the magnitude of the waste stream and the potential for significant environmental problems associated with waste disposal by landfill (DWAF, 1994:12). This process will be discussed in Chapter 4, regarding the study area.

FIGURE 2 : THE LANDFILL PROCESS

Source: DWAF (1994:vii)



2.2.1.1 Classify the landfill sites

The classification of each landfill site is the first step that should be taken and will determine the consequential steps in the process.

The landfill classification system defines the disposal situation or need and identifies the type of landfill according to:

- Waste type - Defined as 'general or hazardous' waste.
- Size of waste stream or landfill operation – The size classification addresses the size of the waste stream and the consequent size of the operation. It is then divided, according to the waste type, into communal, small, medium and large landfill sites for general waste and is given a hazard rating in the case of hazardous waste types.
- Potential for significant leachate generation and need for leachate management - Determine whether there is 'sporadic' or 'significant' leachate generation or potential for leachate from the landfill site, and is determined in terms of the climatic water balance calculations and managed accordingly (DWAF, 1994:17-24).

2.2.1.2 Determine the landfill future and confirm site feasibility with the DWAF

There are many cases of existing, non-permitted landfills in South Africa. These range from well-run operations that have not yet been permitted, to situations where uncontrolled dumping of waste occurs on a large scale.

All non-permitted landfills must be classified and assessed in consultation with the DWAF, to determine the environmental risk that they pose.

In some cases, non-permitted landfills will pose little environmental risk. This may be because of sound choice of site, design and operation or simply because of the high ash and low putrescible content of the waste or the fact that significant leachate is not generated. Such sites should be upgraded in terms of design and operation and permitted in accordance with the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) for disposal of waste by landfill.

Landfills that pose a risk to the environment because of a high pollution potential, however, must be closed in accordance with the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994). They usually require to be replaced by an alternative disposal site that is developed in accordance with the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994:36-37).

It is evident that the state of the landfill site will determine its future, which will either be to continue operation or to apply for closure. The process will then be followed accordingly.

2.2.1.3 Continue operation

When it has been decided that the current landfill should continue its operation, the objective of the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) for landfill operation is to ensure that all waste is disposed of in an environmentally acceptable manner. The operation must thus conform to both the permit conditions and to the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) associated with the site classification. In order to comply with the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) for the operation of a landfill site, the site must commensurate with its classification to the satisfaction of DWAF. Sufficient facilities and resources are required for landfill operations to conform to both the landfill permit conditions and the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) associated with the site classification.

These include the general requirements/impact associated with landfill operations such as:

- *Signposting and access* – These must be in all the appropriate official languages and must be erected in the vicinity of the landfill, indicating the route and distance to the landfill site from the nearest roads.

  Suitable signs must be visible on the landfill site, and should direct vehicle drivers appropriately as well as to control speed.

  A general notice board must be erected at the site entrance with all appropriate information regarding the landfill site, for example, the type of waste accepted, the landfill classification, as well as operating hours.

  Roads must be maintained at all times, and should ensure that waste can reach the working face with the minimum of inconvenience in all weather conditions. No mud from the site may be tracked onto public roads (DWAF, 1994:88-89).
- *Waste acceptance* – This is to ensure that landfill sites classified as general landfill sites, receive only general waste for which they were designed.

  All hazardous waste must be disposed of at classified hazardous waste sites only (DWAF, 1994:89).
- *Access control* – Vehicle access to the landfill site must be limited to a single, controlled site entrance. This is to ensure that no unauthorised entry or illegal dumping of waste takes place.

  The landfill site must also be adequately fenced and/or secured. In all events, the site boundaries must be clearly demarcated and measures should be implemented to prevent unauthorised vehicle access (DWAF, 1994:89).
- *Security* – Suitable security must be provided to protect any facilities on site. Illegal waste picking and squatting should be discouraged at all waste disposal sites primarily for the purpose of protection of public health and safety (DWAF, 1994:89-90).

- *Operating plan* – Adequate, suitable facilities, equipment, and staff are required in order to ensure environmentally acceptable waste disposal. It is therefore a Minimum Requirement that there are sufficient resources to meet the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) relating to the operation (DWAF, 1994:90).
- *Landfill operation* – Landfills must be operated in accordance with the principles of sanitary landfilling which states that waste must be compacted and covered at the end of each day's operations.

  Methods used in order to comply with the sanitary landfilling principles, state that waste must be deposited in trenches or cells, spread, compacted and covered, so that each day's waste is effectively isolated from the environment.

  A wet weather cell must be constructed close to the site entrance or close to an all-weather road, for abnormally wet conditions. The wet weather cell must have sufficient capacity to accommodate one week's waste.

  The cover applied over the waste must be sufficient to isolate the waste from the environment (DWAF, 1994:93-95).
- *Other elements of operation* – Nuisance resulting from landfill operation such as fires, litter, odours, noise, vermin and dust should be controlled. Fires on landfills where burning is not permitted must be extinguished immediately.

  All litter must be contained within the site, and this can be achieved by the application of the sanitary landfill principles of compaction and cover.

  Odours can be contained and controlled in the same manner.

  Un-surfaced roads or unpaved areas, which give rise to dust problems, must be watered regularly to restrict dust so as not to cause a nuisance to workers or users of the facility (DWAF, 1994:95-96).
- *Drainage* – Upslope, run-off water must be diverted away from the waste, to prevent water contamination and to minimise the leachate generation. Where contaminated water or leachate does arise on a site, it must be managed. This means that it must be kept out of the environment. Clean,

uncontaminated, run-off water must not be permitted to mix with, and increase the volume of, contaminated water (DWAF, 1994:96).

- *Leachate management* – The management of leachate will depend on the classification of the site in accordance with the generation of leachate (DWAF, 1994:97).
- *Progressive rehabilitation of completed areas* – This entails the progressive rehabilitation of landfills by means of the establishment of vegetation on all areas where no further waste deposition will take place (DWAF, 1994:97).

2.2.1.4 Apply for closure

When it has been decided that a landfill site is not adequate to continue operation, rehabilitation of the landfill should follow. This should be done in such a manner as to ensure that the site is environmentally acceptable and suited to the implementation of a proposed end-use plan. In the case of an operating landfill that is to be closed, the DWAF must be informed of the intention to close the site, at least one year prior to closure.

Non-permitted landfill sites will require permits before they can be closed. Permitting is then undertaken with a view to closure.

At permitted operating sites and sites developed in terms of the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) for waste disposal by landfill, the end-use and closure requirements will be reviewed.

In other cases where end-use requirements have not been identified, they must be investigated and determined together with the closure requirements (DWAF, 1994:107).

2.2.1.5 Investigate

The objectives of the site investigation are:

To ensure that no critical factors or fatal flaws were overlooked in the preliminary investigation. This includes information regarding geology, geohydrology, soils and an EIA.

The DWAF, as part of the permitting procedure, require an EIA, and it is usually initiated parallel with the detailed site investigation. The objective of the EIA is to identify the various ways in which an existing, proposed or closed landfill will affect the receiving environment (DWAF, 1994:50-59).

2.2.1.6 Determine end-use and design

In cases where the end-use requirements have not previously been identified, they must be investigated and determined, together with closure requirements. The end-use of a landfill refers to its after-use. The most common landfill end-use is an open space, and sometimes, in the case of a general waste landfill site, the open space is used for sport or recreation. (DWAF, 1994:107-109).

2.2.1.7 Upgrade design

The general objective of landfill design is to provide a cost-effective, environmentally acceptable waste disposal facility and should strive towards the minimisation of leachate pollution of the adjacent ground and surface water.

Another objective is the provision of sufficient cover material to ensure an environmentally and aesthetically acceptable operation (DWAF, 1994:70).

2.2.1.8 Closure design

Aspects addressed in the closure design would typically include the following:

- Remedial design to address identified problem areas;
- Final shaping and landscaping;
- Final landfill cover or cap design;
- Permanent storm water diversion measures, run-off control, anti-erosion measures; and
- Any infrastructure relating to the end-use plan.

As seen in Figure 2, investigation is an inherent part of this process. In order to determine the current status of the study area a checklist will be compiled from the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) and the general problems experienced with landfill sites as found in the literature. This will serve to check compliance with regulations through a monitoring plan, by auditing the sites within the study area on a predetermined basis.

2.3 Provincial level legislation

Legislation regarding solid waste disposal is also regulated on provincial level, although the range of aspects are not as wide as they are at national level.

Provincial legislation has mainly been based on legislation prior to the Constitution. These regulations pertain mainly to the control of environmental pollution, particularly that of littering, and was utilised by some of the provinces in terms of the Orange Free State - Prohibition of the Dumping of Rubbish Ordinance (8/1976). This ordinance states that no person may without authority throw, dump or leave any rubbish on public land or water, except in a container or at a place specially adapted or set aside for such purpose or immediately burying or destroying such waste. These regulations have been implemented under the Financial Relations Act (65/1976).

Further regulations regarding waste have also been exercised under the Road Traffic Act (93/1996). This Act prohibits anyone from disposing waste along roads, and is exercised under the different Road Ordinances within the different provinces. Regulations and ordinances have also been issued under the Sea-Shore Act (21/1935) for the coastal Provinces of Natal and the Cape, regarding solid waste disposal (Fuggle & Rabie, 1996:518-519).

Subsequent to 1996, there have been initiatives with regard to a proposal to develop a waste management policy in some of the provinces. These provinces can envisage either new legislation to give it effect, or use existing national legislative provisions delegated to the province, to achieve these initiatives (Durban Metro, 2000:7).

2.4 Local level legislation

Local legislation has also been promulgated prior to the Constitution (1996).

The main functions of local authorities in connection with solid waste are their obligations as far as providing sanitary services for the collection and disposal of refuse. In this regard provincial local governments are empowered to exercise the most common control of solid waste through local authorities over the littering of public places, streets, private premises, streams and dams.

Some local authorities have subdivided refuse into a number of different categories such as 'house refuse'; 'garden refuse' and 'business refuse'. These subdivisions serve to differentiate between the different types of refuse as far as charges and procedures relating to the collection, removal, storage and disposal of waste are concerned. The best example of such by-laws has been promulgated for the Johannesburg municipality (Fuggle & Rabie, 1996:519-521).

No local level legislation has been promulgated for landfill sites under the jurisdiction of the SDM.

Aspects other than those discussed in legislation associated with landfill sites have been identified for the purpose of the study

2.5 The environmental aspects regarding a landfill site

In literature, a number of impacts, associated with landfill activities and sites, are described. These include advantages and disadvantages associated with landfill sites. As landfill-based disposal is currently the most cost-effective method and still appears to be the most forgiving of all the established disposal methods, a landfill which is well designed and managed can operate with minimal adverse environmental impacts (Davoudi, 2000:1; Fuggle & Rabie, 1996:501; Smith, 1994:162).

A sanitary landfill is not a dump site, it is a scientifically selected, designed, engineered and managed refuse-disposal operation where the daily input of waste is spread, compacted and covered with soil to a pre-planned development programme (Fuggle & Rabie, 1996:500; Miller, 1996:546). The development programme specifies the types of waste that are acceptable and those that are unacceptable to the site and also the way in which the site will be managed (Fuggle & Rabie, 1996:501). An example of a sanitary landfill site is illustrated in Figure 3.

These modern landfill sites are landfills on geologically suitable sites, which are lined with clay and plastic before being filled with waste. The bottom is covered with a second impermeable liner, usually made of several layers of clay, thick plastic and sand. This liner collects leachate and is intended to prevent its leakage into the groundwater. Collected leachate is pumped from the bottom of the landfill, stored in tanks, and sent either to a regular sewage treatment plant or

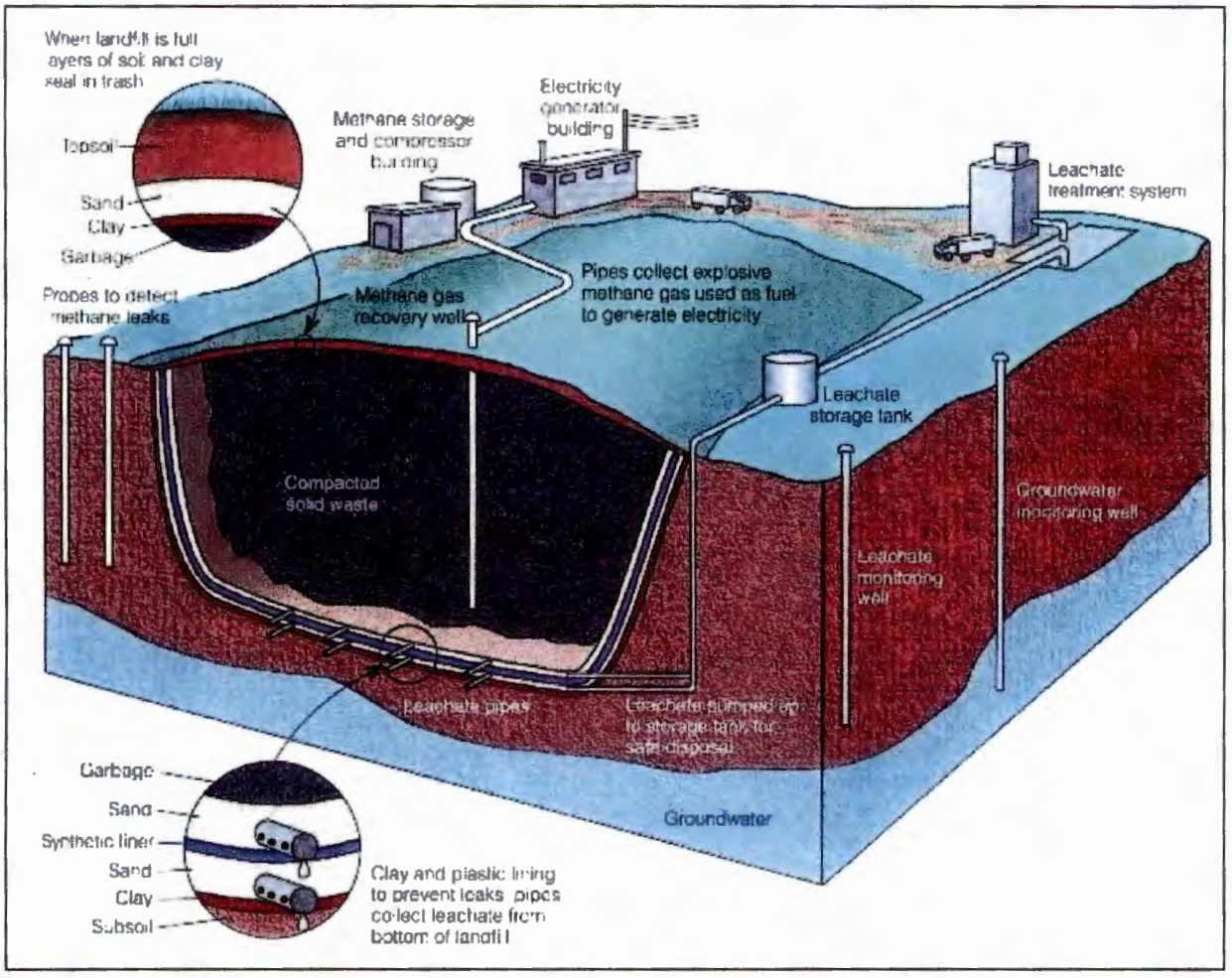
to an on-site treatment plant. When the landfill is full, it is covered with clay, sand, gravel, and topsoil to prevent water from seeping in. Several boreholes are drilled around the landfill to monitor any leakage of leachate into the nearby groundwater (Miller, 1996:546-547).

Site design without operational control serves no purpose. The operational control of the site is as critical to the success of a project as site design and must be incorporated into the conditions for the operation of the site. Operational control includes elements such as:

- Waste specifications in respect of wastes that are site specific. Acceptable wastes and unacceptable wastes must be specified. Some of the waste that needs to be specified includes items such as; cyanides, oil, toxic organics, aqueous inorganics and acids.
- Leachate management and the water balance are very important operational control issues to be dealt with. In spite of good design of the landfill, landfills are bound to leach after heavy rainfall. Leachate that has high levels of heavy metals can be toxic to the receiving environment.
- Good site design, engineering, construction and supervision can ensure that leachate is contained, captured and not allowed to disperse freely into the environment.
- Good landfill management is also essential to ensure environmentally sound landfills. It is necessary to manage the landfill process in order to minimise the negative impacts.
- Leachate disposal may be effected in a number of ways:
- In very small sites slow migration is promoted through specially designed drainage systems.
- In larger sites leachate is best impounded and discharged to sewer.

FIGURE 3 : STATE OF THE ART SANITARY LANDFILLS

Source: Miller (1996:547)



- In those cases where the sewer is not conveniently located or unable to accept the leachate, recirculation is practised. However, it should be noted that the recirculation of leachate will result in the propagation of unacceptable odours if residences are in close proximity to the site.
- Security is another important subject, because good security services keep unauthorised persons off the site. Injury to, or death of, members of the general public is always a serious consideration to contractors and

local authorities. The security service should monitor vehicle movements and control waste inputs (Fuggle & Rabie, 1996:502-506; Miller, 1996:546-547).

The legislation and environmental aspects discussed in this chapter will be used as the basis for the assessment of the selected landfill sites. The methods used will be discussed in the subsequent chapter.

CHAPTER 3:

ENVIRONMENTAL MONITORING AND AUDITING

3 ENVIRONMENTAL MONITORING AND AUDITING

3.1 Introduction

In this chapter Environmental Monitoring and Auditing will be discussed as environmental management tools.

3.2 General

Environmental auditing and monitoring are tools used to determine the status of environmental aspects and the trends that the associated impacts follow. The terms "monitoring" and "auditing" are used together, to make it clear that monitoring data requires an evaluation. Auditing suggests that something needs to be monitored. These two tools will be discussed in more detail in this section.

3.3 Definitions

Monitoring by definition is "to scrutinize or check systematically with a view to collecting certain specified categories of data" (Morris, 1973). Environmental monitoring is a tool that determines the areas for corrective action and improvement by monitoring the characteristics of operations and activities on a regular basis that can have a significant impact on the environment (Nel, 2000:25).

An *environmental audit* is a tool used to examine compliance to legislation (as in this case), and has been described as being associated with a variety of activities intended to examine the performance of a given facility or operation. It is used to determine or verify the extent of compliance with environmental law

requirements, and the soundness of environmental practice; the ultimate goal being to improve environmental performance. The findings of an audit may initiate and prioritise corrective action with regard to environmental management practices within the target facility or operation (Glazewski, 2000:294).

An environmental audit is a systematic, documented, verification process of objectively obtaining and evaluating audit evidence to determine whether specified environmental activities, events, conditions, management systems, or information about these matters conform with audit criteria (ISO 14010, 1996:1). In this study the focus of the audit will be the compliance of the landfill sites with relevant legislation.

The *environmental compliance audit* will be used as a tool to measure the compliance with the relevant legislation. The environmental compliance audit is a systematic and objective evaluation of a facility's compliance with environmental legal requirements (Erickson & King, 1999:193).

3.4 Environmental monitoring

The concept of monitoring can be defined as repetitive measurements made, to specify the state of a system or facility over a period of time. Monitoring implies the systematic collection of a potentially large quantity of information over a long period of time. It can be used as an early-warning system; to identify trends in a locality before it is too late to take remedial action (Du Plessis, 2000:1). It can also help to identify and correct unforseen impacts (Wathern, 1988:118).

3.4.1 Monitoring as a tool

Monitoring can be viewed as an important component of the cyclical planning; program design, implementation, evaluation and re-planning process, and in this study serves the following organisational functions (Carley, 1986):

- Help manage the environment by providing feedback of the relative success or failure of previous actions in terms of policies and programs;
- Used to test compliance with governmental regulations.

Monitoring is a tool of organisation, and is an essential component of a continuing process. It also provides a coordinating and integrating function. It should be viewed as part of a planning process. Monitoring thus includes the collection of information, and also the analysis and evaluation of that information, as well as the provision of advice based on the evaluation.

3.4.2 Aims of monitoring

The aims of monitoring should be formulated clearly and set out in explicit guidelines. This is to ensure that no deviation from the required monitoring program occurs, as changes in sampling procedures may invalidate comparisons of monitoring data. Monitoring aims to establish whether a perceived change is a consequence of a project or its management and not the function of some other cause. A 'reference' is needed against which to assess whether a facility complies with a certain standard (Skalski & McKenzie, 1982:240).

The objectives of a monitoring program must be established before the design can be determined. Monitoring has two objectives namely to:

- Select suitable variables; and
- define the possible changes that may occur.

Once objectives and guidelines have been established it is essential to design a monitoring plan for the collection and interpretation of the results (Skalski & McKenzie, 1982:238).

3.4.3 Components of a monitoring plan

The monitoring program would normally include and is not restricted to

The set of standards to be monitored;
Timing and/or frequency of the monitoring of the aspects;
Agency responsible for ensuring compliance with the monitoring program;
Monitoring requirements (Glasson et al. 1999:195).

Monitoring can be used as a briefing on the status and change in different geographic areas. It has been noted that monitoring can be improved through the use of environmental audits (Glasson et al. 1999:192). For the purpose of this study environmental compliance auditing will be used as a tool within the framework of a monitoring plan to assess compliance to regulation regarding landfill sites.

3.5 Environmental compliance auditing

Compliance audits are conducted to check whether the organisation is in compliance with a particular set of standards (SANF, 1993:24). It is a documented procedure for periodically evaluating compliance with relevant environmental legislation and regulations (ISO 14001, 1996:4; Nel, 2001:30). The goal of environmental compliance auditing is to identify environmental compliance issues and promptly remedy them.

3.5.1 The role-players

In the environmental audit three parties are always involved:

- The client (commissioner) of the audit;

- The auditee (organization/facility or part of it audited);
- The auditor conducting the audit (Vilnius, 1999).
- These roles and responsibilities are discussed in more detail in AppendixA.

3.5.2 The audit process

The audit process involves much more than just undertaking the physical audit itself. The success of an environmental audit is not so much in the undertaking of the audit, but rather in the quality and thoroughness of the pre-audit planning and preparations. Any audit process should be regarded as a guideline only. It is vital to maintain a flexible approach when designing an audit so that adaptations can be made to suit particular circumstances (Eskom, 1997: 5; SANF, 1993:25).

3.5.3 The audit activities

The audit activities include:

3.5.3.1 Designing the audit program/plan, initiating the audit

An audit plan/program must be designed and includes the following activities:

3.5.3.2 Determining the feasibility of the audit

It is important to consider the feasibility of the audit, while taking into consideration different factors that can influence the success of the audit. Factors such as availability of adequate co-operation from the auditee, sufficient and appropriate information for planning the audit, as well

as availability of time and adequate resources must be considered before conducting an environmental audit (ISO 19011, 2001:5).

3.5.3.3 The audit scope and objectives

The audit scope can be defined as the extent and boundaries of an audit. The audit criteria are the set of policies, procedures or requirements used as a reference (ISO 19011, 2001:7). The scope of the audit is left to the client.

The auditors should act with professionalism, confidentiality, and discretion under the orders of the client (ISO 14010, 1996:2; Rainmaker, 2000:2). The first step with regard to an environmental audit is to identify the environmental regulatory program that will be considered within the scope of the audit (Erickson & King, 1999:194). The objectives of the audit can include: conformance to regulations and legal requirements as well as determining the extent of conformity with audit criteria. The audit criteria will be in the form of a checklist compiled by the auditor.

3.5.3.4 Establishing the audit team

When the audit has been declared feasible, an audit team should be established taking into account the competence needed to achieve the objectives of the audit. When deciding the size and composition of the audit team (see Appendix A), it is important to take into consideration the overall competence of the audit team needed to achieve the objectives of the audit (ISO 19011, 2001:7,15).

3.5.3.5 Conducting the document review

Prior to the on-site audit activities, documentation should be reviewed to determine conformity, and establish the audit criteria (ISO 19011, 2001:8). The

audit checklist will be discussed as criteria against which auditing can be conducted.

3.5.3.5.1 The checklist

Environmental auditors use a wide range of environmental audit checklists and questionnaires. Checklists aim to promote thinking about impacts; to provide a concise summary of the effects of proposals, to identify factors and the trade-offs between alternatives. A checklist is thus a collection of key points and important characteristics extracted by the auditor, during the preparation phase, from the information available; it is applied for evaluation and verification purposes during the audit. The points, as they are jotted down on the checklist, will become the specific areas of investigation during the audit. Their task is thus primarily one of impact identification and listing, but there may be some assessment of the character and nature of the impact identified. Ideally, any checklist used should be customized to reflect the scope of the audit and the practices of the particular facility (Eskom, 1997:4; Erickson & King, 1999:194; Barrow, 1997:134-135; Smith, 1994:18).

Checklists mainly serve to:

- Order thought;
- Aid data gathering;
- Help ensure that the assessor does not overlook a possible impact;
- Assist the assessor to screen large amounts of data so that impact assessment can be focused (Barrow, 1997:135).

There are several basic formats for checklists. Simple checklists can help describe impacts and give some measurement and prediction. More sophisticated checklists may apply scaling or weighting techniques to try to measure impact or give it a utility function. The simple list is a listing of potentially affected factors. The list focuses attention on these attributes and the

checklist acts as a guide to identify different aspects. No guidelines or information is included on how the various factors are to be measured (Barrow, 1997:135; Smith, 1994:18).

3.5.4 Preparing for the on-site audit activities

It is evident that preparation is the key to ensuring a professional audit. It is important that the audit plan should be sufficiently flexible to permit changes, such as changes in audit scope, which can become necessary as the on-site audit activities progress. Pre-audit site visits may be conducted by the auditor, which may assist in the preparation of the audit (Eskom, 1997:25; ISO 19011, 2001:18).

3.5.5 Conducting on-site audit activities

It is during this phase that the actual audit of the facility or the company takes place.

3.5.5.1 Conducting the opening meeting

The purpose of an opening meeting is to review the audit plan, provide a summary of how audit activities will be undertaken, confirm communication channels, and provide an opportunity for the auditee to ask questions. It is also an opportunity to set the date of the closing audit meeting (Eskom, 1997:26).

3.5.5.2 Collecting and verifying information

Information relevant to the audit objectives, scope and criteria should be collected by appropriate sampling during the audit and must be verified carefully. Only information that is verifiable can be audit evidence. Audit evidence should

be recorded as such. The auditor uses the available tools to gather all the information required to provide an accurate and objective status of the audited organization. Interviewing personnel can give the auditor a better understanding of the degree of effectiveness of the systems and processes under the present circumstances as well as the employee's attitude towards the organization. All verbal information must be verified by objective evidence. The auditor must record all information on the checklist for verification and feedback at the end of the audit. In all the information provided to the auditor, the objective evidence must be extracted; therefore it is important to verify all verbal information by review and observation. Objective evidence is information which can be verified, based on facts and obtained through observation, measurement, testing or by other means (Eskom, 1997:25-26; ISO 14011, 1996:3; ISO 19011:20, 2001; Rainmaker, 2000:2).

3.5.5.3 Generating audit findings

All audit findings are generally detailed observations made during the audit, which will create an idea of the status of the organization as found at that time. Audit evidence should be evaluated against the audit criteria to generate the audit findings. Audit findings can indicate either compliance or non-compliance with audit criteria and/or identify an opportunity for improvement. Compliance should be summarized to indicate locations, functions, processes, or requirements that were audited (Eskom, 1997:30).

The inclusion of recommendations in the audit results should not provide solutions to the auditee, but help him/her to commence with effective corrective action. The recommendations must contribute to successful improvement of systems and processes by leading, and not forcing, in the right direction (Eskom, 1997:32).

3.5.5.4 The audit closing meeting

After completion of the audit evidence collection phase and prior to preparing an audit report, the audit team should hold a meeting with the auditee's management and those responsible for the functions audited. The main purpose of this meeting is to present audit findings to the auditee in such a manner as to obtain their clear understanding and acknowledgement of the factual basis of the audit findings (Eskom, 1997:35).

3.5.6 Preparing, approving and distributing the audit report

The audit report is the only lasting impression of the audit.

3.5.6.1 Preparing the audit report

The purpose of an audit report is to describe the status of the client's organization, its systems and processes, its overall performance, its strengths, weaknesses, and its associated risks. The writer of the report wants to see that decisions are made, based on his report; actions are taken and that credit is given and confidence installed where business is running well. The audit report should provide a complete, accurate, concise and clear record of the audit (ISO 19011, 2001:19; ISO 14011, 1996:5; Hugo et al,, 1996:205).

3.5.6.2 Approving and distributing the audit report

The audit report should be issued within the agreed time period. Distribution of confidential information must be kept to an absolute minimum, as agreed with the people affected by the information contained in the report. The audit report is the property of the audit client and confidentiality should be respected and

appropriately safeguarded by the audit team members and all report recipients. The audit report should be issued within the agreed time period in accordance with the audit plan. If this is not possible, the reasons for the delay should be formally communicated to both the client and the auditee, and a revised issue date established (ISO 19011, 2001:20; ISO, 14011, 1996:5; Eskom, 1997:33).

3.5.7 Completing the audit

3.5.7.1 Retaining documents

Documents pertaining to the audit should be retained or destroyed by agreement between the participating parties and in accordance with the audit program procedures and applicable regulatory and contractual requirements. Unless required to do so by law, the audit team and those responsible for managing the audit program should not disclose the contents of documents, any other information obtained during the audit, or the audit report, to any other party without the explicit approval of the audit client and, where appropriate, the approval of the auditee. If disclosure of the contents of an audit document is required, the audit client and auditee should be informed as soon as possible. A breach of confidentiality by the auditor is unprofessional and harmful to the auditing organization. Making the audit results public is the prerogative of the audited organization (ISO 19011, 2001:22).

3.5.7.2 Finalising the audit

The audit is completed when all activities in the audit plan have been finalized and the approved audit report has been distributed (ISO 19011, 2001:23).

3.5.8 Conducting audit follow-up

The conclusions of the audit can indicate the need for corrective, preventative and improvement actions, as applicable. Such actions are not considered to be part of the audit and are usually undertaken by the auditee within an agreed timeframe. The auditee should keep the audit client informed of the status of these actions, as appropriate. The completion and effectiveness of corrective action should be verified in accordance with an appropriate procedure. This verification can be part of a subsequent audit (ISO 19011, 2001:24).

3.5.9 Benefits of environmental auditing

Environmental auditing in general has a number of benefits associated with it: Auditing is an interactive process, as it provides feedback, which helps to ensure that the facility or organization remains aware of all of its actual and potential types of impact (Hugo et al,. 1997:200).

- The audit process ensures an independent, objective and reliable verification of satisfactory as well as inadequate performance of the facility.
- Auditing will assist in achieving the environmental goals and assure compliance with relevant legislation.
- Auditing is a fact gathering exercise that helps reduce the risk of avoidable costs.
- Audits are able to give the status of contractual and legal liabilities.
- Audits offer status, solutions and strategies for facilities and operations (Eskom, 1997:13).

CHAPTER 4:

THE ENVIRONMENTAL MONITORING PLAN AND THE AUDIT PROCESS

4 THE ENVIRONMENTAL MONITORING PLAN AND THE AUDIT PROCESS

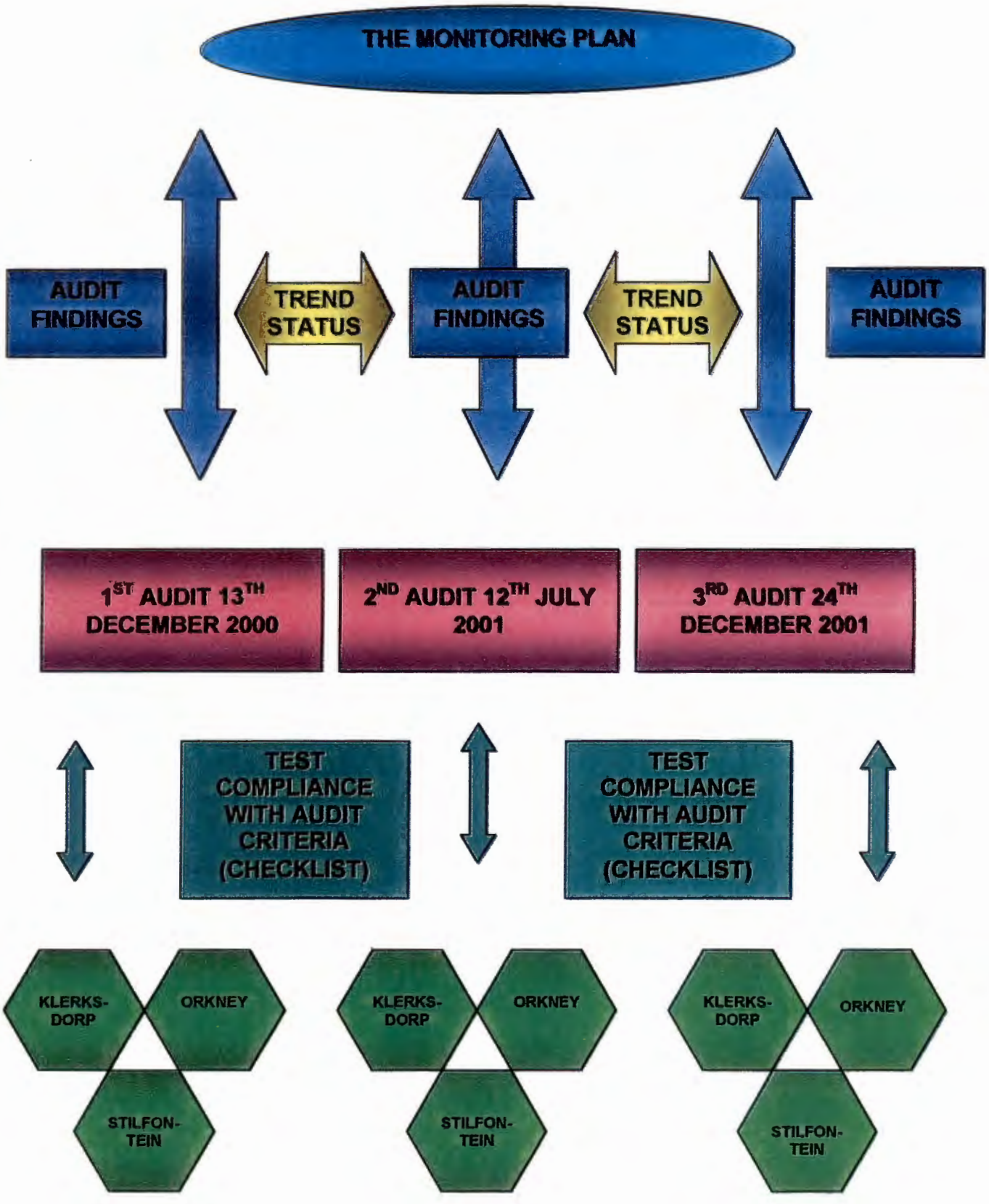
This environmental monitoring plan consisting of the different compliance audits is not meant to produce a statistically significant data set. Instead the focus will be towards giving an early warning of potential problems associated with the general aspects as stipulated in the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994), as well as the general problems experienced and discussed. Reviewing the results of the compliance audits and updating the trend status of the different aspects of the landfill can provide an early warning system by identifying negative trends picked up by the monitoring plan.

In this study a monitoring plan consisting of three environmental compliance audits will be drawn up (see Figure 4). The study period of one year will be divided into three site visits, where compliance with legislation will be tested against a checklist drawn up from the relevant literature.

4.1 The monitoring plan

The aim of this monitoring plan is to examine the trend status with regard to compliance of landfill sites within the jurisdiction of the Southern District Municipality, to the general aspects associated with landfill sites as set out in the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994). The variables that will be monitored are the general aspects described in the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) (see Chapter 2). Monitoring will be done through a series of compliance audits that will be conducted, based on the checklist compiled from these variables. Any changes to be detected will be measured against the compliance to the checklist and thus the general aspects as described in the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994).

FIGURE 4 : THE INTEGRATED MONITORING PLAN



In this study a monitoring plan regulates the timetable for the environmental audits that need to be conducted. From the results of the compliance audits the trend status of compliance to the audit checklist can be determined. The results will identify the areas of deterioration and of improvement over the study period. It will also help identify problem-areas and help prioritise the aspects to be improved at the different landfill sites. Future deterioration and non-compliance can be prevented through early detection of negative trends.

The monitoring plan for the landfill sites within the study area consists of three audits conducted at six-monthly intervals over the period of one year. The aspects to be monitored are limited to the general aspects as described in the Minimum Requirements for Waste Disposal by Landfill site (DWAF, 1994), and the environmental impacts associated with landfill sites (see Chapter 2).

4.2 The monitoring timeframe

Environmental compliance audits were conducted starting November 2000 followed by the second in July 2001 and the last audit was conducted in December 2001. The audit criteria was the audit checklist compiled from the general aspects associated with landfill sites within the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994). The monitoring of the trend status with regard to the general aspects identified the areas for corrective action and improvement. This was established by plotting a trend status from the findings of the different audits. The audit process will be discussed as part of the monitoring plan in the subsequent section.

4.3 The compliance audit

The goal of this environmental compliance audit was to identify environmental compliance issues with regard to the Minimum Requirements for Waste Disposal

by Landfill (DWAF, 1994) and to identify the general problems associated with the landfill sites identified in the SDM's jurisdiction.

4.3.1 The role players

In this study the different role players were:

The client – The Southern District Municipality.
The auditee – The Klerksdorp, Orkney and Stilfontein landfill sites.
The auditor – J.E. de Villiers

4.4 The audit activities

The audit activities will be discussed with regard to the audit plan as set out for the study area.

4.4.1 Determining the feasibility of the audit

The availability of adequate co-operation from the auditee, sufficient time and resources allocated for the audit, as well as appropriate information, justified the feasibility of the audits.

4.4.2 The audit scope and objective

In this study the boundaries of the audit will extend to three landfill sites within the SDM's jurisdiction, namely the Klerksdorp, Orkney and Stilfontein landfill sites. The scope of the audit was limited to these three landfill sites due to the fact that the Potchefstroom site is due for closure. According to the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994), the general aspects

associated with landfill sites should only be considered if a site is to continue operation. This explains the exclusion of the Potchefstroom site from the scope of the audit. The objective of the audit will be to determine compliance with the audit criteria for the three landfill sites. The audit criteria will be compiled in the form of a checklist, and will be discussed in more detail in Section 5.4.3.1.

4.4.3 Conducting the document review

The Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) was reviewed and from the general aspects required for a landfill site to continue operation, a checklist was compiled. The general problems associated with landfill sites were also taken into consideration for the compilation of the checklist as the audit criteria.

4.4.4 The audit checklist

In this study the general aspects as identified in the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) were compiled into a checklist. This, together with the general problems experienced (as discussed in Chapter 2) served as the basis for the checklist. The checklist served as an 'aide memoir' against which compliance audits were conducted during the various site visits. These Minimum Requirements (to test regulatory compliance) together with the problems associated with landfill sites as discussed, (see Chapter 2), served as the audit criteria. The checklist compiled is illustrated in Figure 5.

Compliance to the checklist will be tested and indicated as "Compliance", "Marginal Compliance" and "Non-Compliance".

FIGURE 5 : THE AUDIT CHECKLIST

General Aspects:

Site security:	Dec 2000	Jul 2001	Dec 2001
Protection of facilities on site			
Illegal Picking			
Illegal squatting			
Fencing			
Site access:			
Single entrance for vehicle access			
Controlled entrance for vehicle access			
Lockable gate, managed during operating hours			
Area in use fenced			
Additional after hours security			
Site boundaries clearly demarcated			
Condition of roads and traffic control:			
Access roads to the site maintained for vehicles to use the landfill facility			
On-site roads maintained to ensure waste can reach the working face with minimum inconvenience in all weather conditions			
Two way traffic possible in all weather conditions			
Unsurfaced roads regularly graded			
Unsurfaced roads regularly watered to control dust			
No mud from site tracked to public roads			
Signposting:			
Signs in all appropriate official languages in vicinity of landfill			
Signs to control vehicles			
Signs to control speed on roads to site			
Signs to control speed on site			
General notice board at entrance with name, address, telephone numbers of the responsible person, operating hours, tariffs, class of landfill site and types of waste accepted			
Waste deposition:			
Either trenches or cells used for waste deposition			
Compaction of waste			
Covering of waste on a daily basis			
Only general waste received			
Wet weather cell to handle one week's waste			
Fires controlled on landfill site			

Operational Aspects

Drainage:			
Upslope run-off water diverted away from waste			
Contaminated water contained			
Run-off storm water diverted round the sides of waste body through berms of cut-off drains			
Basis of trenches or cells designed to drain water away and contaminated water drained to be stored in a sump or retention dam			
Drains maintained and not blocked by silt or vegetation			
Covered areas maintained to promote run-off without excessive erosion			
Littering control:			
All litter contained within the site			

- **FIGURE 5 : THE AUDIT CHECKLST - CONTINUED**

Windblown litter picked up on a daily basis from fences and vegetation			

Monitoring

Gate monitoring			
Weighbridge monitoring			
Water quality and leachate monitoring			
Gas monitoring			
Monitoring on rehabilitated areas			
Volume surveys			

LEGEND:

Compliance	Y
Marginal Compliance	M
Non-Compliance	N
No information	?

4.4.5 Preparing for the on-site audit activities

No pre-audit site visits were conducted in the study area, as the desktop study was rendered sufficient for the necessary background information needed to conduct the audits.

4.4.6 Conducting on-site audit activities

The Klerksdorp, Orkney and Stilfontein sites were audited on three occasions. The first audit was conducted on the 13th of November 2000, the second audit on the 12th of July 2001 and the last audit on the 24th of December 2001. As the audits were conducted as part of a monitoring plan, the steps for conducting the on-site activities were modified to suit the study. The steps followed in this study will be discussed in more detail.

4.4.6.1 Conducting the opening meeting

A monitoring and auditing opening meeting was held with the representative of the Southern District Council on the 13th of November 2000. In the meeting the objectives and scope of the study were discussed and the monitoring plan was laid out. Confirmation of co-operation from all the auditees was obtained. This was the only opening meeting held for all three the audit occasions. Because the audits were part of a monitoring plan, the audit scope and objectives did not change over the period of the study. During the meeting it was decided that the consecutive audits would be conducted during July 2001, and December 2001, and that no further opening meetings would be held.

4.4.6.2 Collecting and verifying information

Site visits were conducted on the 13th of November 2000, 12th July 2001 and the 24th of December 2001. On all three site visits the general aspects defined in the audit checklist were used as the criteria, and compliance to the criteria was tested on the Klerksdorp, Orkney and Stilfontein landfill sites. Audit evidence was recorded on the first and last site visits by means of photographs to illustrate the status of the different landfill sites with regard to the audit checklist. Interviews with the personnel responsible for the landfill sites were conducted and information verified through observation. Objectivity of information was ensured through photographing the status of the landfill sites concentrating on the aspects considered in the audit checklist.

4.4.6.3 Generating audit and monitoring findings

Compliance with the audit checklist was evaluated on the three audit occasions, and detailed observations noted. The status of the facilities at the time of the audit was indicated on the checklist. Audit findings were indicated to be

'compliant', 'marginally compliant' and 'non-compliant' to the audit criteria. This was done on all three audit occasions. From these audit findings the monitoring plan was executed. The monitoring plan entailed determining the trend status of the landfill sites. The trend status per aspect identified was determined by comparing the results of the audit findings for the different audit occasions with one another. The trend status was illustrated between the first and the second, and the second and third audit occasions. The trend status was illustrated as 'positive trend status', where the aspect in question showed an improvement with regard to the checklist. A "horizontal trend status" was noted when neither improvement nor degradation was found, and a "negative trend status" where deterioration with regard to the aspect in question was noted.

4.4.6.4 The audit closing meeting

Audit closing meetings were held with the auditees telephonically. This was conducted on the 22nd of January 2002. The audit findings and the trend status with regard to the monitoring plan were discussed. A clear understanding of the audit findings and monitoring trend status were conveyed.

4.5. Preparing, approving and distributing the audit report

In this study only the preparation of the audit reports with regard to the monitoring plan will be discussed, as it is the only aspect relevant to this section.

4.5.1 Preparing the audit report

The audit reports in this study were incorporated into the monitoring plan so that not only the current status of the landfill sites could be assessed, but also the trend status with regard to the general aspects identified. The findings from the

audits and the trend status will be discussed in Chapter 5, as part of the decision to continue operation of the landfill site.

CHAPTER 5:

THE LANDFILL PROCESS

5 THE LANDFILL PROCESS

The aim of this chapter is to do a trend analysis of each general aspect of the landfill process and to determine the level of compliance of each site with the audit checklist and thus with relevant legislation.

The process, as set out in the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) will be followed and is illustrated in Figure 2. The sub-headings were colour-coded corresponding to the legend of Figure 2, so that the steps in the landfill process may be followed more easily.

5.1 Classification of the landfill sites

As discussed in Chapter 2, the classification of the landfill sites is the first step in the process that should be followed, and will determine the consequential steps.

5.1.1 Waste type

In this study all the studied sites can be classified as *General Waste Sites (G).* General waste is the generic term as defined by DWAF (DWAF, 1994:5). All urban areas within the domain of the local authorities generate this type of waste. It comprises garden rubble, domestic, commercial and general, dry, industrial waste, and may also contain small quantities of hazardous substances for example items such as batteries, insecticides, weed-killers and medical waste discarded on domestic and commercial premises. Figure 6 illustrates some of the types of waste deposited at one of the landfill sites within the study area.

FIGURE 6 : GENERAL WASTE FOUND ON LANDFILL SITES IN THE STUDY AREA

5.1.2 Size of the waste stream 

When the type of waste has been determined it is important to know what the quantities are. This will determine the ultimate physical size of the landfill, which is dependent upon the amount of waste received during its lifecycle. The size classification also addresses the amount of waste received and the consequent size of the operation. This may change over time if the waste stream volume increases.

The amount of waste is directly dependent on the size of the population it serves (DWAF, 1994:19). Because the towns vary in population size, this will vary within the study area, and will be discussed separately. The *IRD*, which is a measurement of the existing waste stream in tons per day, shall be determined. The IRD will be used to determine the *MRD*, which defines the maximum average, annual rate of waste deposition, during the expected life of a landfill (DWAF, 1994:5,20).

The Klerksdorp site is permitted with an IRD of 406.7 tons per day (Kambule, 2002).

Neither the Orkney nor the Stilfontein landfill site is permitted, but the IRD was calculated for the Orkney site at 55 tons per day, and that of the Stilfontein landfill site at 125 tons per day (Muller, 2002; Pretorius, C. 2002).

At the Potchefstoom site the IRD was calculated at 150 tons per day.

All the sites had a MRD of more than 25 tons and less than 500 tons per day. With volumes such as these, all the sites are classified in the *Medium* category (De Villiers, 2001(a):7; BKS, 2001:1; Muller, 2002; Pretorius, C, 2002; Kambule, 2002).

5.1.3 Leachate potential

To determine whether leachate management is necessary for the landfill sites in question, it is important to know whether significant leachate will be generated. The potential for significant leachate depends on the water balance, and therefore the water balance associated with the sites must be assessed. The climatic water balance is used for the purpose of classifying landfills. This water balance is not a detailed classic water balance, but a simple calculation that assists in deciding whether leachate management is required. The climatic water balance is defined as being either *sporadic leachate generation* (B^-) type or on the other hand *significant leachate generation* (B^+) type (DWAF, 1994:21-22).

The balance calculated for the different sites studied showed no significant leachate generation. All the landfill sites can therefore be classified as being in the sporadic leachate group. It is however possible, during exceptionally wet conditions, that significant leachate may be generated. The possible frequency of such events is fortunately low and it is therefore still possible to accord the (B^-) status to the sites studied (Muller, 2002; Pretorius, C. 2002; Pretorius, J. 2002; De Villiers (a), 2001:7). The classification of the landfill sites is given in Table 1.

LANDFILL SITE	WASTE TYPE	LANDFILL SIZE	CLIMATIC WATER BALANCE
KLERKSDORP	G	M	B^-
ORKNEY	G	M	B^-
STILFONTEIN	G	M	B^-
POTCHEFSTROOM	G	M	B^-

TABLE 1: Landfill classification for the sites studied

5.2 Determine the landfill future and confirm site feasibility with the DWAF

The Klerksdorp site's permit needs to be reviewed, as the future of the site is still to be determined (Muller, 2002; Pretorius, J, 2002).

For the non-permitted sites within the study area (Orkney and Stilfontein) the landfill future has been determined. The Orkney landfill site is not likely to be permitted to operate due to its location, and will probably be closed within the foreseeable future (Pretorius, C, 2002; Pretorius, J, 2002).

A district landfill site is foreseen for the Klerksdorp, Orkney and Stilfontein areas (Pretorius, J, 2002). Either the Stilfontein or Klerksdorp site will most likely be permitted for this purpose (Pretorius, J, 2002).

The Potchefstroom site is in the process of closure and a new site was selected in the Townlands at a location known as Hartbeesvlaktes. Excavation of the new site is scheduled to commence by the end of January 2002 (De Villiers, 2002).

5.3 Continue operation of the landfill site

For the purpose of this study the Klerksdorp, Orkney and Stilfontein landfill sites will be treated as though a decision to continue operation has been taken. This is due to the fact that the relevant authorities have determined the Potchefstroom landfill site's future – which is closure - as has been mentioned. As discussed in Chapter 2, sufficient facilities and resources are required for landfill operations to conform to both the landfill permit conditions and the Minimum Requirements associated with the landfill site classification.

The general issues discussed in the previous chapters, have been consolidated into the audit checklist, and compliance with the checklist was tested on three occasions. This was done as part of the monitoring plan (Chapter 3). The first audit was conducted as part of the monitoring plan, on the 13th of November 2000; photographs were taken to provide visual evidence of the general issues listed on the audit checklist. A second site visit with no photographic evidence was conducted on the 12th of July 2001, the last site visits were conducted on the 24th of December 2001, when further photographic evidence was obtained. The photographs serve as a means by which to illustrate the trend the sites have followed over the one-year period with regard to the general and some of the operational aspects as listed in the checklist. The audit findings are illustrated in Data Set 1 (Appendix B) and the trend status for the landfill sites in Data Set 2 (Appendix C) and then discussed in the subsequent sections.

5.3.1 Site security

The Klerksdorp landfill site showed compliance with all aspects defined in the checklist with regard to the security of site facilities, illegal picking, and squatting. A horizontal trend to the protection of the site facilities was assigned. This is due to the fact that persons were in fact controlling entrance to the site during all three visits.

The site is fully fenced with a barbed wire security fence. During the first visit the fence was in a good condition with only a few small breaches, which would not allow vehicle access (Figure 7). During the second and third visits the breaches were enlarged to the extent that a vehicle could access the site. This implied a negative trend in the compliance rating.

The security of the Orkney (Figure 8) and Stilfontein landfill sites did not comply with the requirements regarding facility protection, illegal picking, squatting and fencing. This was the case during all three site visits. This can be ascribed to the

sites not being fenced. These sites had no guard and people were in fact busy with illegal picking and squatting. Thus, although these sites were non-compliant, it shows a horizontal trend status, as neither improvement nor deterioration regarding site security was detected.

5.3.2 Site access

When audited on the first occasion, the access to the Klerksdorp (Figure 9) site was through a single controlled entrance through the security fence, which clearly demarcated the site boundaries. Access could only be gained during operating hours, and the site was guarded after-hours. This was in compliance with the requirements of the checklist. Openings in the fence, which allowed vehicle access, were observed during the other site visits, which allowed for an extra access route to the landfill site, and therefore a non-compliance situation arose. A negative trend status was assigned for the site between the first and second visits. These openings remained the same between visits two and three and therefore assigned a horizontal trend.

Both the Stilfontein and Orkney (Figure 10) sites have a single site entrance with no clear boundaries, fences or access control. No change was detected during the site visits, giving these sites a horizontal trend status in this regard.

The Stilfontein site showed a positive trend status regarding demarcation (Figure 11) of boundaries, as tyres were placed in position between the second and third visits. These tyres are used to demarcate the boundaries of the landfill site. This initiative rendered the site with a marginal compliance to the audit checklist, as although it indicated the boundaries, it still allowed easy access.

FIGURE 7 THE KLERKSDORP LANDFILL SITE – 2000 - Site security – Fencing

FIGURE 8 THE ORKNEY LANDFILL SITE – 2001 – Site security – Illegal picking

FIGURE 9 THE KLERKSDORP LANDFILL SITE – 2001 – Site access – controlled entrance for vehicles, lockable gate, area in use fenced, site boundaries clearly demarcated

FIGURE 10 THE ORKNEY LANDFILL SITE – 2001 – Site access – single entrance

FIGURE 11 STILFONTEIN LANDFILL SITE – 2001 – Site access – site boundaries demarcated by tyres

5.3.3 Conditions of roads and traffic control

The Klerksdorp landfill site's road conditions and traffic control complied with the checklist on all occasions (See Figure 9). It showed a horizontal trend status with regard to all the aspects associated with road conditions and traffic control. This means that all roads leading to the landfill site, as well as roads on site were maintained and that all waste could reach the working face without any inconvenience in all weather conditions. The last site visit established this point as it was conducted in wet weather conditions. The waste front could therefore be accessed during adverse weather conditions. No indication could be found that any of the roads were watered during dry spells.

FIGURE 12 ORKNEY LANDFILL SITE – 2000 – Condition of the road and traffic control – access roads road to site maintained, two traffic possible, unsurfaced road regularly graded

FIGURE 13 THE ORKNEY LANDFILL SITE – 2001 – Condition of the road and traffic control – onsite road not maintained to ensure waste can reach the working face in all weather conditions, two way traffic not always possible

FIGURE 14 THE STILFONTEIN LANDFILL SITE – 2000 – Condition of the road and traffic control – Access road to the site maintained, waste can reach the working face with minimum inconvenience. Two way traffic possible in all weather conditions, regularly graded

The roads on the Orkney landfill site (Figure 12 & 13) allowed two-way traffic but with a certain amount of inconvenience. This was true even for the first and second site visits, which took place during good weather conditions. On the last site visit the wet roads allowed access to the working face, but two-way traffic was not possible.

A negative trend was established with regard to two-way traffic during all weather conditions and on-site road maintenance. The roads on site did not show signs of being regularly graded on the last of the site visits. Mud was tracked onto the provincial road by vehicles leaving the landfill site, and did not comply with the checklist in this regard. Non-compliance with the checklist was indicated and a horizontal trend status accorded.

The Stilfontein site (Figure 14) showed compliance with the checklist in all aspects with regard to the condition of the roads and traffic control. Only on the last site visit some mud was tracked from the landfill site's entrance onto the tarred road. A negative trend was established in this regard.

In neither the Stilfontein nor the Orkney sites' cases could any indications be found of watering of roads during dry spells. This causes negative trends, but a horizontal status is still accorded due to the fact that no change took place over the period of monitoring.

5.3.4 Signposting

Signposting at the Klerksdorp site was in full compliance (Figures 15 &16) as signs posted were in two official languages and within the vicinity of the landfill site. Signs controlling vehicle access were posted, both on the road to the site as well as on the landfill site. Signs controlling speed were also posted outside the landfill site, but none on site, which led to marginal compliance in this regard. No general notice boards were found at the site entrance stating the details regarding the site as discussed in Chapter 2. The road signs were not upgraded or changed during the time of the study, although a general warning from the Town Councillor had been painted over. The trend status with regard to this variable is therefore horizontal, but negative between visits 1 and 2.

The Orkney landfill site does not have any signs regulating traffic. No signs were found on the site regulating traffic or speed. This site doesn't have a general notice board. Non-compliance to all the general aspects regarding signposting was found to have a horizontal trend status.

FIGURE 15 THE KLERKSDORP LANDFILL SITE – 2000 – Signposting – general notice board in appropriate official languages

FIGURE 16 KLERKSDORP LANDFILL SITE – 2001 – Signposting – signs in official languages

FIGURE 17 STILFONTEIN LANDFILL SITE – 2001 – Signposting – signs in official languages.

The Stilfontein landfill site's signposting (Figure 17) was also awarded full compliance with regard to signs posted in all official languages. These signs were in the vicinity of – and with clear directions to - the landfill site. These signs were in English and Setswana. Signs to control vehicle access were not present during the first and second site visits. Such signs were however erected before the third site visit. The site showed a positive trend status with regard to the checklist. Signs controlling speed was found on all three occasions. No general notice board was found during the study period, and a horizontal trend status was accorded in this respect.

5.3.5 Waste deposition

On the Klerksdorp landfill site waste was deposited in trenches (Figure 18) during the first and second site visits. On the third site visit waste was being deposited at random (Figure 19) on site. This established a negative trend in this regard, and a non-compliance with the checklist. Compaction of waste was in progress on all occasions, but the site lacked sufficient working machinery for compaction to be done effectively. It was evident from all the site visits and from the amount of litter in the immediate environment of the landfill site, that compaction of waste did not occur on a daily basis. Some evidence of building rubble and used oilcans were identified during all the site visits. As some building rubble is allowed on the landfill site, marginal compliance to the checklist was noted. Tyres were found outside the fence of the Klerksdorp landfill site during the last site visit, which rendered it non-compliant to the checklist with a negative trend status in this regard.

During the first two Klerksdorp site visits it could not be established whether the landfill site possessed a workable wet weather cell. During the last site visit it was evident that the site did not have a wet weather cell to which waste could be transported with minimum inconvenience. This established a negative trend regarding this aspect. Only during the last site visit were fires detected on the landfill site, which led to non-compliance with the checklist and a negative trend status.

Neither the Orkney nor the Stilfontein landfill sites had either trenches or cells in which waste could be deposited. Compaction of waste on the Orkney landfill site was observed on occasion, but this was not done effectively, therefore it received marginal compliance to the checklist, with a horizontal trend status. The compaction of waste on the Stilfontein site did not comply with the checklist on

any occasion, and non-compliance with a horizontal trend status was noted (Figure 20). The covering of waste at both these landfill sites was non-compliant

FIGURE 18 KLERKSDORP LANDFILL SITE – 2000 – Waste deposition – trenches on site

(Figures 21 & 22) to the checklist with a horizontal trend status over the study period.

Both these sites showed marginal compliance with the checklist with regard to the composition of the waste stream. This is due to the fact that some building rubble was found at both sites during the first two site visits. A rise in the amount

FIGURE 19 KLERKSDORP LANDFILL SITE – 2001 – Waste deposition – no trenches or cells used, waste not covered daily, hazardous waste received, uncontrolled fires on site

FIGURE 20 STILFONTEIN LANDFILL SITE – 2001 – Waste deposition – NO trenches or cells used for deposition, waste not covered on daily basis, fires not controlled

FIGURE 21 ORKNEY – 2000 – Waste deposition – no trenches or cells used, no waste compaction

FIGURE 22 ORKNEY LANDFILL SITE – 2001 – Waste deposition – General waste & building rubble on site

of building rubble was evident, as well as the presence of some hazardous waste on the Orkney landfill site. This led to non-compliance to the checklist on the last site visit and a negative trend status. The Stilfontein site didn't show any progression or regression in this regard on the last site visit and a horizontal trend status was established. On the first and second site visit it could not be established whether these sites had wet weather waste deposition cells and was so noted. On the last site visit during wet weather conditions a wet weather waste deposition cell, with easy access to the working face could not be identified. This established a negative trend with regard to the use of a wet weather waste deposition cell. On the first and second site visits fires were detected on both these landfill sites, and non-compliance to the checklist was noted. On the last site visit neither of these sites showed any signs of fires. The fact that no fires were detected could have been due to the wet weather conditions, a positive trend status was noted despite this fact.

5.3.6 Drainage

Drainage forms a part of operational aspects, which should also be considered when deciding to continue a landfill operation.

None of the three sites had drains or cut-off berms in place to divert water away from the waste sites (Figure 23). Upslope run-off was not diverted away from the sites, and no evidence of containment of contaminated water was found on any of the sites within the study area. As there were no drains, no maintenance is possible, and it is very clear from the visits that the maintenance of covered areas is falling behind in both the Klerksdorp and Orkney sites. This results in a negative trend as far as this variable is concerned. None of the sites showed any improvement with regard to the aspect of drainage over the study period, and therefore a horizontal trend status was established for all the sites.

FIGURE 23 STILFONTEIN LANDFILL SITE – 2001 – Drainage – runoff water not diverted from the site

5.3.7 Litter

None of the sites in the study area showed evidence of containment of litter within the site boundaries. Windblown litter was found at all the sites as far away as three kilometres from the landfill site. This ensured non-compliance to the checklist for all the sites during all three the site visits, and resulted in a horizontal trend status in this regard. Figures 24 & 25).

FIGURE 24 KLERKSDORP LANDFILL SITE – 2001 – Litter control – windblown litter not contained within site or picked up on daily basis

FIGURE 25 ORKNEY LANDFILL SITE – 2001 – Litter control – litter not contained within the site, windblown litter not picked up on daily basis

5.3.8 Monitoring 

Monitoring, as part of the operational aspects associated with landfill sites represents a means of control, and the DWAF does not have clearly defined requirements in this regard.

There were only two types of monitoring in the study area.

The Klerksdorp site had both gate monitoring and volume surveys. Gate monitoring ensures that records are kept of all waste entering the landfill site. Volume surveys are conducted to verify and qualify the status of the site and quantify the remaining volumetric capacity.

No other form of "in-house" monitoring was evident on any of the landfill sites in the study area for the duration of the study.

5.4 Apply for closure 

The DWAF instructed the operators of the Potchefstroom landfill site to close the present site during 1996. Due to various reasons this instruction will only be implemented during 2002. The new site at the Hartebeesvlakte terrain will in all likelihood be operative by April 2002. A consultant will be appointed within the immediate future, to rehabilitate the landfill site in order to meet the closure requirements as stipulated in the site's permit (De Villiers, 2002).

5.5 Investigate  

An investigation into the study area was conducted. Investigation is part of both legs of the landfill process (see Figure 2: closure and continued operation) and all four landfill sites will be discussed in this section (see also Chapter 2).

5.5.1 Geohydrology

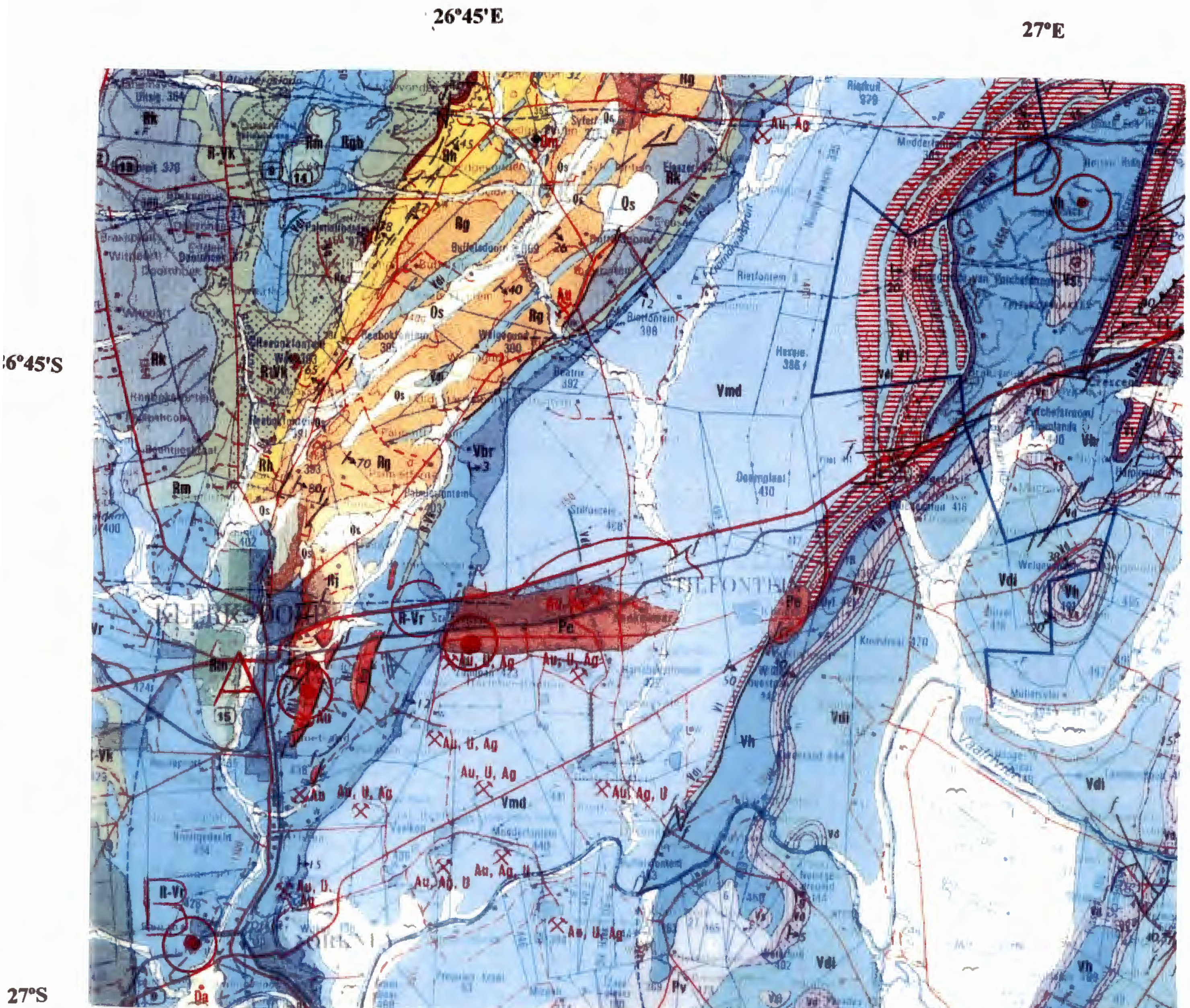

The Geology of the study area concerned consists mainly of rocks of the Witwatersrand and Ventersdorp Supergroups and the Transvaal Sequence. The Klerksdorp landfill site is located on rocks of the former Supergroup, while Potchefstroom and Stilfontein are situated on the latter Sequence. The Orkney landfill site is located on rocks of the Ventersdorp Supergroup. The Orkney landfill site is located on rocks of the Ventersdorp Supergroup (See Figure 7)

In Klerksdorp the underlying geology consists of the Klerksdorp Formation (mainly quartzite), which is part of the Turffontein Subgroup of the Central Rand group (Kent, 1980: Fig 3.2.3).

Andesitic lavas of the Ventersdorp Supergroup underlie the Orkney landfill site (Kent, 1980: Fig 3.3.1). The Transvaal Sequence's Chuniespoort Group underlies the sites at Stilfontein and Potchefstroom. The Stilfontein site was excavated in an old sinkhole in the dolomite that was filled with Dwyka tillite (Karoo Sequence) (Kent, 1980: Fig 4.1.4). The site was used (as in the past) as a source of clay for a brick manufacturer.

The Potchefstroom landfill site, which is also located in a series of old quarries, stretches over a distance of approximately 1500m. These quarries were used to obtain material for road building and other purposes. The rocks underlying this site are comprised of a chert ridge, which is part of the dolomite formations of the Malmani Subgroup.

The Klerksdorp site is the optimal site as far as the geology is concerned. This is due to the fact that the underlying quartzites are ideally suited to prevent infiltration of water and or leachate.



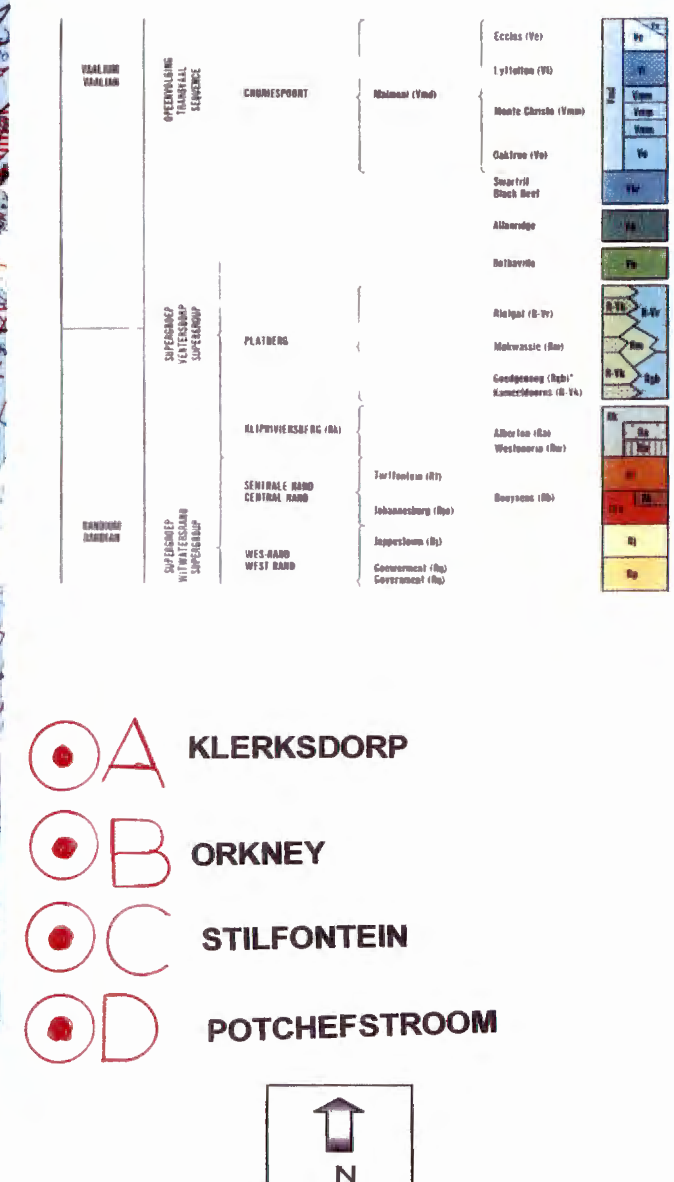


FIGURE 26 GEOLOGY OF THE STUDY AREA
SOURCE: (RSA, 1986)

SCALE: 1:250 000

The Orkney site may cause problems due to the fact that highly weathered andisitic lava tends to be susceptible to water infiltration, this may cause problems for the underground water. However, if the lava is unweathered it is usually impermeable and therefore suited for this purpose. As no borehole information is available at present, no final conclusions can be drawn as far as this site is concerned.

The lithology of the Potchefstroom site is problematic, and the likelihood of water infiltrating into the groundwater is probable. The Stilfontein site on the other hand, although situated on dolomite, is much more favourable. This is due to the fact that there is still a layer of highly impermeable Dwyka materials that remained after the excavations. The likelihood of pollution of the groundwater in this case is very small. From a study conducted by the DWAF on the leachate generated by the landfill sites within the jurisdiction of the SDM, it was found that the Stilfontein site shows no leachate from the landfill site to the groundwater. This can be attributed to this impermeable clay layer.

5.5.2 Topography  

The four sites investigated are all situated on the area generally described as the Pre-Karoo Highveld of South Africa (Wellington, 1955:Figure 7). This area is characterised by the underlying rocks of Pre-Cambrian age, as described in the section on geology.

The Western boundary of the Klerksdorp site is situated on the crest of a homoclinal ridge that dips towards the east. The original slopes gently sloped towards the east with gradients in the order of between 2% – 6%. These gradients were obtained from measurements from the topographic map of the area. The original maximum vertical difference in local relief is in the order of between 6m to 7m over the total area covered by the site.

The Orkney site is located on an east facing gentle slope. The gradient at the site itself is approximately 2%, while the slope adjacent to the site (towards the Schoonspruit) is in the order of 5%. The local vertical difference in relief on the site itself is 3m at maximum.

As far as the Stilfontein site is concerned no original relief is discernable due to the fact that the site is located in an old quarry.

The quarry, however, was originally located on a very gently undulating landscape with no prominent features.

The Potchefstroom site is situated on the most complex landscape of all the sites investigated. The site is situated on a general west-, to northwest facing slope. The original gradient of the slopes was in general in excess of 10 %. The maximum vertical difference in local relief is in the order of between 5m and 10 m.

5.5.3 Climate

This section will be discussed with reference to the Potchefstroom weather station. The climate within the study area is typical of the South African Highveld, with a summer maximum rainfall and a dry winter (De Villiers (b), 2001:18).

5.5.3.1 Rainfall

The average rainfall within the study area ranges between 600 and 650mm per year. The variability of annual precipitation is fairly high as the maximum and

minimum-recorded figures indicate. The absolute yearly maximums recorded are all in the order of 1000mm, while the minimums are all in excess of 360mm. Potchefstroom experiences on average 73,2 days per year with thunderstorms. This will obviously cause a high incidence of lightning strikes in the area. Hail occurs on average within the study area on approximately 3.3 days per year (South Africa, 1988:50).

5.5.3.2 Temperature

The average maximum and minimum temperatures for a specific month all occur either in January or in June, and vary between 25°C and 29,1°C (maximum), while the average daily minimum is approximately 9°C. The actual extreme daily maximum for this region was recorded during a January day in Potchefstroom, and reached 39,2°C (De Villiers(b), 2001:19).

5.5.3.3 Wind

The average wind direction for the study area is predominantly from the northern sector. During the summer months the wind displays a more easterly component, while the early spring months have a more westerly component. Wind speed is generally fairly moderate. The early spring wind speeds are however in general much stronger (South Africa, 1960: Table 3). High wind speed is often associated with thunderstorm activity, while high wind speed is also sometimes associated with whirlwinds.

5.5.4 Soils

The soil of the Klerksdorp site is mainly sandy, although capping material obtained off-site contains approximately 30% clay. The soil, although permeable, will in all probability not cause any problems as far as groundwater is concerned

due to the underlying geology (See Par. 5.5.1). In undisturbed areas adjacent to the landfill site, Mispah soils were encountered.

The soils at the Orkney site are generally considered to be Shortlands (Macvicar, 1991:188,142). The clay content of the B-horizon is such that a structured soil profile developed. Under normal circumstances this type of soil will inhibit water and leachate penetration. This is conducive to the prevention of groundwater pollution.

In the case of the Stilfontein landfill site, no true soil remains due to the fact that it was excavated during the quarrying process.

A similar situation exists in the case of Potchefstoom but, due to the nature of the landfill site, certain areas that weren't quarried were also incorporated into the landfill. These soils can be considered as Glenrosa (Macvicar, 1991:186). Under normal circumstances infiltration through these types of soils is classified as 'Medium'.

5.5.5 Surface drainage

The Klerksdorp site is situated on the east-facing slope alongside a small non-perennial tributary of the Schoonspruit. Due to the highly disturbed nature of the site as well as the excavations on the eastern side of the site, it is highly unlikely that any overland flow will reach the stream.

The Orkney site is also situated on the east-facing slope approximately 300m from the Schoonspruit. Overland flow is highly likely to reach the spruit. The pollution potential can therefore be considered as likely.

The Potchefstroom landfill site is situated on a non-perennial tributary of the Mooi River and overland flow does occur as the site is primarily on the mid- and foot slope of a west-facing hill. The likelihood of water contamination through overland flow is thus fairly high (De Villiers, 2002).

5.5.6 Flora

The flora at all the landfill sites within the study area has inevitably been removed. The vegetation in the vicinity of the landfill sites is not unique. Similar types of flora can be encountered throughout this section of the province and adjacent provinces. In the Potchefstroom and Klerksdorp areas, the most common tree and shrub species still found in the vicinity include *Acacia caffra* (Common Hooked-thorn), *Acacia karroo* (Sweet thorn), *Ehretia rigida* (Puzzle bush), *Grewia flava* (Velvet raisin) and the *Grewia occidentalis* (Cross berry) (Palgrave, 1984: 233, 241, 803,570, 576). In the Orkney and Stilfontein areas mostly grasslands were encountered in the vicinity of the landfill sites. The grass in the study area was not considered, as it has been removed for the purpose of operation of the landfill sites, within the immediate vicinity. No listed red data species were encountered during site visits.

5.5.7 Fauna

The likelihood of the presence of larger mammals within the study area is doubtful, as the fauna living in the areas of the landfill sites are disturbed by the daily operation of the sites. No listed species were identified during site visits and only the fauna that may still be present will be discussed.

5.5.7.1 Mammals

Some small mammals that may occur within the study area include *Chrysocloridae* (moles), *Soricidae* (Shrews), *Macroscelididae* (Elephant shrews), the order *Chiroptera* (bats) and the families *Cricetidae* and *Muidae* (rats and

mice). *Gliridae* (dormouse) (Stuart, 1988:32,42,102-104,118). Some of the other small mammals which are likely to occur within the study area are mammals such as members of the *Leporidae* family (rabbits and hares) (Stuart, 1988:82,84).

5.5.7.2 Reptiles and amphibians

Snakes, lizards and amphibians occur in the area, but no formal record of these species is available for the study area.

5.5.7.3 Birds

A large variety of bird species occur in the study area. The larger bird species that are still found include some *Francolins, Numida* (Guineafowl), *Charadrius* and *Vanellus sp.* (Plovers), *Corvus* (Crow), *Pterocles* and *Columbo sp.*(Doves), although rather disturbed in the vicinity of the landfill sites (Sinclair et al,. 1993:138,292,214-218,160). The smaller bird species found include *Mirafra* and *Calandrella* (Larks) *Cisticola, Melaenornis* (Flycatcher), and *Sigelus* (Flycatchers), *Zosterops* (White eye), *Motacilla* (Wagtail), *Anthus* (Pipit), *Passer* (Sparrow) and *Euplectes* (Widow) (Sinclair et al. 1993:272-280,342-346,346,350,352-354,380). These smaller bird species are more common in the vicinity of the landfill sites. The presence of owls in these areas is unknown.

5.5.7.4 Insects

No checklists for insects for the area are available, but it is doubtful whether any endangered species of this life form occurs within the study area.

5.5.8 Air quality  

The generation of dust and smoke during operation of the landfill sites has been observed on all the sites. Westerly winds may cause unpleasant odours over the adjacent Kanana area (800m East of the Orkney landfill site).

The Klerksdorp and Stilfontein sites however pose little risk of odours within urban areas.

The Potchefstroom site may also cause some unpleasant smells over the neighbouring township.

5.5.9 Aesthetics  

As the eventual configuration of the site should blend in with the natural topography, the flora used in the rehabilitation of the landfill should blend in with the natural environment. None of the landfill sites in the study area comply with this requirement.

The Klerksdorp site is located approximately 2km from the nearest public road, and is not visible from public roads or urban areas.

The Orkney site is located within 300m of the R502 public road between Orkney and Leeudoringstad. It is also visible in the wintertime from the R30 between Klerksdorp and Bothaville – which is approximately three kilometres from the

landfill site. Some complaints have been lodged regarding the landfill site from concerned road-users (Pretorius, J, 2002). This site is also located within 800m of the Kanana Township, and is highly visible from all angles.

The Stilfontein site is also visible from the adjacent tarred road, but as it is not a provincial road it does not have as significant an impact as Orkney's landfill site. As the Stilfontein site is located inside the old clay quarry, the site is not as visible from the adjacent road.

The Potchefstroom landfill site is not visible from the provincial road, but is in close proximity of the Sarafina Township, which makes it aesthetically unacceptable for the neighbouring community.

5.6 Determine end-use and closure requirements 

The consultant appointed for rehabilitating the Potchefstroom landfill site, in conjunction with the DWAF, will determine the closure requirements for the Potchefstroom landfill site. This will be done in accordance with the Closure Report drawn up by the consultant. When the DWAF has approved the Closure Report, it can be implemented. The site will be rehabilitated so that it will meet the end-use requirements as determined in the end-use plan. The proposed end-use plan for this landfill site is an urban open space (DWAF, 1994:107-109; De Villiers, 2002).

5.7 Upgrade design 

In the case of operating sites, design upgrading or remedial design might be required. In such instances, the principles and Minimum Requirements for Waste Disposal by Landfill must be applied. (DWAF, 1994:70,107). It is evident from the investigation into the Klerksdorp, Orkney and Stilfontein landfill sites that

if any of these sites were to continue operation, an upgrade in design would be essential. After further investigation, a responsible person who must have qualifications and experience that are acceptable to the DWAF (DWAF, 1994:70) must upgrade the design. The site should be designed so that it can be operated in a cost-effective, environmentally acceptable way. The design should strive towards the minimisation of leachate pollution of the adjacent ground and surface water. Sufficient cover material should be available and applied to ensure that the site is environmentally and aesthetically acceptable.

5.8 Closure design 

The closure design usually entails remedial design and in some instances the existing designs may require significant upgrading. In all cases the DWAF must be consulted. As the Potchefstroom landfill site is not designed in accordance with the Minimum Requirements for Waste Disposal by Landfill, it will be necessary to assess appropriate closure measures. This will be necessary in order to comply with the relevant legal.

CHAPTER 6

CONCLUSSIONS AND RECOMMENDATIONS

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

As this study progressed the following objectives were achieved:

A literature study was conducted and the relevant legal aspects in South Africa enabling the assessment and determination of environmental impacts associated with the general aspects at landfill sites was discussed. The focus was on the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) with specific regard to the general aspects associated with landfill sites. The legislation that plays an important role in South Africa with regard to waste disposal by landfill was identified and the framework legislation discussed, with particular emphasis on pollution control legislation. From the framework legislation, sectoral legislation with specific reference to solid waste disposal by landfill was discussed in further detail. A brief overview of provincial and local legislation regarding solid waste disposal was also discussed as background. The legislation and environmental aspects discussed was used as the basis for the assessment of the selected landfill sites.

Environmental monitoring and auditing as environmental management tools were discussed. An environmental monitoring plan and an audit checklist were compiled in compliance with the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) and the impacts associated with the general aspects were assessed.

Environmental audits of the Klerksdorp, Orkney, Stilfontein and Potchefstroom waste sites were conducted at six-monthly intervals to comply with the predetermined environmental monitoring plan. The audit findings served to qualify environmental impacts associated with landfill sites within the framework

of the Minimum Requirements. From the audit results the trend statuses of the Klerksdorp, Orkney, Stilfontein and Potchefstroom landfill sites were determined with regard to compliance with the Minimum requirements. The findings served to identify the areas of non-compliance and the trend status indicated whether there was improvement or degradation of the landfill site with regard to previous audit findings.

Steps to be implemented at each site to obtain compliance with the relevant legislation will be discussed under the recommendations in paragraph 6.2.
It is evident from this study that the hypothesis has been proven correct, that the solid waste disposal sites of Klerksdorp, Orkney, Stilfontein and Potchefstroom do not comply with the relevant legislation in South Africa regarding SWD by landfill or with the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994) as put forward by the DWAF. To obtain compliance with the relevant legislation the following recommendations can be made for each site:

6.2 Recommendations

Within the study area, it is evident that the relevant environmental legislation regarding the landfill sites is not fully adhered to. This is clear from evidence such as the lack of compliance with the general aspects as described in the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1994). It is therefore recommended that the responsible personnel are made aware of the implications and the requirements of the relevant legislation.

It is recommended that the landfill sites should be audited as part of a monitoring plan to serve as an early warning system. This is an important tool for the successful management of landfill sites. Regular in-house audits should be undertaken at 6-monthly intervals at least. An independent audit should also be conducted bi-annually.

It is recommended that the checklist or an approximation of it, be used as a tool for monitoring, as it incorporates all the relevant general aspects associated with landfill sites.

All areas of non-compliance should be addressed as soon as identified.

6.3 Site specific recommendations

The Klerksdorp landfill site:

The following problems should be addressed:

- Repair the perimeter fence.
- With regard to signposting the following is recommended:
- Speed control signs should be posted on the landfill site
- A general notice board complying to legislation should be erected
- Waste deposition issues such as covering, compaction, type of waste received and wet weather cells should be addressed in order to comply with legislation.
- Operational aspects such as drainage systems should be implemented and managed according to the Minimum Requirements for Waste Disposal by Landfill.
- Litter control is imperative.
- The monitoring system necessary for compliance also needs to be addressed.

The Orkney landfill site:

Due to the state of this site and its locality as determined during the three audit occasions, it is clear that this site does not comply with critical aspects identified in the Minimum Requirements for Waste Disposal by Landfill. It is also clear that

the environmental aspects such as drainage, leachate and locality cannot be mitigated. This site is therefore not recommended to continue operation.

The Stilfontein landfill site:

At present this landfill site is very similar to the Orkney site with regard to compliance, however the physical aspects associated with this site mitigates most of the problems. With a minimum amount of effort the site can be licensed to continue to operate.

The Potchefstroom landfill site:

Closure of the site is imperative, end-use design and the related rehabilitation of the site should be undertaken.

6.4 Site specific general recommendations

- The new Potchefstroom landfill site that will come into operation in February 2003 has a life expectancy of thirty years. It is therefore recommended that this site should continue to serve the local community.

- A regional landfill site is recommended for the Klerksdorp, Orkney and Stilfontein area to serve all three communities. An economic feasibility study should be conducted to assess which location will be optimal for this purpose. If the budgets of the three landfill sites are consolidated in one landfill site, the infrastructure will be more likely to comply with the relevant legislation. With the implementation of local legislation, management of solid waste disposal can be implemented.
- The current waste management scenario is almost entirely one of waste disposal. It is important to ensure that all unavoidable wastes are safely collected, transported and disposed of at waste disposal facilities

developed and operated in accordance with the DWAF Minimum Requirements and/or other appropriate standards; salvaging at landfills must be phased out along with the incorporation of these communities into safer areas of waste management.

6.5 System specific general recommendations: Identification and Prioritisation of Needs

During this study, as well as during a study by the PU vir CHO (2002), the following general aspects with regard to the waste handling process within the jurisdiction of the Southern Districts Municipality were identified. The implementation thereof is prioritised in the following paragraphs.

The following strategic aspects need urgent attention:

- An integrated waste management and organisational structure for waste management in the SDM.
- Develop a strategy to institute waste minimisation and waste avoidance. Reward good performance through a program of incentives.
- An intensive exercise will be necessary to increase the awareness of the general public of the problems associated with all the aspects of the safe and environmentally acceptable way to handle waste. Education as well as capacity building will have to accomplish this.
- The way forward would be to ensure that minimization and recycling procedures and practices are adopted by all sectors of society as part of a broader initiative focusing on cleaner production.
- The following paragraphs address specific needs identified with regard to:

6.5.1 Waste disposal

- Manage and reduce waste picking at landfill sites, phase out informal salvaging completely in the long term.
- Phase out illegal dumping through access control.
- Prevent the illegal dumping of hazardous materials as well as medical waste. Sewage sludge disposal at solid waste sites must also be phased out.
- Continued assessment of available landfill space at the present (and future) landfill sites. Timeous identification of additional suitable sites is imperative.
- Consider, and if necessary, implement the regionalisation of waste disposal sites.

6.5.2 Waste recycling

- Evaluate the pros and cons with regard to source separation versus mixed-waste collection for the different towns in the study area.
- Support the existing waste recycling initiatives.
- Encourage further recycling initiatives such as the instituting of collection systems for recyclable waste at source such as at commercial, institutional and industrial establishments.
- Establish waste recycling centers and possibly clubs.
- A further initiative that can reduce the amount of waste dumped is to organize drop-off and buy-back centers.
- Develop facilities for composting of organic waste.

6.5.3 Waste prevention and minimisation:

- Develop and implement appropriate incentives or legislation.
- Institute and maintain a database on waste generation and waste disposal to obtain additional waste data.
- Waste prevention and minimisation centers and clubs to be established.
- Waste collection and transportation:
- Institute measures to ensure that waste is collected in all areas not properly serviced at present.
- Determine optimal ways of waste collection in different towns.
- Determine possible alternative ways for waste collection (e.g. assess present systems and investigate different forms and degrees of privatisation as alternatives).

These measures will reduce the amount of waste dumped and therefore extend the life expectancy of the landfill site, with the added incentive of income generation from recycled materials.

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APPENDIX A

1. LEAD AUDITOR

- The lead auditor is responsible for ensuring the efficient and effective conduct and completion of the audit within the audit scope and plan approved by the client
- In addition other responsibilities covered by lead auditor should cover:

a) consulting with the client and auditee
b) Obtaining background information.
c) Determine whether requirements set in ISO 14001 has been met.
d) Forming an audit team.
e) Directing the activities.
f) Preparing the audit plan.
g) Communicating the final audit plan.
h) Coordinating the preparation.
i) Seeking to resolve any problems.
j) Recognizing when audit objectives become unattainable
k) Represent the audit team at meetings with the auditee.
l) Notify the auditee immediately of serious non-conformances.
m) Making recommendations for improvement

2. AUDITOR

Auditor responsibilities and activities should cover:

a) Following directions of and supporting the lead auditor.
b) Planning and carrying out the assigned task
c) Collecting and analysing evidence
d) Preparing working documents
e) Document individual findings
f) Safeguarding documents pertaining to the audit and returning such documents.
g) Assisting in writing the report.

3. CLIENT

Responsibilities and activities should cover:

a) Determining the need for an audit.
b) Contracting the auditee.
c) Defining the objectives of the scope.
d) Select the lead auditor, organisation
e) Providing appropriate authority and resources.
f) Consulting with the lead auditor.
g) Approving the EMS criteria.
h) Approving the audit plan.
i) Receiving the audit report and determining it's determination

4. AUDITEE

The responsibilities and activities of the auditee should include:

a) Informing employees
b) Providing the facilities
c) Appointing responsible staff to accompany the audit team
d) Providing access to the facilities
e) Cooperating with the audit team
f) Receiving a copy of the audit report

APPENDIX B

THE AUDIT CHECKLIST: Klerksdorp landfill site
For the three site visits

General Aspects:

Site security:	Dec 2000	Jul 2001	Dec 2001
Protection of facilities on site	Y	Y	Y
Illegal picking	Y	Y	Y
Illegal squatting	Y	Y	Y
Fencing	Y	N	N
Site access:			
Single entrance for vehicle access	Y	N	N
Controlled entrance for vehicle access	Y	Y	Y
Lockable gate, managed during operating hours	Y	Y	Y
Area in use fenced	N	N	N
Additional after hours security	Y	Y	Y
Site boundaries clearly demarcated	Y	Y	Y
Condition of roads and traffic control:			
Access roads to the site maintained for vehicles to use the landfill facility	Y	Y	Y
On-site roads maintained to ensure waste can reach the working face with minimum inconvenience in all weather conditions	Y	Y	Y
Two way traffic possible in all weather conditions	Y	Y	Y
Unsurfaced roads regularly graded	Y	Y	Y
Unsurfaced roads regularly watered to control dust	N	N	N
No mud from site tracked to public roads	Y	Y	Y
Signposting:			
Signs in all appropriate official languages in vicinity of landfill	Y	Y	Y
Signs to control vehicles	Y	Y	Y
Signs to control speed on roads to site	Y	Y	Y
Signs to control speed on site	N	N	N
General notice board at entrance with name, address, telephone numbers of the responsible person, operating hours, tariffs, class of landfill site and types of waste accepted	Y	Y	N
Waste deposition:			
Either trenches or cells used for waste deposition	Y	Y	N
Compaction of waste	M	M	M
Covering of waste on a daily basis	N	N	N
Only general waste received	N	N	N
Wet weather cell to handle one week's waste	N	N	N
Fires controlled on landfill site	Y	Y	N

Operational Aspects

Drainage:			
Upslope run-off water diverted away from waste	N	N	N
Contaminated water contained	N	N	N
Run-off storm water diverted round the sides of waste body through berms of cut-off drains	N	N	N
Basis of trenches or cells designed to drain water away and contaminated water drained to be stored in a sump or retention dam	N	N	N
Drains maintained and not blocked by silt or vegetation	N	N	N
Covered areas maintained to promote run-off without excessive erosion	N	N	N
Littering control:			
All litter contained within the site	N	N	N

Windblown litter picked up on a daily basis from fences and vegetation	N	N	N

Monitoring

Gate monitoring	Y	Y	Y
Weighbridge monitoring	N	N	N
Water quality and leachate monitoring	N	N	N
Gas monitoring	N	N	N
Monitoring on rehabilitated areas	N	N	N
Volume surveys	Y	Y	Y

LEGEND:

Compliance	Y
Marginal Compliance	M
Non-Compliance	N
No information	?

THE AUDIT CHECKLIST: Orkney landfill site
For the three site visits

General Aspects:

Site security:	Dec 2000	Jul 2001	Dec 2001
Protection of facilities on site	N	N	N
Illegal picking	N	N	N
Illegal squatting	N	N	N
Fencing	N	N	N
Site access:			
Single entrance for vehicle access	Y	Y	Y
Controlled entrance for vehicle access	N	N	N
Lockable gate, managed during operating hours	N	N	N
Area in use fenced	N	N	N
Additional after hours security	N	N	N
Site boundaries clearly demarcated	N	N	N
Condition of roads and traffic control:			
Access roads to the site maintained for vehicles to use the landfill facility	Y	Y	N
On-site roads maintained to ensure waste can reach the working face with minimum inconvenience in all weather conditions	Y	Y	N
Two way traffic possible in all weather conditions	Y	Y	N
Unsurfaced roads regularly graded	Y	Y	N
Unsurfaced roads regularly watered to control dust	N	N	N
No mud from site tracked to public roads	Y	Y	Y
Signposting:			
Signs in all appropriate official languages in vicinity of landfill	N	N	N
Signs to control vehicles	N	N	N
Signs to control speed on roads to site	N	N	N
Signs to control speed on site	N	N	N
General notice board at entrance with name, address, telephone numbers of the responsible person, operating hours, tariffs, class of landfill site and types of waste accepted	N	N	N
Waste deposition:			
Either trenches or cells used for waste deposition	N	N	N
Compaction of waste	M	N	N
Covering of waste on a daily basis	N	N	N
Only general waste received	N	N	N
Wet weather cell to handle one week's waste	N	N	N
Fires controlled on landfill site	N	N	N

Operational Aspects

Drainage:			
Upslope run-off water diverted away from waste	N	N	N
Contaminated water contained	N	N	N
Run-off storm water diverted round the sides of waste body through berms of cut-off drains	N	N	N
Basis of trenches or cells designed to drain water away and contaminated water drained to be stored in a sump or retention dam	N	N	N
Drains maintained and not blocked by silt or vegetation	N	N	N
Covered areas maintained to promote run-off without excessive erosion	N	N	N
Littering control:			
All litter contained within the site	N	N	N

Windblown litter picked up on a daily basis from fences and vegetation	N	N	N

Monitoring

Gate monitoring	N	N	N
Weighbridge monitoring	N	N	N
Water quality and leachate monitoring	N	N	N
Gas monitoring	N	N	N
Monitoring on rehabilitated areas	N	N	N
Volume surveys	N	N	N

LEGEND:

Compliance	Y
Marginal Compliance	M
Non-Compliance	N
No information	?

THE AUDIT CHECKLIST: Stilfontein landfill site
For the three site visits

General Aspects:

Site security:	Dec 2000	Jul 2001	Dec 2001
Protection of facilities on site	N	N	N
Illegal picking	N	N	N
Illegal squatting	N	N	N
Fencing	N	N	N
Site access:			
Single entrance for vehicle access	Y	Y	Y
Controlled entrance for vehicle access	N	N	N
Lockable gate, managed during operating hours	N	N	N
Area in use fenced	N	N	N
Additional after hours security	N	N	N
Site boundaries clearly demarcated	N	N	Y
Condition of roads and traffic control:			
Access roads to the site maintained for vehicles to use the landfill facility	Y	Y	Y
On-site roads maintained to ensure waste can reach the working face with minimum inconvenience in all weather conditions	Y	Y	Y
Two way traffic possible in all weather conditions	Y	Y	Y
Unsurfaced roads regularly graded	Y	Y	Y
Unsurfaced roads regularly watered to control dust	N	N	N
No mud from site tracked to public roads	Y	Y	N
Signposting:			
Signs in all appropriate official languages in vicinity of landfill	Y	Y	Y
Signs to control vehicles	N	N	Y
Signs to control speed on roads to site	Y	Y	Y
Signs to control speed on site	Y	Y	Y
General notice board at entrance with name, address, telephone numbers of the responsible person, operating hours, tariffs, class of landfill site and types of waste accepted	N	N	N
Waste deposition:			
Either trenches or cells used for waste deposition	N	N	N
Compaction of waste	M	N	N
Covering of waste on a daily basis	N	N	N
Only general waste received	N	N	N
Wet weather cell to handle one week's waste	N	N	N
Fires controlled on landfill site	N	N	N

Operational Aspects

Drainage:			
Upslope run-off water diverted away from waste	N	N	N
Contaminated water contained	N	N	N
Run-off storm water diverted round the sides of waste body through berms of cut-off drains	N	N	N
Basis of trenches or cells designed to drain water away and contaminated water drained to be stored in a sump or retention dam	N	N	N
Drains maintained and not blocked by silt or vegetation	N	N	N
Covered areas maintained to promote run-off without excessive erosion	N	N	N
Littering control:			
All litter contained within the site	N	N	N

Windblown litter picked up on a daily basis from fences and vegetation	N	N	N

Monitoring

Gate monitoring	N	N	N
Weighbridge monitoring	N	N	N
Water quality and leachate monitoring	N	N	N
Gas monitoring	N	N	N
Monitoring on rehabilitated areas	N	N	N
Volume surveys	N	N	N

LEGEND:

Compliance	Y
Marginal Compliance	M
Non-Compliance	N
No information	?

APPENDIX C

TREND STATUS: Klerksdorp landfill site

General Aspects:

Site security:	Visit 1-2	Visit 2-3
Protection of facilities on site	H	H
Illegal picking	H	H
Illegal squatting	H	H
Fencing	N	N
Site access:		
Single entrance for vehicle access	N	N
Controlled entrance for vehicle access	H	H
Lockable gate, managed during operating hours	H	H
Area in use fenced	N	H
Additional after hours security	H	H
Site boundaries clearly demarcated	H	H
Condition of roads and traffic control:		
Access roads to the site maintained for vehicles to use the landfill facility	H	H
On-site roads maintained to ensure waste can reach the working face with minimum inconvenience in all weather conditions	H	H
Two way traffic possible in all weather conditions	H	H
Unsurfaced roads regularly graded to control dust	H	H
Unsurfaced roads regularly watered to control dust	N	N
No mud from site tracked to public roads	H	H
Signposting:		
Signs in all appropriate official languages in vicinity of landfill	H	H
Signs to control vehicles	H	H
Signs to control speed on the road to site	H	H
Signs to control speed on site	H	H
General notice board at entrance with name, address, telephone numbers of the responsible person, operating hours, tariffs, class of landfill site and types of waste accepted	H	N
Waste deposition:		
Either trenches or cells used for waste deposition	H	N
Compaction of waste	H	H
Covering of waste on a daily basis	H	H
Only general waste received	H	N
Wet weather cell to handle one week's waste	N	N
Fires controlled on landfill site	N	N

Operational Aspects

Drainage:		
Upslope run-off water diverted away from waste	H	H
Contaminated water contained	H	H
Run-off storm water diverted round the sides of waste body through berms of cut-off drains	H	H
Basis of trenches or cells designed to drain water away and contaminated water drained to be stored in a sump or retention dam	H	H
Drains maintained and not blocked by silt or vegetation	H	H
Covered areas maintained to promote run-off without excessive erosion	N	N
Littering control:		
All litter contained within the site	H	H
Windblown litter picked up on a daily basis from fences and vegetation	H	H

Monitoring

Gate monitoring	H	H
Weighbridge monitoring	H	H
Water quality and leachate monitoring	H	H
Gas monitoring	H	H
Monitoring on rehabilitated areas	H	H
Volume surveys	H	H

LEGEND:

Positive trend status	P
Horizontal trend status	H
Negative trend status	N

TREND STATUS: Orkney landfill site

General Aspects:

Site security:	Visit1-2	Visit 2-3
Protection of facilities on site	H	H
Illegal picking	H	H
Illegal squatting	H	H
Fencing	H	H
Site access:		
Single entrance for vehicle access	H	H
Controlled entrance for vehicle access	H	H
Lockable gate, managed during operating hours	H	H
Area in use fenced	H	H
Additional after hours security	H	H
Site boundaries clearly demarcated	H	H
Condition of roads and traffic control:		
Access roads to the site maintained for vehicles to use the landfill facility	H	H
On-site roads maintained to ensure waste can reach the working face with minimum inconvenience in all weather conditions	H	N
Two way traffic possible in all weather conditions	H	N
Unsurfaced roads regularly graded to control dust	H	N
Unsurfaced roads regularly watered to control dust	N	N
No mud from site tracked to public roads	H	H
Signposting:		
Signs in all appropriate official languages in vicinity of landfill	H	H
Signs to control vehicles	H	H
Signs to control speed on the road to site	H	H
Signs to control speed on site	H	H
General notice board at entrance with name, address, telephone numbers of the responsible person, operating hours, tariffs, class of landfill site and types of waste accepted	H	H
Waste deposition:		
Either trenches or cells used for waste deposition	H	H
Compaction of waste	H	H
Covering of waste on a daily basis	H	H
Only general waste received	H	H
Wet weather cell to handle one week's waste	H	H
Fires controlled on landfill site	H	P

Operational Aspects

Drainage:		
Upslope run-off water diverted away from waste	H	H
Contaminated water contained	H	H
Run-off storm water diverted round the sides of waste body through berms of cut-off drains	H	H
Basis of trenches or cells designed to drain water away and contaminated water drained to be stored in a sump or retention dam	H	H
Drains maintained and not blocked by silt or vegetation	H	H
Covered areas maintained to promote run-off without excessive erosion	H	H
Littering control:		
All litter contained within the site	H	H
Windblown litter picked up on a daily basis from fences and vegetation	H	H

Monitoring

Gate monitoring	H	H
Weighbridge monitoring	H	H
Water quality and leachate monitoring	H	H
Gas monitoring	H	H
Monitoring on rehabilitated areas	H	H
Volume surveys	H	H

LEGEND:

Positive trend status	P
Horizontal trend status	H
Negative trend status	N

TREND STATUS: Stilfontein landfill site

General Aspects:

Site security:	Visit1-2	Visit 2-3
Protection of facilities on site	H	H
Illegal picking	H	H
Illegal squatting	H	H
Fencing	H	H
Site access:		
Single entrance for vehicle access	H	H
Controlled entrance for vehicle access	H	H
Lockable gate, managed during operating hours	H	H
Area in use fenced	H	H
Additional after hours security	H	H
Site boundaries clearly demarcated	H	P
Condition of roads and traffic control:		
Access roads to the site maintained for vehicles to use the landfill facility	H	H
On-site roads maintained to ensure waste can reach the working face with minimum inconvenience in all weather conditions	H	H
Two way traffic possible in all weather conditions	H	H
Unsurfaced roads regularly graded to control dust	H	H
Unsurfaced roads regularly watered to control dust	H	H
No mud from site tracked to public roads	H	N
Signposting:		
Signs in all appropriate official languages in vicinity of landfill	H	H
Signs to control vehicles	H	P
Signs to control speed on the road to site	H	H
Signs to control speed on site	H	H
General notice board at entrance with name, address, telephone numbers of the responsible person, operating hours, tariffs, class of landfill site and types of waste accepted	H	H
Waste deposition:		
Either trenches or cells used for waste deposition	H	H
Compaction of waste	H	H
Covering of waste on a daily basis	H	H
Only general waste received	H	N
Wet weather cell to handle one week's waste	H	H
Fires controlled on landfill site	H	P

Operational Aspects

Drainage:		
Upslope run-off water diverted away from waste	H	H
Contaminated water contained	H	H
Run-off storm water diverted round the sides of waste body through berms of cut-off drains	H	H
Basis of trenches or cells designed to drain water away and contaminated water drained to be stored in a sump or retention dam	H	H
Drains maintained and not blocked by silt or vegetation	H	H
Covered areas maintained to promote run-off without excessive erosion	H	H
Littering control:		
All litter contained within the site	H	H
Windblown litter picked up on a daily basis from fences and vegetation	H	H

Monitoring

Gate monitoring	H	H
Weighbridge monitoring	H	H
Water quality and leachate monitoring	H	H
Gas monitoring	H	H
Monitoring on rehabilitated areas	H	H
Volume surveys	H	H

LEGEND:

Positive trend status	P
Horizontal trend status	H
Negative trend status	N