AN INQUIRY AS TO WHETHER THE OPERATIONAL ACTIVITIES AT SOSHANGUVE LANDFILL SITE COMPLY WITH THE STANDARDS LAID DOWN IN THE DOCUMENT ENTITLED "MINIMUM REQUIREMENTS FOR WASTE DISPOSAL BY LANDFILL" - DEPARTMENT OF WATER AFFAIRS AND FORESTRY

by

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DEDICATED TO MY LOVELY DAUGHTER

KAMOGELO

LIST OF ABRIVIATIONS

AIDS	Acquired Immunodeficiency Syndrome
ANC	African National Congress
BPEO	Best Practicable Environmentally acceptable Option
Ca	Calcium
Cl	Chloride
CSIR	Council for Scientific and Industrial Research
df	degree of freedom
DWA & F	Department of Water Affairs & Forestry
EC	Electrical conductivity
EC	Environmental Committee
EHOs	Environmental Health Officers
GMB-	General, Medium, less significant leachate production
IEM	Integrated Environmental Management
ISWA	International Solid Waste Association
K	Potassium
LFG	Landfill gas
Mg	Magnessium
Na	Sodium
NO_2^-N	Nitrate nitrogen
NO_3 & NO_2^-N	Nitrate & nitrite nitrogen

NPMSS	Northern Pretoria Metropolitan Substructure
PPC	Personal protective clothing
RDP	Reconstruction and Development Programme
SO_4	Sulphate
Ta	Total alkalinity
TDS	Total Dissolved Solids
TWQR	Target Water Quality Range
UK	United Kingdom
UNCED	United Nations Conference on Environment Protection and Development
USA	United States of America

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EXECUTIVE SUMMARY

A cross sectional study was conducted at the Soshanguve landfill site north of Pretoria between June and December 1999. The site is classified as a General, Medium and Less significant leachate producing disposal site (GMB-). The site is situated in close proximity to informal settlement area. Such proximity could cause the landfill site to pose potential public health threats to the residents in the settlements as they are likely to go and scavenge, or salvage disposed waste materials. In addition, stray animals found in the area could be in danger if the operations at the landfill site were not to conform to the minimum requirements for waste disposal as laid down by the Department of Water Affairs and Forestry. The landfill site may not look good to the residents and passers-by due to litter scattered all over the site and beyond the boundaries.

The study was conducted to promote better management of waste through proper disposal and operational activities that meet the standards set in the minimum requirements document, in order to prevent and control negative impact of waste disposal on the environment and health of Soshanguve residents.

The primary objective of the study was to establish whether the operational activities at the landfill site were conforming to the minimum requirements for waste disposal provided for by the Department of Water Affairs and Forestry based on its size and classification.

Data were collected using qualitative and quantitative research methods. In-depth interviews were conducted with the managers responsible for waste management at the NPMSS and workers based at the landfill site. Review of records was done to determine the type and amount of waste that was disposed of at the site during 1998 and 1999. Review of records showed that waste material disposed of at the Soshanguve landfill site comprised of household waste, rubble, building rubble and garden refuse. Household waste formed the bulk of waste and its disposal increased significantly from January 1998 to November 1999 ($t=2.60$, $df=21$, $p<0.02$, $CI=401.0 - 879.8$). Other waste disposed of showed a decreasing trend over the two year period.

Efficiency of compacting the waste was tested by sampling nearby stream and ponds on-site. Chemical testing of water was done by the CSIR. Operations at the site were observed. Infrastructural requirements such as toilet facilities, drinking water and fencing were also observed by the researcher. Observations showed a lack in these requirements. As a result of poor fencing, there was no controlled access into the site and the site was accessed by informal salvagers, scavengers, and stray animals. Reports of the disposal of hazardous chemical materials on the site were received and used disposable nappies were observed on-site. Machinery for waste disposal was insufficient and at times, it would breakdown resulting into waste not covered and compacted for more than a week. The situation led to the presence of flies, rodents and emission of foul smell that could have serious health impact and cause major discomfort in the surrounding communities.

The situation may further prohibit sustainable land-use, as the area may be damaged beyond rehabilitation. Indirect method of measuring waste observed could lead to overestimation of the amount of waste disposed of at the landfill site.

There was generally poor management of waste at Soshanguve landfill site which could be attributed to insufficient machinery. Better efforts in managing the Soshanguve landfill site are needed as the current operations at the site could have major public health implications to the environment and the surrounding communities. Sufficient resources should be provided to ensure sound waste disposal. Waste disposal site management committee should be established and local communities should form part of the committee to ensure objective, informed and acceptable decision-making. Interventions to promote awareness about waste disposal and management, amongst the communities need to be put in place.

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CHAPTER 1

INTRODUCTION

1.1 Background

Waste has been a by-product of society since time immemorial. Today, the major sources of waste world wide are domestic, industrial, mining and power generation (Gibson, 1993). South Africa's "throw-away-society" generates ever-increasing quantities of domestic, commercial and industrial waste, which is estimated at millions of tons per year. The average South African citizen produces 400 kg of domestic waste per year (Gibson, 1993).

Some of the domestic waste that is generated includes cleaning materials, paints, fuels, and other chemicals that are classified as hazardous. Hazardous waste is defined as waste which is flammable, corrosive, reactive or toxic (Gibson, 1993). The exact quantity of hazardous household waste produced in South Africa is unknown and in America, an annual production of 22 kg per person had been reported (Gibson, 1993).

All countries including South Africa's society, welcome industrial development because it produces jobs, products, services and taxes. All industries produce waste and some of it is hazardous (Gibson, 1993). If such waste is not properly managed, it can have negative impact on the environment and the society. Society has to learn to accept the balance between development occurring in any country and the impact on the environment that is likely to occur (Gibson, 1993).
This should encourage countries to learn to minimize the negative impact of development and try to deal with the potential negative outcome of such development processes through pollution prevention approach.

1.1.1 Pollution prevention

The South African government believes that Pollution prevention is one of the most effective means of protecting South Africa's people and environment as it eliminates costly and unnecessary waste and promotes sustainable development. Pollution prevention aims at reducing risks to human health and the environment by seeking to

eliminate the causes of pollution, rather than by treating the symptoms of pollution (Department of Environmental Affairs and Tourism, 1998(b)).

The implementation of pollution prevention focuses on environmental policy and regulation; efficient use and conservation of natural resources; re-use and recycling; integration of environmental concerns into land-use planning and urban development; household waste minimisation and recycling; life cycle analysis; partnerships; and awareness raising, capacity building and development of strategies and tools to enable people to follow sustainable lifestyles (Department of Environmental Affairs and Tourism, 1998(b)).

Pollution prevention is about expanding the range of options for environmental decision making. It also reflects an understanding of the shared responsibility of all sectors of society in protecting South Africa's natural resources and insists on sound waste management (Department of Environmental Affairs and Tourism, 1998(b)).

1.1.2 Sound waste management

Sound waste management starts with the selection of a suitable waste disposal site (Barbour, 1992). After having successfully established a landfill site, waste management companies come under increased public and official scrutiny because of the terribly unpleasant smell waste produces (Gibson, 1993). He believes that no matter how good the waste management strategy of the company could be, mistakes could be made. Spills would, at times occur and objectionable odours occasionally escape. Such situations would need strict operational procedures, regular auditing and comprehensive contingency plan to reduce the risks to a minimum acceptable level.

1.1.3 Community participation

Community participation forms part of the basis of sound waste management within the framework of an integrated environmental management approach. This gives a forum

where the views and concerns of the interested and affected parties are invited and valued so that informed decisions regarding the operation of the landfill sites could be made. This includes, among other things, establishment of waste disposal monitoring committees, waste management community liaising officers, landfill site rehabilitation teams and community waste management educators (Barbour, 1992).

In South Africa, the selection and approval of waste disposal site is based on the permit system administered by the Department of Water Affairs and Forestry. The introduction of this system is aimed at ensuring that waste disposal does not pose unacceptable risks to both public health and the environment. A prerequisite is that all landfill sites should be located, designed, constructed, operated, maintained and closed in a manner that ensures the protection of human health and the environment (Barbour, 1992).

An action plan and a blueprint for sustainable development, commonly known as Agenda 21, is one of the five documents adopted by more than 178 Governments at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992 (Department of Environmental Affairs and Tourism, 1998(a)). Agenda 21 stands as a blueprint for action in every area in which human activity impacts on the environment (Department of Environmental Affairs and Tourism, 1998(a)).

1.1.4 Sustainable development

Sustainable development refers to the development that will continue indefinitely, at current and projected levels, without depleting the social, cultural and natural resources required to meet present and future needs (Department of Environmental Affairs and Tourism, 1998(b)). It requires that consideration be given to the disturbance of the ecosystem and loss of biological diversity; pollution and degradation of the environment; negative impacts on the environment and on people's environmental rights to ensure that they are avoided and prevented or, where they cannot be altogether avoided, are minimised and remedied (Department of Environmental Affairs and Tourism, 1998(c)).

It requires that waste should be re-used or recycled where possible and otherwise disposed of in a responsible manner. It further requires that a risk-averse and cautious approach that takes into account the limits of current knowledge about the consequences of decisions and actions be applied. The development, use and exploitation of renewable resources and the ecosystems which these resources are part of, should not exceed the level beyond which their integrity is jeopardised (Department of Environmental Affairs and Tourism, 1998(c)).

Theron (1993) describes sustainable development as implying enrichment of environmental considerations in economic policy-making and a continual use of resources. It expresses concerns that an environment should be conserved in some way for the use and enjoyment of present as well as future generations. This is evident in the Reconstruction and Development Programme (RDP).

1.1.5 The Reconstruction and development programme (RDP)

In 1994, the African National Congress (ANC), outlined RDP as an integrated and sustainable programme that brings together strategies to harness all the resources in a coherent and purposeful effort that can be sustained into the future.

RDP is an integrated, coherent socio-economic policy framework that seeks to mobilise all the citizens of the Republic of South Africa and its resources towards the final eradication of apartheid and the building of a democratic, non-racial and non-sexist future. It is a programme that is designed to be achievable, sustainable, and to meet the objectives of an improved standard of living and the quality of life for all South Africans within a peaceful and stable society (ANC, 1994).

RDP focuses on the people's most immediate needs and it gives the people the authority to lead the process of meeting identified needs thus ensuring active involvement and empowerment. It provides peace and security for all, through the establishment of security forces that uphold the constitution and respect human rights. It is designed to

link reconstruction and development, and looks at the impact that growth will impose on the environment. In addition, RDP deepens democracy by allowing interested and affected parties to participate in decision making process with a view to meeting their basic needs (ANC, 1994).

One of the basic needs identified in RDP is a clean and healthy environment. The programme aims to improve the quality of life of all South Africans by providing access to safe water and sanitation for all and to protect the environment by addressing the environmental issues in an integrated manner (ANC, 1994).

The RDP recognises the value of the environment and water, and advocates an economically, environmentally and politically sustainable approach to the management of the country's water resources and the collection, treatment and disposal of waste. It gives the local government the responsibility of waste removal at local level. It also gives the government the responsibility to ensure that all South Africans, present and future, have the right to a decent quality of life through sustainable use of resources, whereby the government must work towards safe and healthy living and working environments, and a participatory decision making process around environmental issues, and empowering the communities to manage their natural environment (ANC, 1994).

The RDP requires that environmental considerations be built into every decision making process. Development strategies are required to incorporate expected or anticipated environmental consequences in the course of the planning. Procedures which oblige decision-makers to demonstrate what environmental considerations they have thought of when planning projects, should be put in place. It also requires that the government must establish an effective environmental management system, and must establish strategies to monitor the industrial activities which impact negatively on the environment (ANC, 1994).

Some of the strategies include the development of a waste management system, which would put emphasis on pollution prevention and waste reduction through direct controls.

It increases the capacity of the constituencies and government to monitor and prevent the dumping of toxic wastes, to coordinate environmental education with education policy at all levels, empowers communities to act on environmental issues, and to promote environmental ethics. It also allows for the establishment of procedures, rights and duties to enable workers to monitor the effects of pollution, and dangerous practices, within the workplace, and its impact on the surrounding communities and environment (ANC, 1994). These measures also apply in waste removal services, which is the responsibility of the local government. The local government must manage waste in a responsible and holistic manner. This can only be achieved through a thorough understanding of the components of waste management.

1.1.6 Components of waste management

Waste management is divided into seven components namely, waste generation; storage; transfer (temporary waste storage at the transfer station); collection; transportation; processing (which includes re-use, recycling and treatment) and disposal (Fuggle & Rabie, 1992). Theron (1993) reported that South Africa is saddled with waste management problem of historic proportions and called for urgent introduction of an intervention strategy to control irresponsible practices around waste management that continued to exist in the Country. He believes that such intervention would be an integrated waste management approach.

Integrated waste management involves the "cradle-to-grave" principle approach, that requires the management of waste from its generation until its disposal (Theron, 1993). Integrated waste management involves four steps, namely, cleaner technology, whereby waste generators use processes that make least possible waste; resource recovery, whereby any waste material that can be used again is taken out of the main waste stream; compaction and treatment, whereby some waste materials are compacted to take less space and treated so that they become less harmful; sanitary landfill, whereby all remaining waste materials after the above steps are taken to a properly designed and operated landfill site (Department of Water Affairs & Forestry, 1998(a)).

The concept of integrated waste management is defined by the concept of sustainable development which was brought to the forefront by the Bruntland's report (1997) of the World-wide Commission on Environment and Development in which, it was declared that sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Theron, 1993).

1.2 Rationale for this study

In South Africa, increased activities that are directed to improving the country's economy, have led to rapid urbanisation and an increase in waste production. This has resulted in authorities having to ensure that stringent control measures to reduce the impacts of such activities on both human health and the environment are applied, as well as to promote greater awareness and implementation of policies that control negative impact of such activities. The legislative documents that address this issue are the Environment Conservation Act, No. 73 of 1989 and National Environmental Management Act, No. 107 of 1998. Coupled with other health intervention programmes, the impact of increased awareness on issues affecting health and environment has been illustrated through the latest media reports where concerns about illegal dumping of medical waste and its consequences, in open spaces at Elsies River and Mosselbay in the Western and Eastern Cape respectively, were raised.

This has led to recognition of a need to evaluate operations in South Africa's landfill sites. Following these reports and the objectives of the Minimum Requirements for waste disposal by landfill, this has led to recognition to establish sound waste management practices in the country in order to ensure planning and implementation of appropriate intervention programmes.

1.3 Aim of the study

The aim of this study is to promote better management of waste through proper disposal and operational activities that meet the standards set in the Minimum Requirements for Waste Disposal by landfill document, in order to prevent the negative impact of waste disposal on the environment and health of all South Africans.

1.4 Objectives

The study objectives consist of the primary and specific objectives.

1.4.1 Primary objective

The primary objective of the study is to establish whether the operational activities at Soshanguve Landfill conform to, and implement the minimum requirements as stipulated by the guidelines of the Department of Water Affairs and Forestry (DWA&F) based on its size and its classification.

1.4.2 Specific objectives

The specific objectives of this study are to establish whether: -

1. the landfill site has been registered.
2. the responsible person has been appointed to ensure proper control of waste disposal.
3. there is access control into the site (i.e., whether the area is properly fenced) so as to restrict entrance only to those who will be coming to dispose of waste acceptable at that landfill site.
4. cover material is readily available to ensure that waste is covered properly at the end of each day.
5. waste is covered on a daily basis to prevent and control nuisance or risk occurrence at the site.
6. waste compaction is done properly to maintain the stability of the area.

7. there are landfill monitoring systems in place, especially water quality monitoring system, to detect pollution timeously and to implement control measures.
8. workers are provided with the necessary protective clothing and whether they are using them.
9. there is a weighbridge on site to measure and record waste accurately.
10. there is nuisance control mechanism in place to discourage pests infestation, especially flies and rodents.

1.5 The study area and the waste disposal site

The study was conducted at a waste disposal site that is used by the Soshanguve community north of Pretoria. The total population of Soshanguve is approximately 703014 (Africon, 1998). The waste disposal site is situated approximately 40km north of Pretoria, north-east of Soshanguve, adjacent to the R318 road. The site is situated on the farm Rietgat 105JR. It is underlain by the granophyres of the Bushveld Igneous Complex (BKS & SKC, 1997).

The landfill is classified as a General Waste (G), Medium Size (M) landfill, and does not pose a threat for significant leachate generation (B-) (BKS & SKC, 1997).

The co-ordinates of the four corner parts of the waste disposal site are as follows:

(2 816 483 X, 89 868 Y)
(2 816 342 X, 89 587 Y)
(2 817 020 X, 89 600 Y)
(2 816 880 X, 89 319 Y) (BKS & SKS, 1997).

The eastern and the western boundaries are formed by the R318 road and a perennial stream which are approximately 400m and 500m away from the site respectively. The southern and the northern borders are formed by informal houses approximately one kilometre from the landfill site and include sections, S; KK; PP; GG; W; AND X of Soshanguve township.

The landfill site is approximately 9hactres in size (Appendix 3) (BKS & SKS, 1997).
The waste disposal site belongs to the Northern Pretoria Metropolitan Substructure (NPMSS) who also operates the site (BKS & SKS, 1997).
In proximity to the landfill, there is a reformatory school which is situated approximately one kilometer from the site. Some of the residents of the surrounding sections of Soshanguve township keep animals (e.g. goats, and cattle) in their yards which are not looked well after. As a result, these animals are always found wandering all over the entire area. These settlements lack public infrastructures like schools, shopping complexes and recreational facilities, and residents have to travel long distances to get services. Most of the residents are unemployed and illiterate.

1.6 Problem statement

Because of the close proximity of the landfill site to the informal settlements, the site can serve as a negative force for various reasons. The landfill site poses potential public health threat to the residents in the settlements as they are likely to scavenge or salvage disposed waste materials. Such exposure may put their health at risk as they may contract diseases by contacting disease-causing agents.

Children from the informal settlements are likely to use the landfill for recreational activities and they may pick up injuries or contract diseases. The financial implications of such exposures and outcomes to both the residents and health services could be vast. In addition, stray animals which are always found in the area are also in danger and may contract diseases and may transmit such diseases to human beings on consumption. Objectionable odour can be a psychological stress factor to those who are exposed.

An appealing environmental appearance refreshes the mind. The landfill site may not look good to the residents and passers-by due to litter scattered over the site and beyond its boundaries. The purpose of this study is to evaluate the waste disposal practices at Soshanguve landfill site in order to promote better management of waste through proper disposal and operational activities that meet the minimum standards.

CHAPTER 2

LITERATURE REVIEW

2.1 Importance and need for waste management

Waste management in developing countries like South Africa has always given local governments tremendous problems. There are few local governments that can claim having adequate services. A certain proportion of urban populace of South Africa does not have access to an adequate waste collection service (Mdlalose, 1998). Even in areas that have access to services, the problem of illegal dumping and littering make it difficult for the current conventional municipal collection methods to cope (Mdlalose, 1998).

The situation explained justifies the need for establishment and implementation of waste management strategies, which will serve as a tool to deal with challenges which face waste management, and to ensure the protection of the environment and promotion of human health and well being.

2.2 Challenges facing waste management in developing countries

There are several challenges that face waste management practices in the developing countries, including South Africa. These include among others, urbanisation and population growth. South Africa is experiencing a rapid population growth and rapid urbanisation. These, together with the need for economic growth to accommodate aspirations for improved standards of living, tend to lead to a disproportionate escalation in the rate of waste generation (Fuggle & Rabie, 1992).

The rapid urbanisation taking place in developing countries, including South Africa, has resulted in inadequate waste management, especially solid waste management. This process of urbanisation has been regarded as one of the most serious environmental problems confronting developing countries (Mdlalose, 1998). The effects of urbanisation, which primarily affect poor people, have resulted in the development of informal settlements and a considerable increase in backyard shacks. This situation has also resulted in the increase in the amount of waste generation (Mdlalose, 1998).

Waste generation is concentrated in and around the centres of development in areas which are densely populated. It is estimated that about 15-million tons of general and 0.85-million tons of hazardous waste are generated annually in South Africa (Ball, Blight, & Bredenhann, 1993). All of this is disposed of on landfills. Presently it is estimated that there are 1200 landfill sites countrywide. Of these, nine are sites for hazardous wastes and the rest are for general waste. The landfill standards range from burning open dumps to very well controlled sanitary landfills (Ball, *et al.*, 1993).

The majority of small local authorities have waste management at the bottom of their priority list, with housing and electricity at the top of the table. This is relayed to the communities who just dump waste, especially ash in open spaces (Mdlalose, 1998).
Such situation contributes to the way in which waste disposal operations are carried out by these town councils. It is reported that the waste management principles in terms of waste disposal, especially sanitary landfill principles, that include waste compaction and covering, are not followed at most landfill site in South Africa (Mdlalose, 1998).

Waste management can actually make a difference to the environment and people who depend on that environment for their livelihood (Van der Merwe, 1995).

Obvious and visible difference to people's lives can be made by providing mechanisms for clearing up litter and collecting everyday waste. Van der Merwe (1995) is of the opinion that this does not end here, the task of waste disposal, although it is less visible, is far more important and very crucial.

South Africa is highly committed to sustainable development and environment protection following the Rio Convention in 1992. The government's commitment to Rio Declaration is reflected by the guidelines on Minimum Requirements for Waste Disposal by Landfill, 1998 that were set following this Convention with a view to protect human health and the environment.

2.3 The importance of waste disposal management

Proper waste disposal management has many advantages as it prevents and controls environment degradation due to pollution, and ill-health due to disease occurrence as a result of unhealthy environment.

Unacceptable landfill practices, which occurred before the implementation of the Environment Conservation Act, 1989 (Act No. 73 of 1989), were common in South Africa in early 1990 and some still persist (Ball & Langmore, 1996). Such practices have led to public resistance.

2.3.1 Public resistance

Public resistance to exposure to waste sites has resulted from poor siting, design, operation and management of waste disposal facilities in the past which caused unacceptable risks to the surrounding population (Posnik, *et al.*, 1993). The problem of waste does not end once it is buried out of sight. Badly managed waste processing and disposal can, and has, led to pollution risks of groundwater and rivers (Van der Merwe, 1995).

2.3.2 Pollution risks

Pollution risk depends on the contaminant load threatening the groundwater system. The four characteristics of the contaminant load include, contaminant class, intensity of contamination, mode of contaminant disposal, and duration of contaminant application (Jolly, 1992). The most serious threats to groundwater resources in Europe are mostly presented by pesticides and nitrates, dumping of waste generated from industrial and urban areas (Jolly, 1992).

Waste sites pose a serious risk to the groundwater and soils. The risk depends on the quantity of leachate generated and the composition of leachate. These in turn are

dependent on the mode of deposition, moisture content recharge and on waste type). Even leachate from domestic waste can be toxic. In locations without effective soil cover, 25% to 50% of the precipitation will infiltrate the soil and become leachate (Jolly, 1992).

2.3.3 European waste disposal management

For most European countries, minimum standards for the siting and design of waste disposal sites exists with Germany being a good example. The principle of multiple barriers plays an important role in waste disposal (Jolly, 1992). This includes the capping of disposal sites after it has been completed; the separation of waste and compaction as well as pre-treatment before disposal; the disposal of waste above the water table, i.e., taking the geology below the site into consideration. The regulations regarding each of the barriers are set with the class of waste to be disposed of taken into account (Jolly, 1992).

2.3.4 Waste disposal management and geo-hydrological consideration

The geological formation underlying the waste disposal site must be at least 5 meters thick with permeability of greater than 10/5 cm/sec. No aquifer must however exist below the natural barrier. If the underlined does not have a permeability of 10/5 then a possibility exists of inserting a clay liner of at least 3meters thick with a permeability of 10/6 cm/sec. A drainage system must exist around the site, with the liner extending at least 3m further than the drain (Jolly, 1992).

The groundwater use in the vicinity of the site is also defined in the minimum standards, where the sites may not be placed in areas where groundwater abstraction is taking place or in areas of useable potential, or in areas where groundwater is abstracted for health reasons, i.e., hot springs (Jolly, 1992). Water levels below waste disposal sites must be linked not only to permeabilities but also to the head existing under the circumstance in the leachate. For instance the Environmental Committee (EC) directives insist on a 3m

unsaturated zone with a permeability of at least 10/9 cm/day. Coupled to this, the National Rivers Authority requires that no more than 1m head of leachate occurs at the bottom of the waste (Jolly, 1992). In Germany the groundwater level below toxic or hazardous waste sites must be 3m below the surface, and other less hazardous types of waste the unsaturated zone must be greater than 1m (Jolly, 1992). It is evident that the European minimum standards are the basis on which all decisions regarding the acceptability of landfill siting, design and management are made for every class of waste disposal facility by providing strict requirement with the aim of providing sustainable use of all groundwater resources (Jolly, 1992). South Africa's standards regarding geohydrological investigation are defined in the minimum requirements for water monitoring at waste management facilities.

2.3.5 Water monitoring at waste management facilities

Minimum requirements for water monitoring at waste management facilities addresses the monitoring of water at and around waste disposal facilities with the aim of establishing the quality of water in that area as well as to understand the short-, medium-, and long-term impact that waste management may have on both the surface and groundwater regime (Department of Water Affairs and Forestry, 1998©).

Minimum requirements for water monitoring at waste management facilities is an attempt to, firstly, standardise monitoring procedures, secondly, provide specifications for monitoring designs, and thirdly, provide mechanisms for communication between waste management companies and authorities (Department of Water Affairs and Forestry, 1998©). It stipulates the minimum monitoring requirements as well as recommended monitoring distances and frequencies for different types of waste management facilities (Department of Water Affairs and Forestry, 1998©). This is one way in which the groundwater and waste disposal industries in RSA are taking cognisance of existing European philosophies (Jolly, 1992). These standards are very much significant in countries like South Africa where urbanisation is taking place at a very fast rate in order

to guard against both environmental and social impacts that may be caused during the disposal of waste that shall have been generated.

2.4 Urbanisation and social impacts of waste disposal

In South Africa, communities comprise a range of sizes, races and socio-economic levels, however, a large percentage of the total population may be described as third world (Ball, *et al.*, 1993). This means that there are different needs for different population groups and classes, e.g., jobs, houses, and food. All these needs require some form of development which will eventually increase the amount of waste generation and such waste will need to be disposed of in an environmentally and socially acceptable manner. Consideration of social aspects in the planning of any waste disposal facilities will benefit both the developer and the affected parties. This can be achieved within the context of environmental planning (Posnik, *et al.*, 1993).

By ignoring the social impact of waste disposal, the siting and operation of waste sites has often been conducted in a manner that maximises the economic and regional benefits, and results in unacceptable social costs (i.e., to ignore social issues, whether real or perceived, may lead to delays in the project and a conflict situation which generally require time and money) as the public has been placing pressure on decision -makers, to consider the social cost of their planning decisions due to the growing public awareness of environmental issues in South Africa (Posnik, *et al.*, 1993).

Consequently, it is becoming increasingly difficult to locate waste sites due to their negative connotation as perceived by the public, even if proven to be environmentally acceptable (Posnik, Muller, *et al.*, 1993). This issue is complicated by the fact that increasing urbanisation will have an associated demand for waste disposal facilities due to an increase in waste generation or output.

Hart (1992) stated that the Urban Foundation has made the observation that approximately 750 000 South African blacks move into the urban areas every year.

Urban growth has resulted in waste sites being surrounded by urban land - users, such as residential suburbs and low - income and informal settlements. Further more, factors such as transport costs have resulted in waste sites being located close to urban land - uses (Posnik, *et al.*, 1993). A challenge that is facing waste managers, both immediate and in the long term, is to make sure that waste that is delivered legally to the waste disposal sites does not become a nightmare at a later stage (Van der Merwe, 1995). This means that waste disposal operations and processes must be implemented accordingly with a view to protecting the environment and upholding the status of human health. Such operations or processes need to be channeled by some legislative requirements and they (operations or processes) should conform to those requirements.

2.5 Waste disposal and legislative requirements

The legislative requirements on waste disposal could be seen as the commitment of the government of South Africa on the management of South Africa's waste streams, in a manner which is environmentally, socially, politically acceptable and economically sustainable (Department of Environmental Affairs and Tourism, 1998(b)).

This is evident in some of the Acts of Parliament which contain Sections that deal with environment protection and upholding human health status. Legislative documents and their sections, which are relevant to the protection of the environment and human health as well as waste disposal, will be discussed hereunder:

South Africa's Constitution (Act 108 of 1996) provides, within its Bill of Rights the most pertinent fundamental right in the context of integrated pollution and waste management in Section 24, that: " Everyone has the right

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

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

(i) prevent pollution and ecological degradation;

(ii) promote conservation; and

(iii) secure sustainable development and the use of natural resources while promoting justifiable economic and social development"(South Africa, 1996).

The provision of this Section provides for the basis on which regulatory and intervention measures, which are aimed at promoting human health and protecting the environment, could be promulgated or established. This is evident in the Draft White paper on Integrated Pollution and Waste Management whereby its overarching principles are those of the Bill of Rights (Department of Environmental Affairs and Tourism, 1998(b)).
There are specific principles for pollution and hazardous waste management that have been adopted in addition to the general constitutional principles, and they are, namely:

(i) **Transboundary Movement:** This principle aims at monitoring and containing pollutants to a local area thus preventing the unpolluted area from potential impacts (Department of Environmental Affairs and Tourism, 1998(b)). In waste disposal, this principle addresses the issue of seepage of leachate to either the groundwater or any surface water bodies, whereby leachate management strategies have to be put in place.

(ii) **Duty of Care Principle:** This principle, sometimes called responsible care principle, holds any waste generator responsible and accountable for the management and disposal of the waste he has generated (Department of Environmental Affairs and Tourism, 1998(b)). Generators of waste will also bear the environmental, social and economic costs to society of resulting pollution, and the responsibility for redressing any consequences (Department of Environmental Affairs and Tourism, 1997). This provision is stressed further in Section 28 of the Environment Management Act, 1998 (Act No. 107 of 1998), which puts responsibility upon every person who causes, has caused, or may cause significant pollution or degradation of the environment to take reasonable measures to prevent such pollution or degradation from occurring, continuing, or recurring (South Africa, 1998).

It also directs that all people and organisations should act with due care to conserve and avoid negative impacts on biodiversity, and to use biological and natural resources sustainably, equitably and efficiently (Department of Environmental Affairs and Tourism, 1997).

(iii) **Universal Applicability of Regulatory Instruments:** This principle subjects all industrial operations in South Africa to the same integrated pollution and waste management regulatory system (Department of Environmental Affair and Tourism, 1998(b)). Waste disposal management will be monitored by uniform and comprehensive standards and procedures and the implementation thereof shall maintain consistency and impartiality.

Waste disposal management is also stressed in the Environment Conservation Act, 1989 (Act No. 73 of 1989) of which aims at the provision for the effective protection and controlled utilisation of the environment and for matters incidental thereto (South Africa, 1989).

This Act gives provision for the Minister of Environmental Affairs and Tourism to determine the general policy, including policy with regard to the implementation and application of a convention, treaty or agreement relating to the environment which has been entered into or ratified, or to be entered into or ratified, by the government of the Republic of South Africa, to be applied with a view to;

(i) the protection of the environment against disturbance, deterioration, pollution or destruction as a result of man-made structures, processes, products or human activities; and

(ii) the establishment and maintenance of acceptable human living environments in accordance with the environmental values and environmental needs of the communities; as well as

(iii) the execution and co-ordination of integrated environmental monitoring programmes (South Africa, 1989).

The Act further provides for the prohibition of the establishment, provision or operation of any disposal site by any person without a permit issued by the Minister of Water Affairs and Forestry (South Africa, 1989).

The Minister of Water Affairs and Forestry shall maintain a register in which details of every disposal site for which a permit has been issued shall be recorded. He may from time to time issue directions with regard to the control and management of disposal sites in general (South Africa, 1989). The Minister (Minister of Environmental Affairs and Tourism) may by notice in the *Gazette* identify those activities which in his opinion may have a detrimental effect on the environment with a view to controlling them.

Waste disposal is one of those identified activities, as such, the Act prohibits any person from undertaking such activity or to cause such an activity to be undertaken, except by virtue of a written authorisation by the Minister, or by a competent authority or a local authority or an officer, of which such competent authority, local authority or officer shall be designated by the Minister (South Africa, 1989).

The Environment Conservation Act, 1989, makes provision for the Minister to make regulations regarding waste management, concerning;

(i) the classification of different types of waste and the handling, storage, transport and disposal of such waste;
(ii) the location, planning, design of disposal sites and sites used for waste disposal;
(iii) control over the management of sites, installations and equipment used for waste disposal;
(iv) the administrative arrangements for effective waste disposal;
(v) the dissemination of information to the public on effective waste disposal, and
(vi) any other matter which he may deem necessary or expedient in connection with effective waste disposal for the protection of the environment.

Local authorities have duties and powers, in terms of the Health Act, 1977(Act No.63 of 1977), to take all lawful, necessary and reasonably practicable measures:

(i) to prevent the occurrence within its district of any nuisances, unhygienic condition, offensive condition, or any other condition which will or could be harmful or dangerous to the health of its inhabitants, or where a nuisance or condition has so occurred, to abate such nuisance or remedy such condition;

(ii) to prevent the pollution of any water intended for the use of the inhabitants of its district; and

(iii) to render in its district services approved by the Minister of Health for the prevention of communicable diseases and the promotion of human health (South Africa, 1977).

In waste disposal management, this provision entertains the concern of salvaging and scavenging practices at the landfill site, as well as the potential risks those salvagers and scavengers may be exposed to. This concern extends further to the potential risks that the communities around the landfill site may be exposed to as a result of the operational activities and the procedures that are being followed to carryout those activities.
It is against this background that the need has been identified by the South African Government, to prescribe standards that could be afforded by the communities in a third world country, which will serve as terms of reference to ensure uniformity in terms of waste management principles, especially waste disposal. This will be fulfilling the Rio Convention principle on environment protection and sustainable development. Such standard could be the Minimum Requirements for Waste Disposal by Landfill.

2.6 Overview of Minimum Requirements Guidelines

Minimum Requirements guidelines could be discussed according to the following subheadings:

2.6.1 Importance

Presently, control over waste disposal has been achieved by means of a landfill site permitting system. Furthermore, the Department of Water Affairs & Forestry has formulated a set of Minimum Requirements for Waste Disposal by Landfill in two editions, with the first edition published in 1994 and 1998 respectively (Department of Water Affairs & Forestry, 1998(b)).

The *Minimum Requirements for Waste Disposal by Landfill* forms part of Water Affairs & Forestry's Waste Management Series. This series establishes a reference framework of standards for waste management in South Africa. It also facilitates the enforcement of the landfill permitting systems provided for in terms of Section 20(1) of the Environment Conservation Act, 1989 (Act No. 73 of 1989) (Department of Water Affairs & Forestry, 1998(b)), as a token of commitment by the Department of Water Affairs & Forestry to the needs and rights of the people to a clean and a healthy environment (Van der Mere, 1995). The document addresses landfill classification, and the sitting, investigation, design operation and monitoring of landfill sites. In the landfill classification systems, a landfill is classified in terms of waste class, size of operation, and potential for significant leachate generation, all of which influence the risk it poses to the environment (Fourie *et al.*, 1998).

Graded requirements are then set for all aspects of landfilling, including public participation to determine site feasibility and end-use (Department of Water Affairs & Forestry, 1998(b)) and to envisage refinements which take account of the nature of the municipal refuse and how different refuse compositions may translate into different pollution potentials (Fourie, *et al.*, 1998).

The Minimum Requirements are a milestone on the path towards environmentally benign, safe and sustainable waste management and their existence represents the acknowledgement of the waste crisis facing South Africa in particular and have been adopted by other Southern African countries like Botswana. They illustrate a formal commitment to improving management of waste in these countries (van der Merwe, 1995).

The main aim of the Minimum Requirements is to ensure that the same environmental standards and objectives are applied throughout South Africa, whilst at the same time not simply applying an indiscriminate, "one size fits all" approach (Department of Water Affairs & Forestry, 1998(b)).

Minimum Requirements should be regarded as transmitters guiding waste generators and managers on their route to better waste management. They are meant to raise the standards of waste management and waste disposal sites which will result in increased costs to waste managers and ultimately to the waste generators (i.e., internalisation of the cost to manage waste produced and its impact on the environment and human being) (Van der Merwe, 1995).

It describes the situation where the cost of responsible waste management and the protection of the environment is carried by the waste generator and not by the environment in the form of environmental degradation (Van der Merwe, 1995). The general objective of Minimum Requirements is to ensure that the most cost-effective means, are used to protect the environment and public health, from both short and long term adverse impact of waste disposal (Ball, *et al.*, 1993). They serve as a pro-active step to prevent the degradation of water quality and environment and to improve the standard of waste disposal. To ensure practical and affordable environmental protection, graded requirements are applied to different classes of landfill. The landfill class is determined from the waste type, size of operation, and potential for leachate generation (Department of Water Affairs & Forestry, 1998(b)).

There are two criteria which are considered when evaluating the need for a leachate collection and management beneath a landfill receiving municipal solid waste (Fourie, *et al.*, 1998). These are the climatic water balance index and the size of the landfill (Fourie, *et al.*, 1998). The climatic index uses published, easily available figures for the weather stations closest to the landfill site in question and is defined in terms of a simple atmospheric water balance, with the leachate generating potential, evaluated by the difference between precipitation and evaporation (based on pan evaporation). Factors such as the storage capacity of the waste, runoff and capillary moisture movement are ignored, usually resulting in a conservative estimate of leachate generation potential (Fourie, *et al.*, 1998).

Cognisance is taken of the fact that small landfills pose a lesser environmental risk than do large landfills, by virtue of the smaller pollution load of the refuse that is stored within them (Ball, *et al.*, 1993). The Minimum Requirements document distinguishes between four different categories. It relates the landfill size classification to the maximum predicted rate of refuse deposition for the life of the landfill. These classifications further influence the requirement for installation of leachate management systems at a landfill (Ball, *et al.*, 1993).

The other factor that has been identified, as potentially influencing the need for leachate management system, is the composition of the refuse deposited at a particular site. It is proposed that waste be classified according to its biodegradable content.

If the content of biodegradable material exceeds 20% by dry mass, the waste will be classified as 'W', which implies high biodegradable waste, whilst if the biodegradable content is less than or equal to 20%, it will be classified as 'w', which implies low-biodegradable waste. It is envisaged that relaxed standards may be appropriate for 'w' refuse as compared with those required for 'W' refuse (Fourie, *et al.*, 1998).
Good landfill site selection provides for simple cost-effective design, which, provided the site preparation is correctly carried out, provides for good landfill operation. This in turn ensures the environmental acceptability of the landfill. Environmental acceptability, in

its turn, often relates directly to public acceptability (Department of Water Affairs & Forestry, 1998(b)).

The key to cost-effective, environmentally acceptable waste disposal, is to apply different Minimum Requirements to different situations, in a scientifically defensible way. In order to achieve this, the disposal needs and the effects of climatic conditions are assessed, and hence the required landfill is classified. The Minimum Requirements that will then apply to a particular landfill will depend on its classification (Ball, *et al.*, 1993).

Minimum Requirements for landfill operation are based on accepted sanitary landfill principles of waste compaction and covering. Daily covering and compaction are a Minimum Requirement at most sites. However, at third world sites where the waste characteristically has a low putrescible and high ash content, this may be relaxed (Ball, *et al.*, 1993). Waste compaction minimises voids, reduces volume, prevents rodent breeding, and stabilises the landfill.
Covering is also an integral aspect of site management, as it reduces smell and prevents flies and rodents breeding in the ground (Imiesa, 1997).

Ball, *et al.*, 1993 and Department of Water Affairs & Forestry, 1998(b), stated particular objectives of Minimum Requirements for Waste Disposal by Landfill, and they are:

1. to avoid degradation of the general environment in which the landfill is sited, by improving the standard of waste disposal.
2. to prevent pollution of the adjacent surface and ground regimes by providing a framework of waste disposal standards, within which to work, and upon which to build.
3. to ensure that landfilling process is in itself, environmentally and aesthetically acceptable, by providing guidelines for environmentally acceptable waste disposal for a spectrum of landfill sizes and types (Department of Water Affairs & Forestry, 1998(b)).

2.6.2 Some of the principles governing the Minimum Requirements

Huyskes & Gibbons (1996) stated the principles which governs the Minimum Requirements, and are namely,

1. Waste avoidance and minimisation; in order of priority, this amounts to prevention, recycling, treatment and finally disposal.
2. Best Practicable Environmentally acceptable Option (BPEO).
3. Precautionary principle (waste is highly hazardous until proven otherwise).
4. Duty of care (the waste generator is accountable and responsible for the fate of waste generated).
5. Polluter pays (the waste generator is financially responsible for any damage caused by the waste he/she generated).

2.6.3 Comparison of Minimum Requirements with the Dutch guidelines

Minimum requirements guidelines have been compared with the Dutch guidelines for waste disposal by landfill and some similarities regarding waste isolation; management and monitoring were identified (Hyskes Gibbons, 1996).

2.6.4 Safety and public health risks associated with waste disposal

Waste should be regarded as a dangerous by-product and exposure to it could have significant public health implications. Safety and public health risks associated with waste disposal involve the following,

2.6.4.1 Scavenging and salvaging

A major safety and public health risk associated with waste disposal in third world countries, such as South Africa, results from scavenging and salvaging. Even though there are no studies in South Africa that have shown the association between health risks

and scavenging & salvaging, people may obtain food and a livelihood directly from scavenging or salvaging waste at disposal operations and such actions may be a risk factor to those people's health (Ball, *et al.*, 1993).

In many instances, this practice is associated with squatting, where small communities may live illegally on the site. In the interest of safety and public health, it is a Minimum Requirement that squatting on waste disposal sites be prohibited, while salvaging should be controlled as rigidly as possible (Ball, *et al.*, 1993). Other standard Minimum Requirements relating to site operation include access control, record keeping, site maintenance and pollution monitoring (Ball, *et al.*, 1993).

2.6.4.2 Methane generation

Modern landfills create near perfect conditions for methane generation. These include; large volumes of organic, biodegradable material which contain natural bacteria; anaerobic conditions and moisture. Methane makes up more than half the gas that is generated in landfills. This gas is usually known as landfill gas (Letcher, 1995).

The methane component of landfill gas (LFG) can explode in air at relatively low concentrations. The regular soil cover placed on landfill serves to trap the gas and as a result the LFG builds up pressure. Pressures as high as 8kPa greater than the atmospheric have been recorded (Letcher, 1995). Cracks in the surface or fissures in the soil boundary to the landfill site, and permeable material such as gravel become conduits for the escaping gas. The tendency to escape and to migrate is created not only by the gas pressure but also by the relatively low density of methane gas. This migrating property of LFG together with the explosive nature of the methane moiety, makes LFG a very dangerous gas (Letcher, 1995). LFG is flammable in air when the methane concentration in air is greater than 15% (volume) and explosive in air when the methane concentration in the air is between 5% and 15% (Letcher, 1995).

Hundreds of cases of damage by LFG have been reported over the past two decades from the USA and in the UK. The most dramatic case occurred at Roscoe, Derbyshire in the UK in 1986 where a house was totally destroyed by a methane gas explosion. It was again assumed that LFG had migrated laterally from the landfill site 45m away and had ignited as a result of a radiator which had been switched on shortly before the occupants had left to take their dog for a work (Letcher, 1995).

Unventilated space connected to a landfill by migration routes is the one common feature linking most of the documented LFG explosions (Letcher, 1995). A summary of the main causes of methane explosions on or near landfills show that LFG can infiltrate drains, sewers, pipes rooms and any other closed space. A spark of a cigarette is enough to set off an explosion if by chance the concentration is right (Letcher, 1995).

However, a trench only 1m deep, can create an environment for a potential explosion and such explosions have been known to occur. Many accidents have taken place in South Africa's landfills but most cases have not been publicised. Site offices, toilets, leachate drains and pipes, workshops, open trenches and cracked concrete slabs on or near a landfills have each been the scene of an explosion in South Africa over the past few years and in each case the cause was directly related to the migration or diffusion of landfill gas (Letcher, 1995). Any building, plumbing or construction of any kind on or near a landfill should be seriously considered as a potential collection point for methane migration. Such space should be continually ventilated in order to purge any LFG that might collect. Furthermore venting landfills or actively pumping out of landfill gas from landfills is necessary if migration is to be reduced (Letcher, 1995).

2.6.5 Trend of the Minimum Requirements guidelines in the international arena

The Minimum Requirements for landfills in South Africa, especially the classification and design approach, are considered evolutionary. Furthermore, as far as is known, they have no counterpart elsewhere in the world (Ball, *et al.*, 1993). The document has been

used as the basis for the Botswana Landfill Guidelines and is frequently used as the standard in Namibia and Swaziland (Department of Water Affairs & Forestry, 1998(b)).

Furthermore, the International Solid Waste Association (ISWA) Working Group on Sanitary Landfills has recognised the Minimum Requirements approach developed in South Africa in their document landfilling in developing countries (Department of Water Affairs & Forestry, 1998(b)).

2.6.6 Motivation and justification for Minimum Requirements initiative

It is believed that this is the first set of requirements that takes direct consideration of the climate within which the landfill is situated. It is also believed to be the first set of requirements that specifically considers the effect of the size of the landfill on design requirements and therefore its affordability to the community it serves (Ball, *et al.*, 1993). This approach ensures affordable and environmentally acceptable waste disposal, by applying different Minimum Requirements to different situations, which is ideal for the South African situation, with its diversity of socio-economic levels and mixture of first and third world communities (Ball, *et al.*, 1993).

The Minimum Requirements are a step towards recognising not only desirability, but also affordability and practicality in waste disposal. This is in line with the 'Best Practicable Environmentally acceptable Option' (BPEO) approach, adopted by the Department of Water Affairs & Forestry (Ball, *et al.*, 1993).

2.6.7 Minimum Requirements for a general, medium, no significant lechate producing landfill site (GMB-)

Improper landfilling has got some impact, both short-term and long-term, on the environment and human health. These could range from noise, flies, odour, anaesthetics, wind blown litter to landfill gas generation, air pollution and water pollution (Department of Water Affairs and Forestry, 1998(b)). In order to deal with these issues, Minimum

Requirements for specific classes of landfill sites have been established.

There are several Minimum Requirements which are specifically for GMB- landfill sites (i.e., the class under which Soshanguve landfill site fall). These Minimum Requirements form part of the permit conditions and are therefore implemented through and enforced by the landfill site permit (Department of Water Affairs and Forestry, 1998(b)). For permitted landfill sites, the conditions appearing in the permit represent enforceable standards for that specific landfill. Since permit conditions will usually conform to or exceed the Minimum Requirements, the Minimum Requirements will also, in effect, become enforceable standards (Department of Water Affairs and Forestry, 1998(b)). It is be the responsibility of the permit holder to ensure that the Minimum Requirements are met.

The following sub sections will discuss the Minimum Requirements for GMB-

2.6.7.1 Responsible person

It is a Minimum Requirement that there be a responsible person for the landfill site.
This is to ensure that the minimum requirements for the operation of landfill site are applied to the degree in relation to its class and hence the satisfaction of the Department of Water Affairs and Forestry (Department of Water Affairs and Forestry, 1998(b)). The responsible person must, in all cases, be supported by suitably qualified and competent staff.
He has to ensure that the requirements of the Occupational Health and Safety Act, 1993, (Act No. 85 of 1993) are met, with regard to visitors and site staff (Department of Water Affairs and Forestry, 1998(b)).

2.6.7.2 Facilities and resources

There must be sufficient facilities and resources to ensure that the landfill operation can conform to both the permit and the Minimum Requirements relevant thereof (e.g. there

should be sufficient trained staff to monitor, control, and record incoming waste where required, services like potable water supply, sanitary facilities, and infrastructure like weighbridges, site offices and plant shelters should be provided) (Department of Water Affairs and Forestry, 1998(b)).

There must be provision of sufficient and suitable equipment, drivers and back-up to ensure environmentally acceptable waste disposal at all times. The plant and equipment must provide the means whereby the waste can be disposed of in accordance with the Minimum Requirements. It must also be maintained in good order, so as not to cause nuisances such as noise or air pollution (Department of Water Affairs and Forestry, 1998(b)).

Suitable signs must be erected on-site, to direct vehicle drivers appropriately. A general notice board must be erected at the site entrance. The board must be written in the appropriate official languages, stating the names, addresses, telephone number of the permit holder and the responsible person, days and hours of operation, and an emergency telephone number (Department of Water Affairs and Forestry, 1998(b)). It is of particular importance that the sign clearly states the class of landfill and the types of waste that can be accepted. Waste that cannot be accepted must also be stated.

It must be stated that disposal of non-acceptable waste types is illegal and can lead to prosecution (Department of Water Affairs and Forestry, 1998(b)). All roads, particularly on-site roads, must be so surfaced and maintained as to ensure that waste can reach the working surface with the minimum inconvenience in all weather conditions. Unsurfaced roads must be regularly graded and watered or sprinkled to suppress dust (Department of Water Affairs and Forestry, 1998(b)).

2.6.7.3 Controls

One of the purpose of the landfill classification system is to ensure that general waste disposal sites receive only the general waste for which they are designed, and that all

hazardous waste is disposed of only on hazardous waste disposal sites. Prior to waste being accepted at any general waste disposal sites, it must be inspected by suitably qualified staff and the transporter must confirm that it is general waste (Department of Water Affairs and Forestry, 1998(b)).

The operator at the working face must also ensure that no hazardous waste is disposed of. In the case of doubts, any industrial waste should be considered as potentially hazardous until proven otherwise (Department of Water Affairs and Forestry, 1998(b)). In the event of hazardous waste being intercepted at a general landfill site, it must be diverted to a hazardous landfill site. The source, registration and description of the waste must be reported to the Department of Water Affairs and Forestry (herein after shall be called Department). Should medical waste be intercepted, it is a Minimum Requirement that the responsible person and the permit holder immediately contact the Department for a directive in this regard (Department of Water Affairs and Forestry, 1998(b)).

In order to facilitate waste acceptance procedures, access to the site must be controlled. Vehicles access to a site must be limited to a single controlled entrance, to prevent unauthorised entry and illegal dumping of waste on the site. The site entrance must comprise a lockable gate that must be manned during hours of operation. Where appropriate, additional security should be provide, especially after operating hours (Department of Water Affairs and Forestry, 1998(b)).

In addition to the gate, all sites must have the portion of the site currently in use adequately fenced/or secured. Primary for the purpose of protecting public health and safety, waste reclamation and squatting should be discouraged at general landfill sites (Department of Water Affairs and Forestry, 1998(b)).

2.6.7.4 Operating plan

An operating plan is a site-specific document that is developed as part of the landfill permit application procedure. It describes the way in which the landfill is to be operated.

Any activity that pertains to the operation of a landfill should therefore be included in the operating plan, which is subject to regular update (Department of Water Affairs and Forestry, 1998(b)). The operating plan would include, *inter alia*, the provision of wet weather cells, site access, drainage, and monitoring.

2.6.7.5 Landfill operation

Landfills must be operated in terms of sanitary landfill principles (i.e., waste compaction and covering). Waste must be spread in thin layers and compacted by a purpose-built compactor. Furthermore, waste must be fully covered at the end of each working day (Department of Water Affairs and Forestry, 1998(b)).

Most sanitary landfill operations are based on a series of trenches or cells which are prepared to receive the waste. Waste is deposited in trenches or cells, spread, compacted and covered, so that each day's waste is effectively isolated from the environment. The material to be used for cover may be on-site soil or builder's rubble (Department of Water Affairs and Forestry, 1998(b)).

Strategic stockpile of cover, sufficient for at least three days, should be maintained close to the working face (i.e., an active area where waste is being deposited by incoming vehicles) for use in emergency. Daily or periodic cover must be sufficient to isolate the waste from the environment.

A minimum thickness equivalent to effective covering of 150mm of compacted soil is required. This thickness may, however, have to be increased in the case of poor quality cover (Department of Water Affairs and Forestry, 1998(b)).

2.6.7.6 Methods of landfilling

Any landfill unit/ or a cell, should be compacted and entirely contained by cover material at the end of each day. The working face must be kept as small as possible for control and covering purposes. There must be sufficient cell capacity on-site to accommodate at

least one week's waste (Department of Water Affairs and Forestry, 1998(b)).

An easily accessible wet weather cell must be constructed close to the site entrance or close to an all weather road, for use under abnormally wet weather conditions. The wet weather cell must have sufficient capacity to accommodate one week's waste (Department of Water Affairs and Forestry, 1998(b)). Special cells may be constructed for the disposal of putrescible general waste. Such waste should be deposited and covered immediately with a layer of soil at least 0.5 m thick. This is to prevent odours and to discourage uncontrolled salvaging (Department of Water Affairs and Forestry, 1998(b)).

Alternatively, such waste may be deposited at the base of the working face and covered immediately with other waste. This practice does not disrupt the standard operation (Department of Water Affairs and Forestry, 1998(b)).

2.6.7.7 Landfill site drainage

The principles of landfill site drainage state that upslope run-off water must be diverted away from the waste, to prevent water contamination and to minimise leachate generation. This could be achieved by diverting both run-off and storm water around one or both sides of the waste body, by a system of berms/or cut off drains (Department of Water Affairs and Forestry, 1998(b)).

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 and must be contained on-site in a sump or a retention dam (Department of Water Affairs and Forestry, 1998(b)).The bases of cells must be so designed that water drains away from the deposited waste, or alternatively, cells must be so oriented as to facilitate drainage away from deposited waste. All temporarily and finally covered areas must be graded and maintained to promote run-off without excessive erosion and to eliminate ponding or standing water (Department of Water Affairs and Forestry, 1998(b)).

2.6.7.8 Control of nuisances

Nuisances resulting from the landfill operation should be controlled. It is a Minimum Requirement that all litter be contained on-site. The burning of waste at landfill sites must be prohibited, and accidental fires, where burning is not allowed, must be extinguished immediately (Department of Water Affairs and Forestry, 1998(b)). Good cover application and maintenance should be adhered to, to combat objectionable odours. Furthermore, the prompt covering of malodorous waste to reduce odour problem is a Minimum Requirement. Where breaches in the cover from which significant volumes of landfill gas escape are identified by their odour, proper investigation is a minimum Requirement (Department of Water Affairs and Forestry, 1998(b)). All equipment used on-site must conform to the local authority's by-laws concerning noise levels and hours of operation. In the absence of by-laws, national regulations on noise control must be complied with (Department of Water Affairs and Forestry, 1998(b)).

Landfill sites must be kept free of vermin. Measures must be taken to eliminate disease vectors such as rats or flies (Department of Water Affairs and Forestry, 1998(b)). Unsurfaced roads or ungrassed or unpaved areas, which give rise to dust problems, must be watered to restrict dust to levels which do not pose a nuisance to workers or users of the facility (Department of Water Affairs and Forestry, 1998(b)).

Controlled reclamation and uncontrolled salvaging do take place at landfill sites, these practices can endanger the health and safety of the reclaimers, therefore waste reclamation on-site must be discouraged. Should the permit holder wish to allow controlled waste reclamation at a general landfill site, he should formalise it in the operating plan (Department of Water Affairs and Forestry, 1998(b)). This would include regular consultation with and registration of reclaimers and provision of appropriate safety measures. Safety measures would include the separation of reclamation from compaction activities, and the provision of safety clothing (Department of Water Affairs and Forestry, 1998(b)).

2.6.7.9 Leachate management

Any sporadic leachate generated on account of unusual circumstances must be reported to the Department and should be properly controlled (Department of Water Affairs and Forestry, 1998(b)).

2.6.7.10 Progressive rehabilitation

The progressive rehabilitation of landfills by means of capping and the subsequent establishment of vegetation is a Minimum Requirement. Capping should take place where no further deposition of waste will take place, and vegetation should commence immediately (Department of Water Affairs and Forestry, 1998(b)).

2.6.7.11 Final cover

Immediately on completion of an area, the final cover must be applied. The final cover must comprise material capable of supporting the vegetation called for in the End-use plan. All covered surfaces on the landfill must promote run-off to prevent ponding (Department of Water Affairs and Forestry, 1998(b)).

2.6.7.12 Public participation

The standard of operation at a given landfill may be monitored and enforced by a Monitoring Committee. This should comprise representatives of the Department, the operator, and representative of the interested and affected parties. In the interest of transparency, interested and affected parties must be given access to the site and information relating to the operation (Department of Water Affairs and Forestry, 1998(b)).

2.6.7.13 Landfill site monitoring

It is a Minimum Requirement that all landfills should be monitored to ensure the maintenance of acceptable standards. The waste disposal operation is usually monitored by means of landfill site audit. The Department undertakes routine inspections of waste disposal sites throughout the country and identifies situations which are unacceptable (Department of Water Affairs and Forestry, 1998(b)).

In addition to auditing, monitoring may comprise the collection, processing, and interpretation of certain data. The required data will include the following:

Waste disposal records. The method of waste recording must be appropriate to the nature and the volume of the waste entering the site. Records of all waste entering the site must be kept properly. Waste must be categorised by the number of loads (defined by volume or mass), the type of waste and the source. Records must be kept on both a daily and cumulative basis (Department of Water Affairs and Forestry, 1998(b)). With the accumulation of records, a database must be established and maintained at the landfill site (Department of Water Affairs and Forestry, 1998(b)).

Leachate and water quality monitoring. Regular sampling and analysis of leachate, Where sporadic leachate is generated at a B- site, the Department must be informed. If directed by the Department, the permit holder may have to have such leachate sampled and analysed (Department of Water Affairs and Forestry, 1998(b)). Records must be maintained of any impact caused by the landfilling operation on the quality of the water regime in the vicinity of the site (Department of Water Affairs and Forestry, 1998(b)). The results of the water quality monitoring must be available for scrutiny by the Monitoring Committee (Department of Water Affairs and Forestry, 1998(b)).

CHAPTER 3

METHODOLOGY

3.1 The study design

An observational, cross-sectional study was conducted at the landfill site described in section 1.5 between June and December 1999.

3.2 Data collection

Qualitative and quantitative data collection methods including interviews, observations and water sampling, were used to gather information that could be used to address the specific objectives.

3.2.1 Qualitative methods

Qualitative methods were used to establish practices at the landfill site as well as to establish awareness and understanding of policies governing waste management. In-depth interviews were conducted to obtain information pertaining to Soshanguve waste disposal management from the managers and other officials who are in charge of the management of the mentioned landfill site. Interviews were conducted with officials from the Northern Pretoria Metropolitan Substructure (NPMSS). Interviews were conducted using the in-depth interview guide (Appendix 1) by a trained interviewer.

Because there are few officials that are involved in waste disposal management in the NPMSS (a total of five), three interviews were conducted, with an official from Technical Department, one from Health Department, and one at the landfill site. Interviews were conducted in languages that the interviewees were comfortable with, namely English, Afrikaans and Setswana. With the permission of the interviewees, all interviews were recorded on a tape recorder and translation and transcription was done to English. Issues were followed as they emerged during the interview process.

Observations of procedures and operations on the landfill site were done by the researcher in order to compliment and elicit the in-depth interviews.

Three observation sessions, which focused mainly on the conditions of the site and the operations on-site, were carried out. These observations noted the infrastructural requirements that included, sanitary facilities, storm water drainage, drinking water supply bore-holes, and fencing (Appendix 2). The sanitary landfill principle which is constituted by covering and compaction of waste materials, weighing and recording of incoming waste, occupational health and safety procedures, following the Minimum Requirements for waste disposal, were also noted.

3.2.2 Quantitative methods

Quantitative methods were done in order to determine the quantity of waste disposed of at Soshanguve landfill site and the possibility of the site affecting the quality of the water in the nearby stream. These methods included review of records and water sampling.

3.2.2.1 Review of records

Records of waste disposed of at Soshanguve landfill site from January 1998 to November 1999 were reviewed and analysed. Data included records on domestic waste, garden refuse, building rubble and rubble which consists of waste collected from street corners or open spaces, that has been dumped by the residents).

3.2.2.2 Water Sampling

In order to establish the extent and efficiency of operations at the site, water sampling from a river adjacent to the landfill site and from water pools within the site, was done. Water sampling was done once. Chemical water analysis was done by the Council for Scientific and Industrial Research to determine its chemical content. Samples were taken within a radius of 300m from the landfill site. Six water samples were taken, four from the stream and two were taken from water pools on-site.

Sampling was done between 11h00 and 12h00, and water samples were collected in 11 sampling bottles. One of the four samples was collected upstream (i.e., s-stream-1) and was used as a control in order to establish whether there was any significant change in the water quality parameters that may be associated with the landfill site.

The chemical water parameters of control sample were measured against the South African Water Quality Guidelines for Domestic Use in order to establish whether there were any significant variations. The chemical water parameters measured included pH, Electrical conductivity, Total dissolved solids, Ammonia nitrogen, Nitrate & nitrite nitrogen, Nitrite nitrogen, Total alkalinity, Chloride, Sulphate, Calcium, Magnesium, Potassium, Sodium, and Chemical oxygen demand.

3.3 Data Processing and Analysis

In-depth interviews were transcribed and analysed in order to extract information that could be used to address the main themes in the in-depth interview guide. Quantitative data sets from records which included volumes of domestic and garden wastes, building rubble, and rubble, were analysed by using the Epi-Info program.

Significance test testing was done for the four classes of waste which were recorded from January 1998 - November 1999 in order to determine whether there is any significant variations or trends in waste generation over a period of two years. The results of the analyses of water samples taken both from the stream and the landfill site were compared to the South African Water Quality Guidelines for Domestic Use in order to establish whether their quality fall with in the Target Water Quality Range (TWQR).

CHAPTER 4

RESULTS

4.1 Human resources and equipment

The staff compliment of the landfill site constituted of four employees. Two officers were actually operating at the site, one responsible for operating the compactor whilst the second official controlled access and directed the cars that came to dispose of waste. The other two officers were based off-site. The technician who is working directly with the officials on-site, is based at Soshanguve municipal offices situated approximately 5km from the landfill site and the manager, who is an Environmental Health Officer (EHO) based approximately 30km from the site.

It was established that a contingency plan was in place, in cases of breakdown to ensure that waste covering and compaction occur at all times. Although this was the case, it was observed that at times the machinery would break and waste was left uncovered and uncompacted for more than a week.

Incoming waste was recorded on daily record sheet. It included garden refuse, household waste, rubble and building rubble. Due to shortage of staff, it was observed that there was no consistency in the recording of waste. The official in charge of waste recording would monitor and inspect waste brought by all vehicles that do not frequent the site and therefore not known to them, and would not inspect collection vehicles that frequent the site and are better known to them assuming general waste.

The volume of waste recorded at any point in time was indirectly measured by recording the capacity of the collection vehicle rather than using a weighbridge that would indicate the actual mass of the waste.

4.2 Waste management policy and practice

It was established that there was no waste management policy in place that could guide waste disposal management at Soshanguve landfill site and that operations could conform with. This resulted in the waste disposal management totally dependent on the permit conditions under which the landfill site is registered. This situation promoted the application of waste disposal management based on opinions

and not on guidelines or standards. Consequently, operational activities could not be measured against any standards or guidelines, therefore deviations from the expected performance could not be detected.

Officials in the managerial positions had received a formal training on waste management, and were therefore aware of Minimum Requirements Series documents. Worker at the site received informal training programmes regarding waste disposal, especially waste recording, covering and compaction, but there was no subsequent or in-service training in that regard. This meant that workers at the site received training at the time when they started working at the site and there was no further training to improve or upgrade their skills and knowledge on waste disposal. One official has been working for the municipality for more than six years and the other one worked for more than a year.

4.3 Landfill site infrastructure

It was observed that the municipality has tried to meet some of the major infrastructural requirements like fencing, storm water drainage and collection ponds, site office and toilet facilities and there were some facilities which were not provided, like potable water supply, bore-holes and vent pipes. The fence of the landfill site, which was supposed to control access to incoming vehicles, people and stray animals was lying down on the ground, and there was no access control mechanism in place. As a result of lack of control, site officials reported that hazardous materials like chemicals and dead babies did find their way into the landfill site unnoticed. Four holes and a slab for toilets were observed. Interviews with the officials revealed that toilet facilities used to be provided before, but following several attempts to remove the structures from the site by the surrounding community, municipality decided to remove these structures from the site. So, people at the site were left without toilets and used the bush.

Following lack of drinking water supply facilities, workers at the site brought water from their homes in buckets and other containers. The lack of drinking water supply also affected informal salvagers and scavengers who brought their own water for cooking and drinking. The officials reported the presence of a bore-hole that is not

used, but this was not observed. Engineered storm water drainage and leachate drainage systems were not available and storm water was channeled through a grade the collection ponds on-site. At times, the water in the pools were used by salvagers to wash their unidentified belonging. The unhygienic status of such water was reflected by the presence of carcasses of dead animals. Leachate (i.e., fluid that comes from waste materials) was flowing from the side of the waste cells and run-off on to the surface of the landfill. There was no weighbridge to measure incoming waste, and recorded measurement were indirect estimates based on the capacity of the vehicle transporting incoming waste. In an attempt to establish whether there were any future plans to improve the landfill operations, it was revealed that there were no long- or short-term plans to improve the landfill operations as the NPMSS felt strongly that the landfill site should be closed down.

4.4 Accessibility into the site

A good evidence of the lack of control was demonstrated by the presence of informal salvagers, scavengers, children and stray animals in large numbers at the landfill site. The presence of people and animals at the site was reported to temper with the smooth work flow on-site, especially waste covering, most of the time. This condition led to a situation whereby waste could not be covered in totality at the end of the day, thus leaving waste exposed to the surface. Objectionable smell and flies were evident from exposed waste.

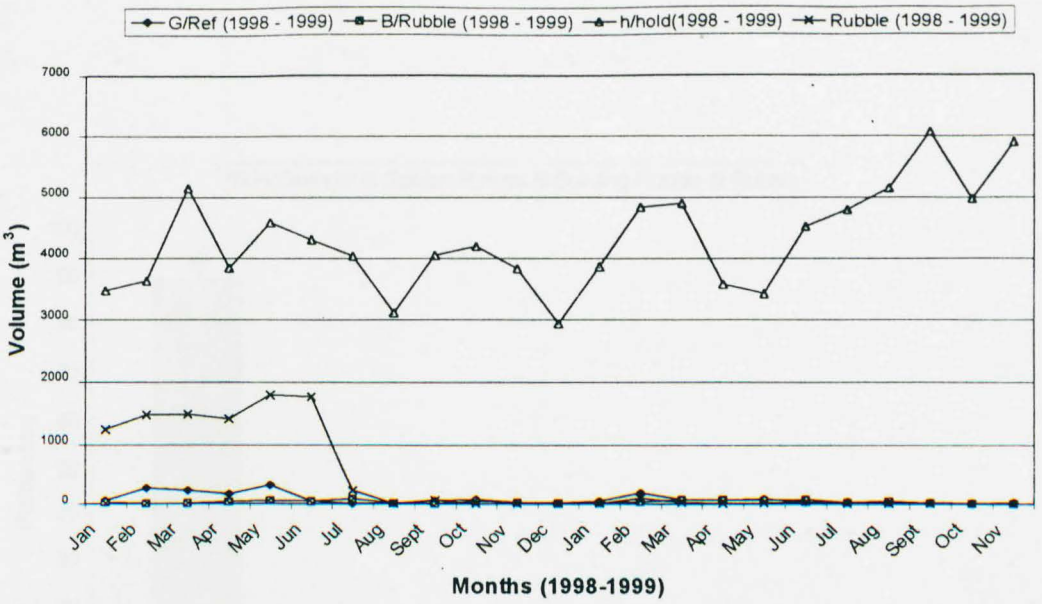
4.5 Recording of waste

Interviews and observations revealed that the type of waste that entered the landfill site was predominantly general waste. Reports were received of waste materials that find their way unnoticed into the site. These were mostly toxic chemicals from local industries. The operators would just cover such waste with soil and compact it in the same manner as he does with general waste. These reports come as no surprise as it was noticed that hazardous waste could be easily disposed of in the site that is not meant for that type of waste. In trying to identify any hazardous waste that could be found at the time, no hazardous waste was noticed during the observations. Though the cover material could be found from a quarry approximately 500m from the landfill

site, sufficient cover material was not available at the landfill site due to shortage or lack of machinery (trucks) and big sizes of the cells. The active waste disposal point was extended to a large area which was not manageable, and therefore large quantities of cover material were needed to cover waste in totality.

The landfill site accepts only general waste material, which comprises of household waste, garden refuse, building rubble and rubble. The volume of incoming waste must, in terms of the Minimum Requirements, be recorded and the records should be properly kept. Review of records revealed that there has been a significant increase in the output of household waste ($t = 2.60$, $df = 21$, $p < 0.02$, confidence interval = -160.48-1441.52) (Figure 3) although building rubble (Figure 4) showed an increase that was not statistically significant ($t = -0.88$, $df = 21$, $p > 0.1$, confidence interval = -32.96-13.26), that was disposed of at Soshanguve landfill in 1999 as compared to 1998.

The output of rubble (Figure 5) and garden refuse (Figure 6) has decreased in 1999 as compared to 1998. The significant test testing has shown that there was a significant difference in volume of rubble recorded in 1998 compared to 1999($t = 3.26$, $df = 21$, $p < 0.01$, confidence interval = 278-1261.3).
It further showed that there was no significant difference in volume of garden refuse recorded in 1998 and 1999 ($t = 1.4$, $df = 21$, $p > 0.1$, confidence interval = -25.45-130.75).



G/ref = Garden Refuse; H/hold = House hold; B/rubble = Building rubble

Figure 1. Volume of the type of waste disposed of at the Soshanguve landfill site during 1998 and 1999.

Figure 1 shows that household waste was disposed of in largest volumes and building rubble was the least when compared with other waste materials. The graph further indicates that an increase in household waste over a two year period and a drastic decrease in the other three waste types for the same period of time. Due to inconsistency in waste recording at the landfill site, it would be difficult to regard these results as an indication of a true situation, and should therefore be interpreted with caution. In addition, because there is no proper measurement procedures, and these are only estimates based on capacity, this could lead to vast overestimation of the amount of waste, as the vehicle at times may not be loaded to its full capacity.

The proportion of different types of waste disposed of at Soshanguve landfill site is illustrated in Figure 2.

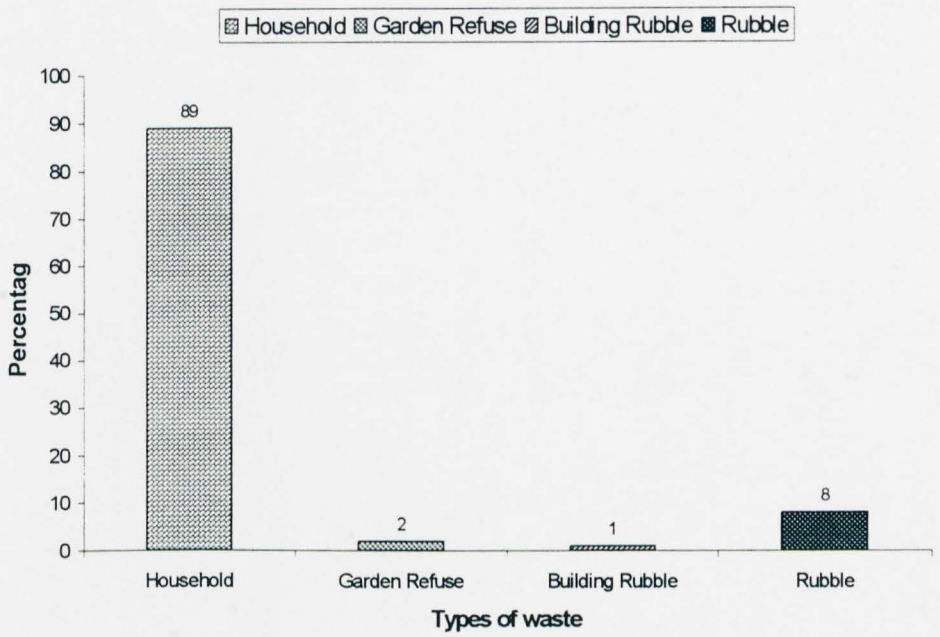


Figure 2. Proportion of the types of waste disposed of at the Soshanguve landfill site during 1998 and 1999.

The largest proportion of waste was made up of household waste (Figure 2). This could be because most of the collection vehicles are for the contractors that render waste collection in Soshanguve township and are responsible for household waste collection.

4.6 Operational activities on-site

The landfill site used the operational cell method whereby waste was disposed of in a block of cells. The officials reported that waste was recorded, covered and compacted in totality on daily basis. The observations further revealed that waste was not recorded at all times nor compacted daily. When the responsible person for recording incoming waste was not at work, there was no one who did the recording nor directing the cars that came to dispose of waste. Consequently, there was gross under reporting of incoming waste. Under reporting of waste output could lead to incorrect waste

output statistics that may influence the life expectancy and the perceived usage of the landfill site. The summary measures of the records of volumes of the types of waste disposed of at the Soshanguve landfill site during 1998 and 1999 is illustrated in Table 1.

Table 1. Summary measures of Records of the Volumes of the Types of Waste Disposed of at the Soshanguve Landfill Site during 1998 and 1999.

Type of Waste	*1998*	*Total Number of Months*	*1999*	*Total Number of Months*	*1998-1999*	*Total Number of Months*
H/hold	$\bar{x}$ = 3919, 33 sd = 613, 83 Range = 2921-5143	12 Months	$\bar{x}$ = 4720, 46 sd = 853, 22 Range = 3411-6064	11 Months	$\bar{x}$ = 4302, 48 sd = 829, 28 Range = 2921-6064	23 Months
Rubble	$\bar{x}$ = 784, 92 sd = 781, 93 Range = 0-1785		$\bar{x}$ = 15, 27 sd = 28, 4 Range = 0-96		$\bar{x}$ = 416, 83 sd = 678, 68 Range = 0-1785	

Table 1. Summary measures of Records of the Volumes of the Types of Waste Disposed of at the Soshanguve Landfill Site during 1998 and 1999.

Type of Waste	*1998*	*Total Number of Months*	*1999*	*Total Number of Months*	*1998-1999*	*Total Number of Months*
G/Ref	$\bar{X}$ = 104, 92 sd = 114, 62 Range = 1-326	12 Months	$\bar{X}$ = 52, 27 sd = 50, 50 Range = 8-184	11Months	$\bar{X}$ = 79, 74 sd = 91, 93 Range = 1-326	23 Months
B/Rubble	$\bar{X}$ = 26, 33 sd = 24, 08 Range = 0-82		$\bar{X}$ = 36, 18 sd =29, 14 Range = 0-72		$\bar{X}$ = 31, 04 sd = 26, 48 Range = 0-82	

- H/hold = House hold; G/Ref = Garden Refuse; B/Rubble = Building Rubble, $\bar{X}$ = Mean, sd = Standard deviation

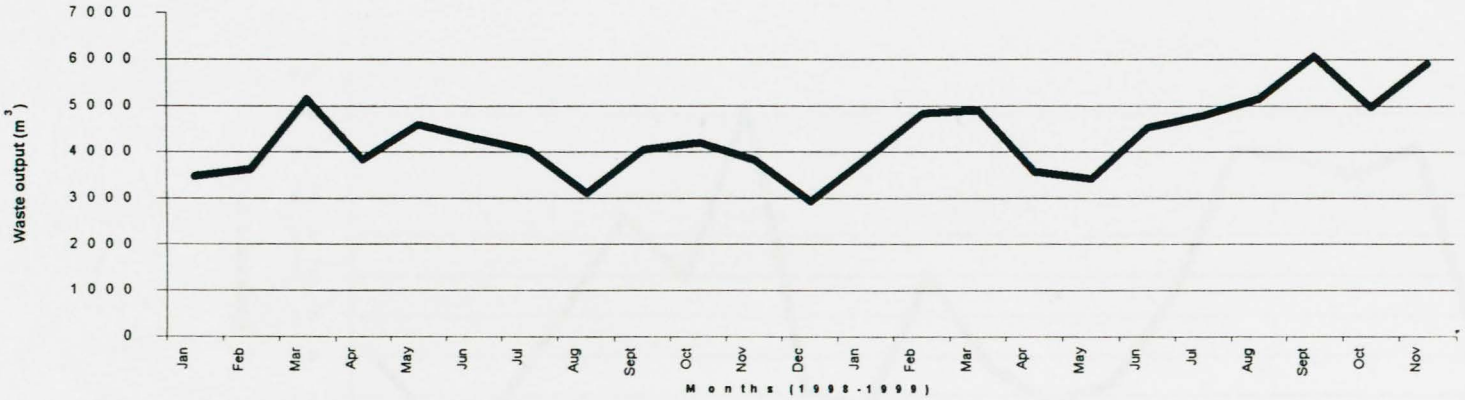


Figure 3. Volume of h/hold waste disposed of at the Soshanguve landfill site during 1998 and 1999

Figure 3 shows a decreasing in household waste output during the second half of 1998 and a steady increase in 1999. This shows that there has been an increase in household output over a period of two years. The trend in household waste output appeared similar for the first six months both 1998 and 1999.Thereafter there was an increase in the output of waste.

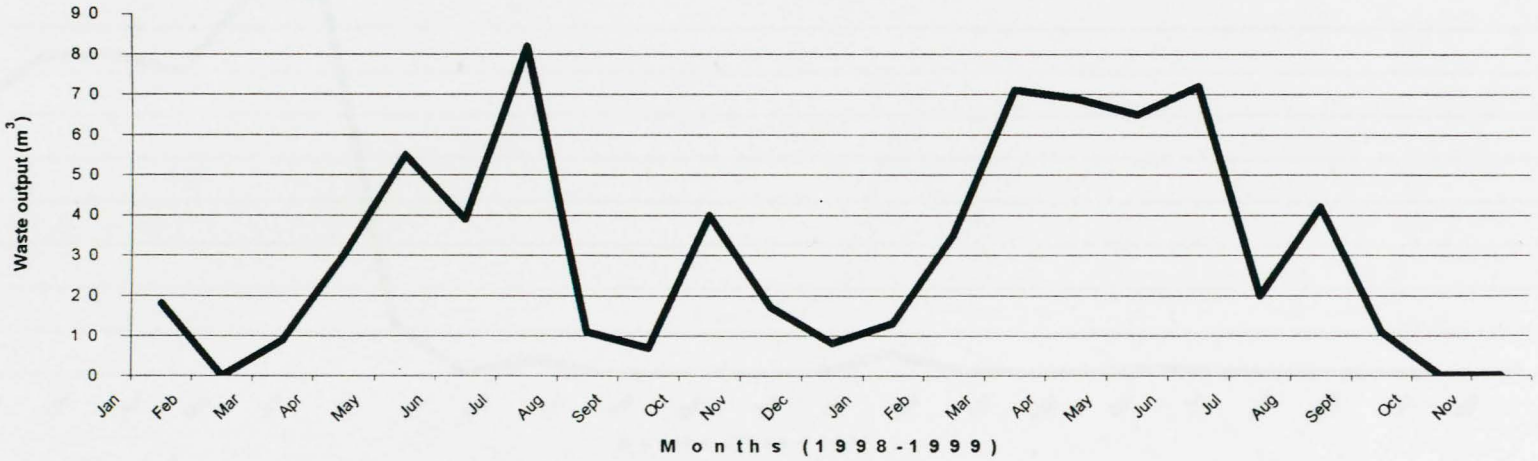


Figure 4. Volume of building rubble disposed of at the Soshanguve landfill site during 1998 and 1999.

Building rubble output over a period of two years is shown in Figure 4. The peak disposal of waste output for both 1998 and 1999 was around winter season, and less waste output was disposed of during rainy seasons. There was no significant difference in mean rubble generated over a 2year period.

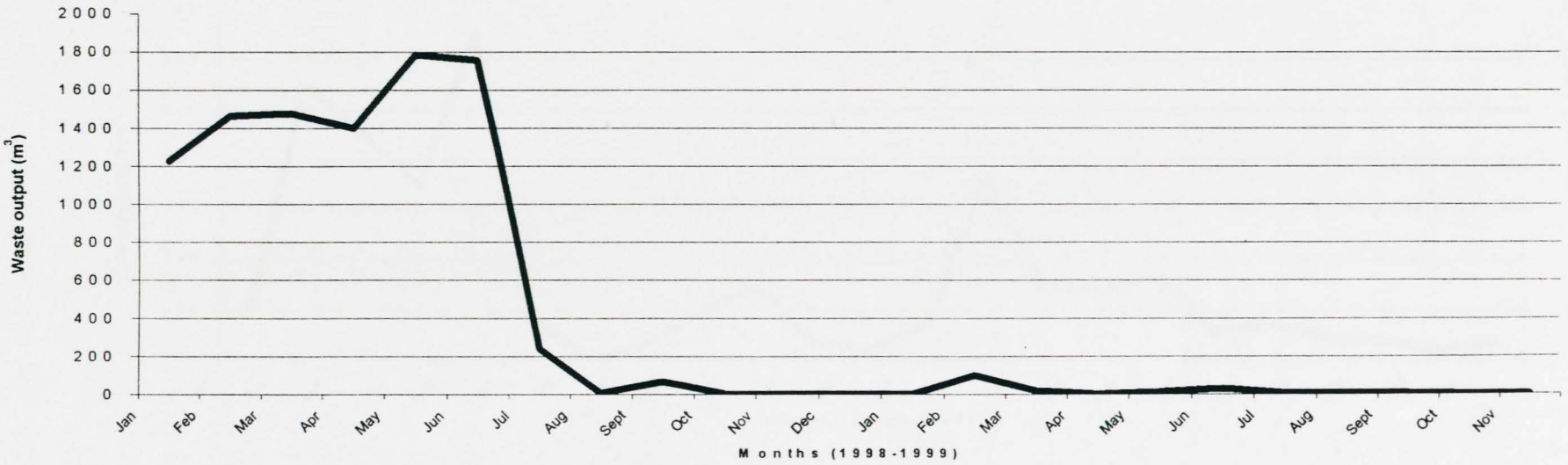


Figure 5. Volume of rubble disposed of at the Soshanguve landfill site during 1998 and 1999.

There was a drastic decline in the disposal of rubble after June 1998 (Figure 5). This could be attributed to the frequency of collection of this waste from street corners and open spaces, or the change in practice of the residents regarding dumping following increased awareness campaigns addressing the effect of dumping on communities.

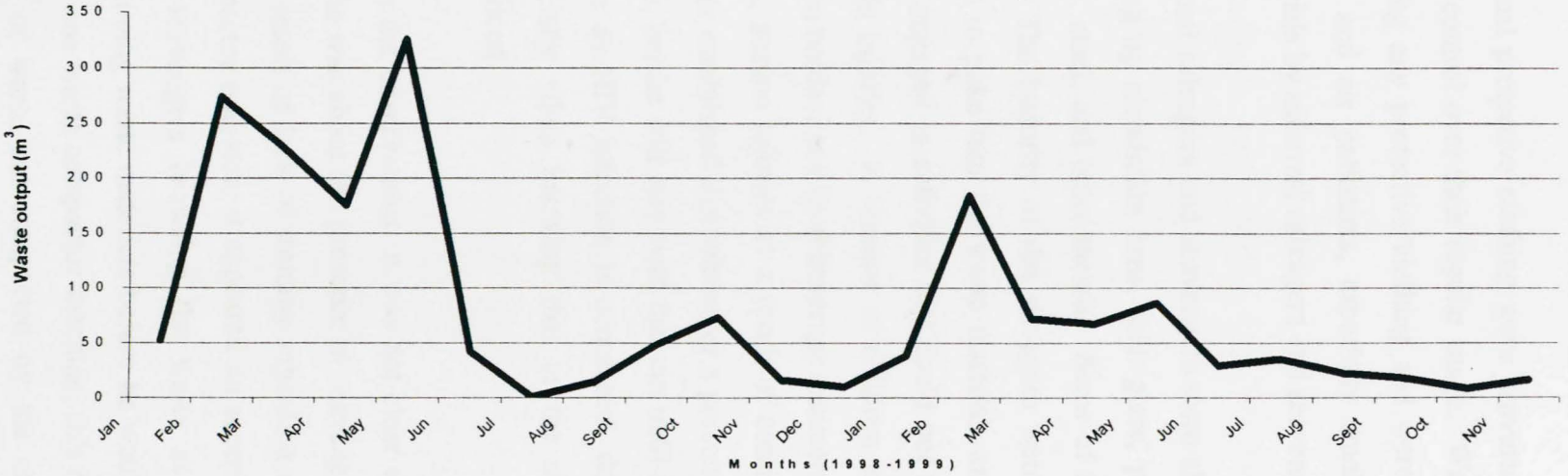


Figure 6. Volume of g/refuse disposed of at the Soshanguve landfill site during 1998 and 1999.

In 1999, there was a reduction of garden refuse output disposed of at the landfill site than in 1998 (Figure 6). The output of garden refuse was greater during the month of May and June 1998 and in 1999 during the same period it declined.

4.7 Occupational health and safety

Personal protective clothing were provided to the workers on-site but there was no strict control over their regular usage. Workers at the site were most of the time not wearing any protective clothing and were exposed to flies nuisance, objectionable smell and air pollutants, especially smoke, as a result of the burning of waste materials by informal salvagers and scavengers.

Informal salvagers and scavengers were always at the site. Their activities included picking up aluminium cans, tins, glass, plastics, clothes, shoes, bread, fruits, meat, wood, steel, and other metals. Some of the food materials picked were cooked on-site. The majority of the salvagers were using pokers, but some were using bare hands to poke into the waste materials and did not have protective clothing. They were engaged in activities that could put them at risk of contracting diseases and to sustain injuries. A number of children were left unattended and were playing with broken bottles, and food beverage canisters. Interviews revealed that people on-site at times, sustain injuries as a result of coming into contact with sharp objects. It was further established that whenever a person was injured, he/she does not consult at any clinic, he/she will stay with that cut until it has healed. This has serious implications as far as HIV infection is concerned, depending on the type of sharp objects and especially when knowing that at the site, hazardous materials are disposed of unnoticed.

From the observations, it was not clear what the level of understanding the officers on-site was about the presence of scavengers and salvagers at the site. This could be as a result of lack of training regarding sound waste disposal management. To the compactor operator, it appeared an acceptable and normal practice to have salvagers and scavengers browsing the waste as he would wait until they had finished reclaiming waste materials before he would start compacting. For a landfill site with only one waste compactor machine, this could be a waste of time that would lead to bulk of waste not compacted by the end of the day as is expected. Not only scavengers and salvagers were found on-site, stray animals, especially goats, were observed feeding on the waste and they were a nuisance because they were tampering with waste covering and the compaction process.

4.8 Monitoring of the landfill site

Interviews revealed that there was no proper landfill site monitoring mechanism in place regarding the operational activities on-site. As a result of this situation, it was revealed that the landfill site was posing a threat to the residents residing nearby.

The only mechanism was irregular inspections by either the supervisor or an environmental health officer from the local municipality offices (i.e., Soshanguve municipal offices). Since there was no programme in place to indicate the frequency with which monitoring and auditing of the operations should be done, as well as which specific aspects to be monitored like nuisances, potential hazards and general public health at the site. The focus of inspectors was on the operational activities like waste covering and compaction and on giving health education to the informal salvagers and scavengers.

4.9 Water quality monitoring

Water quality monitoring was not routinely done at the landfill site. Observations revealed that there was no bore-hole on-site which would serve as a source for groundwater sampling point.

Table 2 shows the results of the water quality parameters that were measured from 6 sampling points. Parameters of the control sample (i.e., s-stream-1), complied well with the target water quality range of the water quality guidelines for domestic use which they were measured against (Figure 7-20). Only ammonia nitrogen exceeded the target water quality range of the guidelines (Figure 10). This trend was observed in all samples (Figure 10).

Table 2: Results of the samples taken from both the stream and landfill site as compared to the Target Water Quality Range (Department of Water Affairs and Forestry, 1996)

Parameter	*Target Water Quality Range*	*So – 01*	*So – 02*	*So – Stream – 1*	*Mid – Stream*	*N – Stream – 2*	*N – Stream - 3*
pH	6 - 9	7	7.3	7.2	7.4	7.4	7.4
Electrical conductivity	0 – 70 mS/m	31.7	132	51.9	51.9	65,1	62.3
Total dissolved solids	0 – 450 mg/l	216	786	241	222	279	275
Ammonia nitrogen	0 – 1 mg/l	<0.2	1.7	8.7	8.6	16.3	13.6
Nitrate & nitrite nitrogen	6 – 10 mg/l	<0.2	4.5	<0.2	<0.2	<0.2	<0.2
Nitrite nitrogen	6 – 10 mg/l	<0.2	0.6	0.2	<0.2	<0.2	<0.2
Total alkalinity	Not Applicable	93	82	154	153	193	184
Chloride	0 – 100 mg/l	27	204	35	35	<5	43
Sulphate	0 – 200 mg/l	41	219	30	30	34	34
Calcium	0 – 32 mg/l	18	52	24	25	32	32
Magnesium	0 – 30 mg/l	05	24	06	6	7	7
Potassium	0 – 50 mg/l	10	98	10	10	10	10
Sodium	0 – 100 mg/l	35	92	42	42	49	47
Chemical oxygen demand	Not Applicable	35	72	20	22	47	41

The values for the water quality parameters of both n-stream-2 and n-stream-3 were showing a different situation when compared to the values of other sampling points in the stream. This could be attributed to the fact that there is a tributary that is joining the stream between the mid-stream and the n-stream-2 sampling points. This tributary is flowing across the township and some farm lands. Sampling could not be done at that point due to inaccessibility to the area, therefore it cannot be emphasised with certainty that the tributary has an influence on the quality of water between the mid-stream and the n-stream-2 sampling points.

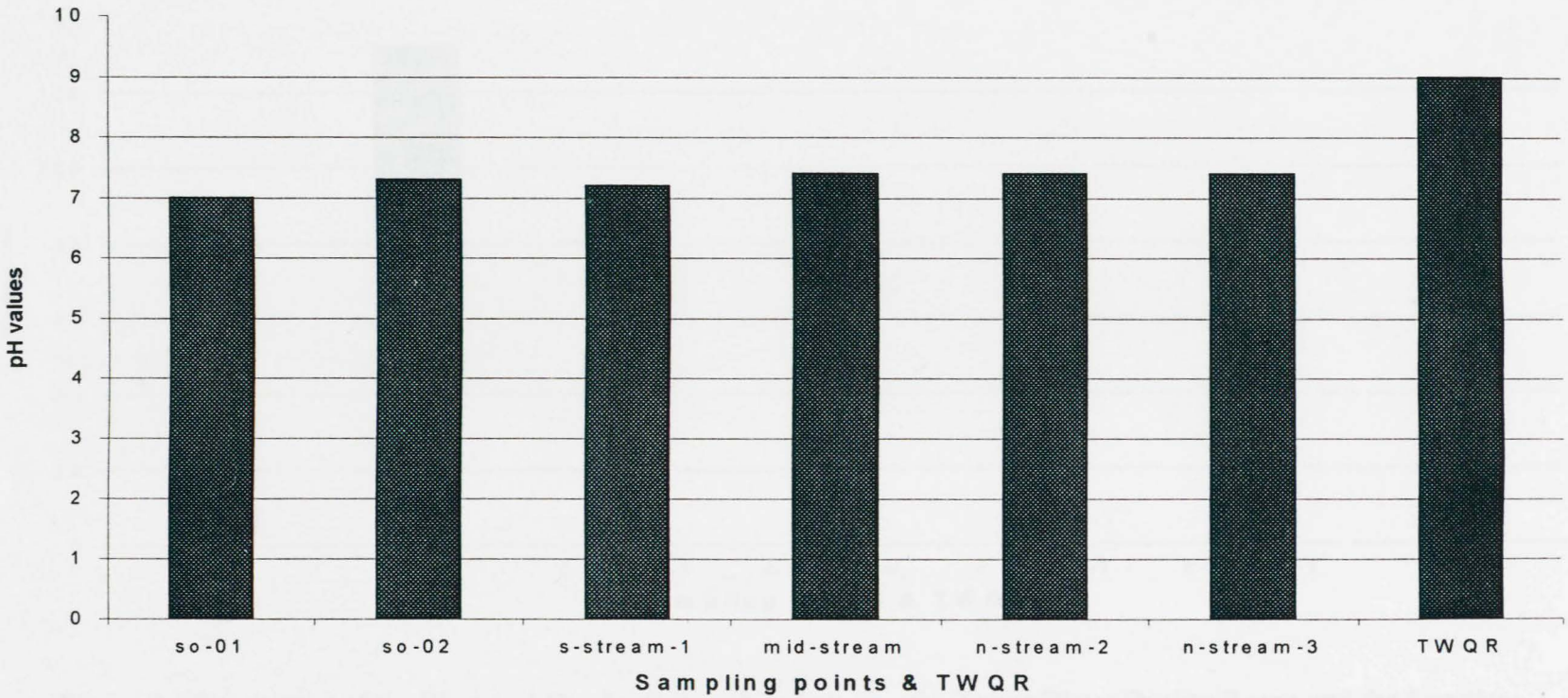


Figure 7. Comparison of the pH values between the Target Water Quality Range and the Samples.

Figure 7 shows that the pH values of the samples from all sites did not differ and were within the acceptable Target Water Quality Range (TWQR).

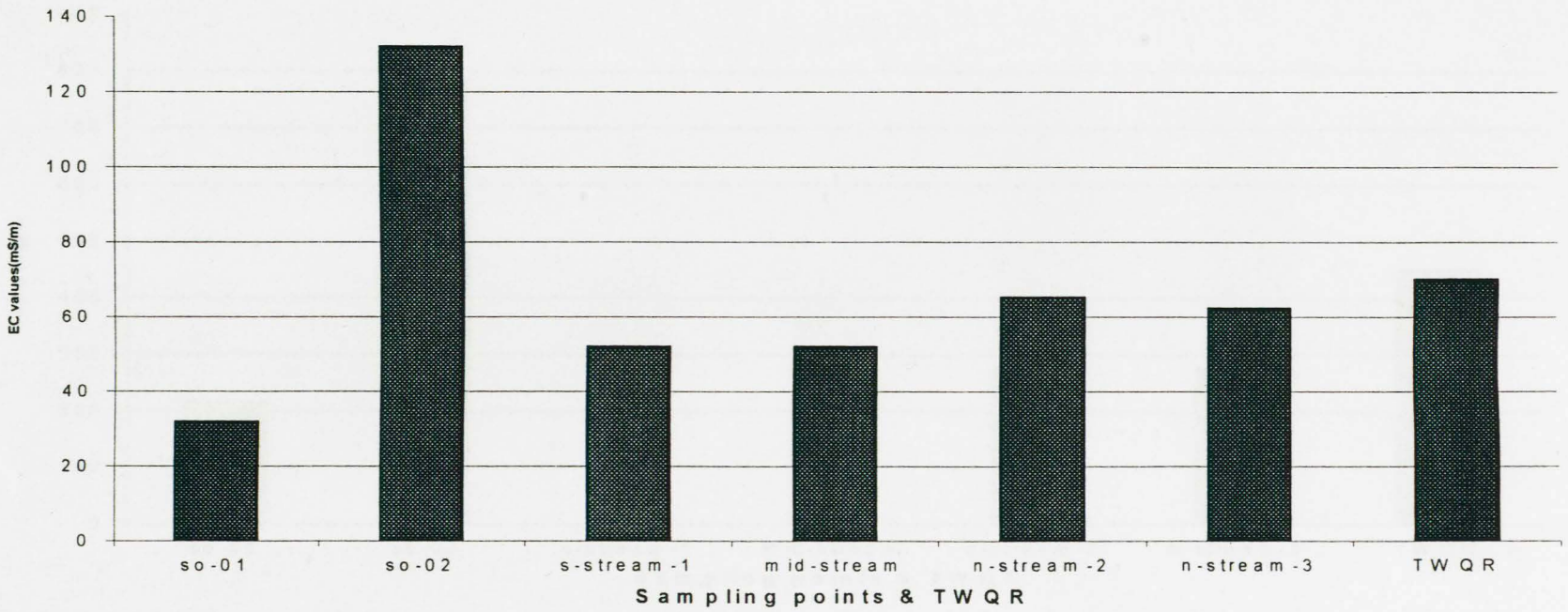


Figure 8. Comparison of the Electrical Conductivity values between the Target Water Quality Range and the Samples.

Electrical Conductivity of So - 02 sample, which was a sample taken from one of the ponds inside the landfill site was much higher than that of all the other sites and exceeded the upper limit of the TWQR. This could be attributed to evaporation and the presence of ions such as Mg, NO3 and CO3, due to seepage of leachate into that water, especially during rainy days, and the presence of dead animals in the water (Figure 8).

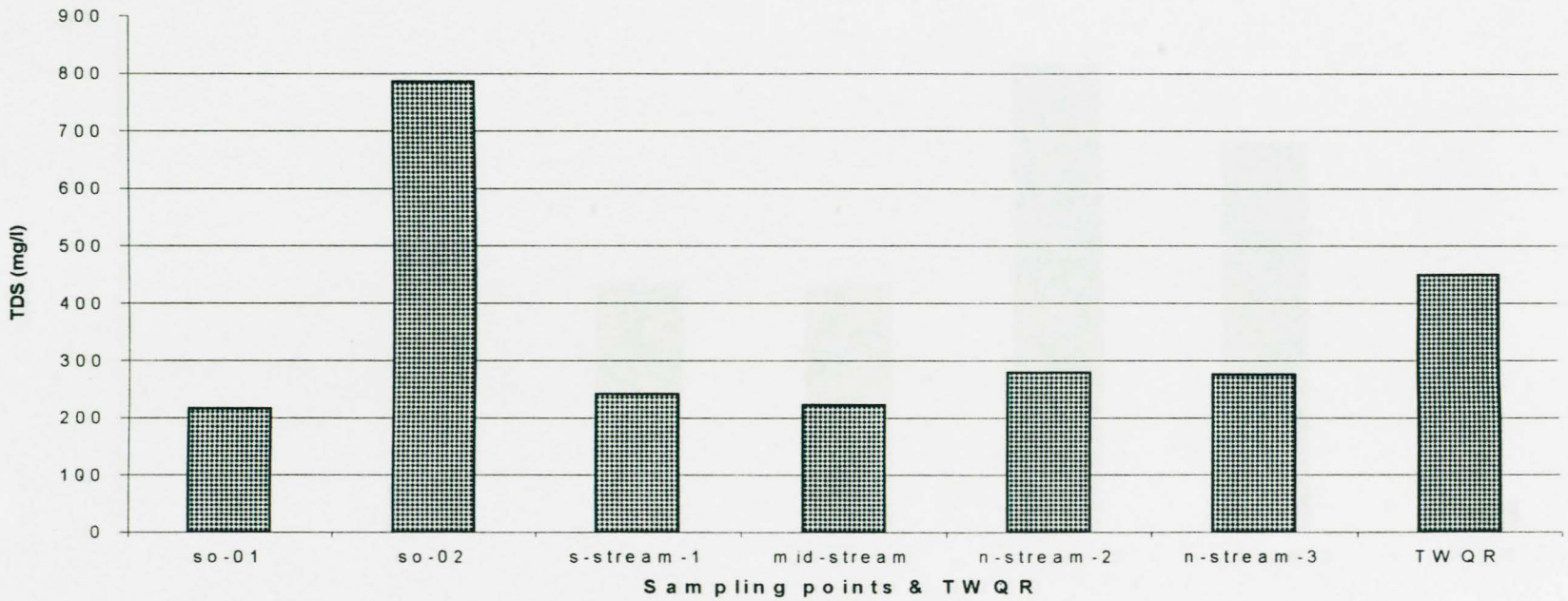


Figure 9. Comparison of the Total Dissolved Solids values between the Target Water Quality Range and the Samples.

The graph indicates that the TDS concentration for all the samples, except So - 02 which had a very high concentration, were within the limits of TWQR. Although this was the case, there is a slight increase in composition downstream to the control (Figure 9).

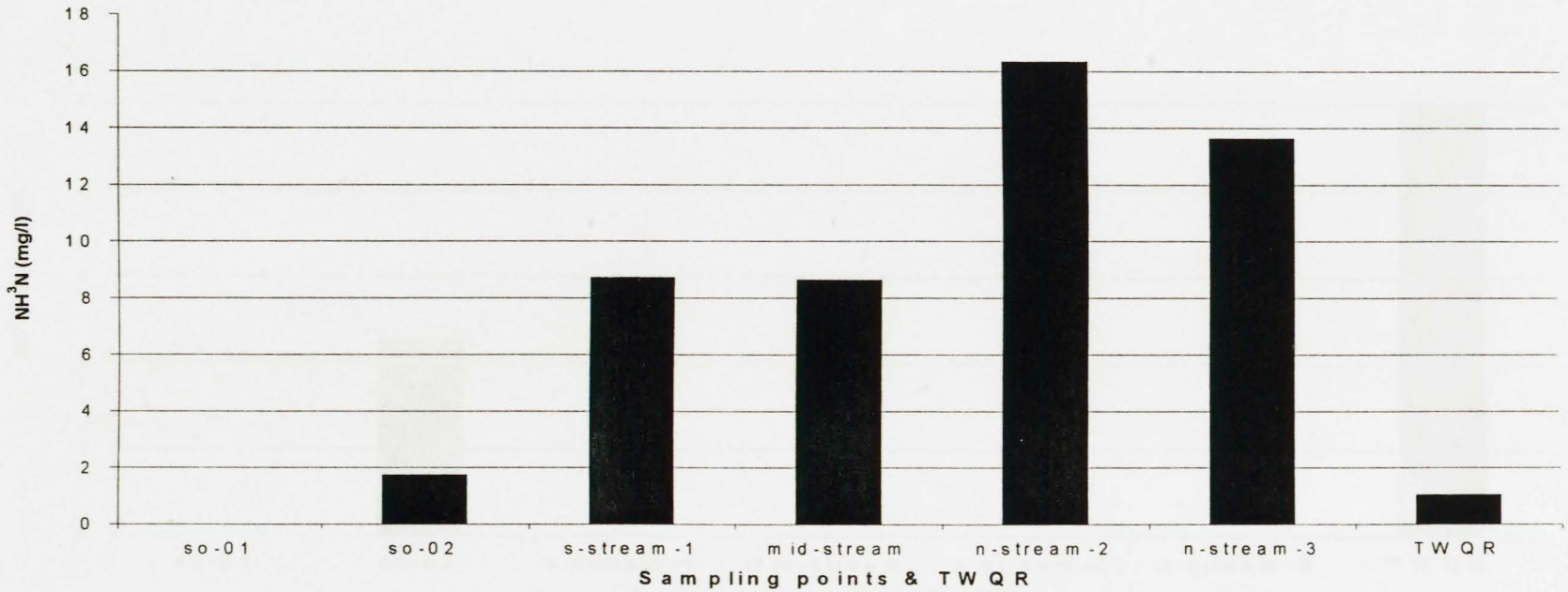


Figure 10. Comparison of the Ammonia nitrogen values between the Target Water Quality Range and the Samples.

Figure 10 indicates that the concentration of ammonia in most of the samples have exceeded the TWQR. Samples n -stream - 2 and n - stream - 3 have exceeded the 10mg/l mark that is a threshold limit. This could be attributed to the incoming water from the tributary that joins the main stream at those sampling points. This tributary is running across the township and farm lands, so it is likely that the water might have come into contact with ammonium salts.

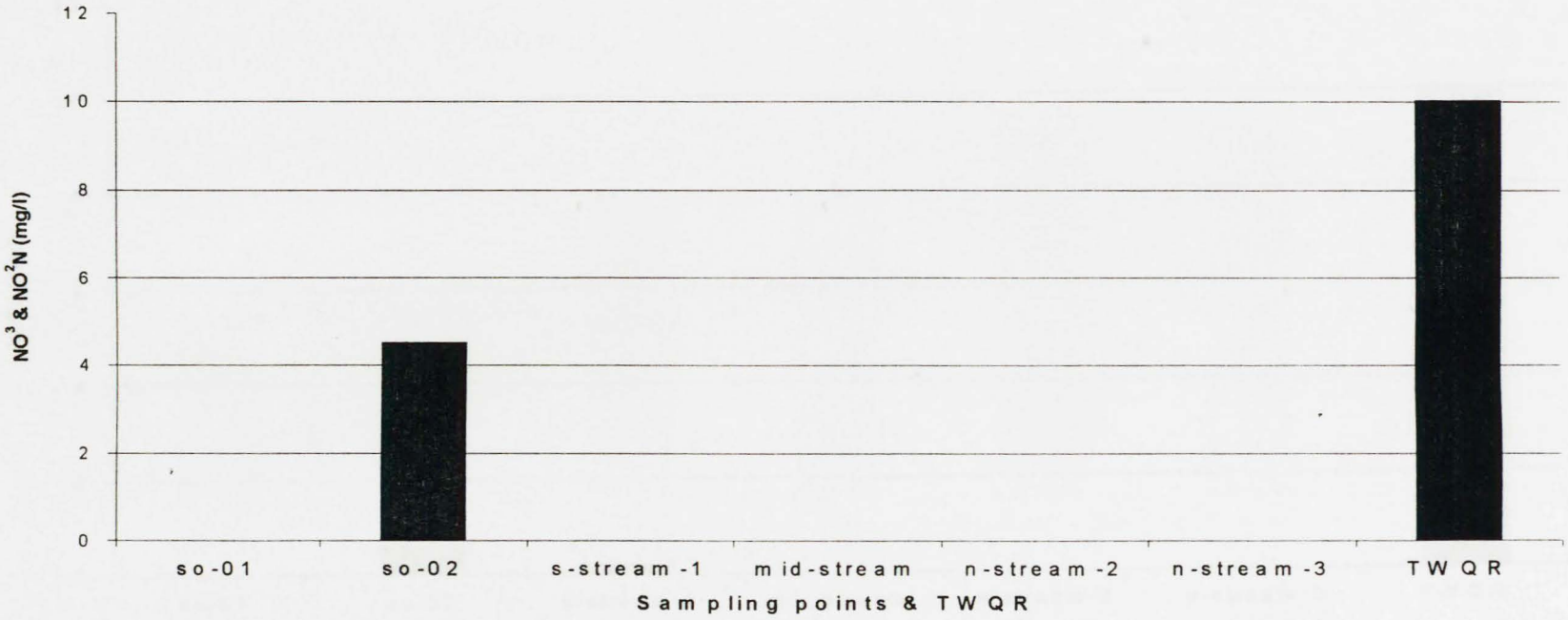


Figure 11. Comparison of the Nitrate and Nitrite nitrogen values between the Target Water Quality Range and the Samples.

Except for So-02, the concentration of Nitrate and Nitrite Nitrogen for all the samples were below 02 mg/l (Figure 11)

The raised concentration in So - 02 could be attributed to organic matter that might have reached it from waste cells through run-off.

The absence of nitrate nitrogen in other sites could indicate that the disposal site has no effect on the water quality of those points.

Figure 12. Comparison of the Nitrite nitrogen values between the Target Water Quality Range and the Samples.

For all the samples, the concentration of Nitrite Nitrogen was below the TWQR (Figure 12). So - 02 had a higher concentration as compared to the rest of the samples (including the control sample). This could be attributed to organic matter which might have gained access into the water through surface run-off as a result of its proximity to waste cells.

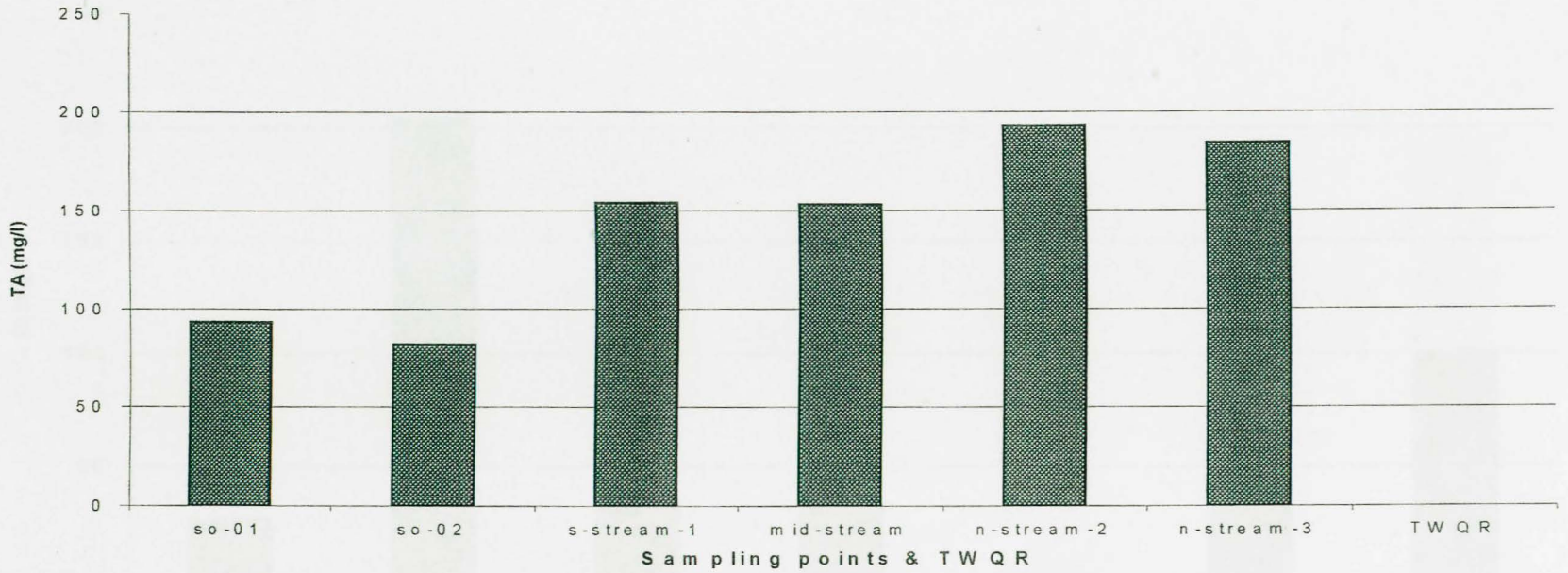


Figure 13. Comparison of the Total alkalinity values between the Control Sample (S-stream-1) and other Samples.

Figure 13 shows that the concentration of Total alkalinity in So - 01 and So - 02 are within the limited concentration level, and the control sample and the mid-stream values were within the maximum allowable concentration (i.e., 150mg/l).

The values at n-stream-2 and n-stream-3 exceeded the threshold limit value. This could be attributed to the tributary that joins the main stream around those sampling points.

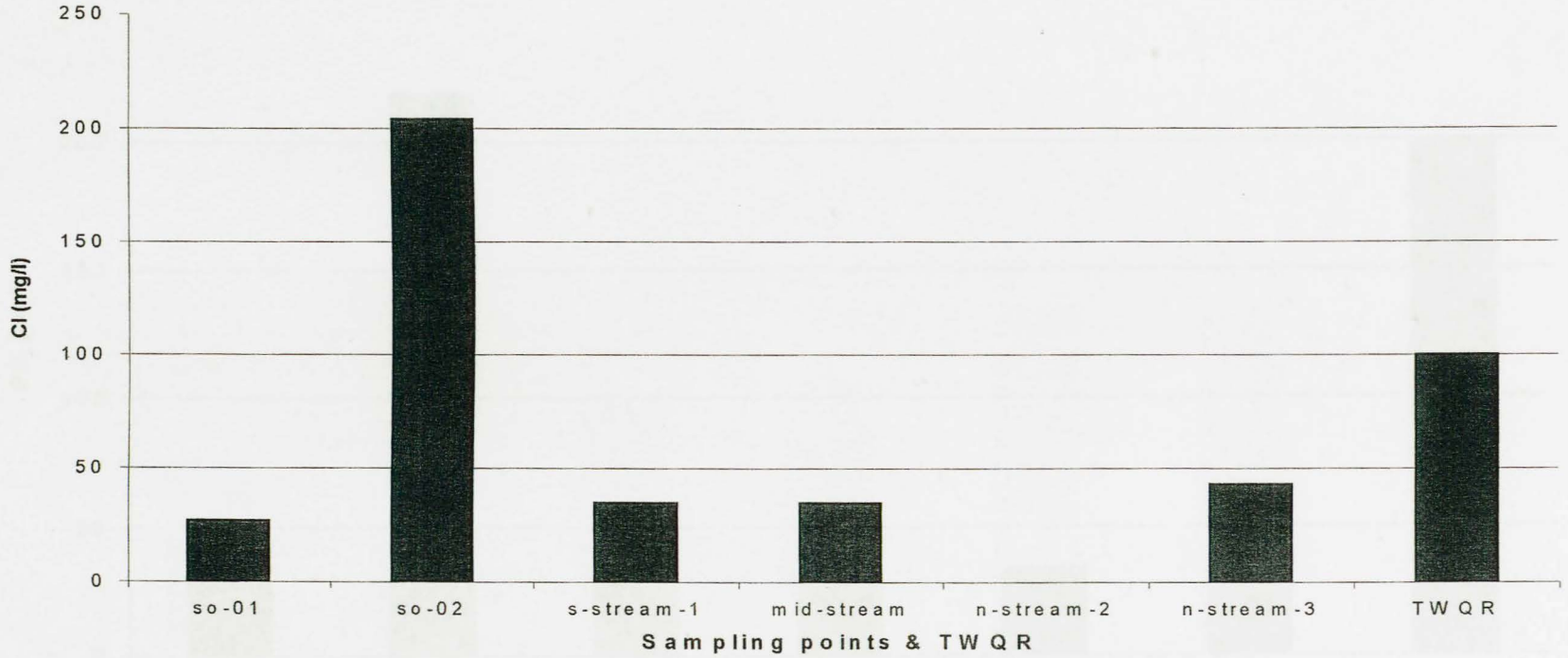


Figure 14. Comparison of the Chloride values between the Target Water Quality Range and the Samples.

All the samples, except So-02 which has exceeded the maximum allowable concentration, had chloride concentration below the TWQR (Figure 14).

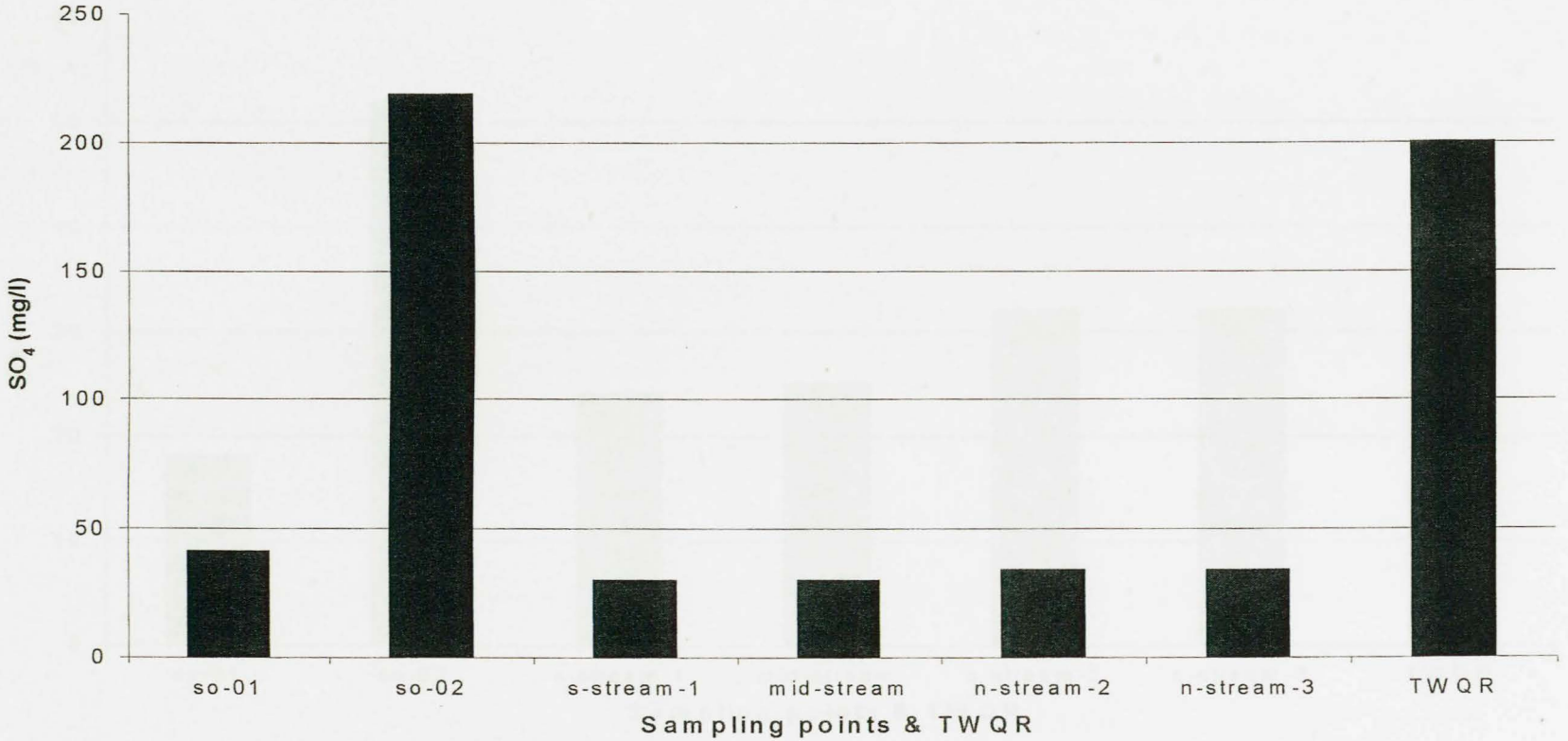


Figure 15. Comparison of the Sulphate values between the Target Water Quality Range and the Samples.

In exception of So-02, all other samples had the Sulphate concentration that was within the allowable limit (Figure 15).

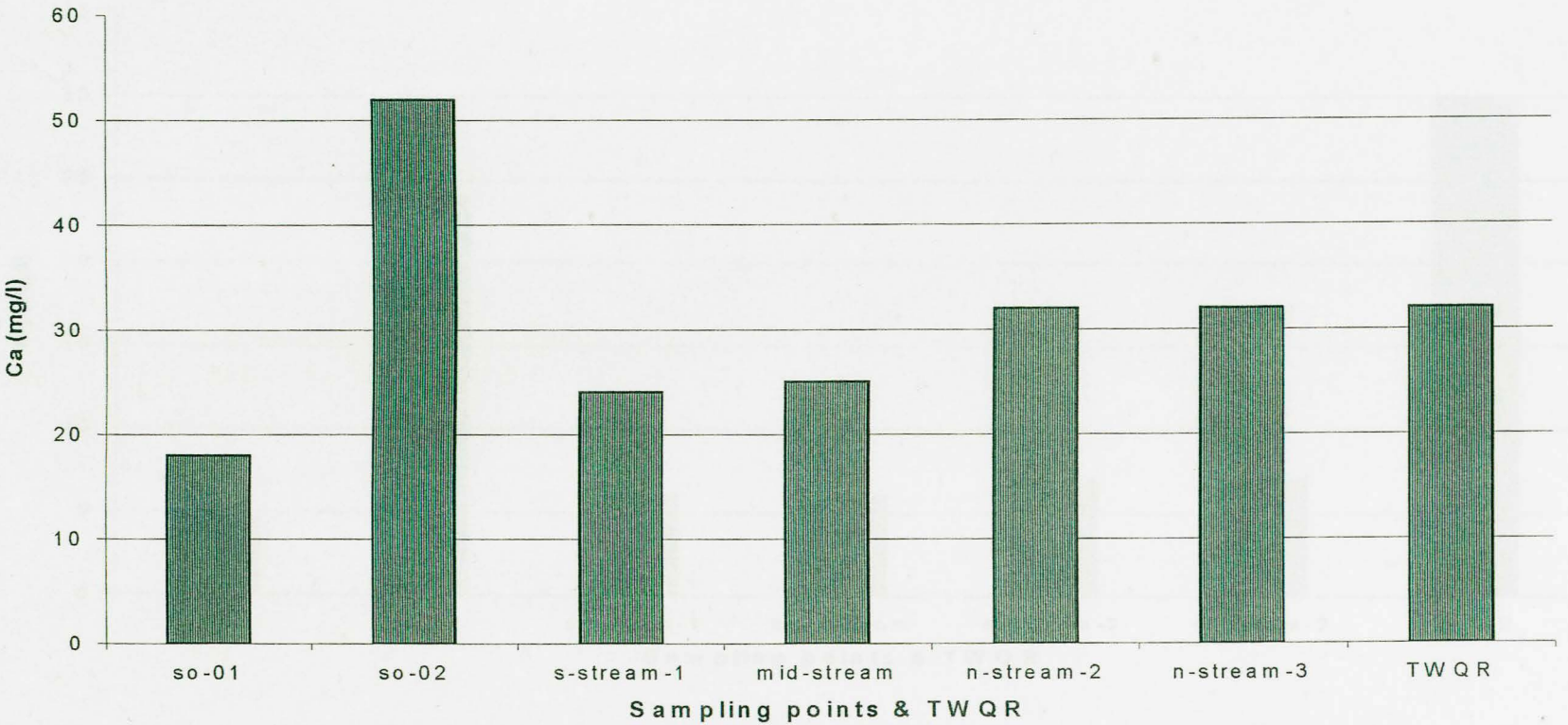


Figure 16. Comparison of the Calcium values between the Target Water Quality Range and the Samples.

Figure 16 indicates that the Calcium concentration of all the samples, in exception of So-02, were within the TWQR.

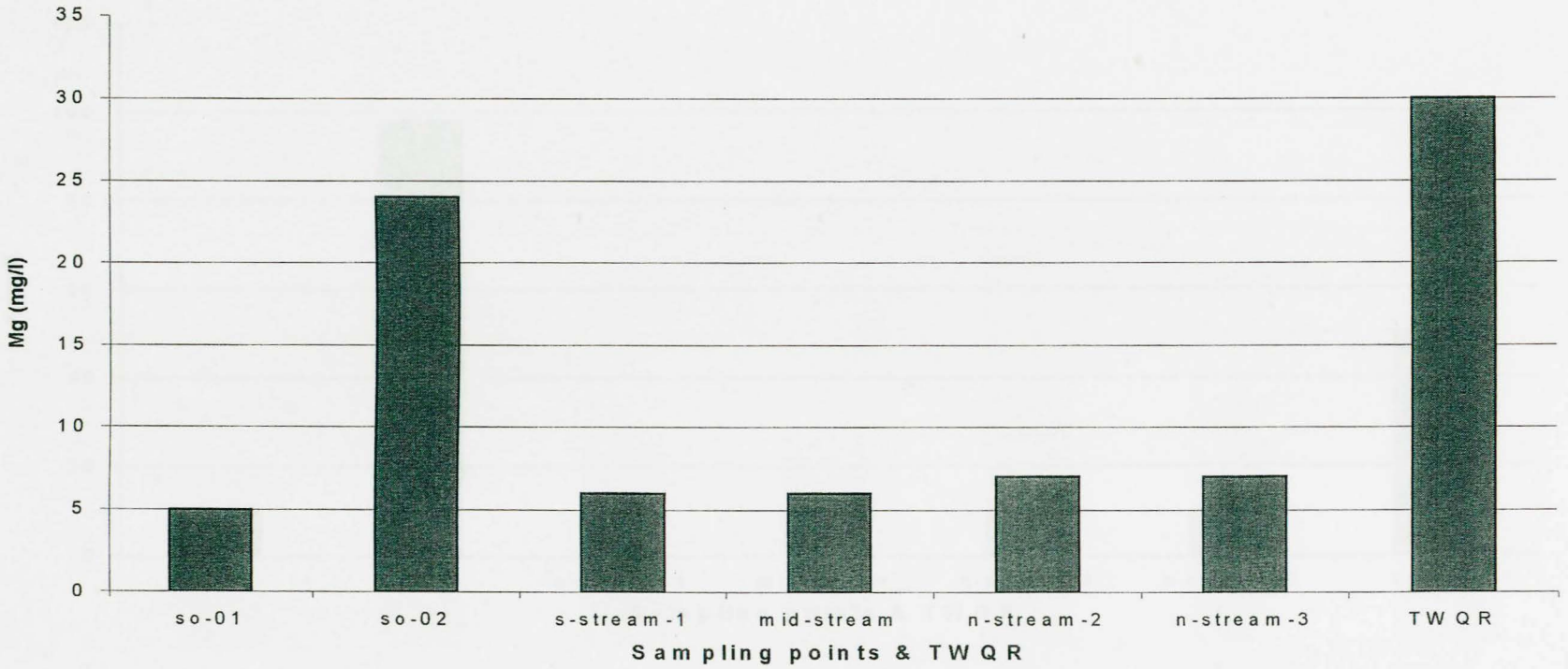


Figure 17. Comparison of the Magnesium values between the Target Water Quality Range and the Samples.

Figure 17 shows that the concentration of Magnesium in all the samples, except So-02, were within the minimum allowable concentration (i.e., 10mg/l).

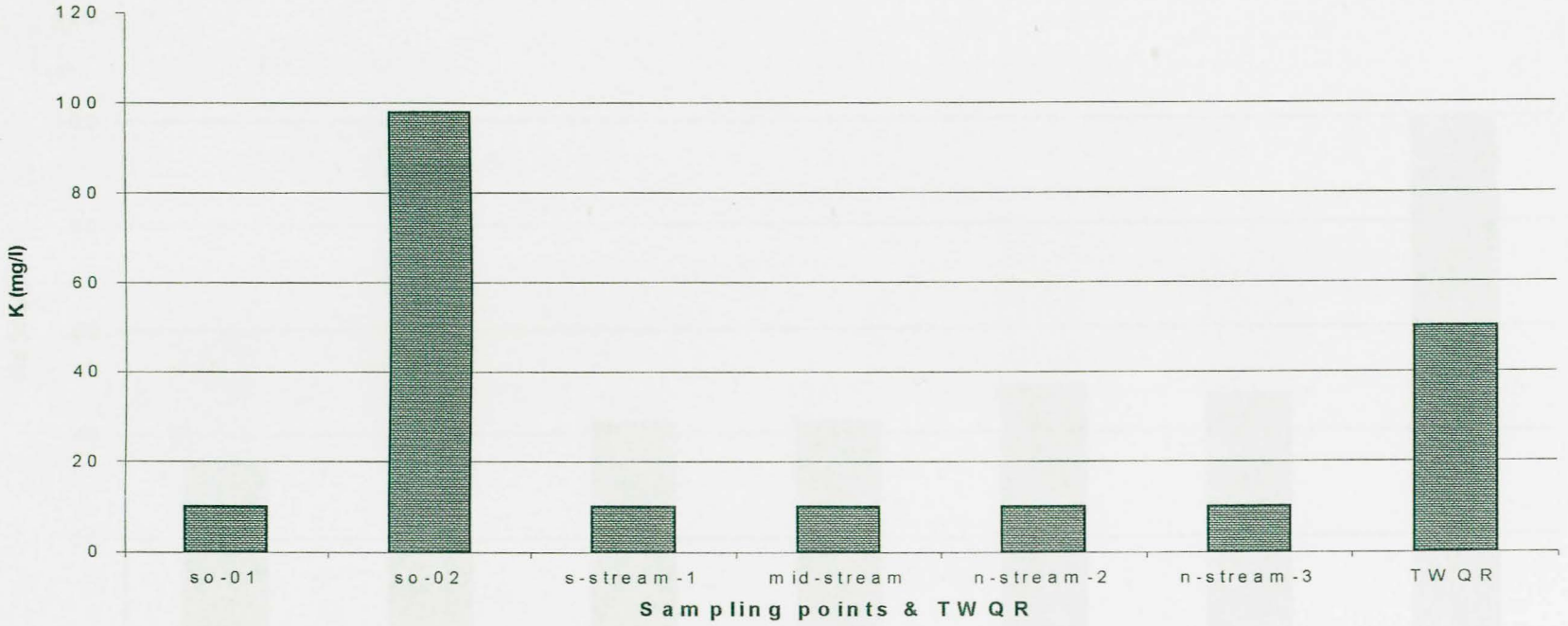


Figure 18. Comparison of the Potassium values between the Target Water Quality Range and the Samples.

Figure 18 shows that Potassium concentration fell within acceptable range and was below the upper limit of the TWQR except for So-02.

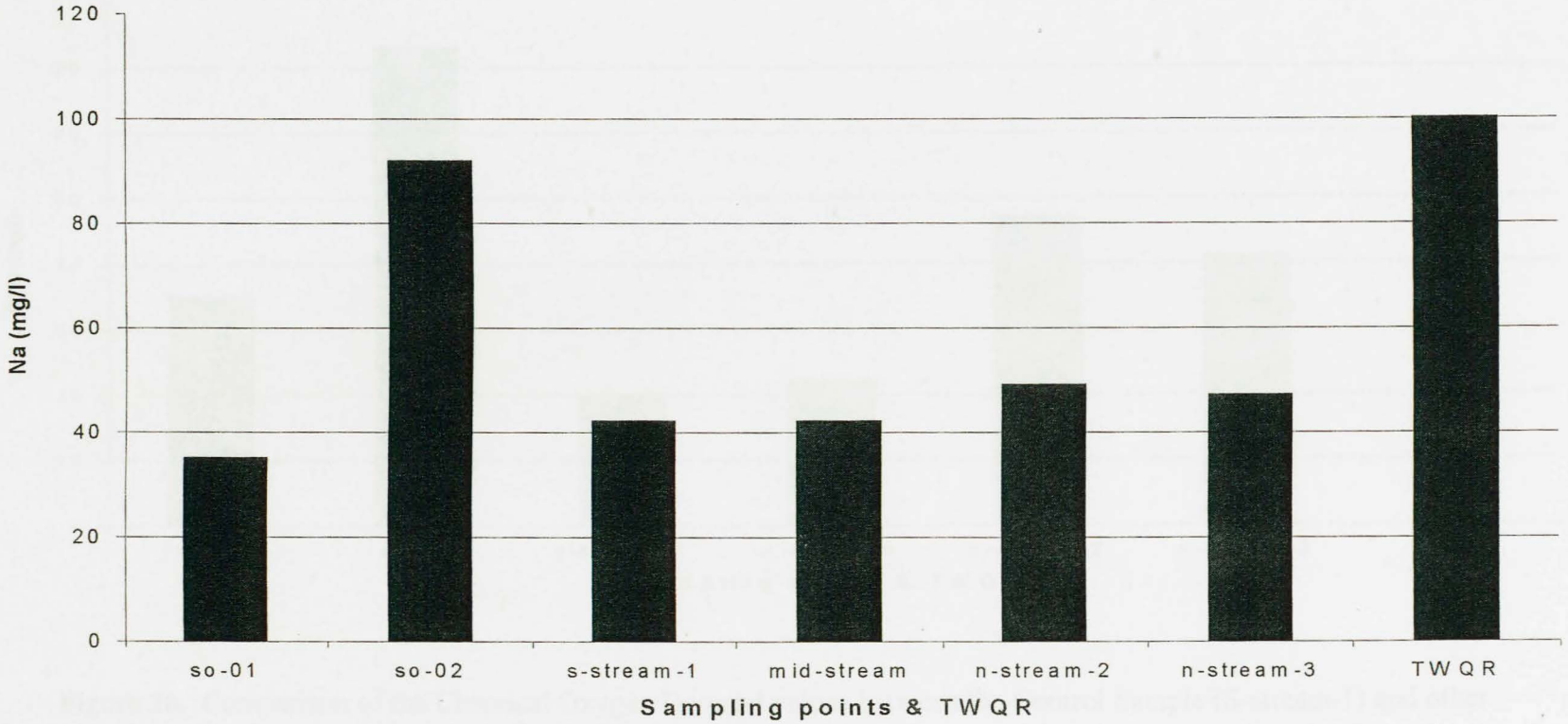


Figure 19. Comparison of the Sodium values between the Target Water Quality Range and the Samples.

The concentration of Sodium in all samples were below that of the TWQR, though the concentration in So-02 was higher than the rest of the other samples (Figure 19). This could be attributed to evaporation of water from which the sample was taken.

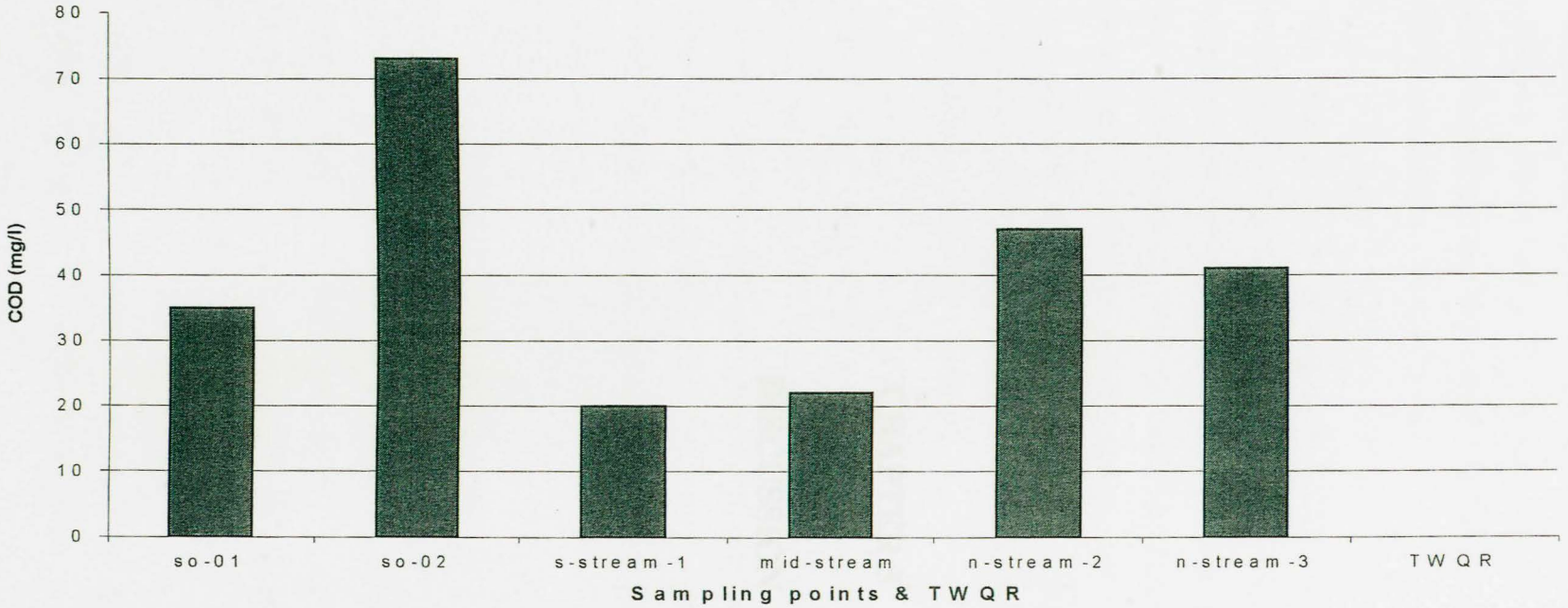


Figure 20. Comparison of the Chemical Oxygen Demand values between the Control Sample (S-stream-1) and other Samples.

All the samples have exceeded the concentration of Chemical Oxygen Demand of the control sample, and So-02 concentration was higher than all other samples (Figure 20).

CHAPTER 5

DISCUSSION

In terms of the Health Act, 1977 (Act No. 63 of 1977), local authorities are responsible and expected to keep their areas and their inhabitants in a hygienic and good state of health. Soshanguve landfill site, as it is operated by Northern Pretoria Metropolitan Substructure (NPMSS), is expected to be operated in an environmentally acceptable manner.

The landfill site is permitted in terms of Section 20 of the Environment Conservation Act, 1989 (Act No. 73 of 1989). This means that the permit was allocated, and the conditions for its operation were stated in the permit. These permit conditions are the minimum requirements the operational activities at Soshanguve landfill site should conform to. Following investigations at the Soshanguve landfill site, the extent to which the operational activities at the Soshanguve landfill site conform to the requirements will be discussed hereunder, and recommendations will be given.

Sound waste disposal management needs formalised and documented work procedures that should be backed by institutional policy. A policy will serve as a tool to guide the workers, explain the required resources and standardise the operations, thus ensuring environmentally acceptable waste disposal. Various aspects of the minimum requirements will form a core component of the discussions.

As it is indicated that all landfills must have a responsible person to ensure environmentally acceptable waste disposal procedures, it was established that there was a responsible person for Soshanguve landfill site working as a technician in the Technical Department.
He was assisted by Environmental Health Officers (EHOs) who received training on waste management.

Landfills should be perceived as health risk areas, and their access should be properly controlled. In order to facilitate waste acceptance and management

procedures, entry into the site should be restricted to the people or vehicles that have come to dispose of waste acceptable to the landfill concerned. At the time of the study, the site was not well fenced in, there was no gate, and access was easy for any one to move in and out. This condition led to a situation where scavengers, informal salvagers and stray animals could easily access the site freely. This situation can have a negative impact on public health and safety of the scavengers and informal salvagers. For these people to fiddle with waste, this pose their health more at risk as there is an increasing home care intervention of terminally ill AIDS patients. Disposable nappies that are lying around can pose health hazards to scavengers as they at times sustain injuries and cuts due to poking waste barehanded. Some of these scavengers and informal salvagers were eating food that they reclaimed from the waste stream. This practice could lead to outbreaks of food borne diseases, food poisoning that could be expensive to treat and may at times cost people's lives.

Stray animals that access the disposal site may get diseased as they feed on some waste materials. This could further lead to contraction of diseases by people who may eat the meat products of those animals that shall have contracted the disease. Despite the efforts of the EHOs, to educate people about the dangers of scavenging, some scavengers visit the landfill site everyday, and therefore increased exposure to waste materials daily. Such exposure could lead to occurrence of chronic diseases due to continuous exposure to the risk factors.

Following reports that hazardous materials were sometimes found on-site and were not removed from the site, instead were buried and covered with soil, could cause potential risks to the scavengers and informal salvagers, since the on-site workers and the responsible person did not receive training on hazardous waste handling. Hazardous waste materials disposed of at the landfill site may not be properly handled and could have negative impact on the environment and public health of the salvagers, scavengers and the on-site workers.

Lack of entrance control identified may result in people disposing of waste at the landfill site during weekends and such waste will not be recorded. This situation may lead to under recording of incoming waste and under estimation of the actual usage of the landfill site, which could affect the life expectancy and planning of the landfill site, as the landfill site could reach its period of closure sooner than it was planned.

Since the landfill site did not have proper fencing, windblown litter had been observed at areas beyond the boundaries of the site, some were seen trapped in and around the nearby stream. The condition has influenced the aesthetic appearance of the area and some litter could serve as a breeding place for rodents. The degree of infestation of both rodents and flies at the landfill site is a course for concern, as it was established that there was no mechanism in place to either prevent or control such verminous conditions.

Even though it is a requirement that adequate and suitable facilities should be provided at the landfill site to ensure environmentally acceptable waste disposal at all times. Local authorities in the country have financial constraints and some are unable to fulfill some of the waste disposal requirements. Though this is the situation, local authorities have a legislated obligation to ensure good hygienic conditions and a healthy environment for its inhabitants.

It was established during the interviews and the observations that there is only one front-end loader that operates at Soshanguve landfill site for waste compaction and covering. Even though the interviews have revealed that there was a contingency plan for breakdowns, it was observed that such a plan was not working properly as problems were identified where waste was not covered and compacted for some days as a result of breakdowns.

The situation contributed to the presence of scavengers and informal salvagers on-site because waste was not covered, and they could reclaim some waste materials. The condition contravened the principle of sanitary landfill whereby waste should be compacted and covered daily, and which, in terms of the Minimum Requirements, should be practiced at all times. Following these observations, it was also noted that services like potable water supply and sanitary facilities were not provided, and that scavengers and informal salvagers were defecating in the bush. This could have an influence on the health of the environment and the people residing around the landfill site, and the workers on-site as they may contract diseases, either airborne or waterborne, as a result of inhaling microorganisms or consuming polluted water. The environment can be affected through surface run-off, whereby human excreta could be wiped off into the nearby stream especially during heavy rainfalls.

Landfill site should have proper sign posting to ensure effective traffic control on-site. This will prevent unnecessary accidents and will discourage indiscriminate waste disposal on-site as the working face on-site would be easily identified. Observations revealed that there were no signs erected on-site which could direct vehicle drivers appropriately, instead that was done by the on-site worker who was also recording the incoming waste.

The practice was a problem because the worker did not have time to establish the type of incoming waste and it could be possible that some of the waste was hazardous and could not be noticed. A general notice board that is supposed to be erected at the site entrance was not available. This created a problem as it was not clear to the people who want to use the landfill as to what type of waste is acceptable and what type of waste is not acceptable, what are the days and hours of operation. This situation could lead to dumping and indiscriminate disposal of waste materials next to or inside the landfill site without recording it.

Recording of waste coming into the landfill site is a requirement for all landfill site and that was observed at the Soshanguve landfill site. Observations revealed that the weighbridge was not available and waste was recorded by means of the capacity of the vehicle. There is a concern regarding the accuracy of the volume of waste disposed of, since the person who was recording incoming waste did not establish whether the vehicle was full to capacity or not.

The practice could lead to inaccurate recording of waste volumes, and that could lead to over estimation or under estimation of the usage of the landfill site. This situation can in turn have a negative impact on the life expectancy of the landfill site as well as the planning process connected therewith.

Landfills should be operated in accordance with the operational plans. This will involve among other factors, cells operations, drainage, monitoring and sanitary landfill. It was observed that the principles of sanitary landfill (i.e., waste compaction and cover) were practiced at the site but not adequately. According to these principles, waste must be spread in thin layers and compacted by a purpose-built compactor and not with a front-end loader as it was the case at Soshanguve landfill. Furthermore, waste must be fully covered at the end of each working day. This was not happening at Soshanguve landfill as waste was at times, left uncovered for more than a day.

The practice had caused fly breeding, rodent infestations and emission of objectionable odour. Due to lack of proper fencing, the spreading of wind blown litter in the surrounding areas was evident. This situation could lead to occurrence of diseases such as trachoma, leptospirosis, and plague. It could also lead to psychological stress to those people in the neighbourhood.

The working face, which should be kept small, was very big and the cover material, which should be readily available and sufficient to cover one week's waste, was insufficient to cover the waste material entirely at the end of the day.

Insufficient cover material could be attributed to a shortage of vehicles and staff to transport the cover material from the quarry to the disposal site. Only one truck was assigned to do this work.

The waste at Soshanguve landfill site was disposed of through cell operations, which is an effective, efficient and manageable method. It was observed that some cells like wet weather cells and special cells for putrescible general waste, which need be constructed to use during rainy days and for disposing rapid decomposing organic waste materials, were not available. This situation could lead to illegal dumping of waste outside the landfill site during rainy days as a result of lack of easy access into the site. Putrescible waste was observed on-site and it was not covered, this promoted scavenging because the scavengers cooked those meat products and ate them, and that could cause food poisoning and may lead to death of those people.

Even though it is a requirement that any sporadic leachate should be reported to the Department of Water Affairs and Forestry, and be properly controlled, observations showed that, leachate did flow through the waste stream (i.e., toe leachate) and this was not controlled. The condition created a problem because that leachate made the working face to be muddy, thus made it difficult for waste collection vehicles to off-load waste at the site.

The principle of landfill site drainage states that up-slope run-off water should be diverted away from the waste, to prevent water contamination and to minimise leachate generation. It was established during the interviews that water drainage systems were constructed at Soshanguve landfill site but they were not seen during the observations. It was further observed that water collection ponds were too close to the working face. Waste, especially windblown litter, was seen trapped in the water.

The water had developed a green-blackish colour, giving anaesthetic appearance, and was smelling terribly bad. This could be attributed to the decomposition of animal carcasses in the water, such as dead dogs and mice, which were seen floating in the water. The water quality results of one of the collection ponds (i.e., So-02), have indicated that almost 95% of the water quality parameters tested, were above the concentration level of the TWQR. This is a course for concern since it was established during the observations that some people on-site were washing their belongings in that water, and such people may develop some skin related diseases or conditions because the water was highly contaminated and there was no control regarding access to such water.

The retention dams should be properly constructed and access to them should be managed accordingly. These should be constructed at a reasonable distance from the working face, to ensure that waste does not reach the water easily. Water should be contained on-site as it is a Minimum Requirement. In addition, water should be sampled at regular intervals to detect any potential risk factors and to implement prevent or control measures.

Regular sampling and analysis of leachate, ground and surface water, and the interpretation of the findings, should be ensured by the permit holder. During interviews, it was reported that there was one bore-hole on-site which was not confirmed by the observations. The Minimum Requirements stipulate that there should be three bore-holes in a landfill site of the size of Soshanguve landfill site which should be used to monitor groundwater quality with a view to detect any pollution due to the landfill site operations.

It was established during the interviews that there was no water sampling programme in place for both surface and groundwater at Soshanguve landfill site. The impact of Soshanguve waste disposal site on the quality of both surface and groundwater was impossible to detect and the permit holder did not take the responsibility, as required by the Department and the Minimum Requirements, to

ensure that water quality monitoring was done. That situation could be a problem since South Africa is a water scarce country as the landfill site may cause irreversible damage to those water sources through pollution, and therefore render them unsuitable for their intended use.

Following the results of the water sampling done for this study, it was established that water samples taken from the stream did not detect any significant relationship between the water quality in the stream and the landfill operations in terms of pollution. However, it should be borne in mind that those results have some limitations. The samples were taken on a once-off basis. This means that factors such as seasonal variations (i.e., dry and wet seasons) were not considered. The sampling points were not repeatedly sampled so as to ensure validity of the sampling process. The sampling process was carried out so as to prompt for further and continuous sampling of water.

Water quality monitoring should, as a Minimum Requirement be done on a six monthly basis to ensure that a number of sets of results become available to assist in the assessment of the impact of the landfill site on the environment. Records of monitoring results should be maintained and should be made available to the interested and affected parties or to the landfill site monitoring committee, if required.

Sampling points for the stream should at least be at the upstream to provide ambient background values, middle stream and down stream so as to detect any pollution resulting from the site. Sampling points should be selected at representative, and easily identifiable sites.

Collection of surface water on-site should be discouraged as it may become polluted and may infiltrate and percolate through the soil and the bed rock, and contaminate the groundwater. To address this problem on a short-term, water that collects on-site could be drained by using a sewage tanker as soon as it collects

on-site and could be transported to the sewage purification plant. Permit for such practice is could be obtained at the Department of Water Affairs and Forestry. Installation of storm water drainage systems, erection of cut-off trenches up-slope to divert run-off around the site, or the construction of a lined collection dam should be considered as medium and long-term solutions.

The drilling of bore-holes at the site should be considered seriously. This is normally done by a qualified contractor, preferably accompanied by a hydro-geologist. This is for logging the bore-holes and to make sure that the information pertaining to water strikes, geology of the area, bore-hole depth, water level in the bore-hole after drilling, construction details, and the type and depth of casing is maintained, and should be made available to the interested and affected parties or the landfill site monitoring committee, if required.

The permit holder is expected by the Minimum Requirements to ensure that all the landfill operations are carried out in strict conformity with the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) to provide for the health and safety of persons at work, and the protection of persons other than persons at work against hazards to health and safety arising from landfill operations.

Interviews revealed that the workers at the site were provided with protective clothing and that there was a mechanism in place to ensure that the workers do wear these at all times at the site. Observations at the site showed that site workers did not wear their protective clothing. This situation could pose a health risk since the workers are exposed to waste on a regular basis, especially that they have never been taken for medical examination before, and do not undergo routine medical check ups as it is required that they should, so that their health status could be known by the permit holder.

Observations at the site showed that scavengers and informal salvagers could cause hazards and accidents due to burning of waste and reclaiming waste whilst

the operator of the compactor is covering waste. This could result in explosions of flammable canisters, or accidents could occur where trucks or a compactor could run over the scavengers.

To prevent hazards or accidents due to the presence of scavengers and informal salvagers, scavenging should be discouraged and salvaging on-site should be formalised in the permit conditions and the health and safety of salvagers should be maintained by the permit holder. Alternatively, a transfer station should be constructed to allow waste reclamation to be done at that site. The latter will be the best since there shall be no interference with the operations at the site by salvagers and it will be done appropriately and it shall be easily monitored.

Waste disposal management is a dynamic challenge due to the impact it has on both human health and the environment if not properly done. It needs a pro-active approach which includes among other factors, capacity building at various levels of the civil society and across various sectors, research and knowledge base development. The fact that there was disparities regarding education and training of the workers involved in waste disposal management at the Soshanguve landfill site, whereby some workers were given formal training and others were given informal training, is a course for concern. All workers who are responsible for waste disposal should be subjected to relevant and continuous training processes to ensure environmentally acceptable waste disposal.

Workshops should be organised to improve the level of knowledge of the workers regarding waste disposal management and to inform them about the potential impact of improper and ill-managed waste disposal procedures. This will enable the workers to be able to detect the problem areas easily and timeously, thus enabling immediate implementation of control measures.

Since it is a requirement that all landfills should be monitored, either through audit or inspection, it was established during the interviews that the site was

monitored through inspections by the officials from the Greater Pretoria Metropolitan Council, Department of Water Affairs and Forestry and Environmental Health Officers from the NPMSS. This was done on an irregular basis because there was no monitoring programme in place which could serve as guideline for proper monitoring of the landfill site.

Monitoring of a landfill site should, for it to be effective and efficient, involve the community through public participation. It was also established that there was no public participation in the monitoring of the site which, according to the Minimum Requirements, should be implemented through a Landfill Monitoring Committee.

This situation could cause public resistance regarding waste disposal operations. Landfill Monitoring Committee should be established and public participation should form part of the landfill monitoring. This will ensure that the monitoring of access control, identification of the types of waste disposed of at the site, leachate management, air and water quality complaints about the site, any investigations and remedial actions required on the site, are attended to. It will further ensure that the public is kept informed of activities or developments on the site and consensus information is properly disseminated to interested and affected parties. This committee could also facilitate campaigns on awareness and health risks associated with landfill sites and could also address the issue of making scavengers aware of the dangers associated with scavenging.

CHAPTER 6

CONCLUSION AND GENERAL RECOMMENDATIONS

6.1 Conclusion

The study has addressed its specific objectives. Following investigations conducted at the landfill site, it is apparent that the NPMSS tries to implement some of the Minimum Requirements, but would still strive to cover some areas that are found to be lacking, not implemented or addressed properly. However, credit should be given to the NPMSS for the efforts it puts in attempting to ensure environmentally acceptable waste disposal, regardless of the constraints it has like insufficient resources and equipment.

The authority has managed to successfully meet some Minimum Requirements, such as registration of the landfill site, availability of a responsible person, proper maintenance of records, and availability of the source of waste cover material. Some Minimum Requirements were not implemented to the satisfaction of the stipulated standards, and they include personnel training, recording of waste, waste covering and compaction, availability of machinery, monitoring of incoming waste, provision of storm water drainage, and monitoring of the landfill site.

There were some Minimum Requirements that the operational activities at the landfill site have not complied with. These include monitoring of the quality of surface and groundwater, provision of drinking water and toilet facilities, sign posting, enforcing the use of personal protective clothing by the on-site workers, and access control which is very crucial.

6.2 Recommendations

In the light of what has been concluded, the following measures are recommended for the sustainability of environmentally acceptable waste disposal operations. It is recommended that;

the NPMSS should take an initiative to address, as a priority, the issue of access

control, as well as to explore the introduction of a 24hour security service to ensure uninterrupted operational activities, and safety of municipal property at the landfill site.

that the possibility of establishing a transfer station be considered by the NPMSS, as this has vast advantages. The advantages could be that waste recovery process will take place at that facility and not at the landfill site anymore. This could eliminate the presence of scavengers and informal salvagers at the disposal site. Furthermore, the principles of sanitary landfilling, whereby waste should be compacted and covered on daily basis, could be adhered to. The exact recording of the actual volume of waste disposed of could be ensured, and the life expectancy of the site could be estimated more accurately. This would help the officers to establish whether the landfill site is being over-, moderately-, or under utilised, and the plans around the usage of the landfill site could be determined and implemented properly.

that a landfill monitoring committee should be established, and community members should be part of the committee to address the complaints due to the operations at the site as well as to disseminate information on the impact of waste disposal on the environment and human health.

Over and above all these, there should be training programmes in place for the workers to keep them updated on the mechanisms of proper waste disposal management. This could be in a form of workshops (informal training) or short courses (formal training).

Workers should be taught about the importance of the use of personal protective clothing (PPC) and be encouraged to use them at all times, and they should be involved in the selection of those PPC which they will feel comfortable with.

CHAPTER 7

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IN-DEPTH INTERVIEW GUIDE *(APPENDIX 1)*

NAME OF THE INTERVIEWER	
NAME OF THE INTERVIEWEE	
DATE OF THE INTERVIEW	

A. DEMOGRAPHIC DATA

1. Sex	

2. Age	

3. Date of Birth	

4. What is your highest school qualification?	

5. What other courses have you done?	
6. Occupation	

B. KNOWLEDGE ON WASTE MANAGEMENT

7. Is there any national waste management policy in place?

Prompt - If yes, is everyone in waste management following it?

8. Are there any other policies in different provinces which different municipalities are following?

Prompt - If yes, which policy (ies) does your Metropolitan Substructure follow for Soshanguve landfill site?

9. Have you attended any workshop on waste management?

10. What other aspects of waste management do you know?

C. LANDFILL SITE INFRASTRUCTURE

11. Is the landfill site well fenced?

Prompt – If no, how is it?

12. Is the site provided with toilet facilities?

Prompt - If yes, what type?
- Are they sufficient?
- If no, what is the problem?

13. Does the site have drainage system (e.g. storm water drainage)?

14. Are there any boreholes on-site?

Prompt - If yes, are they operational?
- How many are they?

15. Is there any potable water supply facilities on site?

Prompt - If no, where do the workers on-site get the potable water from?

16. Does the site have the weighbridge?

D. ACCESSIBILITY INTO THE SITE

17. Is access into the site controlled?

Prompt - If yes, Who controls it?

18. Do you have scavengers on-site?

Prompt - If yes, do you experience problems with them?

- If yes, what are the problems?
- What is being done to overcome the problems?

19. Is there salvaging taking place on-site?

Prompt - If yes, does it give problems?

- If yes, what are the problems?
- What is being done to overcome those problems?
- Are they aware of the dangers of being exposed to the waste materials?
- If no, what is being done to make them aware?

20. Are there any people staying on-site?

Prompt - If yes, do they cook and eat on-site?

- If yes, was is being done about it?

4. HUMAN RESOURCES AND EQUIPMENTS

21. How many workers are in charge of waste disposal?

Prompt - How are they being categorised?

- Do they cope with their work load?

- If no, what are the problems?

22. Do you have the necessary equipment?

Prompt - If yes, are they sufficient?

- If no, what is the problem?
- Do you encounter breakdown of machinery at some stage?
- If yes, what do you do in that instance ?
- Do you have a contingency plan in place?

E. OPERATIONAL ACTIVITIES ON-SITE

E.1. Solid Waste

23. What disposal methods do you use at your landfill site?
e.g. cell; trenches

24. Do you cover your waste?

Prompt - If yes, how often?

- Which cover material do you use?
- Is the material sufficient?
- If no, what is the problem?

25 During rainy days, is the site conducive for waste disposal?

Prompt - If no, what is the problem?

26 Do you compact your waste?

Prompt - If yes, how often?

- What do you use for waste compaction?

27 Do you measure waste that enters the landfill?

Prompt - If yes, how do you measure it?

E.2. Water Quality Monitoring

28 Do you take water samples?

Prompt - If yes, for what analysis? (i.e., chemical or bacteriological)
- What are your sampling sources?
- How often do you sample?
- What do you do with the sampling results?

F. OCCUPATIONAL HEALTH AND SAFETY

29. Is the site provided with signposts?

Prompt - If no, how is the movement being controlled?

30. Are the workers provided with personal protective clothing?

Prompt - If yes, are the workers using them regularly?
- If no, what is the reason

31. What are the potential hazards on-site?

32. What are the potential nuisances on-site? I.e., flies, cockroaches rodents

G. MONITORING OF THE LANDFILL

G.1. Inspection of Waste Material

33. Do you establish the type of waste entering the landfill site?

Prompt - If yes, How do you establish the type of waste entering the landfill site?

34. Do you sometimes receive hazardous waste into your landfill?

Prompt - If yes, what do you do?

G.2. Keeping of Records

35. Do you record the daily waste statistics?

Prompt - If yes, how do you record them?

- How do you keep them?
- Which variables do you keep statistics of? I.e., volume of waste entering the site; volume leaving the site due to recovery; complaints; accidents; injuries

G.3. Auditing of the Landfill Site

36. Are the landfill site operations being audited?

Prompt - If yes, who audits?

- How often does auditing take place?

H. MONITORING OF LANDFILL SITE OPERATIONS

37. Do you do the monitoring of operations on site?

Prompt - If yes, what control measures do you have in place?

- What problems are you encountering?

38. Do you think the landfill site is likely to impose any health hazard to residents in the nearby communities?

Prompt - If yes, which hazards are likely to be imposed?

- What do you do to control them?

39. Do you think the landfill site is likely to cause any damage to the environment? I.e., rivers.

Prompt - If yes, what damage could be caused?

- What do you do to control them?

I. TRAINING AND DEVELOPMENT

40. Do you have training programmes for waste management in place?

Prompt - If yes, what type(s) of training programmes do you have?

41. What are your short-term plans regarding improving landfill operation?

42. What are your long-term plans regarding improving landfill operation?

43. What do you regard as obstacles or limitations in your landfill operation?

Prompt - How do you plan to address these limitations?

- Do you plan to involve the community in waste management, especially waste disposal?

- If yes, how do you plan to involve them?

OBSERVATION PARAMETERS *(APPENDIX 2)*

Observation will focus on the operations at the Soshanguve landfill site. The following variables will be observed,

1. The fencing of the site and access control into the landfill site.

2. The availability of toilet facilities
   - ñ the number and type of the toilets
   - ñ their condition

3. Availability and number of bore-holes

4. Availability of storm water drainage.

5. Availability of potable water supply facilities on-site.

6. Presence of scavengers / salvagers and their activities at the landfill.

7. Evidence of Squatting on-site.

8. Type and number of machinery used on-site.

9. Methods of waste disposal (e.g. cell or trenches).

10. Availability of sources of waste cover material.

11. Frequency and manner of waste covering and compaction.

12. Availability of signs on-site.

13. Usage and availability of Personal Protective Clothing.

14. Potential hazards and nuisances on site.

15. Recording of incoming and reclaimed waste.

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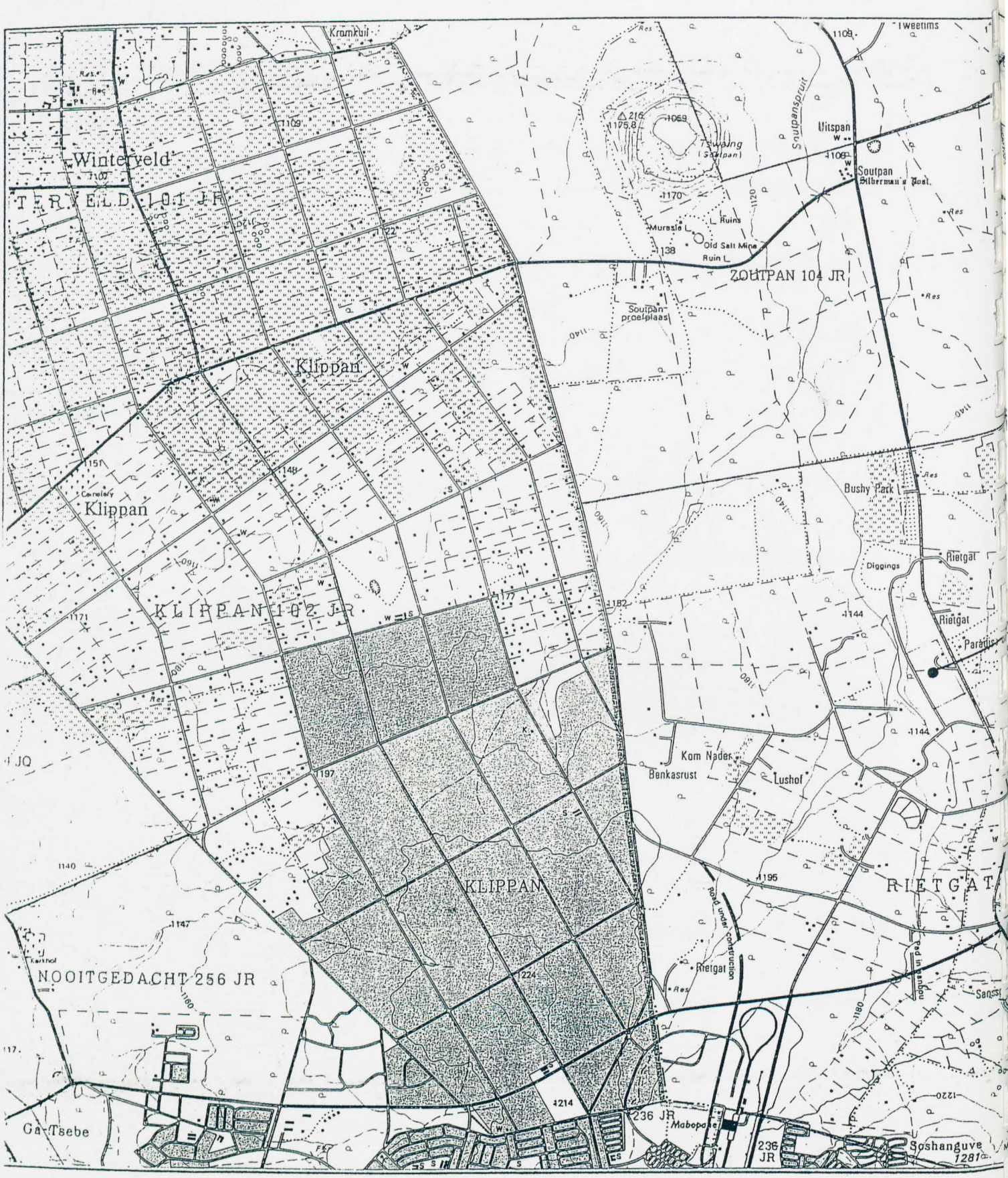

TOPOCADASTRAL MAP NUMBER: 2528 AC MATHIBESTAD

TITLE	MASTER PLAN FOR SOLID WASTE DISPOSAL MANAGEMENT
CLIENT	GREATER PRETORIA METROPOLITAN COUNCIL

	BY	DATE	CH
DESIGNED			
DRAWN			
TRACED			

SCALE: 1: 50 000

DRAWING No: 6494-C08

REVISION: