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MINERAL WASTE

THE REQUIRED GOVERNANCE ENVIRONMENT TO ENABLE REUSE

FINAL REPORT

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GLOSSARY

Extraction waste	Waste resulting from the prospecting, extraction, treatment and storage of mineral resources and the working of quarries.
Mine	Any operation or activity for the purposes of winning any mineral on, in or under the earth, water or any residue deposit, whether by underground or open working or otherwise and includes any operation or activity incidental thereto (Mineral and Petroleum Resources Development Act)
Mineral waste	Mineral waste includes the waste generated from both the mining and processing of minerals, and includes overburden and spoils, waste rock, coarse discard, slurry and tailings from mineral processing, rejects from beneficiation or concentration of minerals, chemical extraction effluent/waste and extractive metallurgical slag, whether hazardous or non-hazardous, or radioactive.
Mining waste	A part of the materials that result from the exploration, mining and processing of substances governed by legislation on mines and quarries. It may consist of natural materials without any modification other than crushing (ordinary mining waste, unusable mineralised materials) or of natural materials, processed to varying degrees during the ore-processing and enrichment phases, and possibly containing chemical, inorganic and organic additives. Overburden and topsoil are classified as waste
Non-mineral waste (NMW)	Non-mineral waste primarily consists of auxiliary materials that support mining and mineral processing such as chemicals including petrochemicals, process equipment and machinery, scrap metal and construction rubble, office and domestic rubbish including garden refuse. Non mineral waste may or may not be hazardous (Moodley & Fleming, 2006)
Residue stockpiles	Any debris, discard, tailings, slimes, screening, slurry, waste rock, foundry sand, beneficiation plant waste, ash or any other product derived from or incidental to a mining operation and which is stockpiled, stored or accumulated for potential re-use, or which is disposed of, by the holder of a mining right, mining permit or production right (Mineral and Petroleum Resources Development Act)
Works	Any place, not being a mine or part of a mine, where any of the following operations and any operation necessary or incidental thereto are carried out and constitute the main operation at such place- (a) the crushing. screening, washing, classifying or concentration of any mineral; (b) the treating of any mineral, in the form obtained from a mine, for the production of coke or for the production of a base metal in any shape or form, including ingots, billets and rolled section (c) the working and treating of any mine tailings deposit or mine dump for the recovery of any valuable content thereof; (d) the extracting of any precious metal from any mineral or concentrate: (e) the refining of any precious metal; (f) the drying or calcining of any source material as defined in the Nuclear Energy Act, 1982, (Act No. 92 of 1982); (g) the making. repairing, re-opening or closing of any subterranean tunnel; (i) the transmitting and distributing, to any other consumer, of any form of power from a mine by the owner thereof to the terminal point of bulk supply or, where the supply is not in hulk, to the power supply meter on such consumer's premises: (iii) (Mines and Works Act)

LIST OF ABBREVIATIONS

CAC	Command-and-control
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
DEAT	Department of Environmental Affairs and Tourism
DME	Department of Minerals and Energy
DWAF	Department of Water Affairs and Forestry
ECA	Environmental Conservation Act
EEB	European Environmental Bureau
EIA	Environmental impact assessment
EIMP	Environmental implementation and management plan
EMP	Environmental management plan
EPA	Environmental Protection Agency
EU	European Union
HDSA	Historically disadvantaged South Africans
IWMP	Integrated waste management plan
LDC	Less developed countries
MBI	Market based instrument
MoU	Memorandum of understanding
MPB	Marginal private benefit
MPC	Marginal private cost
MPRDA	Mineral and petroleum resources development Act
MSB	Marginal social benefit
MSC	Marginal social cost
NDoH	National Department of Health
NECSA	Nuclear Energy Corporation of South Africa
NEMA	National Environmental Management Act
NEM:WMB	National Environmental Management: Waste Management Bill
NWA	National Water Act
NWMS	National waste management strategy
PES	Payment for ecosystem services
PIC	Prior informed consent
POPs	Persistent organic pollutants
PRP	Potentially responsible party
SA	Republic of South Africa
SAMDA	South African Mining Development Association
TSF	Tailings storage facility
UNFCCC	United Nations Framework Convention on Climate Change
WRAP	Waste and resource action programme

1 Introduction

This report presents the findings of research conducted by the CSIR. This research was prompted by the Princess dump case study, a project conducted by the then CSIR Miningtek. The report aims to unpack the current governance (legal and institutional) environment in which mineral waste is being managed, and the opportunities and constraints to mineral waste reuse in South Africa. The intention of this report is to provide insight into the current challenges facing the sustainable management of mineral waste in South Africa.

While the emphasis of this report is on mineral waste from the gold mining sector, the report addresses mineral waste in general, since many of the identified opportunities and challenges are not unique to gold mining. The learning from this project can therefore be taken forward into understanding the waste reuse opportunities from other mining sectors.

This report explores, at a scoping level:

- the definitions of waste, as they relate to mineral waste;
- the status quo regarding mineral waste generation, disposal and reuse;
- the technical reuse opportunities for mineral waste
- the legal roles and responsibilities of the various national, provincial and local government departments regarding mineral waste;
- the legal and economic environment to enable mineral waste reuse;

Section 2 of the report provides an overview of the current problems regarding mineral waste reuse, **Section 3** provides insight into the definition of mining and mineral waste, while **Section 4** gives the status quo regarding mineral waste generation and disposal in South Africa. **Section 5** explores the technical reuse opportunities for mineral waste and outlines the opportunities and challenges facing reuse. The governance aspects of which are expanded upon in **Section 6** and the economic and liability issues in **Sections 7** and **8** respectively.

2 Problem Statement

The damage that the mining industry causes to the environment through the many accidents and spills justifies the question whether sustainability in this sector is possible (EEB, 2000). The European Environmental Bureau (EEB) report quotes certain expert assessments by the Environmental Protection Agency in 1987 concluding that "*problems related to mining waste may be rated as second only to global warming and stratospheric ozone depletion in terms of ecological risk. The release to the environment of mining waste can result in profound, generally irreversible destruction of ecosystems*". In many cases the polluted sites may never be fully restored, for pollution is so persistent that there is no available remedy. Clearly, the environmental effects of mining should set limits to the acceptable rate of exploitation of mineral resources (EEB, 2000).

While mining and the generation and disposal of mineral waste are known to pose many environmental, socio-economic and governance challenges in South Africa (Godfrey, 2006), a number of specific issues with respect to the management of mineral waste[1], prompted and guided this research. These included:

- Significant volumes of mineral waste are generated every year from the mining sector;
- mineral residue stockpiles pose significant environmental and human health impacts if not managed properly over time;
- methods for successful rehabilitation of mineral residue stockpiles are being explored to ensure environmentally sound mine closure;
- conflicting policy and legislation exists with respect to mineral waste;
- a lack of clarity and definition exists with respect to waste, mining waste, mineral waste and residue stockpiles;
- mineral recovery from residue stockpiles has been conducted on a large scale, where economically viable;
- mineral waste reuse is a viable alternative to closure, but a number of obstacles hinder sustainable reuse;
- the ownership and liability of old, often abandoned, mineral residue stockpiles is often unclear;
- uncertainty exists as to when waste, and in particular mineral waste, is no longer considered waste, and is no longer subject to waste legislation;
- uncertainty exists around the liability for mineral waste upon transfer for reuse

[1] These challenges are not unique to South Africa. As will be shown in this report, these challenges are experienced globally in relation to mineral waste.

Figure 1: The environmental scars of mineral waste disposal and recovery (Johannesburg east) (*From: Google Maps*)

It is hoped that this report will unpack these issues in more detail and identify specific issues to be taken forward to ensure the future, sustainable management of mining waste in South Africa.

3 Mining waste

3.1 Definitions

There are currently varying definitions and interpretations of mining waste, both locally and internationally. In order to fully understand the sustainable management of mining waste in South Africa, it is essential to firstly understand what is meant by the term. The following key questions needed to be addressed:

- What is mining waste?
- Are residue stockpiles considered waste?
- Does mining waste include processing waste?
- Is mining waste the same as mineral waste?

3.1.1 Waste

Waste is currently defined in South African legislation under the Environmental Conservation Act (Act No. 73 of 1989) [(2)] and the National Water Act (Act No. 36 of 1998) (**Table 1**).

Current environmental legislation (**Table 1**) is therefore contradictory in terms of the inclusion of mining waste in the definition of waste. Currently pending draft legislation [(3] (National Environmental Management: Waste Management Bill) (NEM:WMB) further refines the definition of waste (**Table 2**).

The proposed definition of waste (**Table 2**), (as is, or as modified through consultation) will repeal the Environmental Conservation Act definition of waste (**Table 1**). While not specifically mentioning mining waste, the NEM:WMB implies the inclusion of mining waste. Waste is further defined in terms of the following guidelines and policy documents (**Table 3**).

[2] As amended by Government Gazette 12703 (1990).
[3] The NEM:WMB is gazetted for public comment between December 2006-March 2007. It is the intention of DEAT to promulgate the Waste Management Act before the end of 2007.

Table 1: Current legal definitions of waste in South Africa

Definition	Source
Waste is defined as "An undesirable or superfluous by-product, emission, residue or remainder of any process or activity, any matter, gaseous, liquid or solid or any combination thereof, which:- (a) is discarded by any person; or (b) is accumulated and stored by any person with the purpose of eventually discarding it with or without prior treatment connected with the discarding thereof; or (c) is stored by any person with the purpose of recycling, re-using or extracting a usable product from such matter, **excluding** - […] (v) any minerals, tailings, waste-rock or slimes produced by or resulting from activities at a mine or works as defined in section 1 of the Mines and Works Act, 1956 (Act No. 27 of 1956); and (vi) ash produced by or resulting from activities at an undertaking from the generation of electricity under the provisions of the Electricity Act, 1987 (Act No. 41 of 1987)."	Environmental Conservation Act (Act 73 of 1989) (GNR 1986, GG 12703, 24 August 1990).
"Any solid material or material that is suspended, dissolved or transported in water (including sediment) and which is spilled or deposited on land or into a water resource in such volume, composition or manner as to cause, or to be reasonably likely to cause, the water resource to be polluted."	National Water Act (Act 36 of 1998)

Table 2: Proposed legal definition of waste in South Africa

Definition	Source
"waste includes any substance, whether solid, liquid or gaseous, which is- i) discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration to the environment, ii) a surplus substance or which is discarded, rejected, unwanted or abandoned, iii) re-used, recycled, reprocessed, recovered or purified by a separate operation from that which produced the substance or which may be or is intended to be re-used, recycled, reprocessed, recovered or purified, or iv) identified as waste prescribed by regulation.	National Environmental Management: Waste Management Bill (NEM: Waste Bill) (GN 1832 GG 29487, 12 January 2007)

Table 3: Additional supporting definitions of waste

Definition	Source
"An undesirable or superfluous by-product, emission, or residue of any process or activity which has been discarded, accumulated or stored for the purpose of discarding or processing. It may be gaseous, liquid or solid or any combination thereof and may originate from a residential, commercial or industrial area. This definition **excludes** industrial waste water, sewage, radioactive substances, mining, metallurgical and power generation waste."	Minimum Requirements for waste disposal by landfill (DWAF, 1998, 2005) [4]
"An undesirable or superfluous by-product, emission, or residue of any process or activity which has been discarded, accumulated or been stored for the purpose of discarding or processing. It may be gaseous, liquid or solid or any combination thereof and may originate from a residential, commercial or industrial area. This definition **includes** industrial waste water, sewage, radioactive substances, mining, metallurgical and power generation waste."	White Paper on Integrated Pollution and Waste Management (DEAT, 2000).

[4] A current revision to the Minimum Requirements (Draft Third Edition) (DWAF, 2005) still refers to the ECA definition of waste (Government Gazette No. 12703, August 1990) as amended.

The definitions provided in supporting guidelines and policy documents (Table 3) are also contradictory and add confusion as to whether mining waste should, or should not be, considered waste.

The Mineral and Petroleum Resources Development Act (Act 28 of 2002) is quite vague on the issue of mining waste, and in particular the use of the term '*waste*', referring only to '*residue deposits*' and '*residue stockpiles*' which need to be managed according to a mine's environmental management programme (EMP). Waste, and in particular mining waste, is not specifically defined or addressed in this Act.

The vagueness in national policy and legislation with respects to firstly mining waste and secondly mineral waste, results in a lack of clarity with regards to the management of this waste stream. It is for example, currently unclear who the responsible government department is for the management of mining waste, The Department of Environmental Affairs and Tourism (DEAT) (lead agent for waste) or the Department of Minerals and Energy (DME) (lead agent for mining).

The DWAF Baseline Studies (DWAF, 2001) identified as an issue of concern, the fact that mining and some industrial wastes fell outside the definition of waste which led to the implementation of dual standards, and recommended urgent attention. The possibility therefore exists that with the lack of clarity as to the roles and responsibilities of the various government departments, that mining waste 'falls through the cracks', resulting in impacts to the South African biophysical, social and economic environment. In addition, current environmental, mining and waste legislation provides little guidance as to the legal requirements to support mining waste reuse.

3.1.2 Mining waste

In the European Union, mining waste has been defined as "*a part of the materials that result from the exploration, mining and processing of substances governed by legislation on mines and quarries. It may consist of natural materials without any modification other than crushing (ordinary mining waste, unusable mineralised materials) or of natural materials, processed to varying degrees during the ore-processing and enrichment phases, and possibly containing chemical, inorganic and organic additives. Overburden and topsoil are classified as waste*" (BRGM, 2001).

Mining waste consists of waste generated both during extraction as well as processing (**Figure 2**). To address the definitions of waste from the mining and processing of ore, the European Union Directive (Directive 2006/21/EC) defined the term *'extractive waste*' as "*waste resulting from the prospecting, extraction, treatment and storage of mineral resources and the working of quarries*".

In addition, mining waste may comprise both mineral and non-mineral waste (Kutranov, 2006; Moodley & Fleming, 2006), which may be either hazardous (including radioactive[5]) or non-hazardous (**Figure 3**).

The US EPA on the other hand, has separate categories for mining waste and mineral processing waste, both of which fall under non-hazardous waste (US EPA, 2006). Mining waste consists of the waste rock, tailings, and overburden material removed during mineral excavation and extraction. Mineral Processing is the process by which the valuable minerals are separated from the native ore.

While there are legal definitions for waste in South Africa (See Section 3.1), there is currently no legal definition of '*mining waste*'. Similarly while the term mining waste is used in many South African policy documents, e.g. White Paper on Integrated Pollution and Waste Management (DEAT, 2000), the National Waste Management Strategy (DEAT, 1999), the draft Gauteng Provincial Integrated Waste Management Policy (GDACE, 2005), no legal definition of '*mining waste*' is provided. There is a general assumption that mining waste in South Africa refers to the 'residue stockpiles'[(6)] from the mining sector, i.e. mineral waste (**Figure 3**); however, there is not the same assumption as to whether mining waste includes processing waste [(7)].

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[5] The current SANS 10228 classification of hazardous waste, includes radioactive waste (Class 7)

[6] Residue stockpile is defined under the MPRD Act as "*any debris, discard, tailings, slimes, screening, slurry, waste rock, foundry sand, beneficiation plant waste, ash or any other product derived from or incidental to a mining operation and which is stockpiled, stored or accumulated for potential re-use, or which is disposed of, by the holder of a mining right, mining permit or production right*"

[7] The DME proposed the following classification of mining waste, to include overburden and spoils (mining), waste rock (mining), coarse discard (processing), slurry (processing), tailings (processing), chemical extraction effluent/waste, extractive metallurgical slag, hazardous waste, radioactive wastes (DWAF, 1998b), which would imply the inclusion of both extractive and processing mineral waste under the classification of mining waste.

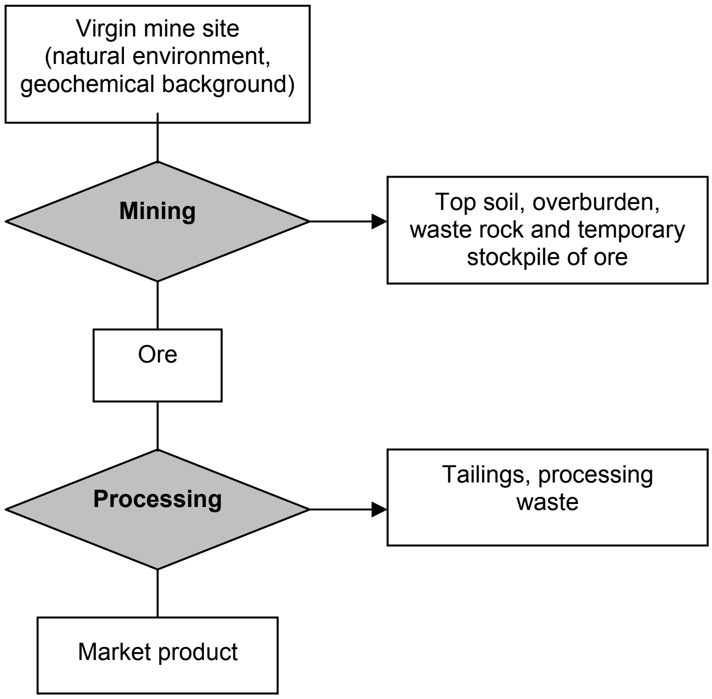


Figure 2: Mining waste types (*from BRGM, 2001*)

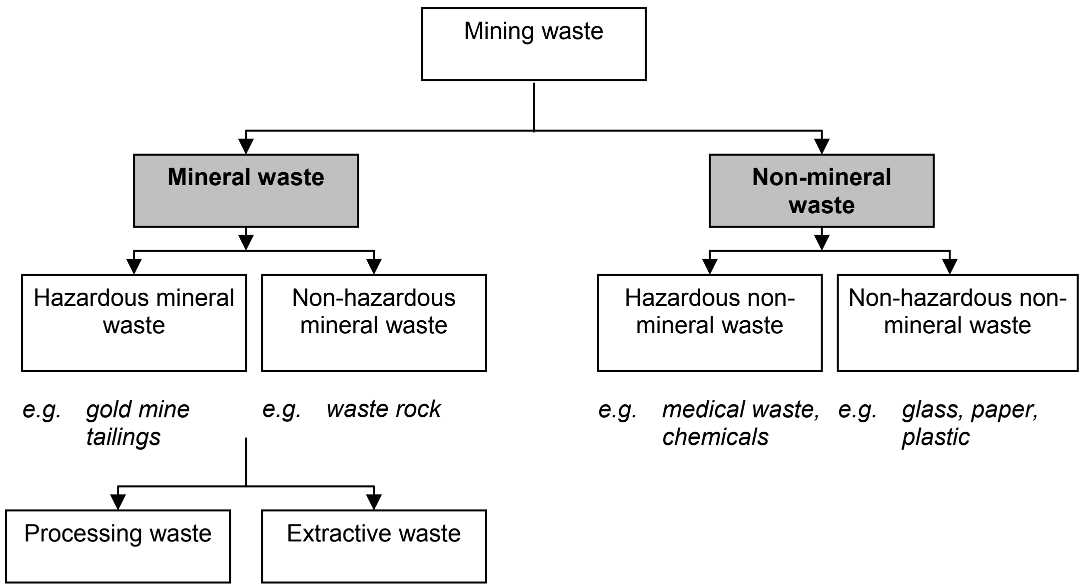


Figure 3: Sub-division of mining waste

The Mineral and Petroleum Resources Development Act does not specifically define waste, mining waste or mineral waste.

The Waste Management By-laws of the City of Johannesburg [8] (Gauteng Province, 2004) includes processing waste in the definition of '*industrial waste*'. It is therefore *assumed* that 'mineral processing waste' would be considered industrial waste. Liquid mining waste, is specifically included in the definition of '*Special industrial waste*'.

The National Water Act Regulation (No. 704 of 1999) on the use of water for mining and related activities creates further fragmentation on the management of mining activities. While recognising both extraction and processing activities, the Regulations address only those

[8] A major gold mining region.

activities conducted on the mine. One could *infer* from these Regulations that where waste is generated from mineral processing on a mine site, that this would be considered mining waste, however, where waste is generated from mineral processing in an industrial area (i.e. not located on a mine), that this waste from a regulatory perspective, would be considered industrial waste by DWAF[9].

3.1.3 Mineral waste

The term mineral waste also varies widely in its definition, and is often synonymously referred to as mining waste. However, as shown above (**Figure 3**) mining waste is more encompassing than mineral waste. A variety of definitions of mineral waste, sourced from the international literature, are given below:

- Mineral waste includes: waste rock, tailings from mineral processing, rejects from beneficiation or concentration of coal and other minerals, red mud from alumina production, refinery discards and sludges, smelter and other furnace slags, ashes, and mine-dredging materials (Rio Tinto, 2003).

- Mineral wastes are the mined rock that contains no economic ore; tailings, which are the fine sand-like residue after the mineral has been extracted from the rock; and slag, the solid residue from the smelting process (Rio Tinto, 2006).

- Waste material resulting from ore extraction that is usually left on the soil surface. (EIONET, 2006).

- Waste matters which are separated from the mineral as a result of extraction (Islamic Republic of Iran, 1998)

In summary, mineral waste includes the waste generated from both the extraction and processing of minerals, and includes overburden and spoils, waste rock, coarse discard, slurry and tailings from mineral processing, rejects from beneficiation or concentration of minerals, chemical extraction effluent/waste and extractive metallurgical slag, whether hazardous or non-hazardous, or radioactive.

3.1.4 Non-mineral waste

Non-mineral waste primarily consists of auxiliary materials that support mining and mineral processing such as chemicals, process equipment and machinery, scrap metal, construction rubble, office and domestic waste, garden waste. Non-mineral waste may or may not be hazardous (Moodley & Fleming, 2006) (**Figure 3**).

Non-mineral waste has been addressed in a Good Practice Guideline for the Management of Non-mineral Waste through the life cycle of a gold mine, i.e. from pre-feasibility and feasibility to exploration and operations through to decommissioning and closure (Moodley & Fleming, 2006) and will not be discussed further here.

Similarly wastewater from the mining sector has been dealt with extensively in other consultant reports (Maree et al., 2004; Pulles et al., 1996; Pulles et al., 2001) and will not be discussed further here.

3.2 Assumptions

As highlighted above, legislative confusion exists around (i) the definition of 'mining waste' in South Africa, (ii) the inclusion of 'residue stockpiles' into the definition of waste, and (iii) the inclusion of mineral processing waste into the definition of mining waste.

For the purposes of clarity in the further sections of this report, the following assumptions are made:

- residue stockpiles from mineral extraction and processing are considered to be mineral waste;
- mineral waste (hazardous and non-hazardous) is a subset of mining waste and consists of overburden and spoils, waste rock, coarse discard, slurry and tailings from mineral processing, rejects from beneficiation or concentration of minerals, chemical extraction effluent/waste and extractive metallurgical slag.

The term '*mineral waste*' will be used here forth to describe both extractive and processing waste from the mining sector.

[9] One may argue that for the purposes of the National Water Act and Environmental Conservation Act, it is not necessary to define *'mining waste'* since *'waste'* is already defined. To understand and interpret *'mining waste'*, one would need to read and apply the definition of waste to a mining activity. This necessitates an interpretation of *'mining'* thereby allowing reference to be made to mining legislation.

4 Status quo

4.1 Mineral waste generation

In 1886 George Harrison, an Australian gold digger, and George Walker, an Englishman, discovered payable gold reefs on the Witwatersrand. This discovery soon led to the development of the reefs that constitute the largest gold deposits known and that made South Africa the foremost gold producer in the world. During a century of mining, some 4,000 million metric tons of ore have been treated from the Witwatersrand deposits, resulting in the recovery of 37 million kg of gold (1,200 million oz) and generating millions of tons of mineral waste (Swiecki, 2006).

The generation of mineral waste is directly related to ore type, economic grade and the type of mine. For example, underground mines remove less waste rock than open cast mines (Rio Tinto, 2006). South Africa's economy is heavily dependant upon mining, and as a result produces significant volumes of mineral waste annually. As at 1997, South Africa was estimated to produce 533 million tons of waste per annum, of which 468 million tons (87.7%) (**Figure 4**) was mineral waste from the mining industry (DWAF, 2001). Gold mining waste was estimated to account for 221 million tons or 47% of all mineral waste produced in South Africa (**Table 4**). Mineral waste is therefore the largest, single source of waste in South Africa, much of which is considered hazardous by government.

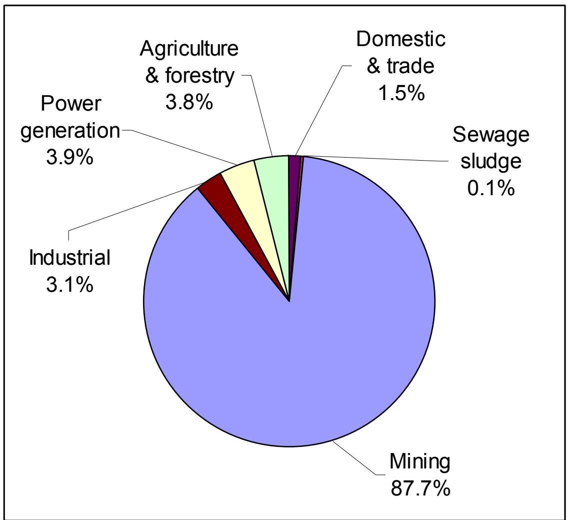


Figure 4. National waste generation rates in South Africa in 1997 (From DWAF, 2001).

The DWAF (2001) baseline studies acknowledge the lack of reliable information on mining and industrial wastes, which are typically disposed of on the site of the mine or industry. While now outdated, the only national data set on the quantity of mineral waste generated in South Africa is presented below (**Table 4**).

Table 4: Comparison of mining (mineral) waste generation (1997 and 1992) (DWAF, 2001).

Mining waste	DME (1997) t/a	CSIR study (1992) t/a
Antimony	525 000	420 105
Asbestos	87 000	150 000
Base metals	70 000 000	59 600 000
Coal	42 000 000	45 600 000
Diamonds	31 000 000	23 000 000
Gold	*221 000 000*	*191 726 070*
Industrial minerals	43 500 000	Not measured
Phosphate	4 000 000	10 920 000
Platinum Group	56 000 000	45 181 701
Zinc	50 000	41 175
Total	**468 162 000**	**376 639 051**

4.2 Mineral waste disposal

Much of this mineral waste (processed mineral waste) is deposited into tailings dams, of which there are more than 270 on the Witwatersrand Basin, covering approximately 400 km^2 in surface area (AngloGold Ashanti, 2004a). These dams are mostly unlined and many are not vegetated, providing a source of extensive dust, as well as soil and water (surface and groundwater) pollution (AngloGold Ashanti, 2004a). Gold mining mineral waste in the form of tailings, slimes, waste rock, and foundry sand has been accumulated at different locations on the Witwatersrand occupying and disturbing valuable land, causing environmental pollution and often left un-rehabilitated by prospectors and miners.

Many of the mine waste dumps, which extend across the gold-bearing reefs of the Witwatersrand, are a legacy of mines that either do not exist anymore, or exist only on paper.

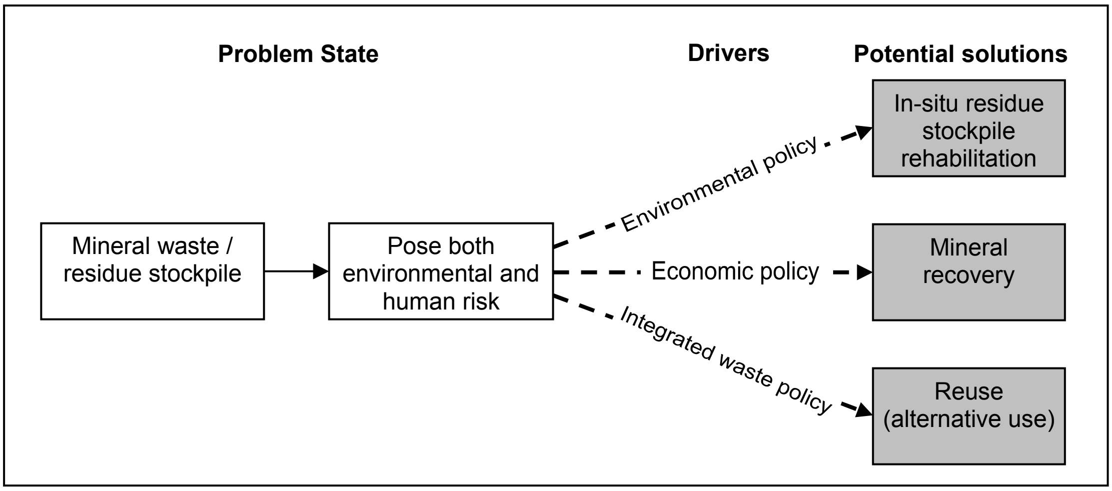


Figure 5: Overview of problem statement

4.3 Mineral waste management

Gold mining waste, a residue produced from the extraction and beneficiation of gold-rich ore, is found in large volumes in South Africa (~42% of all waste generated in South Africa) (DWAF, 2001) and as a result has the potential to present challenges both in terms of physical disposal as well as the associated environmental impacts of disposal.

From the review of available literature, there currently appear to be three main approaches to the management of mineral waste - rehabilitation, recovery [(10)] and reuse (**Figure 5**) (DWA, 2006; Ilgner, 2006; Kumar, 2006; Kutranov, 2006; van Heerden, 2002).

Each of these three approaches is largely driven by varying policies:

- rehabilitation – driven by environmental policy, to ensure that the stockpiles do not pose (or pose minimal) risk to the environment and human health;
- recovery – driven by economic policy (whether national or that of the mining house), to ensure optimum use of the countries natural resources by a cost-effective and competitive mining industry;
- reuse – driven by integrated pollution and waste policy, to ensure that waste is firstly reduced, then reused and recycled, with waste disposal (stockpiling) seen as a last resort.

While the emphasis of this report is on the third option (mineral waste reuse), each of the three options is briefly discussed below.

4.3.1 Rehabilitation

According to Kutranov (2006), the intention of rehabilitation of mining residue stockpiles is to "*create ecosystem stability*"; to reduce the environmental impacts associated with the stockpile after the mine's productive life has ended. However, it is recognised that both short- and long-term management procedures *"pose a significant economic burden on the operating mine".* Rehabilitation is seen as a costly investment with no financial returns (DWA, 2006). It is recognised that the closure of a mine *"results in a transfer of [...] environmental, social and financial risks and liabilities from the mine owners to the State (particularly, the DME), and so must aim to minimise all relevant long-term impacts posed by the mining operations*." (Kutranov, 2006). Rehabilitation of residue stockpiles, while able to address environmental issues such as air quality, surface water quality and erosion control (**Figure 6**), does not remove the problem and the long-term pollution potential associated with mineral waste (DWA, 2006).

4.3.2 Mineral recovery (1^{o} reuse)

While often termed 'reuse', recovery of mineral residue stockpiles involves reworking dumps with the intention to recover economically viable minerals, i.e. to reuse the residue for its primary (1^{o}) intended purpose, e.g. mineral recovery, coal usage as fuel, etc.

[10] Also referred to as re-mining, reprocessing or reclamation.

Figure 6: Rehabilitation of Daggafontein gold tailings dam (from AngloGold Ashanti, 2005)

Figure 7: Aerial photo of the Brakpan TSF gold tailings storage facility (from Google Maps).

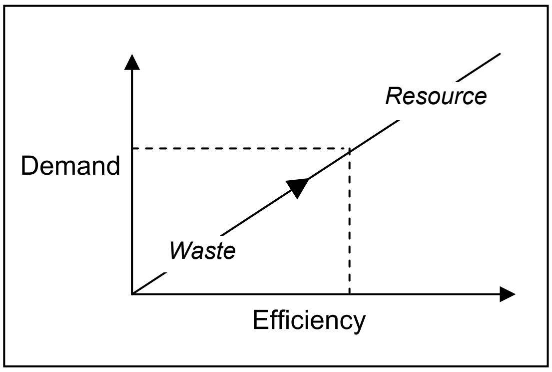
According to van Heerden (2002), there are a number of reasons for mineral recovery from residue stockpiles. These include (i) making land available for alternative uses, (ii) removing harmful substances (pollution potential), (iii) recovering economic minerals, (iv) redemption of costs, and (v) job creation.

In 1977, the Ergo [11] operation was commissioned to extract gold by reprocessing material from about 50 old residue deposits from many historical operations in Gauteng. The residue material from the Ergo operation was deposited on the Withok Tailings Storage

[11] The waste management company for Ashanti Gold.

Facility (TSF). In 1985, the introduction of new technology in the recovery process, led to further extraction of gold from these tailings and yet another TSF was constructed and commissioned – the Brakpan TSF. The Brakpan TSF (**Figure 7**) is believed to be the largest gold tailings storage facility in the world. It covers an area of 869 hectares and stands about 90 metres high (the height of a 30 storey building). The Brakpan TSF holds around 560 million tons of material. (AngloGold Ashanti, 2004b).

The viability of mineral recovery from residue stockpiles depends on a number of economic factors, such as the grade of gold in the waste, the gold price, extraction costs, scale of extraction, processing efficiencies, interest rates and total global stock. According to Nahman (pers comm., 2006) mineral waste reuse is viable only when the net price (price-extraction cost) exceeds the opportunity cost per unit, i.e. demand exceeds cost. The opportunity cost in turn depends on prevailing interest rates and the total (global) stock of the resource [12]. The opportunity cost therefore fluctuates over time (in line with the interest rate and total stock), as do extraction costs.



Per unit extraction costs may be higher in the case of recovery (as opposed to extraction), since more effort is (presumably) required to obtain a given amount of mineral, e.g. gold, due to the lower grades of gold in the residue stockpiles. However, setup costs for recovery may be lower than those of mine establishment. Extraction costs are heavily dependant upon available technology (at the time) to cost effectively extract low concentrations of minerals. According to Mintek (pers comm., H Ilgner) the current grade for economic reworking of gold residue stockpiles is 1.6 gr/t. The average gold content of many tailings dumps in the Johannesburg area is well below this. Grades as low as 0.4 gr/t may still, however, be economically viable (pers comm., AngloGold Ashanti, 2007).

The cost of mineral recovery from residue stockpiles is therefore likely to depend on:

- Demand (economics); and
- Efficiency (technology).

What may currently be considered a waste, due to low economic demand or lack of available technology, may in the future be considered a viable mineral resource, suitable for recovery.

The current approach to mineral waste management in South Africa is to (i) re-mine residue stockpiles where financially viable or (ii) stockpile mineral waste until the recovery of minerals becomes financially viable at some time in the future. At some point in time, however, the resource value of mineral waste will deplete to such a level that the remaining minerals become unviable to recover. It is however not easy to define this point since viability of recovery is dependent on a number of factors as outlined above.

4.3.3 Reuse (2^o reuse)

Reuse of mineral residue stockpiles involves finding alternative uses for the mineral residue (or waste) other than its intended primary use, i.e. secondary reuse. This may include e.g. road building, construction etc. (See Section 5).

It has been shown (Collins & Ciesielski, 1994; van Heerden, 2002; Kumar et al., 2006), that technically, mineral waste can be used for various purposes depending on the physical and chemical properties of the waste. Mineral waste has been found both locally and internationally to perform like, and often better, than conventional virgin material in the construction industry.

4.3.4 Summary

In summary, rehabilitation, recovery and reuse provide three alternative approaches to the management of mineral waste, each with its own advantages and disadvantages (**Table 5**).

[12] Interest rates determine the investment potential of profits, while stock size determines the potential future growth in value of the unmined resource; the combination thus determines whether it is more profitable to mine now or in the future.

Table 5: Advantages and disadvantages of mineral waste management

Option	Advantages	Disadvantages
Rehabilitation	• Environmental impacts may be lessened • Mineral resource potential 'stored' - future mineral recovery	• Long-term pollution potential remains • Residue stockpile likely to outlast the operation/ existence of the mine – liability for future impacts • Costly process
Recovery	• Removal of harmful substances • Mineral resource potential 'utilised' - recovery of economic minerals • Rehabilitation of land with transfer to new site	• Short-term solution, long-term pollution potential remains for new stockpile
Reuse	• Replaces virgin material • Removes long-term pollution potential of residue stockpile	• Mineral resource potential lost - future mineral recovery no longer possible

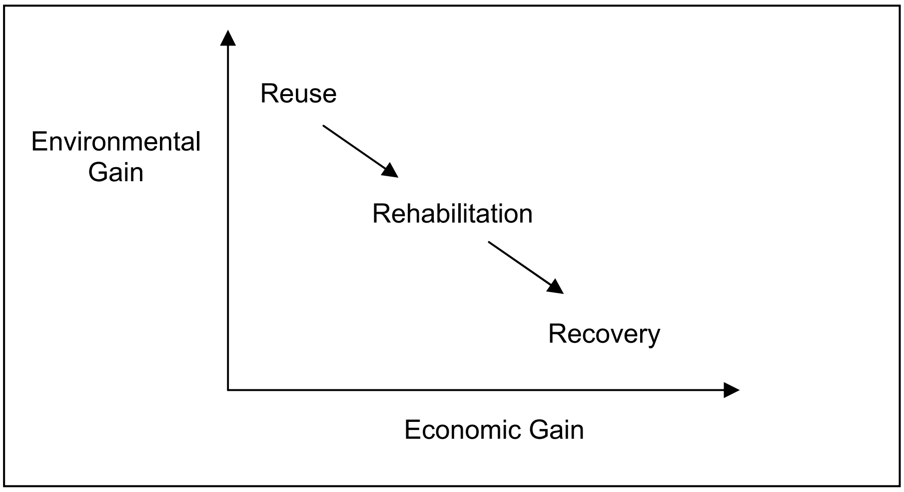


Figure 8: Potential environmental and economics gains of mineral waste management.

Footnote to Figure 8:
(a) Reuse provides short-term environmental gain.
(b) Recovery provides short-term economic gain.
(c) Rehabilitation provides limited, short-term, environmental gain, for long-term potential economic gain.

While environmental and waste policy may promote mineral waste reuse [13], the reality is one of rehabilitation and recovery (where economically viable). While mineral waste reuse provides a long-term solution to the management of large volumes of potentially hazardous waste, the precautionary principle of current legislation would appear to favour rehabilitation over reuse, e.g. National Water Act Regulations (No. 704 of 1999) (See Section 6).

From the above table, it is apparent that rehabilitation/recovery and reuse are competing activities (**Figure 8**). While rehabilitation/recovery provide ready access to mineral resources (either immediately or at some point in the future when economically viable), mineral waste reuse looses the potential for future recovery of mineral resources. It may be for this very reason that mineral waste is instead defined as a 'residue' and that the limited initiatives have been implemented by government to promote mineral waste reuse.

[13] While waste reuse appears higher in the waste hierarchy, waste reuse is not automatically favoured over e.g. treatment and disposal. Waste reuse as a preferred option will depend on the associated benefits and impacts, and the potential for reuse to render the waste inert.

5 Mineral waste reuse

5.1 Introduction

With the global increase in population and the drive for continuing economic development, mining continues to grow to sustain economies, while at the same time generating large volumes of waste of varying composition (Schroeder, 1994). Due to the different types of minerals mined, various types of waste are produced, and produced in bulk. The biggest challenge in waste management in South Africa has been, and will most likely continue to be, mineral waste, a cause of concern to our environmental sustainability. One solution to the growing generation of mineral waste lies in its reuse. Reuse, while supporting national policy on promoting waste minimisation and reuse (DEAT, 1998) helps to decrease the mineral waste in the environment, reduce the volume of virgin material extracted for construction and improve the economy of the communities involved in the waste reuse - an apparent win-win solution for both the environment and the South African economy.

5.2 Objectives

While technically feasible, mineral waste reuse projects have often failed, for a variety of reasons. Local and international literature on the reuse of mineral waste, as a substitute for conventional materials, was reviewed. Sixty-eight mineral waste reuse projects, both locally (15 case studies) and internationally (53 case studies) were reviewed, to determine the reuse potential of mineral waste, and to identify the opportunities and constraints for reuse. The findings are presented below and in more detail in Annexure A.

5.3 Enabling environment for mineral waste reuse

From the review of mineral waste reuse case studies, the following information has been gathered:

- types of mineral waste successfully reused
- known applications for mineral waste reuse
- opportunities for mineral waste reuse
- constraints to mineral waste reuse

While not exhaustive, the following mineral wastes have been reused:

- Coal mine spoil and refuse
- Fly ash
- Tailings – including (amongst others), barite, chrome, copper, feldspar, gold, ferro-alloy, iron-ore, lead, platinum, taconite (coarse), uranium, zinc,
- Mine overburden dumps
- Nickliferrous lateritic waste dumps
- Slag – including (amongst others), iron-blast furnace slag, copper, ferro-chrome, gold, lead, non-ferrous, steel, tin, platinum, zinc
- Spent oil shale
- Waste rock

The following applications for mineral waste reuse were identified:

- Backfill in the mines - stabilisation of underground workings as a fill
- General and civil construction
  - Cement/concrete production
  - Micro-surfacing – cement substitute
  - Production of bricks, clinker, refractories, e.g. fire resistant bricks, tiles, wood substitutes, roof shingles
  - Road construction and resurfacing, e.g. asphalt paving aggregate, base or sub-base aggregate, structural backfill, highway embankment construction, skid resistant aggregate, unbound base course
  - Pavement construction
  - Sub-surface drainage material.
- Erosion prevention
  - coastal erosion,
  - river bank stabilization, e.g. stone fill for embankments and as riprap aggregate for bank and channel protection
- Fuel, e.g. coal waste
- Paint manufacturing, e.g. abrasion-resistant, inert mineral filler pigment
- Soil enhancer – press-mud (co-recycled mining waste and sugar mill waste), e.g. improve soil fertility

From available case studies (Annexure A), it would appear that construction, and in particular road construction, is one of the largest consumers of mineral waste, due to its technical viability, the design of roads which 'shields' mineral waste from leaching/exposure, the volume of virgin material required for road building and the availability of mineral waste (pers comm., E Kleyn).

5.3.1 Opportunities for reuse

From the review of successful mineral waste reuse projects locally and internationally (Annexure A), the following five opportunities have been identified that support mineral waste reuse:

- Material suitability (technical compatibility)
- Technology advancements
- Supporting (enabling) legislation
- Economic viability
- Environmental benefits

Of these five, material suitability and economic viability (cost-effectiveness) appear to be the two main driving factors. Each of the five factors which support mineral waste reuse is briefly touched on below:

- Material suitability
  - Compliance of mineral waste to construction material standards and specifications
  - Compatibility with other virgin materials
  - Clean waste, i.e. does not have high contaminants content
  - Suitable or superior engineering properties
  - Low leaching under normal conditions
  - Suitable aggregate size
- Technology advancements
  - Recent advancements in technology
  - Development of paste fill technology
  - Design advancement
  - Improved technology
  - New beneficiation technique developed
- Supporting legislation
  - Supporting laws and legislation driving reuse
  - Embarking on natural resources conservation
- Economic viability
  - Abundance of waste material
  - Accessibility of waste material
  - Available cheaply
  - Alternative resource (competitive market)
  - Construction material shortage
  - High demand for construction material
  - Increasing prices of minerals
  - Long haulage distance of conventional material
  - Free-up land for other uses i.e. economic activities after rehabilitation
  - Supporting economic instruments

- Environmental benefits
  - Save natural resources
  - Removal of impurities through pre-treatment

5.3.2 Constraints to reuse

Strangely, the exact same five factors which support mineral waste reuse, also constrain mineral waste reuse, i.e.

- Technical incompatibility
- Technology constraints
- Legislation (lack of enabling legislation)
- Uneconomical
- Environmental problems

Similarly, technical incompatibility (unsuitability for use) and cost (financially uneconomical) appear to be the two prohibiting factors in the reuse of mineral waste. Each of the five factors which constrain mineral waste reuse is briefly touched on below:

- Technical incompatibility
  - Impurities such as sulphur, pyrite, cyanide, carbonaceous material, asbestos fibre, arsenic, heavy metals
  - Reduction in engineering properties, e.g. product strength, product aging.
  - Structural failure
  - Density higher than that of natural aggregate.
  - Low content of coarse material.
  - Low glass content (need to add more silica prior to granulation)
  - Needs pre-treatment to remove impurities.
  - Possible high proportion of fines which may require blending with coarser.
  - Requires crushing and sizing prior to use.

- Technology constraints
  - Lack of technology
  - Inappropriate technology

- Lack of enabling legislation
  - No legislation driving mineral waste reuse
  - Liability for mineral waste reuse

- Uneconomical
  - Long haulage distance
  - Lack of funds
  - Low price of virgin materials
  - No economic instruments

- Environmental problems (during rehabilitation and reuse)
  - Increased soil and water contamination due to leaching of impurities
  - Dangers of combustion, e.g. coal waste

- Potential of health impacts e.g. lung cancer, of workers
- Air pollution in the form of dust due to increased vehicle movement on dumps and in area

5.4 Summary

As shown above, mineral waste can be successfully reused [14], thereby reducing the environmental burden of mining, however, reuse is not without its constraints. Not surprisingly the opportunities and constraints identified internationally do not differ to those locally (Annexure A – Table 1 & 2), suggesting that these are global issues influencing the reuse of mineral waste.

Both industry and government have a role to play in overcoming the five identified key constraints to mineral waste reuse, i.e. material suitability, technology, legislation, economics, environmental issues. Since government is typically not involved in material suitability or technology development, the following sections (Section 6 and 7) touch on the two aspects which government can, and does, have control over, namely:

- Legislation, and
- Economics

The following section looks at the legal and economic environment around mineral waste and in particular the opportunities and constraints for mineral waste reuse.

6 Governance

The increase in South African environmental and waste management regulation over the past 10 years means that the responsibility of managing, and in particular reusing, historic and current mineral waste can be one of a mine's greatest liabilities. As outlined in Section 3, there is also some confusion as to the definition of mineral waste in South Africa, compounded by uncertainties as to the roles and responsibilities of various national government departments, as well as national, provincial and local government.

[14] While theoretically mineral waste can be reused, a pertinent question is what proportion of mineral waste can be reused. There is currently no data available on the potential volumes of mineral waste which can be feasibly reused, assuming identified obstacles can be overcome, i.e. the inroads which reuse can make into the existing residue stockpiles.

The following section aims to outline the South African governance and legislative framework within which mineral waste is managed, by:

- providing background on the governance structures regulating mineral waste;
- outlining the legislative framework regulating mineral waste;
- identifying obstacles to reuse of mineral waste in the governance and legal structure regulating mining and waste; and
- proposing changes in legislation and governance structures to support the re-use of mineral waste

6.1 Methodology

A literature review of the international legislation and conventions was undertaken, together with a review of South African legislation at national, provincial and local government level. The institutions involved in regulating mining activities and waste were identified including the roles and responsibilities of each. The findings of this study were then used to identify the legal and institutional gaps and obstacles to the reuse of mining waste.

6.2 Legislation

6.2.1 International

A more detailed discussion of relevant international legislation and conventions, applicable to mineral waste is provided in Annexure B.

6.2.2 South Africa

The discovery of the gold reef outcrop on the Witwatersrand in 1866 and of diamonds in the Cape Colony in 1867 heralded the beginning of the rapid expansion of the mining industry in respect of precious metals, precious stones, and base minerals in South Africa, which is richly endowed with minerals of great diversity. The Gold Act, 1871 (Act 1 of 1871) of the Zuid Afrikaansche Republiek reserved the right to mine precious metals and stones to the State (note that platinum was not regarded as a precious metal in South Africa until the 1930s). Over the years many changes were made to the law, but this principle remained largely unchanged. When South Africa became a Union, the right to mine precious metals and oil remained vested in the state whilst prospecting and mining rights for base metals was vested in the mineral rights owner.

Other laws that were promulgated dealing with mining was the Precious Stones Act, 1964 (Act 73 of 1964) and the Mining Rights Act, 1967 (Act 20 of 1967). In 1967 there was a consolidation of the mining laws which culminated in the Mineral Act, 1967 (Act 20 of 1967). The State retained the right to mine precious metals (gold, silver and platinum), precious stones (diamonds, rubies and sapphires) and oil. All of these minerals had a royalty attached to mining them. Common law still applied to the mining of base metals. The owner of the mineral rights could therefore mine for base metals.

The Minerals Act, 1991 (Act 50 of 1991) largely simplified the mining laws of South Africa and partly reverted to common law principles. It amended or repealed 34 laws dating from 1919 to 1988. It allowed for the continuation of mining rights all the way back to those granted by section 4 of the Gold Act, 1871 (Act 1 of 1871) (Northern Cape Province, 2004).

A number of pieces of national legislation impact the management of mineral waste in South Africa. A summary of these Acts is provided in **Table 6** with further detail provided in Annexures C.

The main issues relating to legislation that impacts on the reuse of mineral are the following:

- Legal resolve as to the status of mineral waste. Is it a waste or a residue?
- Can and should mineral waste be considered for reuse? If so, what are the legal requirements for reuse of mineral waste?
- Mineral waste will be subject to waste discharge charges under the National Water Act, 1998 not finding alternative use may have huge financial implications.

6.3 Institutional arrangements in South Africa

6.3.1 Mining

The State's influence within the mineral industry is confined to orderly regulation and the promotion of equal opportunity for all citizens. Previously in South Africa, mineral rights were owned either by the State or private sector. This dual ownership system represented an entry barrier to potential new investors. Government's objective is for all mineral rights to be vested in the State within the next five years with due regard to constitutional ownership rights and security of tenure (SAMI, 2005). DME is responsible for promoting mining activities as well as regulating the management of mineral residues.

The Chamber of Mines of South Africa is a voluntary, private sector employer's organization founded in 1889 – three years after gold was discovered on the Witwatersrand. The Chamber is an association of mining companies and mines operating in the gold, coal, diamond, platinum, lead, iron ore, manganese, antimony, zinc and copper mining sectors. Today, the organization acts as the principal advocate of the major policy positions endorsed by mining employers. The Chamber represents the formalized views of its membership to various national and provincial government departments and other relevant policy-making and opinion-forming entities, both in and outside the country (SAMI, 2005).

The South African Mining Development Association (SAMDA) is a new organization established with a vision to be the vehicle for the development of a vibrant and sustainable junior mining sector (SAMI, 2005).

The Council for Geoscience undertake geological mapping and carries out studies relevant to the identification, nature and extent and genesis of ore deposits and also maintains a national database of he country's geoscientific data and information (SAMI, 2005).

Mintek's aim is to enable the minerals industry to operate more effectively by developing and making available the most appropriate and cost-effective technology. It is engaged in the full spectrum of minerals research, from the mineralogical examination of ores to the development of extraction and refining technologies, the manufacturing of end products, and feasibility and economic studies (SAMI, 2005).

The South African Nuclear Energy Corporation (NECSA) undertakes and promotes research and development in the field of nuclear energy and radiation sciences and technology in order to process source material, special nuclear, material and restricted material and to co-operate with persons in these fields (SAMI, 2005).

Table 6: Summary of enabling legislation in South Africa applicable to mineral waste

Legislation / policy / guideline	Lead agent	Applicability to mineral waste	Comments
1. Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002)	Department of Minerals and Energy (DME)	Mineral residue ≠ waste	Defines residue stockpile, but does not define waste. Section 42 makes provision for the management of residue stockpiles and residue deposits through Environmental Management Plans and Programmes
2. Mineral and Petroleum Resources Development Regulations (No R 527 of 2004)	Department of Minerals and Energy (DME)	Mineral residue ≠ waste (uncertain)	Does not define waste. Makes reference to both waste and mine residue, but not that mine residue is considered waste.
3. Mine Health and Safety Act, 1996 (Act 29 of 1996)	Department of Minerals and Energy (DME)	Mineral residue ≠ waste (uncertain)	Recognises waste is produced from mining, but not specific reference to mineral residue as waste.
4. Environment Conservation Act, 1989 (Act 73 of 1989)	Department of Environment and Tourism (DEAT)	Applicable to mineral waste originating from industrial areas	Metal extraction and processing industries fall in this category
5. Minimum Requirements for Hazardous Waste	Department of Environment and Tourism & Department of Water Affairs and Forestry	Mineral residue ≠ waste Metallurgical slag = waste	Given legal effect through ECA. Definition of waste particularly excludes mining waste, but mineral wastes associated with industries are subject to these requirements.
6. Hazardous Substances Act, 1973 (Act 15 of 1973)	National Department of Health		Powers to pass regulations iro Group I and II waste have not been exercised with the exception or requirements iro containers that have been used for Group I substances. Relevance of Group IV in respect of radioactive waste uncertain, since definition states that Group IV hazardous substances are defined as meaning radioactive material which is outside a nuclear installation as defined in the Nuclear Energy Act No. 131 of 1993, and is not a material which forms part of, or is used, or intended to be used, in the nuclear fuel cycle […], *<u>and which is used or intended to be used for medical,</u> scientific, agricultural, commercial or industrial <u>purposes,</u> and any radioactive waste arising from such radioactive material."* If one views mining as being commercial or industrial, this Act is likely to apply to mineral waste.
7. National Water Act,	Department of Water	Mineral residue = waste	Based on definition of waste, implies inclusion of mineral residue as waste

Legislation / policy / guideline	Lead agent	Applicability to mineral waste	Comments
1998 (Act 36 of 1998)	Affairs and Forestry (DWAF)	Waste discharge charges	The Pricing Strategy ito Section 56 of this Act provides for waste discharge charges to be collected also from mining waste.
8. National Water Act Regulations (No. 704 of 1999)	Department of Water Affairs and Forestry (DWAF)	No person […] may use any residue or substance […] for the construction of […] any embankment, road or railway, or for any other purpose which is likely to cause pollution of a water resource	Regulation 704 refers only to activities on a mine site
9. National Environmental Management Act, 1998 (Act 107 of 1998)	Department of Environment and Tourism (DEAT)	Historic mineral waste = pollution Mining activities including stockpiles and residue dumps require an EIA	Requires remediation of environmental damage = support reuse of mineral waste EIA regulations are also applicable to mining activities and therefore also mining or mineral waste at a mining site
10. National Environmental Management: Air Quality Act, 2004 (Act 39 of 2004)	Department of Environment and Tourism (DEAT)	Reuse of mineral waste (including fly ash) may result in the formation of dust causing air pollution	Dust is an occupational Health and Safety as well as air pollution issue for reuse of mineral waste
11. Nuclear Energy Act, 1993 (Act 131 of 1993)	National Nuclear Regulator	Mineral waste from gold and uranium mines may be radioactive	
12. Nuclear Energy Act, 1999 (Act 46 of 1999)		Mineral waste from gold and uranium mines may be radioactive	
13. National Environmental Management: Waste Management Bill	Department of Environment and Tourism (DEAT)	Mineral residue = waste	Clarity required that both mineral and non-mineral mining waste is considered waste.

6.3.2 Pollution and Waste

The fragmentation of waste and pollution control legislation is clearly illustrated in the institutions administering them. Virtually all national departments, provinces and local authorities administer one or more laws relevant to waste management and pollution control. There is thus a plethora of state institutions involved. The national situation is reflected in the **Table 7**.

Table 7: State institutions involved in the administration of pollution control and waste management (adjusted from DEAT and DWAF, 1997)

Aspect Requiring Regulation	Government Department Responsible
Overall environmental coordination	Dept of Environmental Affairs and Tourism
Domestic and non-hazardous industrial wastes	Local Government Provinces through the EIA Regulations Dept of Environmental Affairs and Tourism Dept of Water Affairs and Forestry
Hazardous waste	Dept of Environmental Affairs and Tourism Provinces through the EIA Regulations Dept of Water Affairs and Forestry Dept of Transport
Mining waste	Dept of Minerals and Energy
Radioative waste	Dept of Minerals and Energy Dept of Environmental Affairs and Tourism National Dept of Health Dept of Water Affairs and Forestry National Nuclear Regulator
Transportation of hazardous substances	National Dept of Health Dept of Transport
Waste on roads	Provincial Administrations
Water Pollution	Dept of Water Affairs and Forestry Local Government
Air Pollution	Dept of Environmental Affairs and Tourism Local Government Provinces through the EIA Regulations and new Act
Soil quality (and use of pesticides)	Dept of Land Affairs Dept of Agriculture Dept of Environmental Affairs and Tourism ito section 28 of NEMA
Marine Pollution (i.e. from coastal mining activities)	Dept Environmental Affairs and Tourism Dept of Transport Dept of Water Affairs and Forestry
Noise pollution	Local Government Dept of Environmental Affairs and Tourism
Occupational Health and Safety	Dept of Labour and DME for mining issues
International Conventions	Dept of Foreign Affairs Dept of Environment Affairs and Tourism Dept of Trade and Industry Dept of Transport Dept of Water Affairs and Forestry

An enabling legislative environment for co-operation on environmental issues is however created by the National Environmental Management Act, 1998 (NEMA). NEMA makes provision for the establishment of enabling institutions as well as for procedures for co-operative governance including environmental implementation plans and environmental management plans (EIPs and EMPs) that need to be prepared by every listed national department responsible for environmental functions. Other national government departments need to account for how they conduct their specific responsibility in their EIP or EMP to the Department of Environmental Affairs and Tourism (DEAT). The DEAT should therefore as lead department, have a clear picture of implementation through the EIMPs. The actual plans submitted are however, in reality, not as useful a tool as was intended by the requirements of chapter 3 of NEMA.

6.4 Roles and responsibilities

6.4.1 National Government

The National Government is empowered to pass legislation on any matters listed in Schedule 4 of the Constitution of South Africa, 1996 (Act 108 of 1996), which lists concurrent competencies of national and provincial parliaments. For the purpose of this report, the most important functional areas listed in Schedule 4 include environment, pollution control and soil conservation. Areas of exclusive provincial competence are set out in Schedule 5 but national government may override these where it is necessary to maintain national security, economic unity, essential national standards, to provide minimum standards for the rendering of services or to prevent unreasonable provincial action which will be prejudiced or to the interest of another province or the whole country.

According to Dale (1997), the apparent conflict between national and provincial powers has been settled in the Constitution of the Republic of South Africa, 1996 namely that mining and mineral matters are national rather than provincial matters. Nevertheless, recognition is given to regional needs in that the department of Minerals and Energy has a Regional Director in each of the provinces, but they are members of the national government department.

In terms of mineral waste, DEAT, in consultation with other affected government departments, will be responsible for drafting legislation and providing provincial and local government with guidelines for waste management planning. Provincial government will participate in the drafting process (DEAT and DWAF, 1999). However, according to the White Paper on Integrated Pollution and Waste Management (DEAT, 2000) the *“Department of Minerals and Energy sets regulations, norms, standards and guidelines in consultation with DEAT for mining, radioactive and coal combustion waste, and regulates the mining and nuclear industries within the context of environmental legislation”.*

The national government is empowered to administer any of the laws which it has passed. DEAT therefore has the mandate to administer all environmental laws, while DME as lead agent for mining has the responsibility of administering mining related laws. The inconsistencies between the policy and strategy in terms of the roles of the different government departments relating to mining waste gave rise to an ongoing debate.

6.4.2 Provincial Government

Provincial authorities have, in terms of the Constitution, concurrent power with national government to pass legislation on functional areas listed in schedule 4 (environment, pollution control and soil conservation) and exclusive competence over the functional areas listed in schedule 5, which includes the functional area of provincial planning. In the event of conflict of national and provincial legislation in a schedule 4 matter, national legislation which applies uniformly to the country as a whole will prevail if it deals with something which, to be effectively implemented, requires national uniformity, such as the establishment of norms and standards, frameworks or national policies or which is necessary for, among other things, the protection of the environment.

In terms of mineral waste, provincial government will be responsible for establishing a detailed inventory of all potentially polluting sites within their province and for developing hazardous waste management plans to ensure that all industries and mines have access to and use hazardous waste disposal facilities. The plans should also include waste minimization, recycling and re-use initiatives for both industrial and mining waste. Hazardous waste reduction at source (generation) and responsible disposal including alternative treatment options should feature in the initiatives (DEAT, 1999).

Provincial governments are empowered to administer any laws which they have promulgated as well as any laws assigned to them in terms of the Constitution or any other law.

6.4.3 Local Government

Local governments are empowered to legislate on matters listed in Part B of Schedules 4 and 5 of the Constitution. Functional areas in Part B of those schedules which are relevant to integrated pollution control and waste management include air pollution, water and sanitation services limited to potable water supply systems and domestic wastewater and sewage disposal systems, refuse removal, refuse dumps, solid waste disposal, noise pollution and the control of public nuisance. By-laws which conflict with national or provincial legislation are invalid unless the conflicting national or provincial legislation compromises a municipality's right or ability to exercise its powers or perform its functions.

Municipalities are empowered to administer any laws which they have passed as well as any laws assigned to them in terms of the Constitution or any other law.

6.5 Implications of Constitutional Provision

The Constitutional allocation of legislative and administrative competence has important consequences for integrated pollution control and waste management but has further exacerbated difficulties in integrating pollution control between national, provincial and local authorities. By creating concurrent legislative competencies between different spheres of government, the possibility for conflicting legislation is created. For example, water quality standards will be imposed at a national level; however, local governments are responsible for legislation concerning the treatment of water and sanitation services. There is potential for legislative conflict in this situation as well as likelihood that instead of promoting integration, it will create division. This is a result of the seemingly *ad hoc* appearances in schedules 4 and 5 of certain pollution control functions without, apparently, the whole picture having been adequately considered. The Constitution however clearly requires that the responsibility for waste management functions is to be devolved to the lowest possible level of government in accordance with the right to self-determination (Section 235).

Aside from legislative problems, this constitutional arrangement has important practical institutional difficulties. For Example: Reworking of an old mine dump close to a residential area is approved under national legislation (NEMA, Act 107 of 1998, Mineral and Petroleum Resources Development Act, 2002). The development of the associated infrastructure needs to be approved in terms of provincial planning legislation as well as the EIA regulations (at provincial level). If this activity is creating a public nuisance due to noise or dust and also contaminating ground water it may be contravening laws promulgated by different government departments at each of the three spheres of government. From civil society's perspective it is difficult to know to whom to complain in order to remedy the problem and from a bureaucratic point of view there are clearly problems concerning overlapping jurisdiction. It can also create confusion on the side of the company undertaking reworking of the dump since there is a possibility of a plethora of authorisations to be obtained with the possibility of conflicting conditions between the different authorisations.

The fragmentation in constitutional functions may also result in no one, single, government department taking responsibility for a specific activity e.g. mineral waste reuse.

6.6 Co-operative governance

Effective management of mining in South Africa is largely dependent on effective cooperative governance between the different departments regulating different aspects relating to mining.

A Memorandum of Understanding (MoU) between the Department of Minerals and Energy (DME) and the Department of Water Affairs and Forestry (DWAF) has been signed to ensure co-operation and co-ordination between the two Departments. In terms of the MoU the DWAF will assist the DME to evaluate Environmental Management Programmes (EMP's) (DWAF, 1998). The MoU aims to improve efficiency of the authorisation process and will contribute to minimise potential conflict and ambiguity. The full MoU is attached as Appendix A. To date, no MoU has been established be between DME and DEAT regarding the management of mineral and non-mineral waste from the mining sector.

The effectiveness of the MoU can be questioned based on the DME intention to amend the Mineral and Petroleum Resources Development Act, 2002 to remove the cooperative process for EMP approvals (personal communication, DWAF 2006).

No other environmental management co-operation agreements relating to mining and mining waste could be located and therefore it is assumed that no other agreements have been entered into

6.6.1 Department of Minerals and Energy

The Department of Minerals and Energy (DME) as custodian of the nation's mineral and petroleum resources must ensure the sustainable development of the mineral and petroleum resources within a framework of national environmental policy, norms and standards while promoting economic and social development.
The Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002), stipulates an approved environmental management programme or plan as a prerequisite for the authorization of prospecting, exploration and mining activities. Such an environmental management programme or plan must describe the manner in which pollution or environmental degradation will be addressed as well as adherence to prescribed waste standards and management standards or practices. It should be noted that the Act does not define mining waste. "Residue deposit" and "Residue stockpile" are however defined by this Act. Therefore, waste management legislation is not applicable here. However, the draft NEM:WM Bill does not exclude mining waste and therefore if the Bill is enacted, mine residue will become subject to waste legislation and regulation. In this case, the reuse of mining waste will be subject to the same regulatory processes as other waste streams earmarked for reuse.

Section 40 of the Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002) deals with consultation with other government departments administering laws relating to matters affecting the environment, while section 42 deals with the management of residue stockpiles and residue deposits.

The consultation process leading to the White Paper and promulgation of the Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002), however indicated that there is a desire by stakeholders that environmental matters affecting mining be dealt with by DME rather than separately by other affected departments such as the Department of Environmental Affairs and Tourism, Department of Water Affairs and Forestry and Agriculture (Dale, 1997).

The DME Environmental Management Plan (EMP) (DME, 2001), which was compiled as a legal requirement under NEMA (Act 107 of 1998), does not acknowledge mining waste, but recognises that a culture of waste minimization, recycling and re-use should be promoted..

6.6.2 Department of Water Affairs and Forestry

The Department of Water Affairs and Forestry (DWAF) is responsible for the protection, use, development, conservation, management and control of the water resources of South Africa on a sustainable basis. The National Water Act, 1998 (Act 36 of 1998) provides for the development of regulations prescribing the outcome or effect which must be achieved through management practices for the treatment of waste, or any class of waste, before it is discharged or deposited onto land or allowed to enter a water resource.

Residue stockpiles and residue dumps as defined in the Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002) are considered to be waste in terms of the National Water Act, 1998 due to their potential to cause pollution of water resources. Acid mine drainage associated with these stockpiles and dumps is the main source of water pollution emanating from old mining activities.

The National Water Act, 1998 also provides for the removing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people. This activity constitutes a water use that needs to be authorised in terms of the said Act.

All water uses associated with mining operations needs to be authorised prior to the commencement of the water use activity. In practice this means that mining operations can only start once both DME and DWAF have issued the relevant authorisations. In this regard DWAF issued regulations under the NWA specifically dealing with water use for mining purposes.

6.6.3 Department of Environmental Affairs and Tourism

The Department of Environmental Affairs and Tourism (DEAT) is responsible for the sustainable development and conservation of the country's natural resources. The National Environmental Management Act, 1998 (Act 107 of 1998) provides for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions to promote co-operative governance and procedures for co-coordinating environmental functions exercised by organs of state.

While perhaps not defined as waste, minerals residues are subject to Section 28 of NEMA, which requires that "*every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment*".

Mining activities, including reworking of old mine dumps are listed activities requiring authorisation in terms of the EIA regulations (Government Notices 385, 386 and 387 GG 28753 of 21 April 2006) promulgated under NEMA.

The National Environmental Management: Waste Bill is being drafted by DEAT and will (as it currently stands, draft November 2006) also regulate mining waste which by implication could require residue dumps and stockpiles to be licensed as waste disposal facilities [(15)].

6.6.4 National Department of Agriculture

The Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983) aims to ensure that the production potential of the land is retained. To this end, it provides for control over utilisation of the natural agricultural resources to promote conservation of soil, water sources and vegetation and combat weeds and invader plants. The Minister of Agriculture may prescribe control measures which must be observed by land users. Such control measures may be directed at residue dumps and stockpiles as well.

6.6.5 Implementation of cooperative governance

Effective cooperative governance will require good working relationships and communication between the different national government departments, national and provincial government departments as well as national, provincial and local government. The White Paper on Integrated Pollution and Waste Management (DEAT, 2000) fragments responsibility for waste management by stating that hazardous waste will be managed by provinces and general waste by local government.

At provincial level in the Gauteng province, there is an attempt at cooperative governance, where intergovernmental meetings are held between DME, DWAF (regional office) and DEAT (National as well as Provincial). The success of these meetings could however be questioned (personal communication, DWAF 2006).

The effectiveness of cooperative governance is also questioned by the Chamber of Mines (personal communication, Chamber of Mines, 2006). Every government department has a different mandate and therefore looks at mining operations from a different perspective. When dealing with residue stockpiles, for example, the engineers (DME) would prefer free draining facilities with stability (health and safety) as the main concern while scientists (DEAT and DWAF) prefer liners in order to protect the environment and water resources. In such instances it is very difficult to cooperatively agree on a way forward since there is a direct clash in professional approaches which often leads to heated debates without clear outcomes.

Furthermore, every provincial department dealing with the environment has its own, sometimes very different, waste policies, which is very confusing to big mining companies with operations in different provinces.

[15] While the Waste Management Bill intends to include mining residue under the definition of waste, mining activities are not yet listed as waste management activities under the Waste Bill. The roles and responsibilities of DME and DEAT with regards to mining waste will need to be resolved prior to promulgation of the Waste Act.

7 Economics of reuse

7.1 Introduction

During 2004, the mining industry employed 2.9% of South Africa's economically active population, or some 5.3% of all workers in the non-agricultural formal sectors of the economy. A total of 147 125 mineworkers lost their jobs over the ten-year period from 1995 to 2004 as a result of, amongst others, the shrinking gold sector and improvements in productivity in the domestic minerals industry (SAMI, 2005).

Democratic change in South Africa during the 1990's resulted in the endorsement of the principles of private enterprises within a free-market system, offering equal opportunities for all the people. The broad-based Socio-economic Empowerment Charter for the South African mining industry was promulgated in May 2004. The Charter calls for Historically Disadvantaged South Africans (HDSA) to control 15% of mines within five years, rising to 26% within 10 years (SAMI, 2005). Black Economic Empowerment (BEE) mining deals worth about R6.5 billion were concluded in 2004, and new giants such as African Rainbow Minerals and Mvelaphanda Resources are shaping the new South African mining landscape. Most of the BEE deals are taking a form of mergers and acquisition (SAMI, 2005).

The South African Mining Development Association (SAMDA) is a new organisation established with a vision to be the vehicle for the development of a vibrant and sustainable junior mining sector.

According to the Chamber of Mines (personal communication, Chamber of Mines, 2006), it is rather common to have at least three consecutive mining companies operating on the same site. The first company is only interested in the high value ores with production rates of about 15kg/t. The second company will then take over until the production rates drop below 5-10kg/t. Numerous smaller groups and companies also carry out mining and beneficiation activities. Not only do they contribute towards the creation of employment opportunities, but they also exploit the relatively smaller mineral deposits which may not be considered economically attractive to the larger groups. The National Small-scale Mining Development Framework, established in 1999, is contributing to the development of the junior mining sector. The unique mechanism of the framework was designed to assist first-time entrepreneurs in overcoming the many obstacles faced by small-scale mines (SAMI, 2005).

The reality of small-scale mines in the junior mining sector is that they often mine on the sites after a bigger mining company seized operation. The cumulative environmental impacts with the associated environmental liabilities, is more often than not inherited with the site. Being a small company, provision for funding of mine closure and proper remediation is often inadequate with the consequential effect that the company becomes liquidated, people are retrenched and leaving remediation and clean-up for the account of government. In such instances, uncontrolled pollution emanating from the site impacts the surrounding environment with detrimental effects on the environment as well as human health.

The Chamber of Mines undertook economic assessments of the old mine dumps on the Witwatersrand to determine the potential for cross-subsidization of clean-ups. (These reports are unfortunately currently 'quarantined' pending a court case.) The Ergo operation's started after this intervention by the Chamber. The aim of the Ergo operations was not economic benefit, but to address the environmental pollution caused by the old tailings. However, once land owners realised the potential value of the tailings, the cross-subsidization fell flat and Ergo closed down [16]. The remediation of the footprints of the reprocessed sites also came to a stand still as a result (personal communication, Chamber of Mines, 2006). One of the remaining benefits of this project is however, that the tailings are now stored in properly lined and engineered tailings storage facilities that are managed according to current best practices.

7.2 Economic incentives

7.2.1 Introduction

From an economic perspective, the extraction of virgin materials and the failure to reuse mineral waste can be seen as a market failure; in that society as a whole would benefit from

[16] The emergence of new, large, commercial processing facilities (e.g. Crown Gold recoveries operation) to recover gold from tailings dams, has the potential to reopen the discussion on the feasibility of cross-subsidization. Through subsidization, by e.g. government, smaller (often abandoned) dumps (or 'hot spots') could be reworked, where previously these sites were not viable for recovery, due to low grades of gold, or small size of dump.

the reuse of mineral waste rather than the extraction of virgin materials, but the prices (and hence incentives) faced by the agents involved are biased toward extraction. More specifically, the prices faced by mining companies do not reflect the full social (environmental) costs associated with mining activities. Extraction costs are thus too low; hence the quantity of virgin materials extracted is too high relative to the socially optimal level. This is illustrated in **Figure 9**; where the marginal private costs of extraction (the cost to mining companies per unit extracted) is given by MPC, and the marginal private benefits (to mining companies) is given by MPB. According to standard microeconomic theory, the mining firm will extract at the level where MPC = MPB, i.e. at Q1 (Pearce and Turner, 1990).

However, this extraction level does not reflect the full social costs associated with mining. For example, the environmental impacts associated with mining are not taken into account by the mining company, but are borne elsewhere in society. These costs are termed (negative) externalities as they are generated through the activities of the firm but are not internalised in the firm's decision making, thereby driving a 'wedge' between private and social costs. Thus, the true marginal social cost per unit of extraction is given by MSC. An optimal extraction level requires that MSC (rather than MPC) be equated with MSB (marginal social benefits, assumed in this case to be equal to MPB). The optimal extraction level is thus Q2. However, the mining company takes only *private* costs and benefits into account, rather than *social* costs and benefits. Thus, in the absence of intervention, the level of extraction (Q1), and thus of associated environmental impact, is too high relative to the socially optimal level (Q2).

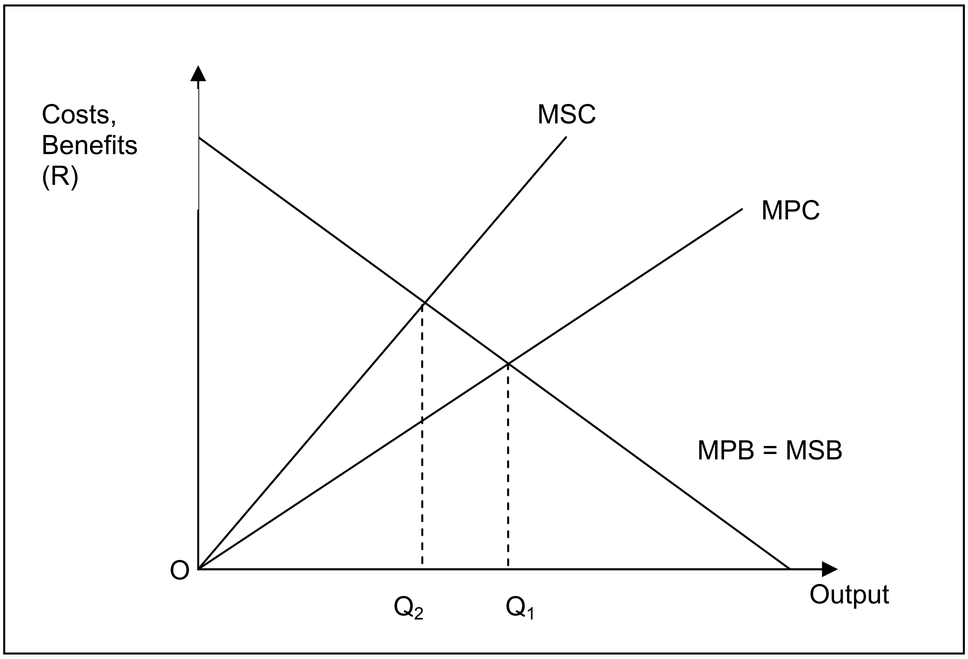


Figure 9: Externality associated with natural resource extraction (adapted from Pearce and Turner 1990

Equivalently, it can also be shown that the private benefits of *reusing* mineral waste are lower than the social benefits, as the environmental benefits of reuse are not reflected in prices, and are thus not appropriated by the firm undertaking the reuse, and are thus not reflected in the firm's decision making (positive externality). Thus, the actual level of reuse, determined by the intersection of private (rather than social) costs and benefits, is too low relative to the socially optimal level (Pearce and Turner, 1990).

Environmentally-related market failures have traditionally been addressed through the use of command-and-control (CAC) regulation, where the behaviour of agents is regulated directly (e.g. technology or emission standards) (Perman *et al*., 2003). In South Africa, CAC mechanisms still dominate environmental policy (National Treasury, 2006). However, by not altering relative prices, these policies treat the symptoms of market failure, rather than the cause. As an alternative to CAC regulation, market-based instruments (MBIs), which seek to influence behaviour in the desired direction *indirectly*; by changing the incentives faced by agents, through changing relative prices, have grown in importance in developed countries, and to an increasing extent in developing countries, since the 1980s (Bell and Russell, 2002). According to the National Treasury (2006:2), MBIs are "*a group of policy instruments that seek to correct environmentally-related market failures through the price mechanism… By seeking to alter the relative prices that individuals and firms face, [MBIs] could be more efficient in addressing certain environmental concerns*"

One example of a MBI is an environmentally-related tax, i.e. a "tax whose tax base is a physical unit (or proxy of it) that has a proven specific negative impact on the environment" (OECD, 1997, in National Treasury, 2006:3). In the case of mineral waste management, a tax could be applied on the extraction of virgin materials. This would have the effect of increasing the per-unit private extraction cost of virgin materials, making reuse of waste materials relatively cheaper and thus more attractive. All else being equal, this should result in decreased extraction and an increase in reuse. For example, **in Figure 10**, which extends on the example in **Figure 9**, a tax (set at level 'T') per unit extracted increases the MPC faced by the mining company, such that when it now equates MPC with MPB in its private decision making, the outcome is a socially optimal level of extraction, Q2. The tax thus has the effect of 'internalising' the externality such that the private firm takes it into account in its decision making, ensuring that a socially optimal outcome is achieved (Pearce and Turner, 1990).

Note also that a subsidy on reuse (another example of a market-based instrument) would yield a similar outcome – the marginal private benefits of reuse would increase such that the level of reuse achieved through the market, i.e. through private decision making, would coincide with the socially optimal level of reuse.

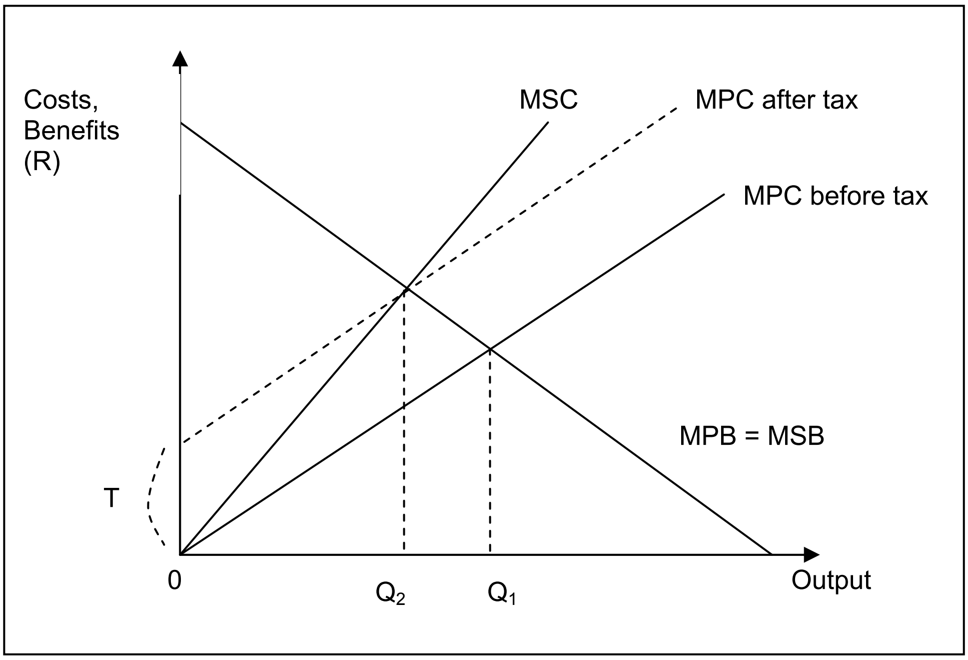


Figure 10: Use of a tax to internalise environmental externalities (adapted from Pearce and Turner 1990

7.2.2 Advantages of market-based instruments over command-and-control

Command-and-control instruments "rely heavily on the availability of technical skills, an effective administrative infrastructure for monitoring and enforcement, and… costly 'end-of-pipe' abatement technologies… these may be largely lacking or pose excessive cost burdens in developing countries" (OECD, 1992:11). Market-based instruments, on the other hand, seem far more appropriate in the developing country context, for a number of reasons [17]:

[17] This is not to say that MBIs are the most appropriate type of policy measure in any given case, or even that an "either/or" approach should be adopted in choosing

1. MBIs are flexible and efficient in terms of informational requirements, and are thus cost-effective (static efficiency). Unlike CAC instruments, which dictate the technology to be used by firms and/or the environmental outcomes each firm must achieve, MBIs give firms the freedom to choose which technologies and environmental outcomes are most appropriate for them. Because firms use different technologies and have different capacities for improving their environmental performance, it is not cost-effective to require all firms to conform to the same standards. With MBIs, a given environmental target is distributed among firms in a cost-effective manner. Thus, any given environmental outcome can be achieved at least cost, without the stringent informational requirements of CAC instruments (OECD, 1992; Perman *et al*., 2003)
2. By addressing market failures, MBIs ensure that inefficiencies associated with distorted prices are overcome, thus improving economic efficiency
3. Taxes and tradable permits conform to the ‘polluter pays principle’ in that polluters are made to take account of the environmental costs of their activities (OECD, 1992)
4. Taxes and tradable permits impose a cost on each unit of pollution, and thus create on-going incentives for continuous innovation and environmental improvement (dynamic efficiency). CAC instruments, on the other hand, provide no incentive to improve environmental performance beyond the required standard (OECD, 1992)
5. Revenues collected from environmental taxes can be used for environmental programmes or other spending purposes, or can help reduce inefficiencies by reducing the rates of distortionary taxes elsewhere in the economy (tax-shifting), such as taxes on labour or capital (the so-called ‘double-dividend’ hypothesis). Revenues could also be recycled back into the affected industry in order to alleviate concerns regarding competitiveness and equity, either through the national budget or by means of tax shifting, while maintaining incentives for environmental improvement (Perman *et al*., 2003; National Treasury, 2006)

7.2.3 *International experience with economic incentives for mineral waste management*

Many countries impose various types of fees, charges, taxes or royalties on mining activities; or on solid waste (see for example EPA, 2004; OECD and EEA, 2006). However, few specifically target mining waste or are intended to deal specifically with the environmental consequences of extraction activities.

The United Kingdom introduced a tax on the extraction of virgin aggregates in the quarrying industry (rock, sand and gravel) in April 2002 (HM Revenue and Customs, 2002). The aim of the ‘Aggregates Levy’ is to reduce the demand for virgin aggregates and encourage the use of recycled materials by increasing the price of the former relative to the latter; thereby reducing the environmental impacts of quarrying (such as noise, dust and visual intrusion) and minimising waste. The tax rate is currently £1.60 per tonne of material extracted (SEPA, 2005; DEFRA, 2006a).

Some of the revenues generated by the levy are recycled back to the industry through a 0.1% reduction in pay-roll taxes (National Treasury, 2006), thereby creating a ‘double-dividend’ in terms of reducing distortions and promoting employment opportunities. Another portion of the revenue, as well as other sources of funding, contributes towards the Aggregates Levy Sustainability Fund, which finances projects contributing to the achievement of four objectives (DEFRA, 2003; 2006a; 2006b):

1. Minimising demand for extraction of virgin aggregates
2. Promoting ‘cleaner’ extraction and transport of aggregates
3. Addressing impacts of extraction in the past
4. Compensating local communities for the impacts of extraction by delivering benefits to affected areas

It was assumed that the levy itself would be insufficient to curtail extraction of virgin aggregates; hence the use of some portion of the Fund for capital grants (subsidies) and projects aimed at promoting reduced demand for, and more environmentally benign extraction of virgin aggregates (DEFRA, 2006b). The UK’s Waste and Resource Action Programme (WRAP) forecasts that use of recycled aggregates in England will increase by 13.9

between CAC and MBIs. Although in certain circumstances pure CAC or pure MBI-based policies may be necessary, often a “package” of complementary instruments will be more appropriate. Such a policy package could consist of elements of both CAC and MBIs, depending on the situation at hand (OECD, 2001b; National Treasury, 2006).

million tonnes between 2005 and 2021 as a result of the grants provided by the fund alone; while research and dissemination projects have increased awareness among contractors and clients regarding potential gains from the use of recycled aggregates, such that the UK market for recycled aggregates is the largest in the EU, and is still growing (DEFRA, 2006b).

Similarly, Denmark imposes a tax on sand, gravel, and clay extraction at a rate of 5 Krone per m3; which raised DK20 million in revenue in 1993 (Ekins, 1999) and DK145 million in 1997 (OECD, 1999). Sweden imposes a tax on natural gravel at 5 Krona per tonne (raising SK120 million in 1997); and on limestone (SK0.004/tonne) and other excavation material (SK0.26/tonne) (raising SK30 million in 1996); and administrative fees on peat (SK7/ha, plus annual tillage fees (SK5/ha), plus exploitation fees) and other minerals (OECD, 1999). Finally, Manitoba province in Canada charges $0.1 (Canadian) per tonne of quarry minerals extracted (Ekins, 1999). However, little information regarding the *environmental* effectiveness of these policies can be gauged from the amount of revenue raised.

Indeed, there is likely to be a trade-off between the revenue-generating capabilities and environmental effectiveness of any given tax, since a tax that provides a sufficient incentive to change behaviour with respect to the environment may erode its own tax base (OECD, 2001b). This trade-off rests on the price-elasticity of demand (responsiveness of demand to changes in price) for the product in question. Taxes on products with a low responsiveness of demand to changes in price, such as water and energy, are likely to raise significant revenue, but are unlikely to achieve significant environmental gains. On the other hand, taxes on products with a higher price elasticity of demand can expect significant environmental gains, but are not likely to raise significant amounts of revenue (National Treasury, 2006).

Other examples of economic incentives related to mining and mineral waste include taxes on water and air pollution resulting from the extraction and processing of minerals (Latvia, see Section 6.2); taxes, charges and non-compliance fees on mining waste (Austria, Italy, Estonia); performance bonds repayable on rehabilitation of mine sites (Australia, Canada); liability payments for damages caused by mining (Papua New Guinea, Peru); and grants for reductions in mining activities and restoration of damages caused by mining (Czech Republic) (Krutofals, 2004; Perman *et al*., 2003; EPA, 2004; OECD and EEA, 2006).

7.2.4 Recommendations for use of economic incentives for mineral waste reuse in SA

Environmental taxes in South Africa currently account for roughly 2% of GDP and 10% of overall tax revenue (National Treasury, 2006). Although this is roughly in line with OECD countries (OECD, 2001a; 2006), 70% of this revenue is raised through the general fuel levy alone, with other environmental taxes playing a far less important role. Furthermore, “since the majority of existing environmentally-related taxes were introduced with the primary intention of raising revenue, there exists the potential to improve the environmental outcomes and behavioural incentives created by these instruments” (National Treasury, 2006:iii). However, MBIs are relatively complex instruments, and require sufficient institutional capacity in terms of acquiring relevant information, monitoring firms’ activities, and ensuring compliance. The following considerations should therefore be taken into account when attempting to implement MBIs for environmental policy:

1. Instrument choice should be based on a review of the full range of instruments available and their respective costs and benefits, and applicability to the situation at hand; including a careful analysis of the source of market failure, aspects of design and administration, potential impacts on distribution, potential impacts on international competitiveness, and “compatibility with broader government objectives” (National Treasury, 2006:104; OECD, 2001b). The possible adverse impacts of taxes on competitiveness and distribution can be mitigated in a number of ways; see OECD (2001b).

   The appropriate instrument(s) depends on the specific type of market failure at hand. In the case of excessive mineral extraction and lack of reuse, two types of market failure are occurring: environmentally damaging extraction of virgin materials involves negative externalities, and should thus be discouraged; while reuse of waste materials involves positive externalities, and should thus be encouraged.

   Negative externalities can be discouraged by means of CAC, or MBIs such as taxes or tradable permit schemes. The advantages of MBIs over CAC were highlighted above. Furthermore, in the developing country context, taxes are more appropriate than tradable permit schemes; since the latter require significant administrative capacity and “extensive supporting regulatory infrastructure” (National Treasury, 2006:50); and are less able to generate revenue. In South Africa in particular, where many sectors are characterised by oligopoly (dominated by a few large firms), it will be difficult to create the necessary conditions for open trade in permits (National Treasury, 2006). Taxes on virgin material extraction are thus a more appropriate instrument for dealing with the negative externalities imposed by mining in South Africa.

Positive externalities, on the other hand, can be encouraged by means of payments for ecosystem services (PES), subsidies, or CAC regulation (National Treasury, 2006). PES is not likely to be appropriate in this case; while again, MBIs such as subsidies have efficiency advantages over CAC regulation. However, “subsidies (in the absence of complimentary disincentive measures such as taxes or charges) do not comply with… the polluter pays principle and can lead to further economic distortions” (National Treasury, 2006:89). As such, they “should only be considered when implemented in conjunction with other instruments such as taxes” (National Treasury, 2006:50). For example, in China, revenues from pollution taxes are earmarked for a fund used to subsidise investment in abatement technologies. In this way, industrial activities imposing negative externalities (pollution) are discouraged by means of a tax, while the revenue collected is used to encourage activities creating positive externalities (development of clean technology) by means of subsidies. Evidence suggests that the pollution intensity of Chinese industries has decreased as a result (National Treasury, 2006). However, earmarking of tax revenue is not considered best practice, as discussed below.

2. Assuming that an environmental tax has been chosen as an appropriate instrument, the next step is to set an appropriate tax rate. Setting the optimal tax rate (‘T’ in **Figure 10**) can be complicated, and requires that the relevant agency has information on firms’ costs, and on the costs of the environmental damages resulting from the firms’ activities. This is a fairly stringent informational requirement, even in developed countries. However, it can be shown that *any* positive tax rate will induce some environmental improvement, even if output isn’t reduced to the optimal level. In principle, therefore, government can set a tax at an arbitrary level, without any prior information as to firms’ costs or environmental damages, and expect some results (Perman *et al*., 2003).

   A key problem with taxes on virgin materials, such as the UK aggregates levy, is that, due to high transport costs, compared with the relatively low selling price per tonne, reuse is only financially viable close to the mine or quarry (DEFRA, 2006b). Even with a tax in place, it is potentially cheaper to extract virgin materials nearby the intended construction site, rather than transport used materials. The lesson here is that tax rates on virgin materials (or subsidy rates on reuse) should be sufficiently high so as to outweigh the transport costs associated with mineral wastes; thereby providing a sufficient incentive to use wastes rather than extract virgin materials. It must be kept in mind, however, that transportation comes with its own environmental costs; these must be weighed against the environmental costs associated with extraction.

3. Consultation, co-operation and consensus with other government departments and industry regarding the need for regulation, the choice of instrument, and the tax/subsidy level, is necessary to ensure that the proposed instrument will be acceptable to the affected industry (OECD, 1992; National Treasury, 2006). State clearly the environmental and fiscal objectives of any proposed instrument (OECD, 2001b; National Treasury, 2006). Phase the instrument in gradually, building on pre-existing institutional structures, legislative framework and government policies, and in accordance with a pre-announced timeline; in order to ensure sufficient time for consultation, certainty regarding what is required from industry, and acceptance; and to build confidence and institutional capacity (OECD, 1992, 2001b; Bell and Russell, 2002).

4. Establish a framework for monitoring and enforcement. Lack of monitoring capacity in

developing countries can be addressed by requiring self-monitoring by firms, combined with random checks and severe penalties for inaccurate reporting (OECD, 1992). Taxes on *output* (as in the case of a tax on extracted virgin material) have advantages over taxes on *pollution* in terms of the ease of monitoring. Instead of monitoring firms' pollution emissions, which requires firms' co-operation and/or fairly sophisticated monitoring capabilities, all that needs to be monitored in this case is firms' output, information which is generally more readily available or obtainable than information on emissions.

5. Finally, the revenue collected from an environmental tax needs to be used in an appropriate way. Tax revenues could be used to "*alleviate a budget deficit, contribute to a budget surplus, …finance discretionary increases in government expenditures… provide room for discretionary reductions in other taxes to reduce distortions (efficiency losses) in labour or capital markets [the double-dividend hypothesis referred to above], address competitiveness [and equity] concerns [revenue recycling], or to increase public acceptance of environmental taxes*" (OECD, 2001b:5-6).

   Revenues can also potentially be used to finance related environmental management projects; such as subsidies for recycling or for investment in cleaner technology. However, for reasons described below, the National Treasury (2006) is cautious regarding the ring-fencing or earmarking of revenue for environmental projects.

   In principle, there are three options as to how revenues can be channelled towards related environmental investments or recycled back to the industry; namely full earmarking, soft/partial earmarking, and allocations through the normal budget process. Full earmarking is not recommended, as it reduces transparency and increases the scope for special interest groups to capture revenue. Earmarked taxes "tend to fragment and complicate the tax system and allow departments and agencies to escape the discipline of the budget process" (National Treasury, 2006:101). They also create rigidities and result in an inappropriate allocation of resources. International best practice asserts that government spending decisions should be separated from revenue collection, via the fiscal budget process (National Treasury, 2006).

   A compromise may be to use 'soft' or 'partial' earmarking, whereby "revenues will flow via the fiscus with the provision that special consideration be given to fund certain activities but with no fixed commitment to allocate all the revenues from a specific source to such activities" (National Treasury, 2006:105). In general, there are no clear guidelines to determine whether earmarking is appropriate; instead, the desirability of earmarking needs to be assessed case-by-case, and, where earmarking is granted, regularly re-evaluated to ensure its ongoing desirability (National Treasury, 2006).

8 Liability for mineral waste reuse

The nature of liability has changed substantially since 1994. Recently promulgated legislation has altered the traditional common law relationship of liability being closely associated with ownership and the legislative liability regime has been considerably expanded - both in terms of people who bear liability and the range of matters which may result in liability. Identifying the exact extent of responsibilities and corresponding potential liabilities in respect of mining therefore requires not only an assessment of ownership, but also involvement in certain activities and/ or the status of a person for the purposes of legislation. The issue is accordingly complex and often requires a detailed case-by-case assessment.

This section accordingly sets out preliminary considerations that should be taken into consideration in respect of liability. It highlights key provisions of four significant Acts that should be considered when defining the nature of liability in respect of mine dumps viz. -

- Constitution (the implications of the Constitution are not discussed in detail);
- Mineral and Petroleum Resources Development Act, 2002 (Act No. 29 of 2002);
- National Environmental Management Act, 1998 (Act No. 107 of 1998)("NEMA"); and
- National Water Act, 1998 (Act No. 36 of 1998)("NWA").

8.1 Constitution

The inclusion of an environmental right as well as rights in respect of access to information and *locus standi* in the Constitution has resulted in substantial changes in environmental liability. In this regard, the environmental right has extended the range and types of issues that may be taken to court. In addition, there is a possibility that the environmental right applies horizontally. This implies that juristic and natural persons have to exercise a duty of care if liability on the basis of the right is to be avoided.

Apart from the expansion of the substantive matters with can found liability, traditional barriers to imposing liability such as *locus standi* and access to information have also been diminished. In this regard, the *locus standi* provision has broadened the categories of people who can sue, including to people who have an altruistic motive, and the access to information right has provided a tool for ensuring that matters that are taken to court are supported by the requisite information.

8.2 Mineral and Petroleum Resources Development Act

The MPRDA is a complex piece of legislation in that it creates layers of rights under the auspices of the State's custodianship role. The nature of the liability that is attracted in terms of the legislation is dependant on a range of factors, the most important of which is the type of mineral right that is held. For example, the re-use of a mine dump could be included in an existing mining right, or specific application could be made.

8.2.1 Nature of environmental liability

The key insight to the MPRDA's approach to environmental liability lies in reading section 38. In terms of that section, the holders of permits and rights are required to-

- appraise themselves of potential environmental impacts;
- manage any environmental impacts; and
- rehabilitate the environment in so far as is reasonably possible.

The section also provides that the holder is responsible for any environmental damage, pollution or ecological degradation which occurs inside or outside of the boundaries to which the right or permit relates.

In terms of this section, the nexus of liability is between the activity which caused the pollution or degradation and the holder of the right or permit. (Directors and members may be jointly and severally liable where there is an unacceptable negative impact on the environment).

The MPRDA accordingly expressly provides for environmental liability based on broad responsibilities of the holder of a right or permit. In practise, the extent of the liability may be limited by pollution or degradation that occurs in accordance with an approved environmental management plan or environmental management programme. The MPRDA does not, however, attempt to expand the range of people to whom liability can attach as the environmental legislation discussed below does.

If the holder creates a situation that results in environmental pollution or degradation and which may cause harm to health or well-being and which requires urgent attention, the Minister may direct the holder to take certain steps to address the situation. Unlike the NEMA, the failure to comply with a directive constitutes a criminal offence. If the holder no longer exists or cannot be traced, the Minister may direct the Regional Manager of the Department to take the relevant steps, to recover the costs from the provision that has been made by the holder and to apply for endorsement of the title deeds.

8.2.2 Duration of liability

The liability created in terms of section 38 is not infinite. Environmental liability may be terminated either by the sanctioned transfer of liability or on the obtaining of a closure certificate.

8.3 National Environmental Management Act

In line with international approaches and the Constitution, NEMA expanded liability for environmental matters by narrowing the divide between what was traditionally left to the realm of civil liability and statutory requirements. One of the mechanisms that was adopted to achieve this was the incorporation of a duty of care in respect of environmental matters.

8.3.1 Nature of the duty

The duty of care is contained in section 28 and is titled "duty of care and remediation of environmental damage". In terms of subsection (1), the duty is imposed on every person who causes, has caused or may cause significant pollution or degradation of the environment to take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.

Waste management activities that cause or may cause pollution or environmental degradation will fall within the scope of the duty, although the extent to which the duty applies to actors throughout the life cycle of waste is not explicit.

The obligation contained in subsection (1) is imposed on a range of people including owners or people in control of land or premises and people who have the right to use the land or premises on which, or in which, an activity or process is, or was, performed or undertaken or any other situation exists which causes, has caused, or is likely to cause, significant pollution or degradation of the environment.

The people on whom the duty is imposed is not confined to these three categories since the subsection is qualified by the statement that the identification does not limit the generality of the duty in subsection (1) and that subsection uses the wording "every person". In view of this, liability is not only linked to rights in the land where the breach of the duty occurs. The identification of people on whom the duty is imposed also indicates that there need not necessarily be a connection between the duty to take steps and the undertaking of an activity. This intent is made clearer when the provisions for costs apportionments discussed below are considered since in that provision successors-in-title and people who negligently failed to stop the pollution may be liable for costs.

8.3.2 Measures that must be taken

The measures that must be taken to discharge the duty are not prescribed, but an indicative range of measures is provided for in section 28(3). In terms of section 28(3), the measures which must be taken can include measures to –

- investigate, assess and evaluate the impact of the environment;
- inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment;
- cease, modify or control any act, activity or process causing the pollution or degradation;
- contain or prevent the movement of pollutants or the consequent degradation;
- eliminate any source of the pollution or degradation; and
- remedy the effects of the pollution or degradation.

The list indicates that remediation is now clearly part of South African law. The list is not exhaustive and the state is entitled to expect that other appropriate measures are adopted if necessary to discharge the duty. However, because section 28(1) requires that "reasonable" measures be taken, without providing any guidance on what would constitute reasonableness, the appropriateness of the measures that must actually be taken in a situation will have to be evaluated against the test of reasonableness on a case by case basis.

8.3.3 Enforcement of the duty

The duty of care may be enforced by government or by private persons. With regards to government enforcement, the Director-General of the Department of Environmental Affairs and Tourism or a provincial head of department may issue a directive to a person to investigate, evaluate and assess the impact of activities and to take specific measures within a certain time period. If the directive is not complied with, government may take the measures itself and recover the costs from a range of people, including the person responsible for the activity or situation, the owner of the land or their successor-in-title, the person in control of the land at the time and any person who negligently failed to prevent the activity or process being performed or the situation from coming about. The failure to comply with a directive to take measures to prevent a situation from occurring or to remedy a situation and the failure to comply with the duty per se has not been criminalized.

8.4 National Water Act

The duty of care contained in NEMA is based on the approach taken to the duty of care set out in section 19 of the NWA. The wording of the duty in the NWA provides for faultless - or strict liability - and is accordingly substantially similar to that contained in section 28 of NEMA and issues that arise only in respect of the NWA are discussed below.

8.4.1 Scope of the duty

The duty of care contained in the NWA is applicable to activities that may cause, or are likely to cause the pollution of water resources. (The provision does not contain the additional term "degradation" that is included in the NEMA duty of care). The scope of the duty is broad as the words "likely to cause pollution" are used. An activity or situation that is land-based may therefore trigger the application of the duty. Unlike NEMA, any pollution is included in the scope of the provision since the NWA merely refers to pollution and does not qualify this with a requirement that the pollution be significant.

The duty will accordingly apply to waste management activities where it impacts, or has the potential to impact, negatively on a water resource.

8.4.2 Measures that must be taken

Like NEMA, the measures that must be taken are not prescribed, but may include the following –

- cease, modify or control any act, activity or process causing the pollution;
- comply with any applicable waste standard or management practise;
- investigate, assess and evaluate the impact of the environment;
- contain or prevent the movement of pollutants or the consequent degradation;
- eliminate any source of the pollution; and
- remedy the effects of any disturbance to the bed and banks of a watercourse.

It is noted that the measures expressly refer to waste management standards and practices.

8.4.3 Enforcing the duty of care

The Act provides that a water management institution may direct any person to whom the duty applies to take the measures that it considers necessary to remedy the situation. The water catchment agency may also take specific steps itself to prevent pollution itself in certain circumstances and recover the costs from a wide list of people, including a person responsible for causing the pollution, the owner or successor-in-title, the person in control of the land who has the right to use the land at the time when the situation occurred and a person who negligently failed to prevent the activity or situation.

The failure to comply with a directive to take measures to prevent a situation from occurring or to remedy a situation is a criminal offence. The failure to comply with the duty per se has also been criminalized by virtue of section 151(1)(i) which states that it is an offence to "unlawfully and intentionally or negligently commit any act or omission which pollutes or is likely to pollute a water resource" and section 151(1)(j) which provides that it is an offence to "unlawfully and intentionally or negligently commit any act or omission which detrimentally affects or is likely to affect a water resource".

8.4.4 Nature of the liability if duty is not discharged

The categories of people that costs may be recovered from include people who were responsible for the pollution or a range of other people including owners, successors-in-title, people in control of the land who have the right to use the land at the time when the situation occurred and people who negligently failed to prevent the activity or situation. The provision makes a clear distinction between people who are at fault and others.

8.5 Concluding remarks

The discussion above provides a preliminary insight as to the expanded scope of environmental liability in legislation.

The discussion on the MPRDA shows that an assessment of liability and the management thereof in terms of the Act will depend on the type or right or permit held and discharge of the section 38 obligations in respect of the environment. Although the MPRDA provides for environmental liability based on broad responsibilities of the holder of a right or permit, in practise, the extent of the liability may be limited by pollution or degradation that occurs in accordance with an approved environmental management plan or environmental management programme. It is also noted that there is a potential for capping the exposure to liability in terms of the Act.

Whist it is beyond the scope of this report to identify the different types of criminal liability that may arise from legislative obligations, the discussion on liability that arises from the duties of care that are expressly provided for in NEMA and the NWA show that the legislation does not provide for people to adopt an arms-length approach to occurrence of environmental pollution and degradation and that the range of people in respect of whom liability can attach is broader than those included within the scope of the MPRDA. Notwithstanding the capping of liability in terms of the MPRDA, it is possible that liability may still attract in terms of NEMA of the NWA.

The issue of liability in respect of the re-use of a mine dump is accordingly complex and merits a more in-depth assessment. In particular, issues around liability for mineral waste upon transfer of such waste for reuse; issues of when waste ceases to be waste when transferred for reuse; issues of ownership and liability of residue stockpiles in relation to mineral waste reuse potential; need to be further investigated.

9 Conclusions

The aim of this report was to unpack the current governance (legal and institutional) environment in which mineral waste is being managed, and the opportunities and constraints to mineral waste reuse in South Africa.

In conclusion, a review of local literature and legislation has shown that currently much confusion exists in South Africa with regards to the definition of mineral waste, the inclusion of residue stockpiles into the definition of waste, and the roles and responsibilities of DME and DEAT with respect to the management of this waste. While technically mineral waste can be successfully reused, current national legislation and economic policy are obstacles to successful reuse. Due to the significant volumes of mineral waste produced, reuse may not be able to consume all waste, but has the potential (assuming obstacles are overcome), to make significant impacts on the disposal of mineral waste. However, it is recognised that by reusing mineral waste, the mineral resource potential is lost and is often in direct conflict to present or potentially future mineral recovery.

Since mineral residue is not defined as waste, residue stockpiles are often left unprotected, causing environmental pollution. It is hoped, that by defining mineral residue as waste, it will assist in (i) promoting reuse where possible, (ii) safely storing mineral waste, through sound rehabilitation, for possible future recovery, and (iii) forcing the inclusion of environmental and social externalities into the cost of mining, to ensure that waste is sustainably managed.

While historically there has been resistance by many countries to define mineral residue as waste, the current approach internationally is that mining residue is considered waste, and in particular mineral waste. In fact the inclusion of mineral waste in the definition of waste within the European Union has been tested in the European Court, which found that the concept of waste does not exclude substances and objects where reuse is economically viable. Many countries have opted to draft separate legislation, dealing specifically with mineral waste.

In conclusion, while the law reform process has resulted in the gazetting of a National Environmental Management: Waste Management Bill, this Bill does not adequately address the definition of mineral waste and the roles of DME and DEAT in the management of mineral waste. Consultation is required between the two national government departments to adequately resolve this issue, without causing further fragmentation in the management of mineral waste in South Africa.

10 Recommendations

This report has highlighted a number of legal, institutional, technical and economic issues which need to be resolved to allow for the improved management of mineral waste in South Africa. Such gaps include:

- agreement on whether residue stockpiles are considered to be waste
- agreement on whether mineral waste will be included in the definition of waste in the NEM:WMB
- agreement on the roles of DME and DEAT with respect to mineral waste (lead agent)
- agreement on terminology for mining waste, mineral waste and non-mineral waste
- assessment of the quantities of mineral waste in South Africa and the viability of this waste for reuse
- consideration of market based instruments in the management of waste, and specifically, mineral waste in South Africa
- in depth comparative analysis of the cost-benefit of mineral waste reuse versus mineral waste rehabilitation
- assessment of the possible local markets for mineral waste
- economic analysis of the potential for alleviating environmental contamination from small, uneconomical residue stockpiles (waste dumps), through financial cross-subsidization

It is proposed that key persons within the fields of mining and waste, from government, the mining sector, consultancies and research institutions, convene to thrash out these (and other) key challenges facing the management of mineral waste in South Africa, with the objective to establish a mineral waste action plan and research strategy for the country, which will allow for key issues to be researched and resolved in greater depth in future.

11 References

AngloGold Ashanti. (2004a). Case studies: South Africa. Woodlands Project – good progres being made with phytoremediation project. Environment – AngloGold Ashanti Report to Society.

AngloGold Ashanti. (2004b). Case studies: South Africa. Stakeholder involvement in the closure planning process at Ergo. Environment – AngloGold Ashanti Report to Society.

AngloGold Ashanti Ltd. (2005). The ERGO Years: 1977–2005. Published as part of a dedication to everyone involved with the ERGO operations over the years, issued during the site visit to ERGO as part of the Conference on Sustainable Development, November 2005.

Asian Development Bank. (ADB). (2006). *The economic price of land*. Available from: http://www.adb.org/Documents/Guidelines/Eco_Analysis/appendix13.asp. Accessed on10/07/2006.

Bainbridge, T. (2006). *Secondary materials: Will new rules make a new beginning for the end-of-waste?* Conference proceedings of the Waste2006 conference held in Statford-upon-Avon, Warwickshire, UK. Conducted by The Waste Conference Limited.

Bell, R.G. and Russell, C. (2002). Environmental policy for developing countries. *Issues in Science and Technology*. 18,3: 63 - 70

Bizilj, P and Marc, D. (2004). Mining, Mining Waste and Related Environmental Issues in Slovenia. In: *Mining, Mining Waste and Related Environmental Issues: problems and solutions in Central and Eastern European Candidate Countries.* Joint Research Centre of the European Commission, Edited by Jordan, G and D'Alessandro, M. Ispra, EUR 20868 EN, ISBN 92-894-4935-7, 155-164pp.

British standards. (2006). Standards, international and industry. Available from: http://www.ihs.com.au/standards/bsi/ (Accessed on 8 November 2006).

BRGM, (2001). *Management of mining, quarrying and ore-processing waste in the European Union*. Study made for DG Environment, European Commission. Co-ordination by P. Charbonnier, December 2001. BRGM/RP-50319-FR.

Buck, S and Gerard, D. (2001). *Cleaning Up Mining Waste*. Research study 01-1 of the Political Economy Research Centre, 28p.

Celik, O. (2006). Utilization of gold tailings as an additive in Portland cement. SAGE Publication. Available from: http://wmr.sagepub.com/cgi/content/refs/24/3/215 (Accessed 22 August 2006).

City of Johannesburg Metropolitan Municipality (2000). *Waste management by-laws*. Available on: http://www.joburg-archive.co.za/bylaws/waste.pdf. (Accessed on 25/10/2006).

COLAS. (2006). Quality and commitment. Available from: http://www.colas.co.za/conditions-spec-pricehistory.htm. Accessed on 26 October 2006.

Collins, R.J and Ciesielski, S.K. (1994). *Synthesis of highway practice 199: Recycling and use of waste materials and by-products in highway construction*. National Academy Press. Washington, D.C.

Collins, R.B and Ciesielski, S.K. (1994b). *National Cooperative Research Program: The recycling and use of waste materials and by-products in Highway construction*. National Academy Press. Washington. D.C.

Dale, M.O. (1997). South Africa: development of a new mineral policy. *Resource Policy*, 23(1/2): 15-25.

DEFRA (UK Department for Environment, Food and Rural Affairs). (2003). *Mid Term Evaluation of the Aggregates Levy Sustainability Fund*. London: DEFRA

DEFRA (UK Department for Environment, Food and Rural Affairs). (2006a). *Aggregates Levy Sustainability Fund in England 2002 – 2007*. London: DEFRA.

DEFRA (UK Department for Environment, Food and Rural Affairs). (2006b). *Study to Inform the Policy Review of the Aggregates Levy Sustainability Fund*. London: DEFRA.

DEFRA (UK Department for Environment, Food and Rural Affairs). (2006c). *Study Review of England's Waste Management Strategy: A consultation document*. London: DEFRA.

Department for Environment, Food & Rural Affairs (DEFRA) (2003). The Implementation of Council Directive 1999/31/EC on the Landfill of Waste. Available from: http://www.defra.gov.uk/ENVIRONMENT/consult/landfill/03.htm. (Accessed 28 November 2006).

Department of Environmental Affairs and Tourism and Department of Water Affairs and Forestry (DEAT and DWAF). (1997). Integrated Pollution Control and Waste Management: Legal Review and Audit (unpublished).

Department of Environmental Affairs and Tourism and Department of Water Affairs and Forestry (DEAT and DWAF). (1999). National Waste Management Strategy and Action Plans for South Africa: Strategy Formulation Phase – National Waste Management Strategy, Version D 15 October 1999.

Department of Environmental Affairs and Tourism, (DEAT). (1998). White Paper on Environmental Management Policy for South Africa. Government Regulation 749, Government Gazette 18894 of 15 May 1998.

Department of Environmental Affairs and Tourism (DEAT). (2000). White Paper on Integrated Pollution and Waste Management for South Africa: A policy on Pollution Prevention, Waste minimization, Impact Management and Remediation. Government Notice 227, Government Gazette 20978 of 17 March 2000.

Department of Environmental Affairs and Tourism (DEAT). (2000b). Programme for the Implementation of the National Waste Management Strategy. Starter Document for Integrated Waste Management Planning: Review of Current Legislation. Final Draft, May 2000.

Department of Environmental Affairs and Tourism (DEAT). (2004). Working with waste. Guideline on waste collection in high density and unserviced areas.

Department of Environmental Affairs and Tourism (DEAT). (2005a). National Waste Management Strategy Implementation, South Africa. Waste Information System: Framework Document, Final Report March 2005.

Department of Environmental Affairs and Tourism (DEAT). (2005b). National Waste Management Strategy Implementation, South Africa. Recycling: Waste streams analysis and prioritisation for recycling. Final Report.

Department of Environmental Affairs and Tourism (DEAT) 2006. Draft amended EIA regulations. Available from: http://www.environment.gov.za. (Accessed on 17 October 2006).

Department of Environmental Affairs and Tourism. (DEAT). (2006). National Waste Management Strategy Implementation, South Africa. Waste Information System: Waste categorisation discussion document.

Department of Minerals and Energy (DME). (2005). South Africa's Mineral Industry (SAMI) 2004/2005. Available from http://www.dme.gov.za/minerals/sami_2005.pdf (Accessed on 17 October 2006)

Department of Minerals and Energy (DME). (2005). Radioactive Waste Management Policy and Strategy for the Republic of South Africa.

Department of Water Affairs and Forestry (DWAF). (1995). *South African water quality management series: procedures to assess effluent discharge impacts*. First edition. Water research commission WRC report No TT 64/94. DWAF, Pretoria.

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

Department of Water Affairs and Forestry, No. M 5.0, (1998b). Operational Guideline for the DWAF to assist the DME with Environmental Management Programmes in terms of the Minerals Act.

Department of Water Affairs and Forestry (DWAF). (2001). *Waste Generation in South Africa*. Water Quality Management Series. Pretoria.

Digby Wells and Associates. (2006). Top Star Scoping Report Summary for Crown Gold Recoveries.

EIONET (European Environment Information and Observation Network). (2006). GEMET Thesaurus: Mineral Waste. Available from: http://www.eionet.europa.eu/gemet/concept?cp=12383&langcode=en. (Accessed on 21 November 2006).

Ekins, P. (1999). European environmental taxes and charges: recent experience, issues and trends. *Ecological Economics*. 31,1: 39–62

European Directive (1975). Council Directive of 15 July 1975 on waste (75/442/EEC). Official Journal of the European Communities No L194/39.

European Directive (2006). Directive 2006/21/EC of the European Parliament and of the Council of 15 March 2006 on the management of waste from extractive industries. Official Journal L 102 , 11/04/2006 P. 0015 – 0034.

European Environmental Bureau (EEB). (2000). *The environmental performance of the mining industry and the action necessary to strengthen european legislation in the wake of the Tisza-Danube pollution*. EEB Document no 2000/016. 32 p

FAO corporate document repository. (2006). *Cost control in forest harvesting and road construction.* Accessed on 23/10/2006 from http://www.fao.org/docrep.

Fodor, B., Tóth, G., Somody, A. and Szebényi G. (2004). Mining, Mining Waste and related Environmental Issues in Hungary. In: *Mining, Mining Waste and Related Environmental Issues: problems and solutions in Central and Eastern European Candidate Countries* – Joint Research Centre of the European Commission, Edited by Jordan, G and D'Alessandro, M. Ispra, EUR 20868 EN, ISBN 92-894-4935-7. 79-90pp.

Gauteng Department of Agriculture Conservation and Environment (GDACE). (2005). Gauteng Provincial Integrated Waste Management Policy, Draft 2, September 2005.

Gientka, M and Kasiński, J.R, (2004). Mining, Minig waste and Related Environmental Issues in Poland. In: *Mining, Mining Waste and Related Environmental Issues: problems and solutions in Central and Eastern European Candidate Countries* – Joint Research Centre of the European Commission, Edited by Jordan, G and D'Alessandro, M. Ispra, EUR 20868 EN, ISBN 92-894-4935-7 103-125pp.

Godfrey, L. (2006). The role of behavioural theory in understanding the barriers to effective waste reuse: The case of mineral waste. CSIR Report CSIR/NRE/PW/IR/2006/0091/A. Pretoria, CSIR.

Hattingh, J. (2002). *Environmental and economic implications of slag disposal practices by the ferrochrome industry: a case study*. Unpublished M-Tech thesis, University of Pretoria, Pretoria.

HM Revenue and Customs, (2002). Aggregates Levy [*online*]. Available from: http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageExcise_ShowContent&id=HMCE_CL_001169&propertyType=document#downloadopt. (Accessed on 5 December 2006).

Ilgner, H. (2004). *Paste as backfill for South Africa*. Biennial conference proceedings on paste and thickened tailings. Cape town.

Ilgner, H. J. (2006). Tailings dams - From catastrophic failure to sustainable closure, Proc. of Conf. Mining achievements, records and benchmarks, South African Institute for Mining and Metallurgy (SAIMM), 13-15 Sept. 2006.

Jones, R.T. (2006). *Economic and environmental beneficial treatment of slags in DC and furnaces*. Available from: http://www.mintek.ac.za/Pyromet/Files/2004Jones_Slag.pdf. (Accessed on 13 September 2006).

Jordan, G. (2004a). Mining and Mining Waste: Problems and Solutions in the Central and Eastern European Candidate Countries. In: *Mining, Mining Waste and Related Environmental Issues: problems and solutions in Central and Eastern European Candidate Countries* – Joint Research Centre of the European Commission, Edited by Jordan, G and D'Alessandro, M. Ispra, EUR 20868 EN, ISBN 92-894-4935-7, 169-206pp.

Jordan, G. (2004b). Mining, Mining Waste: Pressures, Impacts and Responses in the European Union and Candidate Countries. In: *Mining, Mining Waste and Related Environmental Issues: problems and solutions in Central and Eastern European Candidate Countries* – Joint Research Centre of the European Commission, Edited by Jordan, G and D'Alessandro, M. Ispra, EUR 20868 EN, ISBN 92-894-4935-7, 13-34pp.

Kauppi, M. and Niemela, P. (2006). *Formation, characteristics and use of ferrochromium.* 4th Europen Slag Conference 20-21 June 2005. Finland: The European Slag Association.

Krutofals, V. (2004). Mining and Mining Waste and Related Environmental Issues in Latvia. In: *Mining, Mining Waste and Related Environmental Issues: problems and solutions in Central and Eastern European Candidate Countries* – Joint Research Centre of the European Commission, Edited by Jordan, G and D'Alessandro, M. Ispra, EUR 20868 EN, ISBN 92-894-4935-7 91-96pp.

Kumar, S., Kumar, R. and Bandopadhyay, A. (2006). Innovative methodologies for the utilisation of waste from metallurgical and allied industries. *J. Resources, Conservation and Recycling* (In press), 2006.

Kutranov, R. (2006). Towards Management & Closure of South African Gold Mine Mineral Residue Deposits. Mintek report.

Lind, B.B, Fallman, A.M and Larsson, L.B. (2006) Ferro-chrome slag in road construction. Available from: http://www.iscowa.org/wascon2000/abstracts/myabstracts03.htm. (Accessed on 23 September 2006).

Maree, J.P., Strydom, W.F., Adlem C.J.L., de Beer, M., van Tonder, G.J. and van Dijk, BJ. (2004). *Neutralization of acid mine water and sludge disposal*. Water Research Commission Report Number: 1057/1/04.

Moodley, S. and Fleming, G., (2006). *Good Practice Guidelines for the Management of Non-Mineral Waste in South African Gold Mines*. Mintek report, 26 February 2006.

Motz, H. and Geisler, J. (2006). *Product of steel slag: An opportunity to save natural resources*. Available from: http://www.iscowa.org/wascon2000/abstracts/myabstracts03.htm. (Accessed on 23 September 2006).

National Institute for Occupational Safety and Health (NIOSH). Input: economic factors. Available from: http://0-ww.cdc.gov.mill1.sjlibrary.org/niosh/programs/mining/economics.html. (Accessed on 28 October 2006).

National Research Council (NRC). (1999). *Hardrock Mining on Federal Lands*. Available from: (http://books.nap.edu/html/hardrock_fed_lands/). (Accessed on 30 October 2006).

National Treasury, 2006: *A Framework for considering market-based instruments to support environmental fiscal reform in South Africa*. Pretoria: National Treasury.

Nikolaedes, A and Oikonoma, N. (2006). *The use of fly-ash as a substitute of cement in micro-surfacing*. Available from: http://www.iscowa.org/wascon2000/abstracts/myabstracts03.htm. (Accessed on 30 October 2006).

Northern Cape Provincial Government. (2004). *Mining and Mineral Sector Strategy for Northern Cape Province*. Developed as part of the Northern Cape Provincial Growth and Development Strategy for 2004-2014. Available from: www.northern-cape.gov.za/ncpgds/mining/. (Accessed on 19 October 2006)

Oberholster, R.E. (1971). *Utilisation of slag from chromium industry*. CSIR Report Number R/BOU 368. National Building Research Institute, CSIR, Pretoria.

Odendaal, D. (2003). *Test report on slag*. Cement and Concrete Institute. South Africa. Unpublished manuscript.

OECD (Organisation for Economic Co-operation and Development), (1992). Managing the environment in developing countries. Policy brief # 2 [*online*]. Available from: http://www.oecd.org/dataoecd/22/58/1918684.pdf. (Accessed on 14 December 2006).

OECD (Organisation for Economic Co-operation and Development), (1999). *Economic Instruments for Pollution Control and Natural Resources Management in OECD Countries: A Survey*. Paris: OECD.

OECD (Organisation for Economic Co-operation and Development), (2001a). *Environmentally related taxes in OECD countries: Issues and strategies*. Paris: OECD.

OECD (Organisation for Economic Co-operation and Development), (2001b.) Environmentally related taxes: Issues and strategies. Policy brief [*online*]. Available from: http://www.oecd.org/dataoecd/39/18/2674642.pdf. (Accessed 14 December 2006).

OECD (Organisation for Economic Co-operation and Development) and EEA (European Environment Agency), (2006). OECD / EEA database on instruments used in environmental policy [*online*]. Available from: http://www2.oecd.org/ecoinst/queries/index.htm. (Accessed on 13 December 2006).

Oelofse, S. (2006). Samancor chrome slag: *classification and delisting*. CSIR Report Number.CSIR/NRE/PW/ER/2006/0146/C.

Pearce, D.W. and Turner, R.K. (1990). *Economics of Natural Resources and the Environment*. New York: Harvester Wheatsheaf.

Perman, R., Ma, Y., McGilvray, J. and Common, M. (2003). *Natural Resource and Environmental Economics* (3e). Harlow: Pearson Education.

pers comm. (2006). Mr Henry Bruyn, Techno Ecobond. Pretoria.

pers comm. (2006). Mr Eduard Kleyn, CSIR Built Environment, Pretoria.

pers comm. (2006). Mr Nikki Lesufi. Environmental Advisor to the Chamber of Mines on 21 September 2006.

pers comm. (2006). Mr Nikisi Lesufi, Environmental Advisor: Chamber of Mines on 21 September 2006.

pers comm. (2006). Ms Riana Munnik, Deputy Director: Mining in the Directorate: Resource Protection and Waste, Department of Water Affairs and Forestry, on 17 October 2006.

pers comm. (2006). Mr Phil Paige-Green, CSIR Built Environment, Pretoria.

pers comm. (2006). Mr W. Smith, CSIR Built Environment, Pretoria.

Porter, R. (2002). *The economics of waste*. RFF Press. Available on : http://books.google.com/books?lr=&id=0GiiauhF6PwC&oi=fnd&pg=PR9&sig=WKqUIORf2sON12i5qQyLqxVdhZw&dq=Porter,+R.+(date).++The+economics+of+waste&prev=http://scholar.google.com/scholar%3Fq%3DPorter,%2BR.%2B(date).%2B%2BThe%2Beconomics%2Bof%2Bwaste%26hl%3Den%26lr%3D&hl=en#PPP1,M1. (Accessed on 22/11/2006)

Pulles, W., Howie, D., Otto, D. and Easton, D. (1996). *A manual on mine water treatment and management practices in South Africa*. Water Research Commission Report Number: TT 80/96.

Pulles, W., van Niekerk, A., Wood, A., Batchelor, A., Dill, S., du Plessis, P., Howie, D. and Casey, T. (2001). *Pilot scale development of integrated passive water treatment systems for mine effluent streams*. Water Research Commission Report Number: 700/1/01.

Rambousek, P. (2004). Mining, mining waste and related environmental issues in the Czeck Republic. In: *Mining, Mining Waste and Related Environmental Issues: problems and solutions in Central and Eastern European Candidate Countries* – Joint Research Centre of the European Commission, Edited by Jordan, G and D'Alessandro, M. Ispra, EUR 20868 EN, ISBN 92-894-4935-7. 53-69pp.

Regulation No 527. (2004). Government Gazette 26275 Vol 466 of 23 April 2004 Regulations Gazette 7949. Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002): Mineral and Petroleum Resources development Regulations.

Rio Tinto, (2003). *Rio Tinto Environment Standard. Mineral Waste Management*, vs 1.0, Sept 2003. Available from: http://www.riotinto.com/SustainableReview/common/pdfs/MinWasteManage_Sep03.pdf. (Accessed 30 November 2006).

Rio Tinto. (2006). *Mineral and non mineral waste*. Available from: http://www.riotinto.com/SustainableReview/Environment/programmes/Mineral.aspx. (Accessed 1 December 2006).

Sadzik, E. (2006). *TMHI Standard methods of testing road construction material*. COTO Road Materials Committee (RMC). Available on: http://www.csir.co.za/websource/ptl0002/ppt/transportek/9RPF/19%20E%20Sadzik%20COTO%20RMC.ppt. (Accessed 27/10/2006)

Schroeder (1994)

Scott, J.A. and Iyer, R.S. (2000). *Power station fly ash - a review of value-added utilisation outside of construction industry*. Resource Conservation and Recycling Journal. 31(2001)217-228. Griffith University, Brisbane.

Sego, D.C and Qiu, Y. (2001). *Laboratory properties of mine tailings*. Geotechnical and Geo-environmental Engineering Group, Department of Civil and Environmental Engineering, Canada.

SEPA (Scottish Environmental Protection Agency), (2005). Waste Minimisation Legislation: Aggregates Tax [*online*]. Available from: http://www.sepa.org.uk/wastemin/legis/aggregates.htm. (Accessed on 5 December 2006).

Swiecki, R. (2006) Alluvial Exploration and Mining: Gold. Available from: http://www.minelinks.com/alluvial/gold1.html. (Accessed on 4 August 2006)

Trendafilov, V and Gubev, O. (2004). Mining, Mining Waste and related Environmental Issues in Bulgaria. In: *Mining, Mining Waste and Related Environmental Issues: problems and solutions in Central and Eastern European Candidate Countries* – Joint Research Centre of the European Commission, Edited by Jordan, G and D'Alessandro, M. Ispra, EUR 20868 EN, ISBN 92-894-4935-7. 39-52pp.

United States of America (USA) Department of Transport. (2006). Federal highway administration. Chapter 5: Implementation. Available from: http://international.fhwa.dot.gov/paveprestech/chapter5.htm. (Accessed 8 November 2006)

US EPA (US Environmental Protection Agency). (2006). Nonhazarduos waste. Available from: http://www.epa.gov/epaoswer/osw/non-haz.htm. (Accessed 21 November 2006).

US EPA (US Environmental Protection Agency), (2004). *International Experiences with Economic Incentives for Protecting the Environment.* Washington, D.C.: EPA.

Van Heerden, J. (2006). *The potential economic contribution of mine waste to environmental rehabilitation*. M-Tech Thesis, Rand Afrikaans University. Johannesburg.. Accessed on 10/07/2006 on: <http://etd.rau.ac.za/theses/available/etd-12012003-124913/restricted/3.pdf

Veliciu, S and Stratulat, P. (2004). Mining, Mining Waste and Related Environmental Issues in Romania. In: *Mining, Mining Waste and Related Environmental Issues: problems and solutions in Central and Eastern European Candidate Countries* – Joint Research Centre of the European Commission, Edited by Jordan, G and D'Alessandro, M. Ispra, EUR 20868 EN, ISBN 92-894-4935-7, 127-138pp.

Annexure A:
Technical mineral waste reuse options

Table1: International applications of mineral and inert industrial waste re-use.

Type of waste	Where used	Use	Support/opportunity	Constraints	Reference
Barite tailings (chert)	Nevada	Resurfacing near Battle Mountain	Economically available, compatible and clean Meet specifications. Enabling legislation, embarking on natural resources conservation.	Possible contamination from associated minerals and reduce positive properties and use.	Collins, R.B & Ciesielski, S.K. (1994b)
Bituminous coal refuse	Kentucky	Low volume roads	Economically available, compatible and clean. Meet specifications. Enabling legislation, embarking on natural resources conservation.	Possible contamination from associated minerals and reduce positive properties and use.	Collins, R.B & Ciesielski, S.K. (1994b)
Coal mine spoil,	Durgapur coal mine in Maharashtra.	Used as the land for growing of plants and at the same time as land reclamation measure.	Biotechnologies presented an opportunity for land reclamation use and restore the fertility and productivity of coal mine spoils dumps.	Previous lack of technology	http://www.ias.ac.in/currsci/mar252006
Coal refuse	Ohio, UK	Fill and highway embankment	Availability cheaply and suitable engineering properties. Enabling legislation, embarking on natural resources conservation.	Problem of contaminants and small particle size.	Collins, R.J and Ciesielski, S.K. (1994)
Coal refuse (fine) (culm or gob)	USA	Used as fuel and is burned in co-generation facilities.	Suitable aggregate size and replacement.	Possible impurity content	Collins, R.B & Ciesielski, S.K. (1994b)
Coal refuse	USA	Embankment construction and as fuel.	Good for fuel and construction if pre-treated or originally pure. Economic to use	Impurities such as sulphur, pyrite and marcasite which result in acidic leachate. Also carbonaceous material content. Dangers of combustion.	Collins, R.B & Ciesielski, S.K. (1994b)
Copper slag	North America	Roof shingles, railway			Van Heerden, J. (2002)

Type of waste	Where used	Use	Support/opportunity	Constraints	Reference
		ballast			
Copper tailings	Utah and Michigan	Highway embankments & structural backfill	Very good performance standards. Does not have high contaminants content. Economic to use	Possible contamination by impurities an high fines composition.	Collins, R.J and Ciesielski, S.K. (1994)
Feldspar tailings	North_Carolina	Fill and highway embankment	Abundance and comply with conventional paving aggregate requirements. Alternative resource. Economic to use. Enabling legislation, embarking on natural resources conservation.	Possible contamination by impurities or other heavy metals which may impact on the product strength.	Collins, R.J and Ciesielski, S.K. (1994)
Feldspar tailings	North Carolina	Highway embankments & structural backfill	Very good performance standards. Does not have high contaminants content	Possible contamination by impurities and possible high proportion of fines which may need blending with coarser	Collins, R.J and Ciesielski, S.K. (1994)
Ferrochrome Slag	Tornio, Finland	Road and civil construction and producing refractories. Used also for sub surface drainage material.	Possible suitable alternative for natural sand and macadam. Excellent performance results. Complies with the standard SFS5904 and fulfil requirements of standard EN13285.	Impurity content problems	Kauppa, M AND Niemela, P. (2006)
Ferro-chrome slag	Sweden	Road construction	Low leaching under normal conditions. Successfully used. Enabling legislation, embarking on natural resources conservation.	Potassium leaching.	Lind, B.B, Fallman, A.M and Larsson, L.B. (2006)
Fly ash from power station	Navajo and San Juan (New Mexico)	Backfill in the mines	Meet performance standards of the Government regulations. Enabling legislation, embarking on natural resources conservation.	Possible pollution problems but limited.	Collins, R.J and Ciesielski, S.K. (1994)
Fly-ash	India	Paints, fire resistant bricks, tiles, wood substitutes	Legislation forcing all brick manufacturers within 50km radius of power plants to use fly ash. Fly ash		Van Heerden, J. (2002)

Type of waste	Where used	Use	Support/opportunity	Constraints	Reference
			made available free of charge.		
Fly-ash	Europe	Cement production, highway road construction	Abundance and compliance to construction material specifications. Successfully used.	May cause adverse effect in the environment.	Scott, J.A. and Iyer, R.S. (2006)
Fly- ash	Europe	Substitute for cement in micro-surfacing	Meet specifications of cement raw material. Enabling legislation, embarking on natural resources conservation.	Impurities content	Nikolaedes, A and Oikonoma, N. (2006).
Fly-ash, blast furnace slag and iron ore tailings	-	Ceramic floor and wall tiles	Tiles are superior in scratch hardness and strength		Kumar et al. (2006)
Gold tailings	California and Colorado	Highway pavements, embankments & structural backfill	Very good performance standards. Does not have high contaminants. content Economic to use. Enabling legislation, embarking on natural resources conservation.	Possible high proportion of fines which may need blending with coarser.	Collins, R.J and Ciesielski, S.K. (1994)
Gold tailings	From Kolar gold fields and Hatti gold mines	Recovery of scheelite	New beneficiation technique developed	Previously the low prices of minerals and lack of technology had caused non-exploitation of these wastes.	http://www.ias.ac.in/currsci/mar252006/750.pdf
Gold waste rock	South Dakota	Road construction	Economically available and good engineering properties. Meet specifications. Enabling legislation, embarking on natural resources conservation.	Possible contamination from cyanide, asbestos fibre, arsenic and associated minerals and reduce positive properties and use.	Collins, R.B & Ciesielski, S.K. (1994b)
Gold mill tailings and coal mine wastes	Colorado	Highway embankments & structural backfill	Very good performance standards. Does not have high contaminants content. Construction material shortage. Economic to use	Possible contamination by impurities and possible high proportion of fines which may need blending with coarser.	Collins, R.J and Ciesielski, S.K. (1994)
Gold and	India	Use as source of high-	Improved technology and increasing	Previously the low prices of	http://wmr.sagepub.com/c

Type of waste	Where used	Use	Support/opportunity	Constraints	Reference
copper waste	(The Indian Bureau of Mines IBM, India)	grade minerals such as gold and copper. The study is in process.	prices of minerals.	minerals and lack of technology had caused non-exploitation of these wastes.	gi/content/refs/24/3/215
Gold, lead, zinc tailings	Idaho	Highway embankments & structural backfill	Very good performance standards. Does not have high contaminants content. Economic to use	Possible contamination by impurities and possible high proportion of fines which may need blending with coarser.	Collins, R.J and Ciesielski, S.K. (1994)
Gold Dredge tailings, iron ore tailings	California	asphalt paving mixtures for county road near Eagle Mountain	Economically available and good engineering properties. Meet specifications.	Possibility of contamination from cyanide.	Collins, R.B & Ciesielski, S.K. (1994b)
Gold tailings	U.S.A	Unbound base course	abundance, meet specifications	Aggregate properties problem	Collins, R.B & Ciesielski, S.K. (1994b)
Gold tailings	U.S.A	Asphalt paving aggregate	Abundance, meet specifications Successfully used.	Stripping potential	Collins, R.B & Ciesielski, S.K. (1994b)
Iron blast furnace slag	North America	Road surfacing	Predictable chemical and physical properties, superior resistance to polishing and wear compared to natural aggregates.	Impurities need to be fixed in the slag to render them inert.	Van Heerden, J. (2002)
Iron ore waste rock	Louisiana	Road construction	Economically available, compatible and clean. Meet specifications. Enabling legislation, embarking on natural resources conservation.	Possible contamination from associated minerals and reduce positive properties and use.	Collins, R.B & Ciesielski, S.K. (1994b)
Iron waste rock	Missouri and Illinois	Skid resistant aggregate	Economically available and good engineering properties. Meet specifications.	Possible contamination from associated minerals and reduce positive properties and use.	Collins, R.B & Ciesielski, S.K. (1994b)
Lead, zinc and tin slag	North America	Sand blasting, concrete aggregate, road base, coastal erosion prevention		Pretreatment to reduce toxic components may add significantly to costs	Van Heerden, J. (2002)
Lead-zinc	Illinois	Local roads in Northwest	Economically available, compatible and	Small aggregate size	Collins, R.B & Ciesielski,

Type of waste	Where used	Use	Support/opportunity	Constraints	Reference
tailings		Illinois	clean Meet specifications.. Economic to use		S.K. (1994b)
Lead-zinc tailings (Chert)	Kansas	Southeast corner of Kansas	Economically available, compatible and clean. Meet specifications. Enabling legislation, embarking on natural resources conservation.	Possible contamination from associated minerals and reduce positive properties and use.	Collins, R.B & Ciesielski, S.K. (1994b)
Mine overburden dumps	India	Press–mud (co-recycled mining waste and sugar mill waste) – Improve the soil fertility.	Legislation support.	Previously lack of technology to improvise waste use.	http://www.ias.ac.in/currsci/mar252006 (Juwarkar *el al*. (1993)
Mine waste (general)	Various locations In USA	Portland cement concrete aggregate, asphalt aggregate, flowable fill aggregate or fill, engineered embarkment.	Abundance and accessibility. Compatibility with other materials. Low impurity content. Good performance, and satisfy requirements. Economic to use.	Mine waste is too large to be used in this capacity. Also for-seen dangers from contaminants in waste causing long-term problems. E.g. Structural failure or drifting contaminants.	http://www.ias.ac.in/currsci/mar252006, Schroeder (1994)
Nickliferrous lateritic waste dumps.	Sukinda in Orissa	Nickel recovery	New beneficiation technique in Sukinda, Orissa	Previously the low prices of minerals and lack of technology had caused non-exploitation of these wastes.	http://wmr.sagepub.com/cgi/content/refs/24/3/215
Non-ferrous slag	U.S.A	Unbound base course, Asphalt paving aggregate	Enabling legislation, embarking on natural resources conservation.	Contamination and chemical properties	Collins, R.B & Ciesielski, S.K. (1994b)
Spent oils shales	USA	Mineral filler in asphalt paving	Suitable aggregate with good engineering properties	Requires crushing and sizing prior to use.	Collins, R.B & Ciesielski, S.K. (1994b)
Steel slag	U.S.A	Asphalt paving	Meet specifications	Possible fast aging	Collins, R.B & Ciesielski, S.K. (1994b)
Steel slag	U.S.A	Base or sub-base aggregate	Meet specification and good performance. Successfully used.	Possible weak-ness in expansion tests	Collins, R.B & Ciesielski, S.K. (1994b)
Steel slag	Europe	Road and concrete	High demand for construction material.		Motz, H. and Geisler, J.

Type of waste	Where used	Use	Support/opportunity	Constraints	Reference
		construction, and river bank stabilization	Save natural resources. Successfully used.		(2006).
Taconite tailings (coarse)	Minnesota	Roads and bridge decks in Duluth and Minneapolis-St Paul areas	Economically available, compatible and clean Meet specifications. Enabling legislation, embarking on natural resources conservation.	Possible contamination from associated minerals and reduce positive properties and use.	Collins, R.B & Ciesielski, S.K. (1994b)
Tailings (used also with fly ash and silica fume for cement production).	Ovacik Gold mine, Turkey	Additive of Portland cement and production of fire bricks.	Alternative available and cheaper resource.	Impurity content, and so needs pre-treatment. Small aggregate size.	Celik, O. (2006)
Tailings (mining)	USA	Stabilisation of underground workings as a fill.	Development of paste fill increased its use. Economic to use. Design advancement. Enabling legislation, embarking on natural resources conservation.	Possibility of underground water contamination. Low content of coarse which was of greater use.	Collins, R.J and Ciesielski, S.K. (1994)
Uranium tailings	Australia	Paste fill for underground backfilling	Economic and practical advantages of hydraulic sand fill and cemented rock fill.		Van Heerden, J. (2002)
Uranium tailings	New Mexico, Wyoming, Colorado, and Utah	Household construction	Previously met specifications but no longer used.	Potential of lung cancer causing	Porter, R. (***).
Waste rock	New York	Stone fill for embankments and as rap for bank and channel protection	Available cheaply and good engineering properties. Construction materials shortage. Enabling legislation, embarking on natural resources conservation.	Contamination content.	Collins, R.J and Ciesielski, S.K. (1994)
Waste Rock and coarse	U.S.A	Embankment borrow	Abundance, meet specifications and alternative material. Long haulage	Possible contamination and haulage distance	Collins, R.B & Ciesielski, S.K. (1994b)

Type of waste	Where used	Use	Support/opportunity	Constraints	Reference
tailings			distance of conventional material.		
Waste rock	Arizona	Stone fill for embankments and as rap for bank and channel protection	Cheaply available and good engineering properties. Construction materials shortage. Economic to use	Possible contamination by impurities.	Collins, R.J and Ciesielski, S.K. (1994)
Waste rock	Colorado	Stone fill for embankments and as rap for bank and channel protection	Economically available and good engineering properties. Economic to use. Enabling legislation, embarking on natural resources conservation.	Possible contamination by impurities.	Collins, R.J and Ciesielski, S.K. (1994)
Waste rock	Washington	Stone fill for embankments and as rap for bank and channel protection	Economically available and good engineering properties. Economic to use Enabling legislation, embarking on natural resources conservation..	Possible contamination by impurities.	Collins, R.J and Ciesielski, S.K. (1994)
Waste rock (Copper, iron)	Michigan	Stone fill for embankments and as rap for bank and channel protection	Economically available. Enabling legislation, embarking on natural resources conservation.	Possible contamination of impurities.	Collins, R.J and Ciesielski, S.K. (1994)
Waste Rock and coarse tailings	U.S.A	Embankment borrow	Abundance, meet specifications. Enabling legislation, embarking on natural resources conservation.	Possible contamination and haulage distance	Collins, R.B & Ciesielski, S.K. (1994b)
Waste Rock and coarse tailings	U.S.A	Riprap aggregate	Abundance, meet specifications. Enabling legislation, embarking on natural resources conservation.	Possible contamination and haulage distance	Collins, R.B & Ciesielski, S.K. (1994b)

Table 2: South African applications of mineral and inert industrial waste re-use.

Type of waste	Place, Country	Use	Support/Opportunity	Constraints	Reference
Chrome slag	Southern Cross Steel Co. South Africa.	Aggregate for concrete	Generally complies with the construction material requirements.	Density higher than that of natural aggregate. Needs pre-treatment to remove impurities	Odendaal, D. (2003)
Chrome slag	Palmiet Chrome Corp. South Africa	Aggregate for concrete	Meet construction material specifications	Density higher than that of natural aggregate. Needs pre-treatment to remove impurities.	Odendaal, D. (2003)
Chrome slag#	South Africa	Road construction	Meet construction material specifications	Under investigation	Oelofse, S. (2006)
Copper slag	Messina Development Corp. South Africa	Concrete aggregate	Meet minimum construction material requirements.	Density higher than that of natural aggregate. Needs pre-treatment to remove impurities	Odendaal, D. (2003)
Copper Slag	Astra Nourse Metals Corps	Concrete aggregate	Meet minimum construction material requirements	Density higher than that of natural aggregate. Needs pre-treatment to remove impurities	Odendaal, D. (2003)
Ferro-alloy slag	South Africa	Concrete aggregate for building materials	Use of magnetic recovery to separate chrome. Meet specifications for use.	Entrained metal content. Chromium content which may pollute water	Jones, R.T. (2006)
Fly ash	South Africa	Portland cement production, bricks, and pavements.	Abundance of material and meet specifications		Lesufi, N. (2006)
Gold tailings#	East Rand	Road construction	Abundance of material	Impurity and salt content and haulage distance.	Lesufi, N. (2006).
Gold mining waste#	South Africa	Road construction	Meet construction material specifications.	Lack of funds and inappropriate technology.	Lesufi, N. (2006)
Gold and platinum tailings	South Africa	Backfill	Good quality for fill material	Contamination potential due to impurities content.	Ilgner, H. (2004)

Type of waste	Place, Country	Use	Support/Opportunity	Constraints	Reference
Platinum slag	Rustenburg Platinum Mines. South Africa.	Concrete aggregate	Meet minimum construction material requirements.	Density higher than that of natural aggregate. Needs pre-treatment to remove impurities	Odendaal, D. (2003)
Steel slag	Cullinan, South Africa	Successfully used for road construction	Meet specifications	Impurities such as sulphur	Green, P. (2006)
Steel slag	ISCOR, South Africa	Successfully used for road construction	Meet specifications	Impurities such as sulphur	Green, P. (2006)
Steel slag	South Africa	Road construction	Meet chemical composition moduli	Low glass content (need to add more silica prior to granulation)	Oberholster, R.E. (1971)
Waste rock, sand, clay	South Africa	Civil purposes, e.g. road building, cement manufacture	Virgin aggregate in Gauteng being depleted.	Contamination with radioactive elements. Decontamination costs exceeds viability of selling.	Van Heerden, J. (2002)

Note: On-going or failed projects are marked with a #.

Annexure B
International policy and legislation relevant to the management of mineral waste

Environmental legislation related to mining includes environmental planning, e.g. environmental impact assessment, nature conservation, protection of fauna and flora, protection of landscape, water quality protection, clean air laws to limit air emissions, land protection and control of soil contamination, waste disposal and chemicals control (EEB, 2000).

Under the auspices of the United Nations a number of international conventions have been adopted by governments in recent years with implications for cases of environmental pollution. A number of bilateral and multilateral agreements have been entered into by certain states (EEB, 2000) to regulate cross-boundary impacts of mineral waste. Examples of the agreements according to EEB (2000) include: Relevant multilateral agreements from Bern (1979), Szeged (1986), Espoo (1991), Helsinki (1992) and Lugano (1993). Bilateral agreements between Hungary and Romania were concluded in Bucharest (1986,1997) and Temesvar (1996). These agreements have been entered into following a cyanide spill from a tailings facility into the Tisza and Danube rivers (EEB, 2000).

The applicable legislation of selected countries is reviewed in the following section.

1. European Union

The following legislation is applicable to EU member states (Table 8).

Table 8: The European Union (EU) legislation relevant to mineral waste

Legislation	Relevance to mineral waste
• Directive 2006/21/EC on the management of waste from extractive industries	This Directive covers waste resulting from prospecting, extraction, treatment, storage of mineral resources and the working of quarries.
• Council Directive 75/442/EEC on waste as amended by Directive 91/156/EEC	This Directive applies to waste resulting from prospecting, extraction, treatment and storage of mineral resources and the working of quarries.
• Directive on hazardous waste (91/689, 12.12.91) Council decision of 22 December 1994 establishing a list of hazardous waste pursuant of art. 1(4) of Directive 91/689/EEC on hazardous waste	Although metal containing waste and waste related to metallurgy is included, there is certain ambiguity and the opinion exists that mining waste at present is not subject to the controls provided for by this Directive (EEB, 2000).
• Directive 99/31/EC on the landfill of waste (April 26, 1999)	In principle the Directive applies to liquid hazardous mining waste. Tailings ponds are covered by this Directive. However, all issues related to tailing pond management have not been specifically considered in this directive.
• Council Directive 96/61 concerning Integrated Pollution Prevention and Control, 24.09.96, OJ no L257/10.10.96 (IPPC) –	Mines in general are not mentioned in the categories of industrial activities listed in Annex 1 of the Directive, but installations for the production of non-ferrous crude metals from ore are covered. Moreover, cyanides are listed among the main polluting substances, limit emission values of which are fixed, so mineral waste is partly covered by this Directive. There is also another category in Annex 1, which covers tailings dams at mines sites. “land-fills; receiving more than 10 tonnes per day or with a total capacity exceeding 25 000 tonnes, excluding inert waste”.
• Directive on the assessment of	Environmental impact assessments are required for

Legislation	Relevance to mineral waste
the effects of certain public and private projects on the environment, (Council Directive 85/337/CEE, 27.06.85) Amended by Council Directive 97/11/03.03.1997	installations for the production of non-ferrous crude metals from ore, concentrate or secondary raw materials by chemical processes, however, there are no EU wide standards for tailings containment.
• Council Directive on the control of major accident hazards involving dangerous substances (Seveso II) (96/82/EC, 09.12.96)	According to EEB (2000) this directive specifically excludes mines and landfills, but an amendment for the inclusion of mining activities and tailings dams is being considered.
• Environmental Liability white paper COM (2000) 66	The suggested liability scope is too limited (EEB, 2000). Strict liability only applies to 'dangerous activities', as covered by EU environmental legislation. However, extraction activities are not fully covered by environmental legislation. This may raise doubts and uncertainties of which part of the mining activities fall under the liability regimes.

While residues from raw materials extraction and processing (e.g. mining residues, oil field slops, etc.) are defined under Annex 1 of the Amended Waste Framework Directive (Directive 91/156/EEC) as waste, waste resulting from prospecting, extraction, treatment and storage of mineral resources and the working of quarries is excluded from the Waste Framework Directive (Directive 75/442/EEC). According to DEFRA "*control over the disposal and recovery of mineral waste is provided under Town and Country Planning legislation and the Mines and Quarries (Tips) Act 1969. In the Government's view, mineral waste is therefore excluded from the Directive definition of waste*." (DEFRA, 2003)

The inclusion of mineral waste in the definition of waste within the EU has been tested in the European Court, in the case of Palin Granit (Bainbridge, 2006). The case concerned the storage of residual stone from a stone quarrying operation. The residual stone was to be stored pending possible reuse. The company argued that the stone was not waste but was a product with potential economic value. The Court accepted that while the company might intend to exploit the leftover stone, it was nonetheless waste (Bainbridge, 2006). According to the European Court "*the reasoning applicable to by-products should be confined to situations in which the re-use of the goods, materials or raw materials is not a mere possibility but a certainty, without any further processing prior to re-use and as an integral part of the production process*". The Courts also found that the concept of waste does not exclude substances and objects where reuse is economically viable (Bainbridge, 2006).

Due to the fragmentation in legislation addressing mining waste, the Council on the Management of Wastes from the extractive industries, proposed a separate EU Directive dealing with waste from extractive industries (Jordan, 2004a). According to Jordan (2004a) there were three main reasons for justifying separate legislation on mineral wastes:

- to control large material flows involved, i.e. great volumes of waste generated;
- to reduce risk of accidents due to instability of tailings dams and ponds; and
- to reduce environmental risk and secure long-term stability after mine closure and for closed (abandoned) mines.

In addition, the proposal identifies significant water and soil pollution (acid mine drainage for example), lack of harmonization of relevant national regulations and establishment of financial security as further reasons for separate legislation on mineral wastes. The EU Directive on the management of waste from extractive industries, approved in 2006 (Directive 2006/21/EC), covers waste resulting from prospecting, extraction, treatment, storage of mineral resources and the working of quarries. The Directive requires amongst others:

- Waste management plans for the prevention or minimisation, treatment, recovery and disposal of extractive waste
- Specific application and permit procedures for extractive waste facilities, including public participation
- Classification system for waste facilities

- Closure and after-closure procedures for waste facilities
- Prevention of environmental pollution
- Financial provisions to cover costs of rehabilitation of land affected by the waste facility
- Establishment of an inventory of extractive waste sites

In order to meet these requirements, mine waste management has to be studied in the context of complete material flow streams and total product and project life cycle analysis.

The objectives of the new EU regulation (Directive 2006/21/EC) on mining waste are:

- To minimize adverse effects of polluted drainage from waste management facilities, which have the potential to create long-term environmental impacts persisting well after both the facility and the associated mine or quarry have been closed; and
- To prevent, or minimize the impacts of accidents, and in particular to ensure long-term stability of tailings dams and ponds, given that dam bursts have the potential to create widespread environmental damage, including threats to human life. Mine waste facilities and management schemes require not just good design, but also close, consistent and routine monitoring and supervision over a long period. (Jordan 2004b).
- That preference should be given to recovery and especially to recycling, and that the quantity of waste for disposal should be minimised (cleaner production).

2. Slovenia

Slovenia is a country with a very long, and strong, mining tradition and with a variety of mineral resources. The mining history of Slovenia includes mineral fuels (coal, crude oil, natural gas and uranium), metal ores (zinc, lead and mercury) and non-metallic minerals (industrial minerals and rocks, construction materials and aggregates) (Bizilj and Marc, 2004)

Slovenia has a separate law on mining, but there are no specific provisions for mining or mineral waste management in the mining legislation. Handling of mineral waste should be defined in mining technical documentation in accordance with environmental standards (Bizilj and Marc, 2004). Mineral waste management is not among the priorities included in the National Environment Action Programme that was adopted by the Slovenia Parliament in 1999 (Bizilj and Marc, 2004).

Waste management (recycling, recovery, disposal of waste) is prescribed by the Rules on the Management of Waste (OJ RS, No 84 /98 and amendments) that govern the classification, list for waste and hazardous waste, the obligatory management of waste, and other conditions for the collection, carriage, recovery and disposal of waste. The provisions of these rules do not however apply to waste resulting from the prospecting, extraction, treatment and processing of mineral resources. (Bizilj and Marc, 2004). A separate law on prevention of ionisation radiation and nuclear safety regulates uranium-mining waste. (Bizilj and Marc, 2004).

3. Romania

Mineral resources in Romania include mineral fuels (coal, sand and schists), metallic ores (iron, manganese, copper, polymetallic (Cu, Pb, Zn), gold, mercury, uranium, molybdenum and bismuth) and non-metallic ores (Veliciu and Stratulat, 2004).
Romania has separate laws on mining (No 85/2003; Mining Law) and on hydrocarbons (No 134/1995; Petroleum Law). The competent authority responsible for the application of the provisions of the laws is the National Agency for Mineral Resources, "…organised as a public institution of national interest and acting under Government subordination." Hazardous mineral waste is registered with the Ministry of Industry and Resources. The mining waste inventory (including mineral waste), for active mining exploitations, exists with the Ministry of Industry and Resources. The State-owned company CONVERSMIN is dealing with conservation, mine closure and post-closure monitoring works since 2002. Special regulations for remediation methodology and technology are stipulated in the "Mining Closure Manual" issued by the Ministry of Industry and Resources (Veliciu and Stratulat, 2004).

As part of economic reform measures since 1990, the mining sector was reorganised by establishing two types of state enterprises: Regies Autonomes for the production and supply of mining products and Commercial Companies for mining activities and support services. This enabled government to separate policy and regulation from operational functions, to bring accountability and to institute commercial practices in the mining sector (Veliciu and Stratulat, 2004).

4. Poland

In 2001, 7836 deposits of different mineral commodities were recognised in Poland of which 2841 were exploited. About 326 Mt of raw materials are extracted resulting in the production of 57 Mt mineral and processing waste yearly (excluding overburden of lignite mining). In the order of 21% of the mineral waste (12Mt) has been used for reclamation of ground, engineering works etc. (Gientka and Kasiński, 2004). Mineral exploration in Poland includes natural gas, oil, coal, lignite, zinc and lead ores, copper, sulphur, rock salt, natural aggregate, clays, limestone and marl and chalk. Uranium is not currently exploited in Poland, but historically limited exploitation of uranium did occur.

The National Plan of Wastes Management was accepted by the Polish Government in 2002 as a formal basis for waste management. Mineral and processing waste is one of its topics (Gientka and Kasiński, 2004).

5. Latvia

The list of minerals which are produced in Latvia is rather short. These minerals are mostly used as either construction materials or as raw materials: gypsum, limestone, dolomite, clay, sand-gravel mix and sand (including quartz sand). Loam is extracted for some auxiliary purposes. Besides this, there is considerable peat production and small-scale sapropel and medicinal mud extraction (Krutofals, 2004).

In compliance with the Latvian 'Law on natural resource tax', such tax is imposed on waste and contaminants resulting from any kind of economic activity. This tax is imposed on the water and air pollution as a result of extraction and processing of minerals. The amount of contaminants entering the environment is usually determined by calculations, based on the volume of extraction at the mining enterprise (Krutofals, 2004).

6. Hungary

Minerals extracted in Hungary include coal, hydrocarbons, bauxite, ores industrial minerals and other non-metallic minerals (Fodor, *et al.,* 2004).

The most important mining laws and regulations are:

- The Concession Act (ActXVI/1991)
- The Company Act (Act VI/1988)
- The Foreign Investment Act (Act XXIV/1988)
- The Mining Act (Act XLVIII/1993).

The Mining Act cover major environmental problems related to mining. Supervised by the Regional Mine Authorities, these include protection of air quality, natural waters and fertile land. Practically every mining operator is required to carry out environmental impact studies as described in the 86/1993 Government Decree (Fodor, *et al*., 2004).

As a consequence of former mining activities, more than 1000 Mt of mining and processing waste were generated. Mineral waste dumps cover approximately 1% of the total productive land area. The yearly mineral waste output is more than 10 Mt, while the utilized volume is about 0.7-1.0 Mt/year. Mineral waste is used for backfilling in mines and for construction (Fodor, *et al*., 2004). The Ministry of Economy and Traffic's new initiative on the utilization of solid mining waste for construction of highways is a considerable incentive for improvement of the existing mining waste survey (Fodor, *et al*., 2004).

7. United States of America

According to Buck and Gerard (2001), a major mining operation in the United States can be subject to 30 or more federal, state or local regulations. The resulting cost, confusion and uncertainty have caused "*mining companies to replace domestic operations with overseas projects, a trend that is already strongly demonstrated in exploration*." (National Research Council, 1999).

The two most important laws that apply to water-based pollution at abandoned mines are the Clean Water Act and the Comprehensive Environmental Response, Compensation and Liability Act (the Superfund law abbreviated as CERCLA). Liability under the Clean Water Act is effectively retroactive – it makes the current landowner liable for pollution resulting from past activities on that land, even if the current landowner is completely innocent (Buck and Gerard, 2001). CERCLA is the most significant environmental clean-up legislation. The Environmental Protection Agency (EPA) classifies polluted sites under CERCLA by their level of dangerousness, and puts the most dangerous sites on the National Priority List. This makes these sites then eligible for clean-up funds from the Superfund.

It is however crucial to note that under CERCLA, liability is very *strict* (that is, the potentially responsible party or PRP need not have been negligent), *joint* and *several* (that is, any one PRP can be sued for any damages caused by past disposal of hazardous substances). The only limit on liability for damages caused by another party is the 'third-party' defence, which arises for an innocent purchaser who inquires about the property but is unaware of the pollution at the time of purchase (Buck and Gerard, 2001).

Retroactive liability as contained in the Clean Water Act and CERCLA is according to Buck and Gerard (2001), problematic because it fails to place the cost of cleanup on the party that is actually responsible for the damage. Another problem with retroactive liability is that it creates a disincentive to clean up old sites. Modern mining companies can often find ways to 're-mine' old sites, while cleaning up old waste products in the process.

Mineral recovery from old sites can be beneficial in several respects (Buck and Gerard, 2001):

- allowing recovery gives the private sector an incentive to undertake remedial actions;
- revenues from recovery may offset the cleanup costs and shift cleanup costs from the public to the private sector; and
- recovery reduces the need for mining companies to develop new sites.

Buck and Gerard (2001) therefore concluded that current government policies to cope with abandoned mines are counterproductive. The Clean Water Act and the Superfund law (CERCLA) make current mine owners liable for the costs of cleaning-up harm that the previous owners caused – even more than a century earlier. These laws apply even to those who want to renew mining at an old site, cleaning it up as they do. Not only is this unfair to new owners, but it discourages private remediation. For effective remediation and clean up of old mining sites, liability should be restricted to persons or companies that actually causes harm to the environment.

International conventions

Currently, no international conventions have a direct bearing on mining and mineral waste in the South African context. There are however, a few international conventions dealing with pollution and waste that may in certain circumstances be applicable to mining operations and the associated waste streams.

1. Basel Convention

The Basel Convention on the transboundary movement of hazardous substances was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries (LDCs). It does not, however, address the movement of radioactive waste. The Convention is also intended to minimize the amount and toxicity of wastes generated, to ensure their environmentally sound management as closely as possible to the source of generation, and to assist LDCs in environmentally sound management of the hazardous and other wastes they generate.

Hazardous waste can be delisted for use in the construction sector. As outlined above, bricks manufactured using mining waste as aggregates or even cement containing a percentage of hazardous waste, may be transported to neighbouring countries. If these by-products (bricks or cement) are also classified as waste, as is proposed in the South African Waste Bill, the Basel Convention will have to be adhered to.

2. Kyoto Protocol

The Kyoto Protocol is an agreement made under the United Nations Framework Convention on Climate Change (UNFCCC). Countries that ratify this protocol commit to reduce their emissions of carbon dioxide and five other greenhouse gases, or engage in emissions trading if they maintain or increase emissions of these gases.

Emissions resulting from the re-use of waste can add to greenhouse gas emissions. Therefore, depending on the re-use option of the mining waste, this Protocol may be of relevance. Mineral products, waste and waste disposal on land are identified as key sectors in terms of the Protocol.

Annexure C
National policy and legislation relevant to the management of mineral waste in South Africa

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

All legislation has to fall within the stipulations of the Constitution. Relevant Sections to waste management are:
Section 24 – Right to a clean and healthy environment
Section 32 – Access to information
Section 33 – Just administrative action
Chapter 6 – Provincial Government competency (Schedules 4 & 5)
Chapter 7 – Local Government competency (Schedule 4 & 5)

In terms of section 15(1) and (2) of Schedule 6 (Transitional Arrangements) it is anticipated that the permitting of waste disposal sites will be devolved to the provincial level of government.

2. Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002)

The new Mineral and Petroleum Resources Development Act, 2002, which came into effect on 1 May 2004, legislates government's official policy concerning the exploitation of the country's minerals. The main issues covered by the Act include:
- The transformation of the minerals and mining industry;
- The promotion of equitable access t South Africa's mineral resources
- The promotion of investment in exploration, mining and mineral beneficiation;
- The socio-economic development of South Africa; and
- The environmental sustainability of the mining industry.

The Mineral and Petroleum Resources Development Regulations was published in 2004 (Regulation No 527, 2004). Pollution and waste management is covered in Part IV of the regulations. The principles outlined for waste management are in line with the internationally accepted waste hierarchy:
- Avoid the generation and production of pollution, waste and mine residue at source; or
- Where the generation and production of pollution, waste and mine residue cannot altogether be avoided, it must be minimized, re-used or recycled; or
- Where possible, dispose pollution, waste and mine residue in a responsible and sustainable manner.

Specific pollution and waste streams referred to in the regulations include:
- Waste material from reduction works, beneficiation plants, coal preparation plans, screening and washing installations and generating stations at a mine;
- Rubble, garbage, rubbish or discards of any description, whether solid or liquid;
- Sand dumps and slimes dams;
- Coal debris;
- Oils, grease and hydraulic fluids;
- Granite off-cuts and related wastes; and
- Residue stockpiles and deposits.

3. Mine Health and Safety Act, 1996 (Act 29 of 1996)

The Mine Health and Safety Act, 1996, provides for the protection of the health and safety of employees and other residents of mines. A mining company is obliged to maintain a healthy and safe mine environment (Section 5). In this regard the employer must identify the relevant hazards and assess the related risks to which employees (workers) may be exposed; and ensure that people who are not employees, but who may be directly affected by the activities at the mine, are not exposed to any such hazards.

The Minister of Minerals and Energy is empowered by Section 98 to make regulations, on the disposal of hazardous substances used in the mining process and waste produced at the mine, the making safe of tailings, waste dumps, and ash dumps made in the course of mining operations, the protection of water resources and the surface of land.

4. Hazardous Substances Act, 1973 (Act 15 of 1973)

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

In Section 1 the definitions of "dump" and "Group IV hazardous substances" both deal with the matter of waste, the former in terms of its management and the latter in regard to radio active waste.

Section 3A(1) requires a written authorisation to be issued for the importation of Group IV hazardous substances (which includes radio active waste).
Regulations for Group IV hazardous substances were made by the Minister of National Health and promulgated in terms of Government Notice No. R 247 published in Government Gazette No 14596 dated 26 February 1993. The relevant regulation dealing with disposal read as follows:

"*Except where specific provisions regarding the disposal of Group IV hazardous substance are included as a routine measure in the internal rules of the holder of the authority, any disposal of Group IV hazardous substances shall take place strictly in accordance with such directives as the Director-General may with due regard to the circumstances determine and in each case after considering a specific application by a holder in this regard*."

5. National Water Act, 1998 (Act 36 of 1998)

The object of the National Water Act, 1998 is to provide for the protection of the water resources while ensuring sustainable and equitable use of the water resource.

In terms of the National Water Act, 1998, "waste" includes any solid material or material that is suspended, dissolved, or transported in water (including sediment) and which is spilled, deposited on land or in into a water resource in such volume, composition or manner as to cause, or to be reasonably likely to cause, the water resource to be polluted.

"Pollution" means the direct or indirect alteration of the physical, chemical or biological properties of a water resource so as to make it less fit for any beneficial purpose for which it may reasonably be expected to be used; or harmful or potentially harmful to the welfare, health or safety of human beings; to any aquatic or non-aquatic organisms; to the resource quality; or to property.

The Act also identifies in Section 21, eleven water uses requiring authorisation of which the following may, have a bearing on mining waste:
21(f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or any other conduit;
21(g) disposing of waste in a manner which may detrimentally impact on a water resource;
21(h) disposing in any manner of water which contains waste from or which has been heated in, any industrial or power generation process;
21(j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.

Regulations on the use of water for mining and related activities aimed at the protection of water resources were promulgated in Government Notice 704 of 4 June 1999. These regulations impose a range of restrictions and obligations on relevant persons regarding waste ("residue") which includes, any debris, discard, tailings, slimes, screenings, slurry, waste rock, foundry sand, beneficiation plant waste, ash and any other waste product derived from or incidental to the operation of a mine or activity and which is stockpiled, stored or accumulated for potential re-use or recycling or which is disposed of. Further provisions also relate to the protection of water resources directly. The restrictions and obligations include:

- Restrictions on the locality of residue deposits in relation to water resources
- Restrictions on the use of residue for road building and construction of dams on mining sites
- Obligations to protect the water resource from pollution resulting from the storage and use of residue.

6. National Environmental Management Act, 1998 (Act 107 of 1998)

This Act provides for co-operative environmental governance by establishing principles for decision making on matters affecting the environment. As the principal framework Act for environmental issues, it has direct relevance to the implementation of the National Waste Management Strategy (NWMS), one of the key implications being the designation of the Department of Environmental Affairs and Tourism as lead agent for the environment. In the NWMS specific roles have been identified for the National Environmental Advisory Forum and for the Committee for Environmental Co-ordination, while provision has also been made for using Environmental Implementation and Management plans, and Environmental Management Co-operation Agreements. Chapter 7 of NEMA also has important direct implications for the achievement of the NWMS initiatives. Reuse initiatives are bound by the 'Duty of care' principle to prevent possible pollution or environmental degradation as the result of reuse of waste materials.

NEMA also provides for regulations on Environmental Impact Assessments (EIA's) and the identification of activities which require EIA's to be done. Initially Mining was excluded from the EIA regulations, but the 2006 regulations includes mining as identified activities for which EIA studies needs to be undertaken.

7. National Environmental Management: Air Quality Act, 2004 (Act 39 of 2004)

Certain sections of the National Environmental Management: Air Quality Act, 2004 came into effect on 24 February 2005. It entrusts the Department of Environmental Affairs and Tourism with the task of preventing pollution and ecological degradation, while at the same time promoting justifiable economic and social development.

Metropolitan and district municipalities are charged with issuing atmospheric emission licenses for certain listed activities. It must be shown that the best practical means are being employed to limit air pollution before these certificates will be issued.

8. Environment Conservation Act, 1989 (Act 73 of 1989)

The Environment Conservation Act was to a large extent repealed by the National Environmental Management Act, 1998 (Act 107 of 1998) which is the primary legislation governing protection and control of the environment. The provisions that have not been repealed deal with, amongst other waste management, regulations on noise and vibration and shock.

The Department of Environmental Affairs and Tourism issue permits to waste disposal facilities following the commencement of the Environment Conservation Amendment Act, 2003 (Act 50 of 2003). Mineral waste deposits (i.e. slag dumps) at industrial sites are however considered as waste disposal facilities under this Act by government officials.

In terms of the definition of waste (Government Gazette, 1990) under the Environment Conservation Act (Act 73 of 1989), "*Any minerals, tailings, waste rock or slimes produced by or resulting from activities at a mine or works as defined in section 1 of the Mines and Works Act (Act 27 of 1956)*" have been excluded from the provisions of the Act (DWAF, 2001).

In terms of the Mines and Works Act, 1956 (Act 27 of 1956) "*works means any place, not being a mine or part of a mine, where any of the following operations [...] are carried out and constitute the main operation at such place -*

(a) the crushing, screening, washing, classifying or concentration of any material;

(b) the treating of any mineral, in the form obtained from a mine, for the production of coke or for the production of a base metal in any shape or form, including ingots, billets and rolled sections; [...]"

9. Nuclear Energy Act, 1993 (Act 131 of 1993)

The Act falls under the Minister of Minerals and Energy and has on 24 February 2000 been partially repealed by the Nuclear Energy Act, 1999 (Act 46 of 1999) and the National Nuclear Regulator Act, 1999 (Act 47 of 1999).

The Act provides for the continuation of the Atomic Energy Corporation (AEC) (now NECSA), the objectives of which include the control over the discarding of radio-active waste. In terms of section 6, the AEC may, amongst others, control the discarding of radio-active waste, discard radio-active waste and operate waste-disposal facilities for such purpose [(18)].

In terms of Section 29, subject to the provisions of Section 34 and 51(1), the authority over discarding of radio-active waste shall vest in the AEC. Section 30 provides that , subject to authorities granted from time to time in terms of the Hazardous Substances Act, 1973 (Act 15 of 1973), no person may except with proper written authority in terms of the Act, in any manner discard any radio-active waste or cause it to be discarded. An authority to discard of radio-active waste, may in addition to the conditions contained in a nuclear licence in terms of Section 51 or Section 52 of the Act, be granted on such conditions as the relevant chief executive officer (appointed in terms of the Act) may impose.

Section 51 deals with licences in respect of nuclear installations and activities involving radio-active material. In terms of this section, no person shall, except under the authority of a nuclear licence granted by the Council for Nuclear Safety construct or use a nuclear installation; or in any manner dispose of radio-active waste, subject to limited exceptions.

10. Nuclear Energy Act, 1999 (Act 46 of 1999)

The South African Energy Corporation Limited was established under the Nuclear Energy Act to oversee the implementation of the Safeguards Agreement relating to the Nuclear Non-Proliferation Treaty, to regulate nuclear fuel, nuclear material and equipment, and to prescribe measures governing the discarding of radioactive waste and the storage of irradiated fuel.

The Nuclear Energy Act, 1999 partially repealed the Nuclear Energy Act 131 of 1993. The 1999 Act regulates a range of nuclear related issues, including the acquisition and possession of nuclear fuel, certain nuclear and related material and certain related equipment, as well as the importation and exportation of and certain other acts and activities relating to that fuel, material and equipment. The Act also prescribes measures regarding the discharge of radio-active waste and the storage of irradiated nuclear fuel.

In terms of Section 45 of the Act, the authority over the management and discarding of radio-active waste and the storage of irradiated nuclear fuel vests in the Minister of Minerals and Energy. The Minister of Minerals and Energy, in consultation with the Minister of Environmental Affairs and Tourism and the Minister of Water Affairs and Forestry may make regulations prescribing the manner of management, storage and discarding of radio active waste and irradiated nuclear fuel, having due regard to the provisions of the National Nuclear Regulator Act. Except where authorized by a Ministerial Authority, issued under the Hazardous Substances Act, 1973 (Act 15 of 1973), no person may, without the written permission of the Minister, discard radio active waste in any manner or cause it to be discarded. The required permission may be granted subject to any conditions that the

[18] This Act has been partially repealed by the Nuclear Energy Act, 1999.

Minister, in concurrence with the Minister of Environmental Affairs and Tourism and the Minister of Water Affairs and Forestry deem fit to impose. The conditions so imposed will be additional to any conditions contained in a nuclear authorization as defined in Section 1 of the National Nuclear Regulator Act, 1999.

11. National Environmental Management: Waste Management Bill

The National Environmental Management: Waste Management Bill (NEM:WMB) (version 1 of 21 September 2006), is currently being drafted by DEAT. This Bill once enacted, will give legal standing to government's policies and strategies on waste management as contained in the White Paper on Integrated Pollution and Waste Management (DEAT, 2000) and the National Waste Management Strategy (DEAT, 2000b).

This draft of the Bill does not specifically include nor exclude the term 'mining waste'. By implication, the regulation, or not, of mining waste through this Bill is open to interpretation. If this Bill is read in isolation, then mineral waste is included, However, if read with the Mineral and Petroleum Resources Development Act, one can assume that material that is defined as mine residue, cannot also be viewed as waste. Since the Mineral and Petroleum Resources Development Act specifically regulates the mineral sector, it is likely that mine residue will not be interpreted as also being waste material. By not being explicit, the question of relevance of different pieces of legislation to specific conditions arises. When do you apply the NEM:WMB and when the MPRDA?

If mineral waste is deemed to be managed by this Bill, it will have far reaching implications such as:

- Mines may have to compile industry waste management plans
- Mining waste could be identified as a priority waste stream for which:
- specific waste management measures will be prescribed
- prescribed measures for recycling, reuse, recovery, treatment or disposal
- Mining waste sites may have to be licenced if identified as a waste management activity and will be subject to the same controls as other hazardous waste streams.

12. National Waste Management Strategy

The National Waste Management Strategy (NWMS) presents government's long-term plan (up to the year 2010) for addressing key issues, needs and problems experienced with waste management in South Africa (1997/8).

A number of key priority initiatives were identified in different areas of integrated waste management.

Integrated Waste Management Planning
Planning for mining and power station waste management is specific to each sector and is the responsibility of the developer or owner. Provincial government will ensure that planning for disposal of mining and power station waste is undertaken in a responsible manner and according to the standards and guidelines prepared by the Department of Environmental Affairs and Tourism (DEAT, 2000b).

Waste Information System
The database on mine and power station waste sites and the inventory of old abandoned polluting waste sites will be incorporated into the waste information system. This will however only be the case if the sites are considered H:H, H:h, GLB or GMB according to the requirements for Phase 1 of the waste information system (DEAT, 2005).

Recycling
Research is to be undertaken to identify the possibilities of reclaiming or recycling mining and power station wastes and to investigate the formulation of necessary regulatory mechanisms for such reclamation and recycling (DEAT and DWAF, 1999). This is the exact purpose of this study.

Waste Collection and Transportation
There is no strategic initiative for collection of mining and power station waste, as these wastes are treated on site by the mines and the power stations, in terms of their environmental permits. The owners/operators of these operations will be obliged to separate hazardous waste streams from non-hazardous waste (DEAT and DWAF, 1999).

Waste Treatment
Mines and power stations will investigate, develop and implement pre-treatment technologies to reduce the environmental impact of their wastes (DEAT and DWAF, 1999).

Waste Disposal
The mixing of different chemical waste streams at mining operations will be discouraged, particularly the dilution of hazardous wastes by large volumes of non-hazardous waste streams. This requirement will be included in the new permitting process that will also include a chemical classification component. The use of mine waste facilities for general waste disposal will be prohibited (DEAT and DWAF, 1999).

Mine owners or operators will be required to assess waste minimization processes, pre-treatment or stabilisation of waste prior to disposal.

The requirements of the NWMS (DEAT and DWAF, 1999), as well as the DWAF Minimum Requirements (DWAF, 1998) will be integrated with the Code of Practice for Mine Residue Deposits and the Code for Residue Deposits of 1998.

The SABS Code of Practice for Mine Residue (SABS 0286:1998) was developed following on the disaster at Virginia in the Free State in February 1994. A slimes dam collapsed killing and injuring people in the nearby suburb of Merriespruit. The Code of Practice provide South African companies that are involved in mine residue disposal with objective principles and, where appropriate minimum requirements for good practice in the various stages of the management of the life cycle of such residues. The development of the standard was initiated primarily to address safety concerns related to structural failure (collapse of dams).

Waste minimisation is one of the key principles in this Code. “Recycling, separation and treatment at source should be encouraged, subject to economic, environmental, health and safety considerations. After all possible measures to maximise recycling and pre-treatment of waste have been exploited, disposal may be considered” (SABS 0286:1998).

All requirements for auditing and permits in the NWMS will be integrated with the requirements of the EMPR process. The permitting process will be compatible with that prescribed for the industries. The permitting procedures will usually require the inclusion of: waste classification and characterization; an environmental impact assessment; engineering aspects; construction controls; management controls; closure requirements; compliance auditing; and a description of the public participation process undertaken.

The NWMS will also address the current practice of different regulations applied to the disposal of mine waste in mine property, compared to those regulations for other waste. (DEAT and DWAF, 1999)

13. Radioactive Waste Management Policy and Strategy

The Radioactive waste management policy and strategy serves as a national commitment to address radioactive waste management in a coordinated and cooperative manner (DME, 2005).

Radioactive waste is produced during the operational and decommissioning phases of the extraction, processing and combustion of raw materials containing naturally occurring radioactive materials. Large volumes of radioactive waste such as tailings at mines originate from the mining and milling of ores that contain uranium and thorium and their radioactive decay products.

Whilst the Nuclear Energy Act is the leading legislation with regard to the governance of radioactive waste, it is recognised that waste containing un-concentrated natural occurring radioactive materials from the mining industry, minerals processing industries and the combustion of coal will also be managed as set out in the White Paper on Integrated Pollution and Waste Management for South Africa (DEAT, 1998) and other relevant legislation.

Appendix D

Memorandum of understanding between Department of Water Affairs & Forestry and Department of Minerals and Energy concerning Integrated Environmental Management for prospecting and mining activities in the Republic of South Africa

1. THE SCOPE OF THE MEMORANDUM

This memorandum is intended to provide an understanding of the nature of the working relationship between the Department of Water Affairs and Forestry (DWAF) and the Department of Minerals and Energy (DME) concerning **participation** pertaining to **Integrated Environmental Management for prospecting and mining activities** in South Africa as implied by the requirements of the Minerals Act and the Water Act. This will improve the efficiency of the process, and will minimise potential conflict and ambiguity.

In order to serve this purpose, the memorandum records a mutual understanding on the following issues:

- The fundamental premises with regard to Integrated Environmental Management, the role of such a system and its key success factors.
- The principles and obligations of both Departments regarding participation in the integrated environmental management.
- More detailed procedures and guidelines may be developed from the agreed principles contained in the memorandum.

2. INTEGRATED ENVIRONMENTAL MANAGEMENT

2.1 Fundamental premises

The Department of Minerals and Energy (DME) is required in terms of the Minerals Act (1991) to ensure the optimal utilisation and safe exploitation of mineral and energy resources, together with the rehabilitation of the surface of land concerned in any prospecting and/or mining operation according to an acceptable Environmental Management Programme (EMP). Prior to the approval of an Environmental Management Programme, the Regional Director of Minerals and Energy has to consult with each Department, which administers an Act concerning the environment. The Department of Water Affairs and Forestry is one such Department.

The Department of Water Affairs and Forestry (DWAF) is required in terms of the Water Act (1956) to manage the development and utilisation of the water resources of the country for the economic and social prosperity of all its inhabitants. With regard to water quality, this includes the responsibility for ensuring that these resources remain fit for use on a sustained basis. Mining activities have been identified as a specific concern with regard to impacts on the water environment, which resulted in increasing the focus on more effective strategies to exercise control.

Both the DME and the DWAF must therefore exercise control over the environmental impact of mining activities in order to satisfy the requirements of their respective mandates. Co-operation between the DME and the DWAF in this regard is in the best interests of both Departments as well as the mining industry, and it will be facilitated by participation in the Integrated Environmental Management process for prospecting and mining activities.

2.2 The role of Integrated Environmental Management

Integrated Environmental Management has a key role to play in the regulatory system of both Departments with respect to:

- Placing the Departments in a position to address anticipated effects on the environment before mining proceeds.

- Placing the Departments in a position to address effects on the environment of operating mines.

- Placing the Departments in a position to ensure that acceptable environmental objectives including regulatory requirements are constantly met.

- Ensuring that mining proponents have understood the magnitude and nature of the effect which their activities will have on the environment and have committed themselves to a practical means of dealing with these effects throughout the life of the mine before commencing with a mining venture.

- Providing the authorities with an opportunity to satisfy themselves that the proponents have the means to ensure that the management measures proposed to control the environmental effect of their activities will be implemented.

It is acknowledged that the DME is best placed to assume the role of leadership (lead agent) for the overall co-ordination of the integrated system but that decision-making by the lead-agent on matters of common concern shall be accomplished after consultation with the DWAF.

2.3 Key success factors

Effective operation of Integrated Environmental Management is based on the following key success factors:

- Clear definition of the role and mandate of each Department.

- Consensus-based decision-making within the framework of the lead-agent concept as contemplated in paragraph 2.2 above.

- Effective communication based on a structured system.

- Effective leadership.

- Effective conflict resolution mechanisms.

- A good working relationship between the officials of the two departments, based on a spirit of goodwill and co-operation at all levels.

- Consistent implementation.

3. PARTICIPATION

3.1 Principles

Participation in Integrated Environmental Management is based on the following principles:

- The process requires dynamic leadership, regular contributions and consistent attention by both parties.

- Responsibility for leadership and facilitation of the process maintenance lies with the lead agent.

- Participation within the environmental management process is based on the understanding that the regulatory objectives of both parties are being satisfactorily served.

- Participation in the environmental management process will impose certain obligations on both parties.

3.2 Obligations of the DME

The DME hereby agrees to:

- Consult with the DWAF on the formulation of policy, legislation and regulations, which have a bearing on water and other aspects that could have an effect on the water environment.

- Consult before:

  - Approving any EMP (Environmental Management Programme)
  - Granting any mine closure (partial or in full)
  - Amending or withdrawing an EMP
  - Granting temporary authorisation for the commencement of any prospecting or mining operation
  - Allowing any activity, which requires a recommendation from DWAF through the regulations, promulgated under the Minerals Act.

- Consult when water-related issues are involved in determining the original quantum financial provisions.

- Establish procedures to facilitate co-operation in approving implementation and revision of EMP's.

- Consult on setting up guidelines, which have a bearing on water, and other aspects that could have an effect on the water environment.

- Facilitate and adjudicate in matters pertaining to the resolution of conflict between government departments, and between the proponent and government.

- Investigate and implement, where appropriate, the provisions of the Minerals Act (1991) to provide for adequate pecuniary provision, monitoring, auditing, prosecution of offenders and remediation.

- Consult before imposing rectifying measures where water-related aspects are concerned.

- Ensure all relevant data, information and reports regarding water quality and water supply in terms of monitoring and auditing as required through the EMP or other legislation are made available to the DWAF.

- Consult before approving any site for impoundment or placement of discard material.

- Consult before approving undermining of riverine areas and water containing structures.

- Notify the DWAF of any proposed/possible river diversions.

- Notify the DWAF of any incident reported in terms of the Mineral Act Regulations 25.6(d)(i) and (iii).

- Establish and maintain formal communication systems between the departments.

- Refer differences, in the case where consultation and/or facilitation does not result in agreement, to the next level in the hierarchy, and to continue referring it higher until a solution has been found.

3.3 Obligations of the DWAF

The DWAF hereby agrees to:

- Consult with the DME on the formulation of policy, legislation and regulations that could have a bearing on the integrated environmental management process.
- Support the DME in providing the required expertise and resources to evaluate and respond to applications from mining proponents timeously and in accordance with agreed procedures.
- Provide proponents through the lead agent with clearly defined requirements on water related aspects for the preparation of their EMP's and give feedback on proposals where necessary.
- Provide the required expertise to support the DME in setting up procedures and guidelines, and to ensure that the DWAF requirements are clearly defined in this process.
- Provide the DME with assistance in the resolution of conflict.
- Endeavour to provide the DME with assistance regarding Integrated Environmental Management wherever requested.
- Respond to any request from the DME for consultation within an agreed period of time.
- Ensure that the requirements of the DWAF are clearly identified and defined in the relevant EMP's.
- Maintain the formal communication system between the departments, as established by DME
- Refer differences, in the case where consultation and/or facilitation does not result in agreement, to the next level in the hierarchy, and to continue referring it higher until a solution has been found.