Annex G.15

Waste Management Specialist Report

Proposed Gamsberg Zinc Mine and Ore Beneficiation Plant

WASTE MANAGEMENT: Specialist Study

Prepared for:

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EXECUTIVE SUMMARY

To be Completed Once Report Approved by Client

1 INTRODUCTION AND SCOPE

Environmental Resources Management (Southern Africa) Pty Ltd (ERM) requested En-Chem Consultants cc to undertake a Waste Management Specialist Study for the Gamsberg Zinc Mine and associated infrastructure ESIA Project, which ERM has been contracted to undertake with Vedanta Resources plc.

Zinc is the fourth most common metal in use. About 70% of the world's zinc originates from mining, while the remaining 30% comes from recycling secondary zinc. There are zinc mines all over the world, the largest producers of zinc ore are China, Australia and Peru whereas South Africa is currently a fairly small producer. The major uses of Zinc are in galvanizing; die cast alloys; brass; and bronze. Sphalerite (zinc sulphide) is the primary ore mineral from which most of the world's zinc is produced and this is the mineral that will be extracted at the Gamsberg Facility.

At Gamsberg, the zinc ore will be mined and beneficiated to produce a Zinc concentrate that will be exported for further processing into the metal and other products. The ore contains a number of other metals from which the Zinc must be separated, i.e. Cadmium, Lead, Iron and Manganese, which can potentially impact on the environment during the mining and beneficiation process. Although zinc is an essential requirement for good health, excess zinc can be harmful to the environment. Excessive absorption of zinc suppresses copper and iron absorption. The free zinc ion in solution can be highly toxic to plants, invertebrates, and even vertebrate fish. Clearly, the correct management of wastes generated during the mining and beneficiation of the ore must be undertaken, at least, in terms of the National regulations to minimise the potential impact on the human health and the environment.

1.1 Scope and Terms of Reference for the Investigation

The scope of the investigation should cover the affected project area covering the mine concession area and adjacent areas that may be impacted. The study for the proposed project will be undertaken in accordance with International Best Practice and include the following project components:

- Proposed Gamsberg Zinc Mine and associated Concentrator;
- Waste rock dumps and tailing dams;
- Upgrading of an existing water pipeline from the Pella abstraction point to the proposed mine;
- Construction of a transmission line from Aggeneys to the proposed mine;
- Construction of additional housing in Aggeneys or Pofadder; and
- Two transport options for the movement of zinc concentrate (*Option 1*: existing road to loop 10 and existing railway line from Loop 10 to Saldanha Bay Port; *Option 2*: existing road to Saldanha Bay Port).

The detailed Terms of Reference for the Waste Management Specialist Investigation is as follows:

- Review the previous investigations undertaken for the project and utilise the information, where relevant;
- Attend one specialist integration workshop;
- Identification and classification of waste material using the Draft Standards and Regulations, which are expected to be published at the end of 2012 (now during 2013); the Draft Contaminated Land Strategy and, if necessary the Minimum Requirements for the Classification and Disposal of Hazardous Waste, 1998;
- Identifying and Quantifying expected wastes , i.e. potentially hazardous and non-hazardous;
- Procedures for the removal and suitable disposal of asbestos roofing;
- Compile a Waste Management Plan, i.e. using the NEM: Waste Act and amendments; the National Waste Management Strategy; OHS Act; and relevant SANS documents such as SANS 10234: 2008 and SANS 10248. This will include opportunities for Waste Avoidance, Recycling and Reuse, Treatment and Disposal; and
- Review and update (where relevant) the Final Waste Management License Application, for submission to the competent authority.

This waste impact study highlights the key issues that will impact on the management of the chemicals and hazardous and non-hazardous wastes that will be used and generated at the facility and during the construction of associated infrastructure such as pipelines and housing. In addition, the risks posed to human health and the environment by the various waste streams have been assessed based on chemical knowledge plus research of the possible chemical components in products and wastes generated at similar zinc mines and beneficiation processes. Any information provided by the client was evaluated and expanded by the waste specialist team based on expert knowledge and information obtained from various publications and waste management sources.

1.2 The Zinc ORE Beneficiation Process

Beneficiation of zinc ores can include the following processes:

1) Milling, i.e. crushing and grinding;

   Milling operations are designed to produce uniformly sized particles by crushing, grinding, and wet or dry classification. The capital investment and operation costs of milling equipment are high. For this reason, economics plays a large part in determining the type of milling equipment and the degree of crushing or grinding performed to prepare the ore for further beneficiation. Other factors include the value concentration of the ore and its mineralogy, hardness, and moisture content. Milling is a multi-staged operation of crushing and grinding. Crushing is usually a dry operation, using water sprays only to control dust. Frequently, a primary crusher (jaw crusher) is located at the mine site to reduce the ore material into particles less than 150mm in diameter.

The crushed ore is then transported to a mill site for additional crushing, grinding, classification, and concentration. Additional milling uses a cone crusher, usually followed by grinding in SAG and ball mills. Grinding is a wet operation in which water and initial flotation reagents are added to form slurry. Between each grinding unit operation, hydrocyclones are used to classify coarse and fine particles. Coarse particles are returned to the mill for further size reduction. The resulting size of the classified ore is usually about 65-mesh (.208 mm). Chemical reagents that will be used during flotation separation activities may be added to the ore during milling activities

2) Froth Flotation:

Flotation is the most common method for separating the zinc minerals from gangue according to differences of their hydrophobicity, and to refine the zinc ore concentrate. The ore may be treated with conditioners during or after milling to prepare the ore pulp for flotation. Common conditioners may include lime, soda ash, caustic soda, or sulphuric acid. The conditioned ore is then slurried in fresh or recovered water with chemical reagents to beneficiate the ore. Several separate flotation steps may be needed to concentrate individual metal values from the ore. Reagents used in the flotation processes typically include listed in the table below.

Table 1: List of Reagents used in Froth Flotation of Zinc Sulphide Ores

Type of Reagent	**Zinc Flotation**	**Description**
Promoter	Xanthates Aerofloats Sodium Aerofloat	Cause adherence between solid particles and air bubbles in a flotation cell.
Frother	Dow Froth Flotal B Methyl Isobutyl Carbinol Pine Oil	Stabilize air bubbles by reducing surface tension, thus allowing collection of valuable material by skimming from the
Activator	Copper Sulphate	Promote flotation in the presence of a collecting agent when added to mineral pulp.
Depressant	Sulphur Dioxide Sodium Hydrogen Sulphide Zinc Sulphate Sodium or Calcium Cyanide	React with particle surfaces in the flotation cell to keep materials from remaining in the froth. Instead, materials fall to the bottom as tails.

. Reagents used in the flotation processes typically can include such chemicals as sulfur dioxide; zinc sulphate; coal tar; copper sulphate; sodium or calcium cyanide; and various frothers and organic conditioners to produce a stable froth during the flotation process. A final concentration of zinc of about 50% is reached by this process with the remainder of the concentrate being sulfur (~32%), iron (~13%), and Silica (~5%).

1.3 Structure of Report

The report is structured as follows:

- Section 1: Introduction and the Zinc Beneficiation Process
- Section 2: Legal Requirements: the key legal requirements for the management of waste are presented, including National and International Best Practice;
- Section 3: Chemicals and Wastes Produced by the Proposed Zinc Mine: as far as possible all hazardous and general wastes have been listed with abroad brush estimated of the preferred and alternative options for their management;
- Section 4: Environmental Impact Assessment;
- Section 5: Management Approach to the Mitigation of Environmental Risks: this section includes detail on the waste management infrastructure that will be required; and
- Section 6: Conclusions.
- Appendix 1: Details of Specialist

2 LEGAL REQUIREMENTS

The legal requirements aqueous effluents are briefly discussed below in sections 3.1; as they do impact on the type, nature and management of some of the "solid" wastes generated that are the principle focus of this report. However, an independent study on the surface water and groundwater are being undertaken as part of the ESIA and the reader is directed to these documents for detailed information.

2.1 Aqueous Effluents

National Water Act, Act 36 of 1998 provides for the protection of the quality of water and water resources in South Africa and for the establishment of Water Management Areas to be managed by Catchment Management Agency's. The Act contains a list of identified water users, including such water related practices as:

- Water abstraction;
- Effluent (waste) discharge;
- Evaporation of effluent (waste);
- Land uses, which impact the natural runoff, etc.

In addition, the Water Services Act, 1997 (Act 108 of 1997) provides for the regulation of water boards and the setting of national water quality standards. Approval for all of the above uses is required from the Department of Water Affairs but can be included in an overall water licence for proposed CTL Plant and associated infrastructure.

South African Water Quality Standards are available for many uses including domestic, industry, and agricultural use (Department of Water Affairs, 1996) and more recently a revision of the drinking water quality standards, i.e. SA National Standard 241: 2011.

2.2 "Solid" Wastes

2.2.1 Introduction

Since 1994, the management and in particular, the disposal of general and hazardous waste has been controlled initially by the Department of Water Affairs and Forestry and more recently by the Department of Environment Affairs using the Minimum Requirements documents published in terms of the Environmental Conservation Act (73 of 1989). The documents that must be conformed to by generators, transporters and treatment and disposal facilities are:

- Minimum Requirements for the Classification and Disposal of Hazardous Waste, 2nd edition, 1998
- Minimum Requirements for Waste Disposal to Landfill, 2nd edition 1998; and
- Minimum Requirements for Water Monitoring at Waste Management Facilities, 2nd edition 1998

The publication of these documents, which emphasised the disposal of wastes, gave the requirements for permitting of landfills, hazardous waste classification plus landfill design, management and monitoring. Note that hazardous waste includes solids, sludges and liquids that do not fall under the Water Act.

The publication of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEMWA) fundamentally reformed the law regulating waste management, and for the first time provided a coherent and integrated legislative framework addressing all the steps in the waste hierarchy. A number of important initiatives have been taken by the Department of Environment in terms of this Act. These include:

- Publication of a Draft National Waste Management Strategy (NWMS): March 2010
- The publication of the "National Policy in Thermal Treatment of General and Hazardous Waste", July 2009;
- Draft Norms and Standards for the Remediation of Land and Soil Quality: Government Gazette, 35160, 11th March 2012;
- Draft Health Care Risk Waste Management Regulations: Government Gazette, 35405: June 2012
- Draft National Standards for validation of the treatment efficacy and operation of a non-combustion technology for the treatment of health care risk waste: Government Gazette, 35406, June 2012
- The "Development of a Revised Hazardous Waste Classification System for South Africa", which will result in Regulations governing the management of hazardous and other waste and will replace the current Minimum Requirements documents. Draft documents that include:
  - Standard for Assessment of Waste for Landfill Disposal: Government Gazette 35405, August 2012;
  - Standard for Assessment of Waste for Disposal to Landfill: Government Gazette 35572, August 2012
  - Waste Classification and Management Regulations: Government Gazette 35572, August 2012
- Waste Information Regulations: Government Gazette 35572, August 2012

Final publication of the regulations and the appropriate standards is expected during 2013, when they will effectively come into force.

The imminent publication of a revised system for the management of hazardous waste and contaminated soil means that the proposed Gamsberg Zinc Facility will have to conform to these requirements and standards particularly for those wastes that are sent off-site. Therefore, they must be taken into account, when considering the waste management options for the chemicals that are used and wastes that will be generated by the facility. In this baseline document, the main principles and approach in these new regulations will be presented and their implications for the proposed Plant will be evaluated.

Note that currently the actual standards and limits for assessment of wastes are still being finalised and therefore, the hazard class of most wastes that will be generated by the proposed facility cannot be accurately determined. Once the regulations and standards have been finalised an attempt should be made to classify the wastes, if the required information is available.

2.2.2 National Waste Management Strategy (NWMS)

The fundamental focus of the NWMS, which aims to meet the key objectives of the Waste Act, is implementing the waste hierarchy, which is depicted in figure 1 below.

Figure 1: Waste Hierarchy: NWMS 2010

The waste hierarchy was first included in the first NWMS published in 1999 and was incorporated in the Minimum Requirements documents listed in section 2.1. However, at the time, the emphasis tended to be on ensuring that wastes that were generated, were properly treated before disposal and thus limit the impact on the environment. The foundation of the hierarchy and the first choice of measures in the management of waste are waste avoidance and reduction. Where waste cannot be avoided, it should be recovered, reused, recycled and treated. Waste should only be disposed of as a last resort. The NEMWA, and consequently the NWMS, in addition addresses those situations in which the waste hierarchy is not implemented successfully through providing additional measures for the remediation of contaminated land to protect human health and secure the wellbeing of the environment; thus establishing links between section 28 of NEMA and the NEMWA.

To achieve the goals and objectives of the NWMS, a tiered and consensual model has been adopted, which seeks the optimal combination of regulation and compliance measures with self regulatory components, voluntary initiatives, economic incentives, and fiscal mechanisms. This model aims to establish a level of baseline regulation for the waste sector, as a foundation for a co-regulatory system that relies on industry initiative and voluntary compliance. The foundation of the tiered and consensual model is the development of a system of national norms and standards, which creates a common national platform for waste management activities to be undertaken by both public and private sectors. The three Department of Environment initiatives presented in section 2.2, i.e. on Thermal Treatment of Waste, Waste Classification, and Management of Contaminated Land, have been undertaken to meet some of these objectives.

The NEMWA and the NWMS place an emphasis on Industry Waste Management Plans (IndWMPs), which are the central element in the co-regulatory system. This supports a permit application, particularly where a site may have multiple permit applications and may be prepared independently of a company level IndWMP. It supports the application of Standard Operating Procedures developed by the mother company. The plan must report on how the site manages its waste and the targets for achieving the waste hierarchy, particularly waste reduction and recycling. It is essential to introduce the principles of clean technology and the waste hierarchy during the design phase of the project, particularly waste avoidance and recycling.

2.2.3 Waste Information System (WIS)

The National Environmental Waste Act – Waste Information Regulations were gazetted on the 13th August 2012. The purpose of these regulations is to regulate the collection of data and information to fulfill the objectives of the South African Waste Information System (SAWIS); some of the interesting issues are that:

- Persons and companies must register that:
  - Generate >25kg/day of hazardous waste;
  - Recover and Recycle waste – including facilities for energy recovery; general and hazardous waste recycling; and even scrap car dealers;
  - Treat general and hazardous waste;
  - Dispose of general and hazardous waste to land.
- Wastes must be categorised, an example is: HW 02: Mercury Containing Waste

The submission of information to SAWIS, which includes types and quantities of each waste accepted for recycling and disposal must occur ninety (90) days after the end of registration period. Note that recycling companies such as "Collect-a-Can"; the Oil Recyclers and General Waste Recyclers and Landfills will have to supply the information. At least initially, the Gamsberg Facility can rely on these companies to report information to the DEA and supply the relevant information to Gamsberg for any wastes that leave the mine and flotation plant. Note that the Waste Companies are not obliged to tell the Department the generator of any waste but, clearly, as soon as the Gamsberg facility registers with the Department, they will have that information.

2.2.4 Revised Waste Regulations and Standards

One of the clear objectives when developing the new regulations and standards was to move away from the current the Minimum Requirements, which emphasise disposal to landfill and provide a mechanism for generators to be able to more readily recycle, re-use and/or utilise any unavoidable wastes generated.

The purposes of the revised waste regulations and standards are, therefore, to:

a) Regulate the classification and management of waste in a manner which supports and implements the provisions of the Act (i.e. the NEM: Waste Act);
b) Establish a mechanism and procedure for the listing of waste management activities that do not require a Waste Management Licence;
c) Prescribe requirements for the assessment of the environmental risk associated with disposal of waste to landfill;
d) Prescribe requirements for a waste manifest system; and

e) Prescribe requirements for the management of waste, including acceptance criteria and restrictions on waste disposal to landfill.

The following key issues are relevant to the management of the waste at the proposed Zinc Mine and Beneficiation Plant:

(i) Wastes must be classified in accordance with SANS 10234, Globally Harmonised System for the Classification and Labelling of Chemicals. Note that this supersedes the previous requirements which use SANS 10228, although the latter standard must still be used for transport purposes.

(ii) Some wastes have been pre-classified and will not require classification in terms of SANS 10234:
- Non-hazardous wastes, such as general waste and uncontaminated and un-used soil; and
- Hazardous wastes, such as Health Care Risk Waste and Asbestos.

(iii) Safety Data Sheets must be prepared for all hazardous wastes in accordance with SANS 11014;

(iv) Waste may not be stored for more than 12 consecutive months before being managed;

(v) Waste may not be mixed or treated, where this would reduce the potential for re-use, recycling or recovery, unless this is necessary to reduce the risk(s) associated with the waste;

(vi) The regulations include a mechanism for listing of an activity that does not need a waste management licence.

(vii) Included are requirements for Record Keeping, the use of a Waste Manifest System and Reporting to the Authorities, i.e. a Waste Information System (WIS);

(viii) Wastes that have been classified using the Minimum Requirements must be re-assessed in terms of the requirements within 18 months from the effective date of the regulations;

(ix) Four classes of landfill have been designated including the required engineering design requirements, i.e.
- Class A, which can accept all classes of hazardous waste, except very high risk waste, and is equivalent to an HH landfill in the Minimum Requirements;
- Class B, which can accept moderate and low risk hazardous waste and is equivalent to the previously designated GLB^+ landfill;
- Class C, which can accept only low risk hazardous waste, and is a new design with an HDPE membrane and only a 300mm clay liner,
- Class D, which is for Inert Waste and only has 150mm base preparation layer.

(x) Six types of waste are recognised:
- Type 0: Very High Risk, which cannot be landfilled;
- Type 1: High Risk, which can only be landfilled in a Class A Landfill, which is equivalent to the current HH/Hh Landfill in the Minimum Requirements;
- Type 2: Moderate Risk, which can be landfilled in a Class B or, alternatively, a Class A landfill, which is equivalent to a GLB^+ Landfill in the Minimum Requirements;

- Type 3: Low Risk, which can be disposed in a Class C, which has a lower grade liner and lower management system than a Minimum Requirements' GLB^+ Landfill, or alternatively a Class A or Class B Landfill;
- Type 4: Inert Waste, which can be disposed in a Class D landfill, which is equivalent to the current GLB^- Landfill in the Minimum Requirements, or, alternatively, a Class A, B or C Landfill;
- Non-Hazardous Waste, which includes General Waste, must be disposed in a waste site designed and operated as specified in the Minimum Requirements.

(xi) A waste that has not been pre-classified (see (ii) above) must be classified by determining both the total concentrations (TC) and the leachable concentrations (LC) of a large number of inorganic and organic target pollutants As these standards have not yet been finalised the whole list has not been included in this report, but selected potential contaminants of interest are presented in table 2.Only the LCTi, TCTi, LCT0 and TCT0 values have been included to simplify the table. The inclusion of the TC is a new requirement. The LC values must be determined by using the Australian Standard Leaching Procedure, which uses an acetate buffer to leach putrescible wastes; reagent water for mono-disposal of inorganic wastes; and reagent water and a borate buffer for inorganic wastes that are to be disposed together. The proposed approach is based on international standards.

Table 2: Proposed Selected Standard Values for Waste Assessment; LCTi, TCTi, LCT0 and TCT0 values only

Contaminants in Waste	LCT0 mg/l	TCT0 mg/kg	LCT1 mg/l	TCT1 mg/kg
Inorganic Species				
As, Arsenic	0.01	5.8	0.5	500
Cd, Cadmium	0.003	7.5	0.15	260
Co, Cobalt	0.5	50	25	5000
Cu, Copper	1.0	16	50	19500
Cr, Chromium	0.05	46000	2,5	800000
Hg, Mercury	0.001	0.93	0.05	160
Pb, Lead	0.01	20	0.5	1900
Ni, Nickel	0.07	91	3.5	10600
Zn, Zinc	3.0	240	150	160000
Anions				
Chloride	100	N/A	1000	N/A
Nitrate	11	N/A	550	N/A
Sulphate	200	N/A	2000	N/A
Organic Contaminants				

Benzo(a)pyrene	N/A	0.05	0.035	1.7
PAHs (total)	N/A	0.05	N/A	50
Petroleum H/Cs, C6 to C9	N/A	0.05	N/A	325
Petroleum H/Cs, C10 to C36	N/A	0.05	N/A	5000
Phenols (total, non-halogenated)	N/A	0.05	7	560
Toluene	N/A	0.05	35	1150
Xylenes (total)	N/A	0.05	25	890

(xii) Wastes that have both LC and TC values less than the LCTi and TCTi values are defined as Inert (Type 4) wastes, whereas if either value is above these values but less than LCT0 and TCT0 then they are classed as low risk (Type 3) wastes. It is important to note that a waste can contain a contaminant such as mercury but provided the TC is below the TCTi standard and it doesn't leach above the SA Drinking Water Standard (LCTi), it is considered an extremely low risk to the environment. The proposed TC standard recognises that most natural materials contain low concentrations of some contaminants, such as mercury, manganese and other heavy metals, e.g. soil, but they are usually not able to be mobilised into the environment. Hence the very low LCT0 values assigned even under acid leach conditions.

(xiii) There are a number of important Prohibitions or Restrictions on the disposal of waste that are intended to minimise the risk associated with landfilling and that will be implemented either immediately after the regulations are published or after a certain period from publication and these are presented in table 3a and 3b below. Note that the timeframes indicated are provisional and may be subject to adjustment before publication. However, the amount of time required for approval, construction and final operation of the proposed facility means that all the requirements must be included in the planning for the facility.

Table 3a: Disposal Prohibitions included in the Draft New Standards for Waste Disposal (August 2012)

	Waste Prohibited or Restricted in terms of Disposal	***Provisional* Compliance Timeframe**
(a)	Waste which, in the conditions of a landfill, is explosive, corrosive, oxidizing, or flammable (according to SANS 10234).	Immediate
(b)	Waste with a pH value of <6 or >12.	Immediate
(c)	Reactive waste that may react with water, air, acids or components of the waste, or that could generate unacceptable amounts of toxic gases within the landfill.	Immediate
(d)	Waste compressed gases (according to SANS 10234 or 10228).	Immediate
(e)	Untreated Health Care Risk Waste (HCRW).	Immediate
(f)	(i) POPs pesticides listed under the Stockholm Convention. (ii) Residue pesticides and pesticide containers.	Five (5) years Three (3) years
(g)	Lead acid batteries.	Immediate
(h)	Other batteries	Eight (8) years
(i)	Reusable, reclaimable or recyclable used lubricating mineral oils as well as oil filters, but excluding other oil containing wastes.	Four (4) years
(j)	Reusable, reclaimable or recyclable used or spent solvents.	Five (5) years
(k)	PCB wastes (>50 mg/kg or 50 ppm).	Five (5) years
(l)	Waste Electric and Electronic Equipment (WEEE) – Lights.	Three (3) years
(m)	Waste Electric and Electronic Equipment (WEEE) – Other.	Eight (8) years
(n)	Waste tyres: Whole.	Immediate
(o)	Waste tyres: Quartered.	Five (5) years

Waste Prohibited or Restricted in terms of Disposal	*Provisional* Compliance Timeframe
(p) Liquid waste– (i) Waste which has an angle of repose of less than 5 degrees, or becomes free-flowing at or below 60 ºC or when it is transported, or is not generally capable of being picked up by a spade or shovel; or (ii) Waste with a moisture content of >40% or that liberates moisture under pressure in landfill conditions, and which has not been stabilised by treatment.	Six (6) years
(q) Hazardous waste with a calorific value of: (i) > 25 MJ/kg. (ii) > 20 MJ/kg. (iii) > 10 MJ/kg. (iv) > 6% TOC.	 Four (4) years Six (6) years Eight (12) years Ten (15) years
(r) Brine or waste with a high salt content (TDS > 5%), and a leachable concentration for TDA of more than 100 000mg/l	Eight (8) years
(s) Disposal of garden waste: (i) 25% diversion from baseline. (ii) 50% diversion from baseline.	 Five (5) years Ten (10) years
(t) Infectious animal carcasses and animal waste.	Immediate

Table 3b: Additional Disposal Prohibitions in the New Standards for Waste Disposal (August 2012)

Prohibited or Restricted Waste Disposal Activities	Timeframe
(a) Disposal of– (i) Type 1 Waste that has been treated with waste listed in Section (2)(a) of Annexure 1 of the Regulations; (ii) Waste classified as hazardous in terms of Regulation 4(1), or waste listed in Section (2)(b) of Annexure 1 of the Regulations, with waste listed in Section (2)(a) of Annexure 1 of the Regulations; and (iii) Type 5: Inert Waste with any waste other than Type 5. Unless part of the treatment (e.g. ash used to stabilise other wastes).	 Five (5) years Five (5) years Three 3 years
(b) Macro-encapsulation of waste, meaning the isolation (or long-term storage) of waste through containment in containers within a sealed or reinforced cell in a specifically prepared and engineered area within a permitted hazardous waste landfill.	Eight (8) years

The implications of the new approach to waste management, particularly the expected landfill restrictions, for the proposed Gamsberg Mine and Beneficiation Plant will be discussed below. Note that the proposed standards and regulations my change somewhat before final publication and the current report may need some revision in the future.

2.3 DME Requirements for Mine Residues

Regulation 527 of April 2004 that was promulgated under the Mineral & Petroleum Resources Development Act of 2002 requires that the following physical and chemical characteristics for a Mine Residues must be determined:

(a) Mine residue must be characterised to identify any potentially significant health or safety hazard and environmental impact that may be associated with the residue when stockpiled or deposited at the site(s) under consideration.

(b) Residue stockpiles and deposits must be characterised in terms of its physical characteristics, that may include -

- The size distribution of the principal constituents;

- The permeability of the compacted material;
- Void ratios of the compacted material;
- The consolidation or settling characteristics of the material under its own weight and that of any overburden;
- The strength of compacted material;
- The specific gravity of the solid constituents; and
- The water content of the material at the time of deposition, after compaction, and at other phases in the life of the deposit;

(c) Chemical characteristics, that may include -

- The toxicity;
- The propensity to oxidize and decompose;
- The propensity to undergo spontaneous combustion;
- The pH and chemical composition of the water separated from the solids;
- Stability and reactivity and the rate thereof;
- Neutralising potential; and
- Mineral content that may include the specific gravity of the residue and particles and its impact on particle segregation and consolidation.

(b) All mine residue stockpiles and deposits must be classified by a competent person.

(d) All residue stockpiles and deposits must be classified into one or a combination of the following categories -

- The safety classification to differentiate between residue stockpiles and deposits of high, medium and low hazard on the basis of their potential to cause harm to life or property; and
- The environmental classification to differentiate between residue stockpiles and deposits with:
    - A potentially significant impact on the environment due to its spatial extent, duration and intensity of potential impacts;
    - No potentially significant impact on the environment.

Note particularly the requirement to determine the potential impact on the environment and the environmental risk posed by the tailings. The Department of Water Affairs has published a best practice guide and prescribes significant testing programme for assessment for residues. The programme includes static testing that includes an analysis for the trace element composition, leach extraction to determine the soluble components and acid-base accounting and kinetic testing which is used to confirm the acid generating or neutralizing characteristics, while determining the rates of reaction for acid generation and neutralization ("Gamsberg Zinc Project - A High Level Review of Trends in Iron Residue Management & Disposal": SRK, October 2009). Analytical data are presented in this document for a sample of the tailings from the Gamsberg Mine and this is discussed in further detail in Section 4.2.

An evaluation of the risk for a waste has been frequently undertaken using the Minimum Requirements and, presumably, the new standards and regulations will apply when they come into force. It is important to note that due to the nature of ore bodies, the composition of both the ore and the tailings could vary depending on the section of the ore body that is being mined.

3 CHEMICALS USED AND WASTE GENERATED BY THE PROPOSED ZINC MINE AND ORE BENFICIATION PLANT

3.1 Introduction

The Gamsberg deposit is considered to be a low grade deposit with zinc contents in the order of 6% zinc but also containing iron, manganese, lead, cadmium and other contaminants including sulphides that can provide a significant environmental risk, if the products and wastes are not managed in an acceptable manner. The extraction of zinc, as the sulphide, will also make sulphide available to the water environment via the mining of the ore; the beneficiation process; and storage of ore, products, and solid and liquid wastes, such as during tailings management.

Acid Rock Drainage and *Acid Mine Drainage* refer to acid formation that occurs in "Potentially Acid Generating" materials that occur in excess of acid neutralizing compounds, such as carbonates. The minerals can release sulphuric acid in an environment containing oxygen and water by a process that largely occurs by microbial degradation. Acidic conditions will mobilise the metals that can impact on surface and groundwater systems. This potential for acid mine drainage must be assessed at the planning stage and prevented and controlled by using the most appropriate design and management systems available (International Finance Corporation, "Environmental. Health and Safety Guidelines – Mining", October 2010)

Where necessary any possible impact on air emissions and surface and groundwater will be indicated as appropriate below. In addition, any non-hazardous and hazardous materials used or wastes generated during construction, and commissioning operations and decommissioning must be evaluated, assessed and managed correctly.

Table 4 lists the solid and liquid wastes, and the preferred and alternative management options for each waste are given in columns 4 and 5, respectively. Approx. quantity of Waste rock will be 1.5 Billion MT and that of the Tailings will be 132 Million MT over the period of Life of Mine. The preferred option is that which is considered to be higher in the waste hierarchy and, therefore, would be expected to have a lower risk to the environment. The alternative options provided would also be more acceptable in terms of the legal requirements as many meet the requirements of the waste management hierarchy.

3.2 Mine Overburden

The overburden covering the ore body will be removed and deposited onto a waste rock dump. Although this material has frequently assumed to have little environmental risk, there are a number of issues that must be considered:

(a) The material that is stockpiled has a lower surface area than the soil and rock in its natural state and, thus, becomes potentially more readily leached;

(b) As discussed in the introduction (section 4.1), the rock may be susceptible to acid rock drainage and this potential must be assessed.

Table 4: Types and Possible Management Options for Wastes Generated at the Gamsberg Zinc Mine.

Unit / Source	**Description**	**Waste Type/Composition**	**Preferred Management Option(s)**	**Alternative Management Option(s)**
1.Construction Phase				
Construction Wastes	Metal Scrap	Steel, wood, rubber & plastic & tyre scrap Electrical cable scrap	Recycle/Recover	Dispose to General Waste Landfill
	Building Rubble	Cement Bags, bricks, cut-offs, hardened cement etc	Recycle, reuse, if possible	Dispose to General Waste Landfill
	Paint	Waste Paint, "Empty" Containers	Recycle to "Collect-a-Can"	Dry out/Solidify and Dispose to General Waste Landfill
	Fuels	Spillage, Contaminated Soil	See Sections 6 and Below	
	Lubricating Oil and Grease	Used oil and grease, oil filters, oily rags, etc		
	Sewage Treatment	Activated Sludge		
	Health care risk waste	Used bandages, plasters, syringes, Sanitary Towels, and Pads etc.		
	Hazardous Packaging:	Drums, Plastic and Paper Bags, "Empty" Containers of Cleaning Agents		
	Batteries	Vehicle Batteries Batteries from electrical equipment, e.g. cell phones, torches		
2. Mining				
Waste Rock	Residue Rock, Soil, etc.	Natural material from the mining area.	Dispose to Rock Dump in accordance to Requirements	Use to back fill open pit workings, if permitted
Drilling Oils	Soluble petroleum oils	Soluble oil can be considered potentially hazardous if it enters the ground and surface water	Temporary storage on-site followed by disposal at Vissershok, Cape Town.	Dispose any residual Oil and packaging to an HH Landfill
Explosives	Ammonium Nitrate Fuel Oil (ANFO)	Classed as SANS 10228/GHS 10234 Class 1 Waste, Explosive, when not de-sensitized.	The spilled over explosives would be collected and used in the void bore hole (stemming) just above the ANFO fill.	Small amounts can be treated with water and disposed to hazardous waste landfill
Crusher Dusts	Rock dusts	Spillage, Dust from extractors	Process in flotation plant if possible	Dispose to Tailings Dam
Petroleum Wastes	Diesel, Petrol	Spillage, Contaminated Soil	See Section Below	

Unit / Source	Description	Waste Type/Composition	Preferred Management Option(s)	Alternative Management Option(s)
Oil and Grease	Vehicle lubricants	Used oil, oil filters, oily rags, empty oil cans, etc.		
3. Processing – Flotation Plant				
Carbon Flotation:				
Depressants	1. Zinc Sulphate 2. Calcium Cyanide	Solid Residues and dissolved Zn and Cyanide	The spillage will be transferred to PCD. Liquid will be recycled suitably and the solid part will be taken back into the circuit.	
Frothers	Anionic or non-ionic Detergents	Waste material, spillages, empty containers and tailings	The spillage will be transferred to PCD. Liquid will be recycled suitably and the solid part will be taken back into the circuit.	See text
Lead Flotation				
Frother	Anionic or non-ionic Detergents	Waste material, spillages, empty containers and tailings	The spillage will be transferred to PCD. Liquid will be recycled suitably and the solid part will be taken back into the circuit	See text
Collector	Sodium ethyl xanthate	Waste material, spillages, empty containers and tailings	The spillage will be transferred to PCD. Liquid will be recycled suitably and the solid part will be taken back into the circuit	See text

Unit / Source	Description	Waste Type/Composition	Preferred Management Option(s)	Alternative Management Option(s)
Zinc Flotation and Zinc Concentrate Flotation				
Activator	Copper sulphate	Waste material, spillages, empty containers and tailings	The spillage will be transferred to PCD. Liquid will be recycled suitably and the solid part will be taken back into the circuit	See text
pH Modifier - lime	Calcium oxide/hydroxide	Waste Lime, spillages, empty bags, etc.	Utilise to raise pH of tailings before discharge to dam	High pH wastes, pH>12, should not be disposed to landfill. Can be used to neutralise acid wastes at an HH landfill.
Collector	Sodium ethyl xanthate	Waste material, spillages, empty containers and tailings	Oxidise xanthate using hydrogen peroxide: Effluent to tailings dam and solid residues to HH Landfill	
Ore (in Open) and Concentrate (under Cover) Stockpile Pads				
Spillage and Sweepings??		The ore and concentrate both contain heavy metals and sulphides: spillages, sweepings, etc.	Recover values or dispose to Tailings Dam	
4. Flotation Plant - Other				
Chemicals	Redundant Chemicals, Reject Products,	Various – see above	Recycle, if possible	Dispose to Hazardous Waste Landfill, if permitted
Laboratory	Laboratory Waste	Waste Samples Waste or redundant chemicals	Dispose to HH Landfill	See text
5. Maintenance including Vehicle Wash Bay				
Effluent Treatment	Oily Sludge	Oily waste from Workshops, Maintenance Yard,	Oil recovery – ROSE	Treatment/Disposal to

Unit / Source	Description	Waste Type/Composition	Preferred Management Option(s)	Alternative Management Option(s)
System		Sludge from Vehicle Wash Bay	foundation. Waste to Energy: 1) Cement Kiln or 2) Dedicated On-Site Facility	Hazardous Waste Landfill, if permitted
	Oily Wastes	"Empty" oil cans, oily rags	Oily Cans to Recycling, Oily Rags to Landfill, if permitted or alternatively to Vissershok.	
	Scrap Tyres and rubber waste	Scrap tyres from cars, trucks plus conveyer belt waste.	Utilise/Recover to manufacture rubber product Waste to Energy: 1) Cement Kiln or 2) Dedicated On-Site Facility	Landfill of tyres whole or quartered may be prohibited: see text.
Fuel Storage	Diesel, petrol	Spillage, Contaminated Soil	Bio-remediate in-situ or Compost	Dispose to HH Landfill, if permitted
6. Tailings Dam				
Tailings	Residues from flotation process.	Contains heavy metals, iron, cadmium, zinc, lead, copper, manganese, etc. plus high amount of sulphur as the sulphide. Classed as significant environmental risk.	Dispose to tailings Dam, ensure pH of 8 to 9 to minimise possibility of acid mine drainage.	
7. Effluent Treatment System				
	Bio Sludge	Activated Sludge	Agricultural Use Compost	Treatment/Disposal to Landfill, if permitted
	Water Treatment Sludge	Mainly Inorganic Solids	Could be used in the manufacture of clay bricks	Treatment/Disposal to HH Landfill, if permitted
7. Plant and Office Buildings				
	Office waste	Non-hazardous Paper, packaging waste, plastics	Recycle where possible.	Treatment/Disposal of

Unit / Source	Description	Waste Type/Composition	Preferred Management Option(s)	Alternative Management Option(s)
				Residues to General Waste Landfill
	Garden waste	Green waste from gardens	Compost	Excess and non-compostable material, dispose to General Waste Landfill.
	Empty Metal Containers	Soft drink cans, paint cans, empty oil cans, etc.	Recycle to Collect-a-Can	Dispose to licensed to General Waste Landfill, if permitted.
	Batteries	1) Lead-acid Batteries from Vehicles 2) Dry Batteries, e.g. from cell phones, torches and other equipment.	1) Lead-Acid Batteries recycle 2) Dry Batteries recycle if possible.	Treatment/Disposal of Residues to Landfill, if permitted: see text.
	Waste Electric and Electronic Equipment (WEEE)	1) Lamps 2) Other, e.g. computers, Cell Phones	Recycle through licensed WEEE management company.	Incinerate
	Cleaning Materials	Hazardous Packaging: Drums, Plastic and Paper Bags, "Empty" Containers of Cleaning Agents, Aerosols, Pesticides, etc.	Clean and recycle if possible. Use principles of the Responsible Packaging Management Association of South Africa (www.rpmasa.org.za)	Dispose to Licensed General or Hazardous Waste Landfill

(c) Low grade ore will be also disposed and this will contain significant amounts of sulphides and, thus, the material could potentially generate an acid drainage that would dissolve Fe and other heavy metals;

(d) If Ammonium Nitrate Fuel Oil (ANFO) is used as the explosive, ammonium and nitrate ion residues will be present in the rock and can leach into surface and groundwater.

Clearly, the rock waste should be assessed using the approach suggested by the Department of Water Affairs: see section 3.3, and an appropriate facility designed and operated.

3.3 Mine Tailings

A preliminary characterisation of a tailings sample was undertaken by SRK in 2009 ("Gamsberg Zinc Project - A High Level Review of Trends in Iron Residue Management & Disposal": SRK, October 2009). Table 5, below, gives the data obtained for the composition of a sample of tailings.

Table 5: Total Composition of a Sample of Tailings (SRK, 2009), in mg/kg unless otherwise indicated.

Element	Total Concentration (TC)	Element	Total Concentration (TC)
Aluminium, Al	2.38%	Molybdenum, Mo	<0.1
Antimony, Sb	16.3	Nickel, Ni	161
Arsenic, As	291	Potassium, K	7,348
Cadmium, Cd	36	Selenium, Se	<3.0
Calcium, Ca	3,441	Sodium, Na	561
Cobalt, Co	61	Strontium, Sr	4.4
Copper, Cu	130	Titanium, Ti	328
Iron, Fe	29.30%	Total Chromium, Cr	219
Lead, Pb	905	Vanadium, V	61
Magnesium, Mg	2,778	Zinc, Zn	212
Manganese, Mn	4,995		

Note that the sample has very high sulphur content and that most of this is present as sulphide. A concentration greater than 9.5% is considered acid producing.

Unfortunately, the original leaching data was not made available but many of elements that are shown in figure 2 are above their Minimum Requirements' acceptable risk limit, at least during the first two days of the leaching process:

- Cd, which is classified as an extreme hazard species;
- As, Co, Cu, Ni, Pb, and Ti that are classified as high hazards; and
- Cr, which is classified as moderate hazard.

The concentrations of all elements leached from the tailings decreased significantly over a period of 6 to 7 weeks but some appear to remain above their Minimum Requirements' acceptable risk limits.

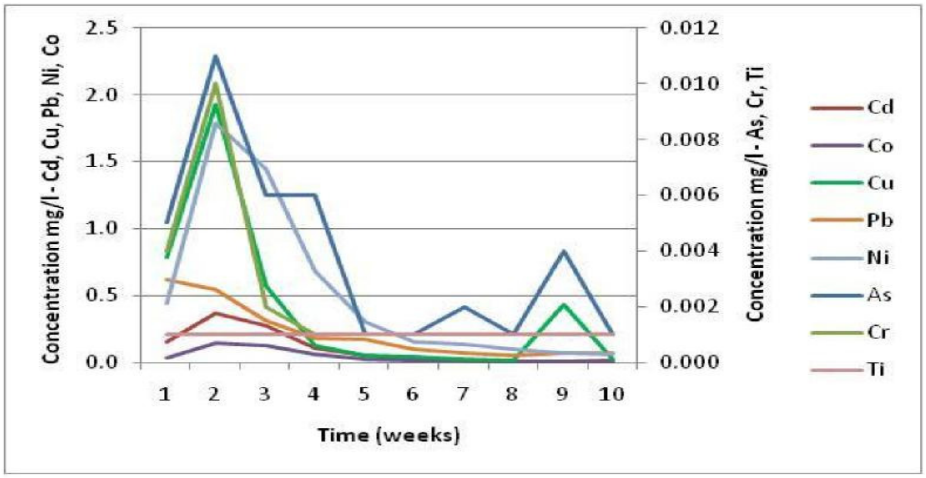

Figure 2: Column leaching of a sample of tailings: (SRK, 2009),

In addition, a column leaching test demonstrated that a number of elements can leach at environmentally significant concentrations; figure 2.

The Draft Standards and Regulations (section 3.2.4 and Table 3) would classify the tailings as a low environmental risk based on the data in table 5, as the elements highlighted in green are below TCT0; those in orange are between TC0 and TCT1; whereas the other elements are not classified as a risk to the environment. However, in terms of the leachability, it appears from figure 2 that the leaching concentrations at least for As, Cd and Cu could be above their LCT1 limits even after a few weeks. The leaching of the tailings could possibly be increased above the concentrations presented in figure 2, if the tailings begin to turn acidic due to acid mine drainage.

The presence of water and some salts in the tailings also means that the material could impact significantly on the environment unless the water is well managed in a properly engineered facility

3.4 General and Hazardous Wastes

The types of general and non-hazardous wastes that will be generated by the proposed development were obtained from documents provided by Environmental Resources Management (SRK EIA and Fe Residue Specialist Study) and expanded by the specialist consultant; the preferred and alternative waste management options that should be considered have been assessed.

Apart from the Office Waste listed in table 4, almost all the wastes generated at the proposed Facility must be assumed to be *hazardous* until proven otherwise. Table 4 lists the management options and, if considered non-hazardous, disposal to a General Waste Landfill is indicated.

A search of the literature indicates that very little has been published on the quantities of general and hazardous waste that would be generated at the facility except for the tailings and mine overburden. However, once the plant has been commissioned, all wastes will have to be classified and analysed, if required, according to the regulations and standards that are relevant at that time. Thus, in the planning stages, it will be appropriate to use the worst case scenario, i.e. the wastes are identical to those produced at other Zinc Mining and Beneficiation Facilities.

The following should be noted when assessing the chemicals, wastes and waste management options that are listed in table 4:

(a) Apart from general waste there are many hazardous waste streams that will be generated at the Mine and Beneficiation Plant and the associated offices that are "generic", i.e. they will be generated at any large mining or manufacturing facility. These include:
    - Lead-acid batteries from road vehicles, forklifts, etc. The rate of recycling in South Africa of these wastes is currently extremely high at ~97% for lead-acid batteries, as they are taken back by the suppliers for recovery of the lead and treatment of the acid content.
    - Dry cell batteries from electronic equipment including cell phones. The rate of recycling of these wastes in South Africa is currently low but an initiative to recover these wastes is being put into place. Although it is unlikely that such initiatives will be established in such a remote area.
    - Waste Electric and Electronic Equipment (WEEE), such as computers, VDUs and cell phones. There are a few small companies in South Africa involved in the recycling of these materials. The development is being encouraged by the Government and good facilities should be in place in future. Again the distance that the waste will have to be transported from the proposed facility will determine the viability of the recycling option.
    - Medical and Sanitary Wastes are both health care risk wastes and must be collected an existing waste management company. Both wastes are considered potentially infectious and, thus, are treated either by incineration or an alternative technology such as autoclaving before disposal of the residues to landfill.
    - Containers and packaging that previously contained hazardous chemicals, such as drums and packaging from chemical reagents and some materials used in the offices and general maintenance of the facility, e.g. plastic containers containing cleaning agents and pesticides, pesticide cans. The principles of the Responsible Packaging Management Association of South Africa (www.rpmasa.org.za) should be used; note that empty containers must be considered as hazardous waste unless shown to be non-hazardous.

    a) A number of liquid wastes will be generated for example oil and water. It is important to note that these wastes often cannot be disposed to landfill and, therefore, recovery by a waste management company or alternatively treatment on site to recover any values or to purify the water to discharge quality will be required.

b) It is proposed that both general waste and hazardous waste that will be going off-site be managed in a "Salvage Yard", so that recovery and recycling can be accomplished plus the bulking of any ultimate wastes can be accomplished to minimise that cost of transport off-site particularly the Vissershok HH landfill near Cape Town, which is at a distance of ~675km from the facility. Note hazardous wastes must be stored in appropriate facilities with a roof, concrete floor, possible HDPE liner, and bunded to prevent any spills migrating from the storage areas. Various hazardous wastes such as dry cell batteries, WEEE, used oil, pesticide containers and even health care risk waste should be stored in their own separate areas or even in a separate store room.

Although the ore and product stockpiles would not generally be considered as hazardous wastes, the possibility of drainage of hazardous species, such as heavy metals must be considered a possible risk. It is recommended that both materials are subjected to a leaching test, either a batch leach, using the Toxicity Characteristic Leaching Procedure or a column test. Note that the new draft waste standards indicate that *water can be used as the extractant* for materials that are mono-disposed or stored.

4 ENVIRONMENTAL IMPACT ASSESSMENT

At this stage of the project, only the preferred option and the no go alternative are included in this assessment of the possible human health and environmental impacts of the chemicals and products used and the wastes that will be generated.

The assessment of the impacts is given in this section of the waste specialist report; the management options that will be used to mitigate any risks to human health and the environment are discussed in Section 5 and the conclusions presented in Section 6.

4.1 Baseline

4.1.1 Aqueous Effluents

The site should be separated into clean areas, where any rainfall is considered uncontaminated, for example from the offices and other facilities not handling chemicals; and dirty areas, where rainfall and other water used could possibly be contaminated by chemicals and products. The standard procedure used is to assume that the first flush of rainfall, i.e. 20mm is potentially contaminated and divert this to a holding dam, where it is either discharged to water course, if shown to meet the required water discharge standards; used as process water; or, alternatively, diverted to an effluent treatment facility. The potentially "dirty" water can be mixed with the process water stream. This approach will minimise the potential environmental impact of facility on the surface and groundwater in the water scarce region where the plant is located.

4.1.2 Solid Wastes

According to a landfill survey carried out by the Department of Environment (Kv3, Disposal Site Census Report of Un-authorised Landfills in South Africa, October 2007), the Gamsberg GCB- Landfill was authorised to Anglo Operations Ltd., Marshalltown, Johannesburg on the 28th May 2001. Note that a GCB^- Landfill can only accept <25 tonnes or ~75 m^3 per day of general waste. A larger facility may be needed: if the amounts disposed are above 25 tonnes but less than 150 tonnes per day, a GSB^- Landfill would be acceptable. The use of an on-site general waste landfill is recommended and, because an approved facility is apparently already present, this would simplify matters considerably. The site should be assessed to ensure that the operation gas been carried out in terms of the Minimum Requirements. The management facilities for general wastes available in the region of the proposed Gamsberg Facility and in Northern Cape Province generally do not meet the current or new licensing requirements for general waste sites. The two waste sites operated by BMM are permitted under ECA and BMM are in the process of converting these licenses into NEMA:WA permits.The Kv3 report indicated that a number of sites, which do not have a permit, could be upgraded and then licensed in terms of the Waste Act: see table 6 for the examples of municipal waste facilities at various distances from Aggenys.

In addition, there are no licensed hazardous waste management facilities in Northern Cape Province and all hazardous wastes are currently are transported to EnviroServ's Vissershok

HH Waste Management Facility Landfill in Cape Town. Using this commercial facility is a very acceptable option for the Gamsberg's hazardous wastes, particularly as the facility has a small plant that can be used to reduce cyanide residues. Note, however, that the distance to Cape Town from the Gamsberg Facility is of the order of 675km and, therefore, the cost of transport will be high

Table 6: General Waste Landfills

Location	Approximate Distance from Aggenys	Type	Authorised[1]	Comments[2]
Pella	38km	GCB-	No: Should be authorised for continuation	Feasibility study of upgrade, 2012
Pofadder	50km	GCB-	No: Should be authorised for continuation	Scheduled for Development 2013
BMM (2 nos.)	0	GMB	Yes under ECA	Currently operating
Onseepkans	98km	GMB-	No: Should be authorised for continuation	No other information

1. Kv3, Disposal Site Census Report of Un-authorised Landfills in South Africa, October 2007
2. Namakwa District Development Plan, Fourth Revision, 2011 - 2012

4.2 Significance Ratings

4.2.1 Methods Used to Identify Impacts

Impacts are changes in an environmental parameter as a result of the undertaking of an activity. Table 7 below gives the approach used in this study to define the nature of the impact.

Table 7: Defining the Nature of an Environmental Impact

Nature of Impact	Definition
Positive	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Negative	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
Direct impact	Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors (e.g. between occupation of a site and the pre-existing habitats or between an effluent discharge and receiving water quality).
Indirect impact	Impacts that result from other activities that are encouraged to happen as a consequence of the Project (e.g. in-migration for employment placing a demand on resources).
Cumulative impact	Impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the Project.

Note that impacts can be either positive or negative.

4.2.2 Ratings

Table 8 give the definitions used for the ratings process.

Table 8: Descriptors used in ascribing significance to impacts identified in the Gamsberg Zinc Mine and Beneficiation Plant Assessment Programme.

Category		Description: Descriptor	Description: Example
Impact intensity	Intensity potential (positive)	Low	Waste disposed to landfill or incinerator but at reduced volumes
		Moderate-low	Waste can be treated to improve toxicity or other hazardous characteristics prior to disposal or incineration
		Moderate	Waste can be recycled and/or sold or recovery of resources from it
		Moderate-high	Waste can be re-used
		High	Waste production avoided
	Intensity potential (negative)	Low	Nuisance
		Moderate-low	Reduced functionality of soil, water or air
		Moderate	Measurable effects on the environment requiring monitoring, but results are within legislative guidelines or loss of a valuable resource
		Moderate-high	Monitoring results are in excess of legislative guidelines or loss of an irreplaceable resource
		High	Impacts are highly uncertain or involve unique/unknown risks
		Severe	Public health or safety risks
	Extent	Site only	
		Local (50 km radius of the source)	
		Regional (provincial scale, airshed, large scale catchment)	
		National	
		Transboundary/International	
	Duration	Temporary – short duration	
		Short-term – pacts that are predicted to last only for the duration of the construction period.	
		Long-term – impacts that will continue for the life of the Project, but ceases when the Project stops operating	
		Permanent – impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime.	
Probability - Likelihood		Unlikely: The impact is unlikely to occur.	
		Likely: The impact is likely to occur under most conditions	
		Definite : The impact is likely to occur	

4.2.3 Assumptions and Reasoning

The following assumptions were made while compiling the Risk Assessment:

(i) Waste management policies and procedures will, at least, meet all the national legislative requirements and standards. These include the Government Policy to implement the waste management hierarchy that was presented in section 3.2.2.
(ii) Waste storage facilities will be built in accordance with requirements from the Department of Environmental Affairs and will include, if required, linings, bunds, roofing, etc.
(iii) Impacts have been based on chemical knowledge and research of the various chemical components of products and wastes.
(iv) All suppliers/service vendors will be scrutinised at the appointment stage and audited on a regular basis, in terms of their compliance to legislation and "Best Environmental Practice" i.e. impacts that could occur, e.g. the transport of waste in unroadworthy vehicles; the disposal of waste at non-permitted facilities or the recycling of waste at non-approved facilities, which will give rise to pollution, have not been included.
(v) All employees dealing with waste streams on site will have a sound basic training and knowledge of how to handle each particular waste stream with which they are dealing.
(vi) Two permitted general waste landfill sites will be available at BMM. As far as possible, hazardous wastes, such solvents, will be sent off-site to an appropriate recycling, re-use or landfill facility.
(vii) Health care risk waste including sanitary waste will be handled by a reputable waste management company and transported from the site, as the amounts are expected to be small.

4.3 Assessment of Impacts

4.3.1 Introduction

The environmental impacts of the managing the wastes that will be generated by the facility are tabulated and discussed below as the table. Where possible, wastes that are similar in nature, e.g. organic wastes are considered together.

The assessment demonstrates that there are potentially a significant number of risks to human health and the environment and that the possible impact can range from a negative to a positive depending on the technology used to manage a particular waste. The worst impacts that have to be managed are, however, of medium significance for decision-making.

Disposal of waste to landfill including tailings to the proposed tailings dam will clearly have the most negative impact, even though it is described below as moderate. This description is dependent on applying the best national and, if necessary, international design; construction; operational; and closure requirements to the mine, beneficiation plant and associated infrastructure

The Impacts/Aspects have been listed in the tables below and recommended mitigation measures have been described. The mitigation measures are presented briefly in this section but the reader is directed to Section 6 for a complete discussion of the mitigation options, including the very important implementation of an environmental management system, and the waste management facilities that will be required.

Table 9 **Significance of Waste Management Impacts that May Occur During Construction, Pre-commissioning, Commissioning and Operation**

9.1 General Non-Hazardous Waste Management

ACTIVITY	NATURE OF IMPACT/ASPECT	INTENSITY POTENTIAL	EXTENT	DURATION	PROBABILITY	IMPACT SIGNIFICANCE
Collection of general non-hazardous waste	Air – diesel/petrol fumes.	Low (-)	Local	Long Term	Likely	Moderate
Handling and storage of builders rubble, soil, etc.	Air – dust	Low (-)	Local	Long Term	Likely	Moderate
Re-use of builders rubble	Positive impact – reduction of waste to landfill. In line with government waste minimization policies. Decrease in use of resources.	Low (+)	Local	Long Term	Likely	Minor
Handling and Storage of general waste, including office waste, garden waste and recyclable wastes including paper, tins, glass and plastics at Salvage Yard	Possible contamination due to bulking at salvage yard. Wind-blown litter	Low (-)	Site	Long Term	Likely	Minor
Recycling or re-use of packaging material and other recyclables	Positive impact – reduction of waste to landfill. In line with government waste minimization policies. Protection of a natural resource.	Low (+)	Site	Long Term	Likely	Minor
Handling and storage of scrap tyres and rubber waste	Storage - fire hazard Storage – provide receptacles for the collection of rain water which stagnates. Provides receptacle for living and	Low (-)	Site	Long Term	Likely	Minor

ACTIVITY	NATURE OF IMPACT/ASPECT	INTENSITY POTENTIAL	EXTENT	DURATION	PROBABILITY	IMPACT SIGNIFICANCE
	breeding of vermin.					
Disposal to landfill of scrap tyres and rubber waste	Difficulty in handling on landfill – non compactable, fire hazard, vermin breeding receptacles, damage to landfill equipment and do not remain buried.	Low (-)	Site	Long Term	Likely	Minor
Utilisation of scrap tyres and rubber waste in a cement kiln or on site facility	Positive Impact – energy recovery, decrease in use of natural resources, and reduction in amounts of solid waste disposed to landfill.	Low (+)	Site	Long Term	Likely	Minor
Recycling or re-use of scrap tyres and rubber waste	Positive impact – reduction of waste to landfill/incineration. In line with government waste minimization policies. Decrease in use of resources	Low (+)	Site	Long Term	Likely	Minor
Disposal to landfill of general waste	Reduction in landfill airspace	Low (-)	Site	Long Term	Likely	Minor
Disposal to landfill of general waste, including office waste, greens/garden waste and paper, tins, glass and plastic waste, scrap tyres and rubber waste	Wind-blown litter. Production of leachate	Low (-)	Site	Long Term	Likely	Minor
Composting of vegetation from site	Positive – reduction of waste to landfill. In line with government waste reduction policies. Addition of nutrients to soil.	Moderate-Low (+)	Site	Long Term	Likely	Minor
Re-use of clean storm water run-off	Positive impact – in line with government waste minimization policies. Protection of a scarce natural resource.	Moderate-Low (+)	Site	Long Term	Likely	Minor

9.2 Hazardous Waste Management

ACTIVITY	NATURE OF IMPACT/ASPECT	INTENSITY POTENTIAL	EXTENT	DURATION	PROBABILITY	IMPACT SIGNIFICANCE
Collection of Hazardous waste	Air – diesel/petrol fumes.	Low (-)	National	Long Term	Likely	Minor
Transport of Hazardous waste	Vehicle accidents or spillages resulting in soil and/or water pollution	Low (-)	National	Long Term	Unlikely	Minor
Handling and storage of: Hazardous wastes generated by the construction, plant and maintenance operations	Incorrect storage could result in contamination of air, soil and water resources. Human health – potential hazards of handling hazardous substances include inhalation of hazardous vapours and corrosive reactions to body parts Fire hazard Potential for reaction between incompatible chemicals	Moderate-Low (-)	Site	Long Term	Unlikely	Moderate
Disposal to landfill of hazardous waste	Reduction in landfill airspace Production of leachate and reduction in quality of leachate	Moderate-Low (-)	National	Long Term	Likely	Moderate
Disposal of Tailings to Tailings Dam	Permanent loss of an irreplaceable Resource Potential Contamination of Ground and Surface Water. Possibility of Acid Mine Drainage	Moderate (-)	Local	Permanent	Likely	Moderate (high volumes of tailings)
Recycling of vehicle and plant maintenance waste i.e. oil or grease contaminated filters and Recycling or re-use of empty chemical containers or bags	Positive impact – reduction of waste to landfill. In line with government waste minimization policies. Decrease in the use of resources.	Moderate-Low (+)	Site	Long Term	Likely	Minor

ACTIVITY	NATURE OF IMPACT/ASPECT	INTENSITY POTENTIAL	EXTENT	DURATION	PROBABILITY	IMPACT SIGNIFICANCE
Disposal to landfill of empty containers e.g. chemical containers or bags or paint, thinners, turpentine containers etc.	Health - Removal of contaminated containers for personal use by salvagers on landfills. Potential flammability of residues in containers. Chemical reactions on landfill with residues in containers.	Moderate-Low (-)	Site	Long Term	Unlikely	Negligible
Disposal to incinerator of: Spillage materials that have been absorbed e.g. soil, absorbent material, booms etc. Empty containers e.g. paint, thinners, turpentine, chemical containers or bags	Air – impact on quality and quantity of emissions from incinerator. Reduction in disposal capacity of incinerator.	Moderate-Low (-)	National	Long Term	Likely	Negligible
Energy recovery in on-site facility or off-site Cement Kiln of empty containers e.g. paint, thinners, turpentine, chemical containers or bags	Positive impact – reduction of waste to landfill/incineration. In line with government waste minimization policies	Moderate-Low (+)	Site	Long Term	Likely	Negligible
Disposal to incineration of empty containers e.g. paint, thinners, turpentine, chemical containers or bags	Positive Impact - Reduction in amount of waste disposed to landfill	Moderate-Low (+)	Site	Long Term	Unlikely	Minor
Spillage of hazardous liquid	Air – release of potentially dangerous fumes. Ground – contamination of soil. Water – potential contamination of clean stormwater, surface water or ground water.	Low (-)	National	Long Term	Unlikely	Minor
Disposal to landfill of redundant chemicals or reject products (excluding organics)	Human health – potential exposure of landfill employees to high hazard and toxicity of certain chemicals and products,	Moderate	National	Long Term	Unlikely	Minor

ACTIVITY	NATURE OF IMPACT/ASPECT	INTENSITY POTENTIAL	EXTENT	DURATION	PROBABILITY	IMPACT SIGNIFICANCE
	including inhalation of vapours or corrosion to skin. Production of leachate and reduction in quality of leachate Fire hazard Potential for incompatible chemicals to cause reactions.					
Recycling of: Lead-acid and dry batteries Waste electric and electronic equipment Cleaning material containers	Positive impact – reduction of waste to landfill. In line with government waste minimization policies. Decrease in use of resources	Moderate-High (+)	Site	Long Term	Likely	High
Handling and storage of health care risk waste and sanitary waste	Human health – exposure to potentially contagious vectors. Odour Attraction of vermin	Moderate-Low (-)	Site	Long Term	Likely	Moderate
Sterilisation of health care risk waste and sanitary waste by incineration, autoclaving, etc.	Air emissions including potential pathogens. Waste non-pathogenic but potentially hazardous due to metal content.	Moderate-Low (-)	Site	Long Term	Likely	Moderate
Disposal to landfill of non-infectious residues of health care risk waste and sanitary waste	Production of leachate and reduction in quality of leachate	Moderate-Low (-)	Site	Long Term	Likely	Moderate
Handling and storage of spent fluorescent tubes and other electrical bulbs	Human health – potential exposure to mercury vapours. Potential to cut oneself on glass fragments.	Moderate-Low (-)	Site	Long Term	Likely	Moderate
Recovery and Recycling of mercury from spent fluorescent tubes	Positive impact – reduction of waste to landfill. In line with government waste minimization policies. Decrease in use of resources	Moderate-High (+)	Site	Long Term	Likely	High

ACTIVITY	NATURE OF IMPACT/ASPECT	INTENSITY POTENTIAL	EXTENT	DURATION	PROBABILITY	IMPACT SIGNIFICANCE
Disposal to landfill of spent fluorescent tubes and other electrical bulbs	Production of leachate and reduction in quality of leachate Human health – release of mercury vapour which could be inhaled. Mercury is non-biodegradable in landfills.	Moderate-Low (-)	Site	Long Term	Likely	Moderate
Disposal to landfill of redundant chemicals or reject products (excluding organics)	Human health – potential exposure of landfill employees to high hazard and toxicity of certain chemicals and products, including inhalation of vapours or corrosion to skin. Production of leachate and reduction in quality of leachate Fire hazard Potential for incompatible chemicals to cause reactions.	Moderate- (-)	Site	Long Term	Likely	Moderate
Recycling of: Lead-acid and dry batteries Waste electric and electronic equipment, fluorescent tubes, etc. Cleaning material containers	**Positive** impact – reduction of waste to landfill. In line with government waste minimization policies. Decrease in use of resources	Moderate-Low (+)	Site	Long Term	Likely	High

5 MANAGEMENT APPROACH TO MITIGATION OF ENVIRONMENTAL RISKS

5.1 Mitigation of Environmental Risks

5.1.1 Introduction

The waste management infrastructure at the proposed Gamsberg Zinc Mine and Beneficiation Plant must meet or even exceed the national standards, which are based on international best practice. As discussed in section 3.2, the Government's policy on waste management, i.e. the NWMS, and the legislation is to promote the waste hierarchy as a way of reducing the environmental impact that waste will have by implementing waste avoidance, waste recycling and reuse when possible. Unavoidable waste must be treated and finally disposed to licensed landfill in a manner that will minimise the environmental impact both in the short term and long term.

In the sections below, some of the important management approaches to the mitigation of environmental risks, particularly those posed by the use, handling, treatment and final disposal of chemicals used during product and wastes generated are presented.

5.1.2 Cleaner Production and Design

Cleaner production and design is a major Government Policy and has been presented in the document "Guidelines for the Compilation of Integrated Waste Management Plans" (draft May 2000).The Department of Trade and Industry (DTI) plays a primary role in relation to waste avoidance and reduction through focusing on cleaner production and technology. The Cleaner Production Strategy (2004) is an important policy framework of the DTI, which has overseen the establishment of the National Cleaner Production Centre (NWMS, Draft, January 2010) and has undertaken a number of demonstration projects, which aim to investigate the viability of various cleaner production initiatives and mechanisms. Historically the mining sector has been targeted as having a major impact on the environment, as well as being a significant consumer of energy and water. Coupled with this, the sector has traditionally been responsible for significant exporting of raw materials and minerals with little or no beneficiation. Cleaner Production (CP) is one possible mechanism, which could be used to enhance the efficiency particularly during the beneficiation of ores. CP typically looks at a process holistically, considering all factors that may impact the efficiency of the process (i.e. energy, water, raw materials consumption and waste). The adoption of Cleaner Production activities would assist any company in attaining an improved environmental efficiency and subsequent improved financial bottom line.

Whilst cleaner production and product design fall within the areas regulated by the DTI, the Waste Act provides for the DEA to identify suitable products according to their contribution to the waste stream, and liaise with the DTI in terms of the appropriate response. The interdepartmental committee to be established between DEA and the DTI will consider specific proposals in relation to different products, and agree on the appropriate regulatory response.

The long-term objective for waste prevention, minimisation and recycling is to ensure that minimisation and recycling procedures and practices are adopted by all sectors of society as part of a broader initiative focusing on cleaner production:

- Harness renewable materials and energy sources or reduce the use of natural resources by using them more efficiently and productively;
- Reduce or eliminate pollution and toxic wastes;
- Deliver equal or superior performance compared with conventional offerings;
- Provide investors, companies, and customers with the promise of increased returns, reduced costs, and lower prices
- Create quality jobs in management, production, and deployment

Clearly, for a project such as the proposed Gamsberg Zinc Mine and Beneficiation Plant, the proponent has the opportunity to select the technologies for each part of the process that that would be more efficient and minimise waste production.

5.1.3 Environmental Management Planning

Environmental Management Planning is an essential and required component of any mining facility. Important environmental initiatives that are used to ensure sound environmental and waste management include:

- ISO 14001, Environmental Management System
- The Government’s requirement for Waste Management Plans;
- The International Finance Corporation’s Environmental health and Safety Guidelines;
- UN Environmental Programme and
- Green Procurement

5.1.3.1 Environmental Management Systems (EMS)

The most important strategy for a company is to develop its own Environmental Management System, e.g. such as adoption of ISO 14001 or other industry guidelines, which represents the core set of standards used by organisations for designing and implementing an effective Environmental Management System. An EMS is defined by the International Standards Organisation (ISO) as: “part of the overall management system that includes organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving and maintaining the environmental policy. The management of waste and toxic chemicals is a key component of an EMS. Prior to the development of the ISO 14000 series during the 1990s, many organizations voluntarily constructed their own EMS systems, but this made comparisons of environmental effects between companies difficult and therefore the universal ISO 14000 series was developed. A core principle is that of continual improvement. ISO 14000 acts both as an internal management tool and as a way of demonstrating a company’s environmental commitment to its customers and clients.

Note that achieving the waste hierarchy is an important component of the management systems but they also include aspects such as: operational planning for disaster management and environmental cleanups and the training of personnel in work instructions and procedures (SOPs). Environmental monitoring at plants and associated waste management facilities will be required to ensure compliance to all permits and authorisations, e.g. monitoring of air emissions, ground water and surface water, together expert evaluation of the results on a regular basis. Auditing of environmental compliance must include internal, external, and authority audits of the plant and all on-site storage and waste management facilities. The auditing of service providers must also be undertaken: for example, of any off-site waste recycling, treatment and disposal facilities that are used, to ensure permit compliance and that the wastes from the facility are being correctly managed and are not contributing to any contamination or pollution that may be occurring.

5.1.3.2 Industrial Waste Management Plans

As discussed in section 3.2, the NEMWA and the NWMS place an emphasis on Industry Waste Management Plans (IndWMPs), which are the central element in the co-regulatory system. Such a programme should be part of any ISO 14001, Environmental management System and would be needed to meet IFC Guidelines. These will include the management of the ore and rock dumps, the input chemicals, chemical waste and the management of effluents; recycling and treatment plants; storage facilities; and disposal facilities; and how the principles of clean technology and the waste hierarchy will be implemented during the design phase of the project, particularly waste avoidance and recycling.

5.1.3.3 International Guidelines and Resources

International environmental and waste management guidelines are available from many institutions; these include requirements from the International Finance Corporation (IFC); the United Nations Environmental Programme (UNEP); the European Union and various country requirements.

5.1.3.3.1 International Finance Corporation

The International Finance Corporation (IFC), which is part of the World Bank Group, has published amongst other documents Environmental, Health, and Safety (EHS) Guidelines (www. IFC.org). The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP), as defined in the International Finance Corporation’s Performance Standards, e.g. on Pollution Prevention and Abatement. IFC uses the EHS Guidelines as a technical source of information during project appraisal activities, as described in IFC's Environmental and Social Review Procedure. The EHS Guidelines contain the performance levels and measures that are normally acceptable to IFC and are generally considered to be achievable in new facilities at reasonable costs, by existing technology. The environmental assessment process may recommend alternative (higher or lower) levels or measures, which, if acceptable to IFC, become project or site specific requirements. One key advantage for an exporter such as the Gamsberg Facility, the IFC Guidelines can be used to demonstrate to clients an international level of Environmental, Health and Safety compliance, even if IFC Finance is not required.

5.1.3.3.2 United Nations

The Stockholm Convention to limit or ban the release of "Persistent Organic Pollutants" (POPs) has been signed by South Africa. Most of these pollutants are chlorinated hydrocarbons such DDT, PCBs and Dioxins. However, the Gamsberg Facility would not use any of the materials/pollutants covered by this Convention.

The United Nations Environmental Programme (UNEP) has produced resources on waste management to facilitate the transfer of knowledge for sustainable development (www.unep.org*).* These include:

- Integrated Waste Management
- Solid Waste Management; and
- Training resources

Many of the documents that were produced by UNEP were used as a basis for many aspects of waste management policy and legislation in South Africa, e.g. on health care risk waste.

5.1.3.4 International Cyanide Management Code

The Cyanide Code (www.cyanide code.org) is a voluntary initiative for the gold mining industry and the producers and transporters of the cyanide used in gold mining. Such a programme should be adopted at the Gamsberg Facility for the management of the calcium cyanide required at the Carbon Flotation Plant, even though the amounts of cyanide used will be small compared to that used in gold mining. The code gives standards of practice for various operations some of which will be used at the Gamsberg Facility, i.e.

- Transportation;
- Handling and Storage;
- Management of cyanide process solutions and wastes;
- Worker Safety;
- Emergency Response; and
- Training.

5.1.3.5 Green Procurement Programme

One important mechanism that can avoid the generation of hazardous wastes is a "green procurement (GP) programme". Many companies ensure that they only buy materials from accredited and approved suppliers. The first step in any waste minimisation programme is the selection in the procurement process, of environmentally less hazardous materials and services, which generate less waste during and after use. It is recommended that a GP be implemented for the project, particularly aimed at the hazardous materials utilised during the construction, commissioning and operation of the facility. A programme could take account of the entire life-cycle of goods and services, design and engineering, procurement and materials management, production, marketing and distribution and waste management within the company, The procurement of hazardous materials that is unavoidable, such as those used in the flotation plant, should be undertaken to ensure that, the least hazardous, but still effective alternative is chosen. This should, for example, include procurement of non-chlorinated degreasing solvents, PVC-free plastic products or the substitution of plastic products that contain heavy metal dies or colouring. The process need not be restricted to hazardous materials, since one can select products with only the minimum packaging required, since this will result in less waste being generated. New initiatives clearly have to be balanced in relation to the functionality and cost effectiveness of the alternative products.

The preferred suppliers of services to the project should be selected on the basis that they conform to acceptable environmental principles. A Standard Operating Procedure for waste management that includes this requirement for the selection of the environmentally active waste management companies (preferably BEE compliant) should be available. However, all contractors must be required to conform to the facility's requirements and to manage waste materials and utilise any hazardous chemicals in an acceptable manner. All service suppliers should, if possible, be ISO 14001 rated or, at least, be implementing an acceptable environmental management system.

5.2 Waste Management Infrastructure

In this section, the key waste management infrastructure that will be required or is optional for the proposed Gamsberg is outlined. The overall objective is to minimise any environmental risk posed by the materials used, the products and the wastes generated. The choice of technology must reflect not only the National and Provincial requirements but, if necessary any local requirements.

5.2.1 Chemical and Waste Storage Facilities

Storage facilities will be necessary for hazardous chemicals and any hazardous wastes used and generated during pre-commissioning, commissioning and operation at the central storage and waste recycling facility should be included. The proposal includes a salvage yard and the various areas for separating and storing general and hazardous wastes must be developed according to the requirements. Note that storage facilities will require either a basic assessment or possibly a full EIA assessment, although these can be included in the final authorisation for the whole facility: (Draft NEMWA Amendment, Government Gazette 33880, 14thDecember 2010). Waste storage facilities must be built in accordance with requirements from the Department of Environmental Affairs and will include linings, bunds, roofing (except for large stockpiles such as ore, rock and tailings). A hazardous chemical and waste storage facility should include a low permeability surface, preferably concrete, that is protected from the ingress of storm water from surrounding areas to ensure that accidental spillage does not pollute local soil or water resources. All storage areas must also be properly demarcated and, if the material is hazardous, there should be adequate labelling and security at the facility. A facility must provide for separate storage of incompatible chemicals or wastes, e.g. acids and bases; calcium cyanide and acid; and for flammable materials.

The migration of spillage into the ground and groundwater regime around storage areas must be prevented. This is particularly important for temporary storage areas that may be required during construction. Flammable materials must be kept separate from other hazardous materials and be well ventilated in order to prevent build up of explosive vapours and gases. A record of all incidents must be kept and, if it does result in contamination of ground or surface water resources, it must be reported to the Department of Water Affairs, as required by the National Water Act and, in future, reporting on contaminated land will also go to the Department of Environment Affairs in terms of the NEMWA.

5.2.2 Licensed General Waste Site

A licensed general waste site will not be incorporated in the Project as there is sufficient capacity at the two licensed BMM sites in Aggeneys.

5.2.3 A Disposal Facility for Uncontaminated Construction Waste

Uncontaminated construction waste, which is classified in terms of the draft waste standards as an inert waste or very low risk waste, will be required. The material could be used to landscape the proposed Gamsberg Facility to ensure the correct run off of rainfall from clean areas and its diversion from potentially contaminated areas of the site to a holding dam. In addition, construction waste could be used as cover material in the General Waste Site or be crushed and used as backfill or building bunds, WRDetc.

5.2.4 Water Containment Dam(s)

Dams for storage of potentially contaminated water prior to analysis and discharge to water course; to the activated sludge water treatment facility or oxidation pond; or used as process water will be required. As indicated in the text the Facility will utilise significant amounts of water which will be stored in pollution control dams and reused in processing.

5.2.5 Activated Sludge Treatment Plant or Oxidation Pond

An activated sludge plant or oxidation pond for treatment of sewage, contaminated storm water and, possibly, selected plant effluents will be required.

5.2.6 Storage Areas for General Waste and a Central Recycling and/or Reclamation Yard

Storage Areas for General Waste and a Central Recycling and/or Reclamation will be necessary. A Central Recycling area would recycle and recover general waste materials and possibly collect and store selected generic hazardous wastes such as used oil, fluorescent tubes, batteries and electronic wastes for bulking and final collection for recycling or possibly disposal.

5.2.7 Lubricating oils from workshops and other areas

Lubricating oils from workshops and any other areas of the Facility can be stored on-site and the waste collected for recycling by a company approved by the ROSE (Recycling Oil Saves the Environment) Programme. Up to 80% of South Africa’s recoverable oil is already collected by this country wide programme. An area at the central recycling/reclamation yard would be required for storage.

5.2.8 On-site health care risk waste

As the amount of health care risk waste including sanitary waste generated at the proposed Facility is expected to be very low, it is recommended that the licensed removal service is used. Many waste management companies offer a health care risk waste and sanitary waste collection and treatment services and it is recommended that one of these service providers by appointed to handle this very high risk waste.

5.2.9 Treatment Area for Potentially Contaminated Soil

A Treatment Area for Potentially Contaminated Soil should be made available. Soil that is inadvertently contaminated with petroleum hydrocarbons, e.g. lubricating oil, can be treated by biodegradation technologies to a standard that would be acceptable for using as a fill, as landfill cover or even to bulk compost. A central facility is normally preferable to using in-situ technologies where less control can be maintained over the processing. Bioremediation of contaminated soil will be undertaken at the BMM facility unless quantities exceed the

carrying capacity of the site, in which case, this soil will be transported to HH facility. Emergency Response

An emergency response procedure must be in place, e.g. provision of appropriate absorbents, for the cleanup of any accidental spills. Note that spilled materials are classified as wastes.

The following should be noted:

(i) Nearly all processes in the Ore beneficiation Plant require the use of reagent chemicals: many are hazardous;
(ii) Separation of incompatible materials, so that they cannot come into contact, is essential, e.g. alkali and acid materials: a standard is available, i.e. SANS 310-1:2007, Storage Tank Facilities for Hazardous Chemicals P1, Above Ground facilities for Non-flammable Substances;
(iii) SABS approved tanks should be utilised in all cases. These tanks should have installation certificates, as well as annual certificates when they are inspected.

5.3 Waste Management Contractor(s)

A large number of external contractors will be on-site during the *construction, pre-commissioning, and commissioning* of the facility and there are a number of areas that will generate waste during operation of the plant. It is suggested that a waste contractor be appointed that will be specifically responsible for the handling, collection, recycling, transport and disposal of all wastes generated. The waste management company must be able to handle all types of waste: construction waste, industrial waste, commercial waste and hazardous waste and should, either have their own Hazmat team or, alternatively, subcontract a team for the duration of the project. The company must be capable of meeting the varied demands that the project will place on them and have the financial strength to undertake such a large project. The advantages of appointing an independent waste management company are that:

- There will be a single contractor that can be held responsible for the management of all wastes, which will make it easier for the Construction Manager and the staff to ensure that the waste is managed according to the required standards and procedures.
- The waste management company could appoint a site waste manager. The site waste manager must be an integral part of the team, be involved in all project meetings, and report to the Construction Manager.
- The appropriate colour coded or marked waste bins/skips can be placed, where and when required, depending on the varied demands of the project.
- Separation of recyclable wastes such as scrap metal, wood, glass and paper and hazardous wastes, such as oil, grease, etc. can be carefully managed by the site waste manager.
- Hazardous waste must be classified, handled, treated and disposed according to the SANS 10234 and the Regulations and Standards being developed by the Department of Environment Affairs.
- At most large construction sites, waste is often simply dumped by workers at any convenient location, even though receptacles may be close by. The waste manager can ensure that the site remains clear of waste, which may be a safety or environmental hazard. It is recommended that the waste company have a site clean-up team that will be responsible for placing discarded waste in the correct receptacles, ensuring full skips are removed timeously, and that windblown paper, plastic and other waste is collected on a regular basis.

6 CONCLUSIONS

From an environmental point of view, the mine and the zinc beneficiation plant *could pose* a significant risk to the human health and the environment, if the risks are not managed in an environmentally sustainable manner. In practice, the economic improvement provided by the facility, greatly increases the quality of life and the health and welfare of inhabitants and will improve waste management facilities and waste services in the area.

At the Gamsberg Facility, the management of the resources used; the processing of these resources; and the products and the wastes generated all pose some risk. However, these risks can be managed and, particularly for hazardous and general wastes, as the legal requirements and management procedures, together with the technologies available to minimise the environmental risks have significantly improved over the last two decades. Provided the mine and beneficiation plant commit to and demonstrate their compliance with the requirements of the country's National Waste Management Strategy and the Waste Act of 2008 and the subsequent regulations and standards, the impact of the wastes generated can be satisfactorily managed.

The assessment of the chemical and waste management needs of the facility indicates that the plant will have to conform to the Department of Environment's new Waste Management Regulations and Standards that are expected to be published in 2013. These requirements also include a regulation that prohibits the disposal of certain wastes categories to landfill, e.g. liquid wastes, organic solvents and inorganic wastes classified as very high risk. Even though many of these requirements will not come into force for 3 to 8 years, the long time required to get approval, construct and commission of the Mine and Beneficiation Plant and associated facilities, means that when operational many of these restrictions will be in place. Thus during the planning phase, provision must be made for on-site or, if available, off-site facilities that can meet the new waste management requirements. The objective of the landfill restrictions is to promote the waste hierarchy, i.e. waste avoidance; waste recycling, recovery and utilisation; and treatment rather than disposal to landfill in line with Governmental Policy as included in the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), and Draft National Waste Management Strategy (March 2010). The overall objective is to reduce the short, medium and long term impact of waste on human health and the environment, in particular surface and groundwater.

Assessment of the environmental risks posed by the wastes shows that the highest environmental risks from the facility will be the tailings, both because of the high volume and the possibility of it developing acid mine drainage in the medium to long term. This is dealt with in the geochemical and hydrogeological specialist reports. All the other wastes were determined to be of negligible or minor significance for decision making.

The report briefly discusses the waste management facilities that will be required by the proposed Gamsberg Zinc Mine and Beneficiation Facility and the available mitigation measures that need to be implemented to minimise the environmental and health impact of the various waste streams.

APPENDIX 1: DETAILS OF SPECIALISTS

David Baldwin: Lead Waste Specialist Consultant

Dave Baldwin has a PhD in Chemistry from the University of Manchester, England and, for more than 20 years, a research fellow and Professor of Chemistry at various Universities including the University of the Witwatersrand, Johannesburg, University of Washington and California Institute of Technology in the USA, and University College, London. For the last 25 years, he has been involved in consulting on environmental and chemical projects mainly in Southern Africa, with the emphasis on hazardous and solid waste management. For five years, he was acting technical director of Waste-tech, a leading national waste management company. Projects have included hazardous waste consultant on the Department of Environment's Waste Classification Project, 2009 to 2010; and development of the South African Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste. He regularly consults to the leading companies and many municipalities on the classification, treatment and handling of waste and the cleanup of contaminated land.