

# An investigation into the incorporation of sustainability principles in the Environmental Management Programme and Social and Labour Plan for a gold mine, South Africa

**T Ratshibvumo**  
**23121394**

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Supervisor: Ms C Steenkamp

Co-supervisor: Dr J Pope

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## **ABSTRACT**

Sustainable development in gold mining is crucial to ensure that resources are extracted in a responsible manner to the benefit of the environment, society, the economy and all other integral factors that affect sustainability in this industry. Legislation such as the Mineral Petroleum Resources Development Act, the National Environmental Management Act and others are set in order to drive management of mining to deliver sustainability through the Environmental Management Programme and the Social and Labour Plans in South Africa. It is imperative that these management documents include all principles of sustainability in order to move towards sustainability. A well developed and supported sustainability framework plays a crucial role in avoidance of possible significant negative environmental and social impacts which might affect sustainability achievement. This research is aimed at assessing the incorporation of sustainability principles into the Environmental Management Programme and the Social and Labour Plan of a specific gold mine in Gauteng Province, South Africa. This will be achieved through the development of sustainability assessment criteria specific to a gold mine in South Africa, an assessment of their incorporation into working documents and through the provision of recommendations to improve sustainability in the gold mining sector. Through the review of various documents, this research has established a suite of Gold Mine Sustainability Assessment Criteria. These criteria, established as part of this research project, were then used to assess the working documents of this specific gold mine. The assessment and analysis of the documents concluded that, although the documents do contain the relevant sub-criteria information as per the new criteria, some sub-criteria were lacking or insufficiently covered. Based on the analysis and results, it is therefore recommended firstly that the structure of the working documents must include the new criteria as identified in the study. Secondly, it is recommended that further research be conducted to ensure that all gold mine sustainability assessment criteria are addressed in the working documents and are assessed regularly to achieve sustainability.

### **Key words:**

Sustainability, Sustainability Assessment, Criterion, Environmental Management Programme, Social Labour Plan, Gold Mine, Social and Labour Plan

## DECLARATION

I hereby declare that this research, *An investigation into the incorporation of sustainability principles in the Environmental Management Programme and Social and Labour Plan for a gold mine, South Africa*, is my own unaided work. Any other contribution have been referenced and mentioned in the acknowledgements. This research report is being submitted for the Degree Master of Environmental Management at the North-West University, Potchefstroom Campus. It has not been submitted before for any degree or examination at any other university.

Signature of candidate

April 2016

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## ACRONYMS AND ABBREVIATIONS

ABET	Adult Based Education and Training
AMD	Acid Mine Drainage
BBBEE	Broad-Based Black Economic Empowerment
CFCs	Chlorofluorocarbons
COMSA	Chamber of Mines of South Africa
CONNEP	Consultative National Environmental Policy
CSR	Corporate Social Responsibility
DEAT	Department of Environmental Affairs and Tourism
DMR	Department of Mineral Resources
EIA	Environmental Impact Assessment
EMPR	Environmental Management Programme
FSE	Federation of Sustainable Development
GMSAC	Gold Mine Sustainability Assessment Criteria
GSAC	Gibson Sustainability Assessment Criteria
HIV/AIDS	Human Immunodeficiency Virus and Acquired Immune Deficiency Syndrome
ICMM	International Council of Mining and Metals
IDP	Integrated Development Plans
IISD	International Institute for Sustainable Development
LED	Local Economic Development
MDG	Millennium Development Goal
MHSA	Mine Health and Safety Act
MMSD	Mining Minerals Sustainable Development
MPRDA	Minerals and Petroleum Resources Development Act
NEMA	National Environmental Management Act
NFSD	National Framework for Sustainable Development
OECD	Organisation for Economic Co-operation and Development
SA	South Africa
SAPA	South African Press Association
SDM	Sustainable Development through Mining Programme
SLP	Social and Labour Plan

SMME	Small Micro Medium Enterprises
STATSSA	Statistics South Africa
TAC	Treatment Action Campaign
TB	Tuberculosis
TBL	Triple Bottom Line
UNDP	United Nations Development Program
WCED	World Commission on Environment and Development
WHC	Women's Health Cooperation

## CHAPTER 1: INTRODUCTION AND RESEARCH BACKGROUND

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### 1.1 Introduction

Research is not just a process of gathering information, rather its concerns lie in the process of providing answers to the unanswered questions and in creating a new understanding or knowledge which currently does not exist (Fink, 2000:1). This research work is designed to provide some answers to unanswered questions and to provide a new understanding of what currently exists. The introduction and research background chapter will introduce the problem statement behind the research topic and elaborate on the research objectives to be achieved. Furthermore the same chapter will illustrate the research structure.

### 1.2 Problem statement

Gold mining has been the backbone and a key contributor to the South African economy for more than a decade (Swart, 2003:489; Winde, 2011:36; STATSSA, 2013). It hosts about 500 000 direct jobs and 800 000 indirect jobs (CM, 2014:2). By its nature, the mining process is environmentally invasive and socially intrusive (Mohr-Swart *et al*, 2008:166). However mining companies have managed to convert their mineral assets into national wealth providing economic means to address social and environmental impacts (Mohr-swart, 1998:165). In South Africa the Department of Mineral Resources (DMR) through the Minerals and Petroleum Resources Development Act (MPRDA) 2002 has set two main foundation documents which must be submitted as part of the initial process of embarking upon a prospecting/mining operation. These are the Environmental Management Programmes (EMPR) and Social and Labour Plans (SLP) as stipulated in the MPRDA.

According to the (ICMM) International Council of Mining and Metals (ICMM, 2012:7) and Aucamp *et al*, 2011, mining industry seems to be inherently unsustainable due to massive social, environmental and economic challenges. These challenges have left South Africa with an enormous legacy on environmental rehabilitation, community resource depletion and health challenges (Swart, 2003:489), as well as offsetting since the mine itself cannot be offset as the ore deposit exists where it is (ELAW, 2012:26). Mining companies can however contribute towards sustainable development provided that the environmental responsibility, economic development, social, health and safety practices are adopted and implemented (Hamman, 2003:237). Different provisions should be made within the mining environment for developing the alternative sustainable livelihoods replacing those which have been lost due to mining practices and mine closure (NSFD, 2008:17). Mulizane *et al* (2005:57) emphasise that if the

mining industry is to contribute effectively to sustainable development, it must develop and consistently apply sound environmental management practices to minimise on- and off-site environmental impacts. The mines are required to have the mining license and mining works program prior commencement of any activity. Furthermore the MPRDA has set two main working documents, EMPR and SLP, which assist the mining industry to manage their activities and compliance as described below.

The EMPR is defined as a plan to manage and rehabilitate the environmental impacts associated with prospecting, production or mining rights (MPRDA, 2002). The EMPR is prepared following an environmental impact assessment (EIA) which is conducted for a proposed prospecting or mining project as prescribed in the MPRDA. This document must be approved by the Department of Mineral Resources (DMR) and the mining rights be granted prior to commencement of any activity for the proposed mining project. Any person conducting any mining activities as applied for must comply with the contents as stated in the approved EMPR document (MPRDA, 2002).

The SLP is designed for South African mining companies with the aim of encouraging the company to embrace social responsibility and encouraging a positive impact through its activities on the employees, communities and stakeholders (DMR, 2010). The SLP document is a pre-requisite document under the MPRDA that requires applicants for the mining and production rights to develop and implement comprehensive Human Resources Development Programmes, Mine Community Development Plans, Housing and Living Conditions Plans, Employment Equity Plans, and Processes to save jobs and manage downscaling and/or closure based on the summary of the social impact assessment (DMR,2010:5). Adherence to the SLP is one of the positive ways that industry is undertaking to contribute towards sustainable development (DME, 2007:16).

The EMPR and SLP documents must outline the potential area(s) which will be affected by the operation's socio-economic and environmental challenges, measures which will be used to prevent and manage those challenges and how it will ensure sustainability. These documents must be submitted and officially approved (Swart 2003:490) to ensure that the DMR is aware of all measures to implement and in future they can audit specific operations as per their commitments.

Worrall (2009:1426) indicated that most of the mining companies are trying to integrate sustainable development practices into their business activities. However sustainability in mining is not a simple concept, as mining results in severe environmental, social and economic impacts like depletion of natural resources, it affects water quality and quantity and it brings inequality amongst communities (Mudd, 2009:1 & Aucamp *et al*, 2011). Mining production

depletes the non-renewable gold resource, uses enormous amount of fresh potable water, causes water pollution, affects water quality; in some instances resulting in Acid Mine Drainage (AMD). In Ramontja (2011:392) it was illustrated that the local air quality is affected by mine dumps, which are used for dumping the mine waste after the pre-gold processing, heavy duty vehicles, gravel roads and waste rock dumps. The research indicates that biodiversity is also affected.

Good environmental decision making constitute greatly in ensuring good governance, accountability (Feris, 2010:74) and provision of adequate financial support and closure costs within companies and delivering in sustainability. Kotze (2006:3) indicated that the institutional and legislative fragmentation, lack or relevance of skills amongst authorities can affect the implementation of commitments in the EMPR and SLP can certainly hinders sustainability. If sustainability principles are included in the documents as a prerequisite prior approval of the mining right, this will be taken seriously and implemented to ensure compliance.

Different environmental management systems play a crucial role in aiding the implementation and achievement of commitments as detailed in the SLP and EMPR. For the purpose of this research the management systems and effective implementation of EMPR and SLP commitments will not be assessed as the research is designed to look at the incorporation of principles and develop suitable criteria thereof. This research will develop research objectives to assess the incorporation of sustainability principles into EMPR and SLP documentation and develop a criterion that can be used to assess sustainability in mining as stated in the research aim and objectives below.

### **1.3 Research aim**

#### **1.3.1 Research main aim**

The main aim of this research is to investigate the extent to which the sustainability principles are incorporated in the EMPR and SLP for a gold mine in SA.

#### **1.3.2 Research objectives**

In order to achieve the main aim of this research, the following steps have to be undertaken. These will be referred to as research objectives and are outlined below:

- 1 To develop sustainability criteria relevant to the gold mining industry in South Africa.
- 2 To assess the extent to which the sustainability criteria have been incorporated into the EMPR and SLP for one specific gold mine.
- 3 To provide recommendations to improve sustainability in gold mining.

#### 1.4 Research structure

The research will be comprised of five different chapters namely: Introduction, Research Case Study and Methods, Literature Review, Results and Discussion and Conclusion. The table below illustrates the research structure and how they are interlinked to achieve the research objectives. This structure is illustrated in Table 1.1 below.

<b>Research Topic:</b> An investigation into the incorporation of sustainability principles in the Environmental Management Programme and Social and Labour Plan for a Gold Mine, Gauteng Province, South Africa		
<b>RESEARCH MAIN OBJECTIVE</b>	<b>RESEARCH SUB-OBJECTIVES</b>	<b>CHAPTERS ADDRESSING RESEARCH QUESTIONS</b>
To investigate the extent to which the sustainability principles are incorporated in the Environmental Management Programme and Social Labour Plan for a specific gold mine	To develop sustainability criteria relevant to the gold mining industry in SA	Literature review Chapter 3
	To assess the extent to which the sustainability criteria have been incorporated into the EMPR, SLP for one specific gold mine	Data analysis and interpretation Chapter 4
	To provide recommendations to improve sustainability in gold mining	Conclusions and recommendations Chapter 5

Table 1.1: Summary of the research structure.

## CHAPTER 2: RESEARCH METHODOLOGY

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### 2.1 Introduction

According to Iacono (2009:39) research methodology can be described as a philosophical process of research that includes the values that serve the rationale that the researcher uses for the collection and interpretation of data and reaching desired aims or conclusions in any chosen subject. Researchers need knowledge of different research methods (Mende, 2005:204) as different methods are applied in different research fields.

The Research methodology chapter will outline different methods to be used in this research in order to achieve the research objectives.

### 2.2 Research design

Research design is the programme that guides the researcher in the process of data collection, analysis and interpretation in order to achieve the research objective (Creswell, 2003:5). The research design stage constitutes the step where the methodological procedure is planned and prepared (Fink, 2000:5). This research will be conducted using a qualitative approach which will include extensive literature review and review of associated documentation. Qualitative research dates back and has been motivated for its advantages in flexibility, in depth analysis and potential to observe a variety of aspects of a social situation as indicated in Kawulich (2005). Brikci and Green (2007) explained qualitative research as research which is conducted using methods such as participant observation or case studies that result in a narrative, descriptive account of a setting or practice. Qualitative study has become an important methodology for scientific research and industrial applications in many fields, such as economics and environmental management (Kawulich, 2005). This method is also getting increasing attention in the domains of sustainability due to its inherent advantages of analyzing data in multiple ways (Han, 2011). For example, Morrissey (2004) used this methodology to research sustainable waste management. This approach is relevant to this study as the SLP and EMPR will be analyzed to develop sustainability criteria which is suitable for gold mining.

### 2.3 Research study area selection and setting

The research will be conducted in a gold mining operation owned by one of the top five mining companies in South Africa. As a researcher I went in detail through the code of ethics and the values of the concerned company to ensure that there is no contravention with any of such during and after the research. A thorough consultation was done with relevant personnel to

ensure the concerned code of ethics and values are fully understood. For ethical considerations the study area sample site will not be disclosed to avoid any influence that might arise due to the nature of the research results. Furthermore, based on this reason the management documents, i.e. EMPR and SLP to be used in this study will not be referenced.

The selected operation is situated in the West Rand District Municipality (WRDM) in Gauteng Province, South Africa. The location is indicated in Figure 2.1 below. This mine hosts more than 5 000 employees from different communities, cultures and countries like South Africa, Mozambique, Lesotho, Malawi, Namibia, Swaziland, Zimbabwe, Botswana etc. Furthermore this gold mine hosts all the main, typical activities of such an operation, including: underground ore extraction; conveyance of reef to a metallurgical plant; processing of gold; deposition of waste rock and deposition of slurry after gold processing under one mining right; as well as a hostel and village for employees. The site setting and components motivated the researcher to adopt this operation as a case study as it contains full mining cycle components and will be able to reflect on the realities and evidence of the incorporation of sustainability principles into its working documents. Selection of case studies being single or multiple can be motivated by aspects like scope and process and this can yield different results (Baxter and Jack 2008, Yin 2013). In this research one case will be used with the predictions that it will yield a literal replication results for similar conditions in other operations. Furthermore replication of studies like this can be done to experiment and determine the robustness of the findings as recommended in Yin (2013:57).

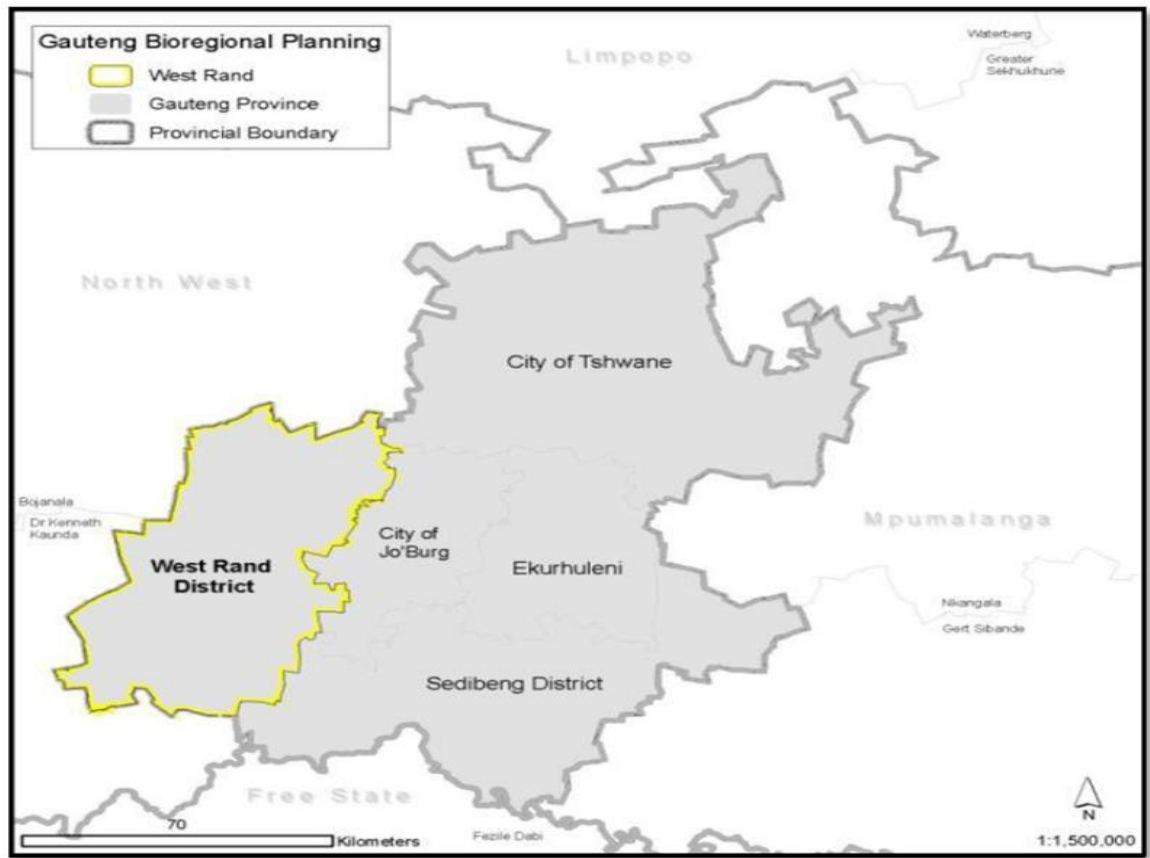


Figure 2.1: Location of West Rand District Municipality in relation to other municipalities of Gauteng Province, South Africa. Source: (WRDM, 2013).

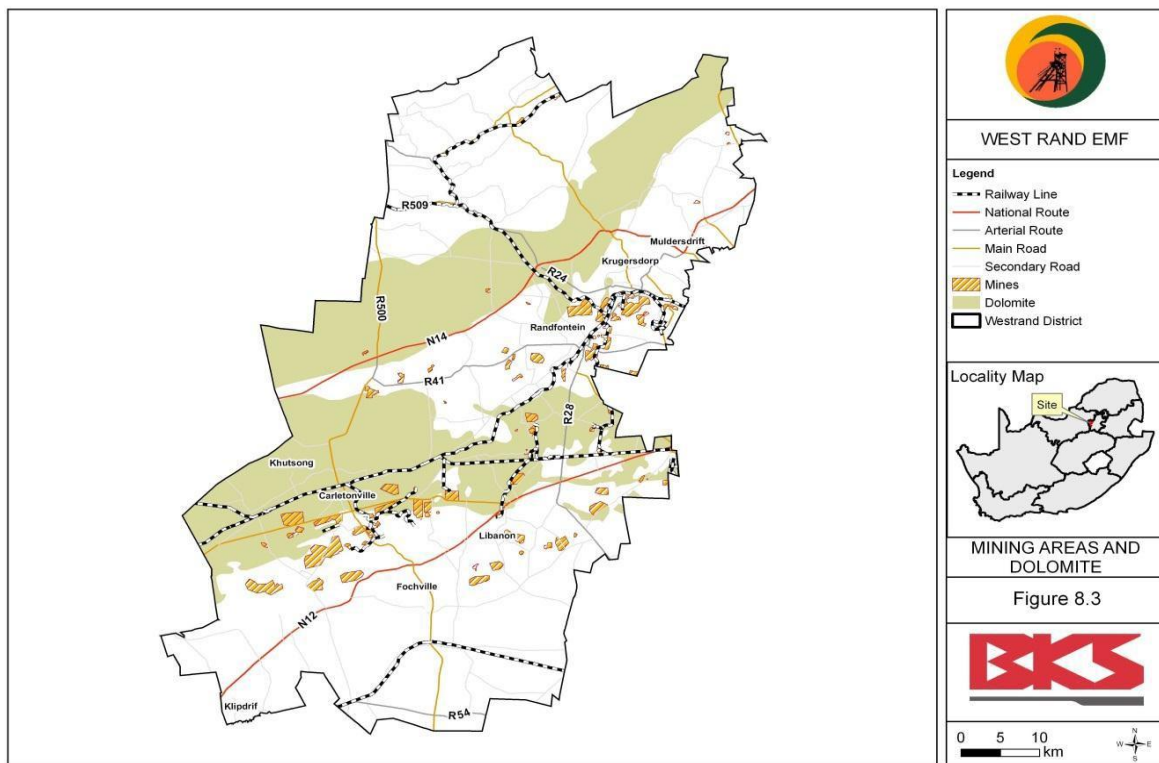


Figure 2.2: Gold Mines of the West Rand District Municipality. Source: (WRDM, 2013).

## **2.4 Research methods**

### **2.4.1. Literature review**

A methodological review of past literature is a crucial endeavor for any academic research as indicated by Webster and Watson (2002:48). An effective review of relevant literature is an essential part of any academic project, as it creates a firm foundation for advancing knowledge and closing the existing gaps in research where they exist and uncovers areas where further research is required (Webster & Watson, 2002:1). The literature review will be done on different sources of data including journals, books, the internet, reports and newspapers at local, regional and international context to identify workable and applicable sustainability criteria for a specific gold mine.

### **2.4.2. Document review**

The document review will be done to assess and determine the extent to which the sustainability criteria have been incorporated into the two working documents, namely the EMPR which was approved by the DMR in 2010 and the SLP approved by the DMR in 2007 for the term 2007-2011. These documents were selected because they have been approved by the department and were accessible during the period of study.

### **2.4.3 Assessment technique**

Sustainability evaluation will be done using a robot indicator technique. According to Mendoza and Prabhu (2000:330) indicators can be viewed as variables that can be used to measure the condition or status of the system or process. The robot indicator technique which is shown in table 2.1 below provides for three colours to be used in the assessment, namely green, orange and red. These colours can suit the three possible statuses of assessment: full incorporation; partial incorporation; and no incorporation of sustainability principles in the working documents. Justification will be provided for each robot colour indicated on each specific criterion. Where the document shows evidence of incorporation of the principles without the management measures the rating matrix scoring points will be balanced to cater for gap in the document.

The suitable criteria for gold mining industry will be developed and the relevant documentation (in this case EMPR and SLP) will be reviewed to evaluate the incorporation of sustainability principles within these documents. Furthermore, recommendations will be provided on new criteria which can be used to promote sustainability principles in the gold mining industry.




Colour code	Description of colour indicator
<b>Green</b>  Full incorporation <b>A</b>	The criteria were fully incorporated and addressed in either the SLP or EMPR management documents.
<b>Orange</b>  Partial incorporation <b>B</b>	The criteria were partially incorporated and addressed in either the SLP or EMPR management documents.
<b>Red</b>  No incorporation <b>C</b>	The criteria was not incorporated nor addressed in either the SLP or EMPR management documents.

Table 2.1: Robot indicator technique description.

## CHAPTER 3: LITERATURE REVIEW

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### 3.1 Introduction

According to Levy and Elis (2006:171) the need to uncover what is already known in the body of knowledge prior to initiating any research study should not be underestimated. Academic literature recognises the knowledge-yielding character of inquiry from the inside, and legitimises the contribution of industry practitioners to management research as said in Lacono, *et al* (2009:44). According to Webster and Watson (2002:8), a prior review of effective relevant literature is an essential feature of any academic project as it creates a firm foundation for advancing knowledge. Furthermore literature review also facilitates theory development, closes areas where a plethora of research exists, and uncovers areas where research is needed (Webster & Watson, 2002:1).

The literature review will form an essential part of this research in order to establish the various sustainability criteria that can be used to improve sustainability through the use of EMPR and SLP in the gold mining industry in South Africa. In this literature review, and for the purposes of this research, the term sustainable development will be used interchangeably with sustainability and their meaning is considered synonymous. This chapter will review related applicable literature internationally, nationally and locally to come up with the criteria that are applicable to a gold mining operation.

### 3.2 Definition of sustainability and South African background

Sustainability is currently an international issue that is driving international competition in industry (Krajnc & Glavič, 2005:190 and Schau *et al*, 2012:1). This concept has earned its popularity in the Report of the World Commission on Environment and Development: Our Common Future, also known as the Brundtland Report (Abaza, 2003; IISD, 2010:2). The Brundtland Report defined sustainability as “the development that meets the needs of current generations without compromising the ability of future generations to meet their own needs” (WCED, 1987:45). The concept has further been defined locally in South Africa by the National Environmental Management Act section 1 (NEMA, 1998:10) as “the integration of social, economic and environmental factors into planning, implementation and decision making in order to ensure that development serves present and future generations”.

The South African government realised the need for environmental sustainability in 1995 when the Deputy Minister of Environmental Affairs, Major General Bantu Holomisa launched the

Consultative National Environmental Policy (CONNEP) (DEAT, 1996b:6). CONNEP was established to guide South Africa to achieve its sustainability, as follows:

- *“To accelerate environmentally and economically sustainable growth with greater equity and self-reliance.*
- *To improve the health, income and living conditions of the poor majority.*
- *To ensure equitable and sustainable use of environmental and natural resources for the benefit of present and future generations.”*

The following paragraph will elucidate on the legislation that has played a crucial role in propelling the sustainability concept into the mining industry.

### **3.3 South African Legal Framework on Sustainability**

South Africa has a sound network of environmental legislation, which is aimed at achieving sustainable development. This includes legislation that supports public participation, impact assessment and environmental management (DEA, 2013, Du Plessis and Nel, 2011). This country has set an example as a country where the impact assessment system has embraced the sustainability concept (Morrison-Saunders & Retief, 2012:1). The discussion on the legal framework will be limited to the legislation discussed below as the main, mining-relevant pieces of legislation to complement the discussion on sustainability in South Africa.

#### **3.3.1 Constitution of the Republic of South Africa**

The constitution is the supreme law of the Republic of South Africa (Constitution, 1996a:1243).

Section 24 of the 1996 Constitution stipulates that *“everyone has the right to an environment that is not harmful to their health or well-being; and the right to have the environment protected, for the benefit of the present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.”*

The State is required to respect, protect, promote and take all reasonable measures to fulfil the Bill of Rights (Constitution, 1996a:1245).

### **3.3.2 National Environmental Management Act of 1998**

The National Environmental Management Act mandates all the environmental issues (NEMA, 1998) and its principles shall apply throughout the Republic for all matters which might affect the environment (NEMA, 1998). NEMA's objective is to *“provide for co-operative, environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by organs of state; and to provide for matters connected therewith”* (NEMA, 1998).

It further aligns its principles to deliver this definition through the following (amongst others):

- a) Placing people and their needs first, promoting socio-economic and environmental sustainable development, promoting integrated environmental justice, equitable access to resources, responsibility in environmental health and safety.
- b) Enabling public participation, awareness, transparency in decision making, prevent and reduce socio-economic and environmental impacts. Enshrining the polluter pays principle and recognising the role of women and youth participation (NEMA, 1998:1).

### **3.3.3 Minerals and Petroleum Resources Development Act of 2000**

In South Africa Environmental Impact Assessment is provided for under the National Environmental Management Act (NEMA), except for the mining sector which is mandated by the Minerals and Petroleum Resources Development Act (MPRDA) of 2000, through the EMPR and SLPs. The MPRDA's main objective is to make provision for equitable access to and sustainable development of the nation's mineral and petroleum resources (MPRDA, 2000:1). This will be delivered through beneficiation of the previously disadvantaged, promoting socio-economic growth and employment. The objectives clearly indicate that the Act's key issue is to balance the mining industry's ability to create wealth from the mineral resources with the environmental and social needs of society (Cawood, 2004:58). The MPRDA requires all operations classified as mines to conduct an environmental impact assessment and submit the EMPR to the state (MPRDA, 2000:26). It is the responsibility of the mineral rights holder to ensure that the submission is made and that they comply with the SLP (MPRDA, 2000:18).

### **3.3.4 Mine Health and Safety Act of 1996**

The Mine Health and Safety Act (MHSA), Act No. 29 of 1996, which regulates the health and safety within the mining industry, is administered, implemented and enforced by the

Department of Mineral Resources (DMR). It elucidates the following objectives which must be complied with by all guided by this Act.

“To provide for protection of the health and safety of employees and other persons at mines and, for that purpose-

- to promote a culture of health and safety;
- to provide for the enforcement of health and safety measures;
- to provide for appropriate systems of employee, employer and State participation in health and safety matters;
- to establish representative tripartite institutions to review legislation, promote health and enhance properly targeted research;
- to provide for effective monitoring systems and inspections, investigations and inquiries to improve health and safety.”

The Act also:

- stipulates that investigations and inquiries be conducted to improve health and safety, promote training and human resources development, to regulate employers' and employees' duties to identify hazards and eliminate, control and minimise the risk to health and safety; and
- entrenches the right to refuse to work in dangerous conditions and gives effect to the public international law obligations of the Republic relating to mining health and safety and provides for matters connected therewith” (MHSA, 1996c:1).

### **3.3.5 Sustainable Development through Mining Programme and National Framework for Sustainable Development**

The Sustainable Development through Mining Programme (SDM) is a cornerstone initiative launched by the Department of Mineral and Energy (DME) in 2004. The definitive goal of the SDM Programme is that by 2010 the South African Mining Industry contributes optimally to Sustainable Development (DME, 2007:2). According to the National Framework for Sustainable Development (NFSD), South Africa aspires to be a sustainable, economically prosperous and self-reliant nation state that safeguards its democracy by meeting the fundamental human needs of its people, by managing its limited ecological resources responsibly for current and future generations, and by advancing efficient and effective integrated planning and governance through national, regional and global collaboration.

### 3.4. Factors hindering and promoting sustainability in mining

Mining is strenuous (see Figure 3.1 of a miner mining gold underground) and bears positive and negative impacts, which can affect the achievement of sustainability (Ranchod, 2001:21). This section attempts to identify all mine-prone activities which can hinder or promote sustainability in the mining industry in South Africa. This industry is one of the country's few world-class industries with the capacity to continue to generate wealth and employment opportunities on a large scale in South Africa (IBP, 2007:88). However it also brings some negative social and environmental impacts in society (Ramontja *et al.* 2011:389).



Figure 3.1. Employee drilling in an underground gold mine. Source: (CM, 2013).

#### 3.4.1 Positive factors promoting sustainability in mining

##### 3.4.1.1 Provision of gold resources material and Gross Domestic Product (GDP)

The South African gold mining industry is by far the largest participant in the South African gold business based on investment, employment and its contribution to the local economy (Malherbe, 2000:1). This industry is considered the largest gold producer on the African continent and provides for resources that contribute to the economy (Gajigo *et al.*, 2012:2). Mining houses also pay profit-based royalties to government, which is defined as a rate assessed on the profit of the mine (Gajigo *et al.*, 2012:17). These royalties are used for the purpose of economic development within the country (MPRDA,2000:62).

##### 3.4.1.2 Employment provision

Unemployment is a major concern in South Africa (Harington,2004:68) and labour has received considerable scrutiny recently, partly as a result of the stubbornly high levels of unemployment, poverty and inequality (Kerr *et al.*, 2013:1 and Triegaardt, 2008:480). One of the main objectives of the DMR is to ensure that there is promotion of employment and advancement in social and

economic welfare within the country (DMR, 2010:5). Mining industries provide for a significant number of jobs comprising migrant labour from all around Africa (Harington *et al*: 2004:65). Indirect jobs are also provided in mining, an example is a case of three mining houses in the WRDM who have initiated a waste recycling center where eight permanent jobs have been created and additional casual jobs exist (AngloGoldAshanti, 2013:58).

#### **3.4.1.3 Local economic development and infrastructure provision**

According to Nel (2001:1003) local economic development (LED) has become a widely practiced strategy in most of the countries at both local government and community levels. Mining houses are obliged to implement LED projects as per legislation and as per the SLP guidelines (DMR, 2010:26). The AngloGold Ashanti Mining Company provided a community park, library, and laboratory and established the township Wedela to service the local communities in WRDM in 2013 and 2014, providing future investments into the communities (AngloGold Ashanti, 2013:61). In another case Harmony Gold Mine has established a waste recycling facility in collaboration with other three mining houses and this has significantly reduced the impacts of irresponsible waste management and has developed community skills in recycling of waste (Harmony, 2013:6). Mining plays a major role in improving infrastructure like transportation, as resource extraction needs materials and final commodities need further transportation to their final processing plants and to the market (CM, 2000:24).

#### **3.4.2 Negative mining impacts**

According to Mathee and Wright (2014:114). South Africa is amongst the most unequal societies in the world where lack of employment opportunities, unhealthy quality of living environment, high levels of exposure to environmental hazards and compromised health status amongst the poor are vastly different from the conditions enjoyed by the wealthiest in the country. Mining impacts have left significant legacies and have received high public scrutiny as a major risk (Ramontja *et al*, 2011:389). This section will elucidate the negative legacy emanating from mining activities which will be used to identify criteria elements which affect mining sustainability to complement this research.

*“The business of gold mining is not an easy one. There are many risks: economic, environmental, and social which impact on us and our people. We have many different stakeholders, who may at different times, have divergent interests, and who have sacrificed and earned the right to be viewed as main players in the story of our success.”(SLP: undisclosed).*

### 3.4.2.1. Environmental impacts

Due to its extractive nature, mining can lead to a range of impacts on the environment such as resource depletion; biodiversity and land degradation; and water and air quality deterioration (DME, 2007:22 and ICMM, 2012:5). Extensive mining waste dumps result in ground water pollution and air pollution when dumps are poorly maintained, refer to Figure 3.5 (Myers & Spoolman, 2014:187; Clarke *et al*, 2002:109). The mining impacts also lead to extensive water quality impacts causing Acid Mine Drainage (AMD) (Boocock, 2002; Ramontja, 2011:392).

#### 3.4.2.1.1. Acid Mine Drainage and water resources

The Witwatersrand region located in the Gauteng West Rand District is famous for its gold production (Naicker, 2003:29). Acid Mine Drainage (AMD) is associated with the mining, milling and processing of ore and usually occurs in abandoned mines (Johnson *et al*.2002:249). AMD occurs when the mineral pyrite comes into contact with oxygenated water producing sulphuric acid, ferrous sulphate and ferric hydroxide (McCarthy, 2011:1 and Johnson *et al*, 2002:249). It is widely accepted that AMD is responsible for the most costly environmental and socio-economic impacts which must be incurred by the present generation (DEAT, 2008:3, McCarthy, 2011:7). AMD has impacted sensitive ecosystems and still poses potential pollution challenges in several areas (Usher & Vermeulen, 2006, Adler *et al*/2007 and Abiye *et al*, 2011). Mine pollution through AMD is threatening the remarkable resource of the Cradle of Humankind Archaeological and Palaeontological Heritage Site located in the West Rand District, Gauteng Province (Strydom & King, 2009:529). Refer to Figure 3.2 below showing evidence of AMD. Durand *et al* (2010:73) indicate that this environmental degradation will have a major ecosystem and heritage impact not only in South Africa, but the world, as well as the tourism, hospitality and education sectors of South Africa. In terms of NEMA (1998), all operations are required to demonstrate that they have put all reasonable measures to prevent pollution.



Figure 3.2 Acid Mine Drainage Water in the West Rand. Source: (FSE, 2013).

Turton et al, (2007) and Llemobade et al, (2009) indicated that South Africa's water resource is increasingly becoming limited and its scarcity have shown to be affecting most of its provinces, towns and industries including the gold mines. Gold Mining industry over centuries have impacted on the usage, availability and quality of both surface and ground water resources (Winde, 2013). The main factors affecting water usage being activities like drilling, cooling, ventilation, plant processing, washing activities and other internal activities (Biffi and Stanton, 2008) and Adler 2007). The cooperative governance, cooperation within the gold mining industry and alignment of regional strategy will surely limit the impacts and ensure sustainability of the water resource in the future as highlighted in Pulles, et al, (2005), Adler 2007 and de Villiers 2010.

#### **3.4.2.1.2. Waste**

All mining operations generate waste such as hydrocarbons, medical waste, construction waste, metal waste and general waste which is associated with management challenges due to sheer volume, chemical composition and long-term impacts (MMSD, 2012:5). Mining waste includes both general and hazardous waste. The use of asbestos in the construction and roofing of some buildings and heaters have left most operations with challenges which might badly affect occupants (Nelson, 2013:89). Cyanide is considered a waste of concern in the gold mining industry, due to its severe destructive environmental and health impacts which have led to the initiation of the International Cyanide Management Code to ensure cyanide and cyanide-contaminated waste are managed properly (Akcil & Mudder, 2003:445).

#### **3.4.2.1.3 Mine closure and rehabilitation**

Mining is a non-renewable resource and at the end of each mining period, the mine closes (Usher & Vermeulen, 2006:301). According to Swart (2003:489), mining closure leaves severe negative legacies that relate to social, health and environmental impacts of the communities around the mining areas mostly if the areas are not well rehabilitated. This is mostly be influenced by inadequate mine closure rehabilitation plans and lack of financial provision to address all negative impacts which emanated from mining (Pulles *et al*, 2005:1). Common impacts associated with mine closure are AMD; air pollution; silicosis and TB-related diseases; and unemployment, as indicated in (Stacey *et al*, 2010:381). The legacy that is left behind affects the community and environment. Ongoing rehabilitation, monitoring, and maintenance after closure are necessary to make sure that stability is maintained (Van Zyl, 2006:306). For a mining operation to contribute positively to the society and environment, closure objectives and impacts must be considered during project inception (Van Zyl, 2006:307).

#### **3.4.2.1.4 Energy, Greenhouse gases emission and climate change**

South Africa is highly dependent on fossil fuel energy and is highly vulnerable to the greenhouse gas associated impacts of climate change and global warming (Cohen & Winkler, 2014:1 and GDARD, 2011:53). Gold mines require extensive energy for drilling, mining, ventilation, cooling, material and transportation of people and other activities have resulted in significant air quality impact, climate change and emission of greenhouse gases (Chavalala and Nhamo,2014:52). Furthermore massive refrigeration for underground cooling and this in many cases is done using chlorofluorocarbons (CFCs)-containing refrigerants which are considered a significant contributor to greenhouse gases (Clarke, *et al* 2002:66 and Prasad, 2007:20). Veld fires and controlled burning, together with the use of explosives during blasting, release some traces of carbon monoxide, sulphur dioxide, methane and carbon dioxide (GDARD, 2011:52). Due to these challenges this country remains at high risk of suffering the effects of climate change and global warming (MDG, 2006:11).

#### **3.4.2.1.5 Establishment of alien invasive species**

South Africa has a long history of invasive alien species problems (Richardson & Wilgen, 2004:45).The tremendous growth of the mining industry has adversely affected the functioning of the natural environment by allowing the establishment of invader species like pampas grass, black wattle, and blue gums (Van der Walt *et al*, 2012:103). These species impact the establishment of indigenous species, habitat quality, and surface water runoff, increase flooding, groundwater recharge, livestock production and biodiversity, as well as fire (GDARD, 2011:82; Van Wilgen, 2008:336, Chamier *et al*, 2012:345). Furthermore this affects the quantity and quality of water within the ecosystem (Eviner, *et al*, 2012, Clarke *et al*, 2002:286). The country initiated a Working for Water Program to cut and kill all alien species to reduce the impacts associated with alien establishment challenges and improve ecosystem services (Wilgen *et al*, 1998:1, Clarke *et al*, 2002:280).

#### **3.4.2.1.6 Radioactivity and uranium**

Radioactivity is mostly associated with the gold mining industry due to uranium which is contained in the ore (Ramontja *et al*, 2011:390). These impacts have led to several significant environmental impacts like water contamination and fatalities of aquatic animal species and health impacts like cancer within the society (Adler *et al*: 2007:38). Leaching of uranium contained ore from tailings and decant water in the West Rand area of Gauteng have increased the levels of uranium and radioactivity in surrounding water resources (Winde, 2010:247).Radioactivity pollution in the town of Carletonville in the West Rand area has affected the Wonderfontein stream and associated water users around the concerned area (Usher and Vermulen, 2006:305).

### **3.4.2.2 Health, safety and fatalities impacts**

The South African mining industry contributes to mortality levels as its miners are subject to significant risks and threats to their health, safety and environment. Threats may include explosions, falling ground, seismicity, air pollution, and fire and hence increased risk of mortality (Felix *et al*, 1993:269, Reimer & Durrheim, 2011; SAPA, 2012; Nelson, 2013:89; Myers & Spoolman, 2014:187). Some examples of mining impacts are illustrated (in Figures 3.3-3.5) below showing evidence of air pollution and sink hole incident in the West Rand District of Gauteng Province. Poor ventilation in underground operations have led miners being exposed to harmful gases, dust, toxins, and heat which have in most cases led to silicosis, cancer, Tuberculosis (TB), heat stroke and some fatalities due to explosion and seismicity (Bambas-Noleen, 2013:3; Nelson, 2013:89).

Major contributing factors to disease in the mining environment are immigration and single-sex compounds which increase high-risk sexual behavior, and hence excessive Human Immune Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS) rates (DME, 2007:22; McCulloch, 2013 & Frankel, 2013:73). According to the MHSA the employer must ensure promotion of health and safety to employees (MHSA, 1996c:1). Cases of silicosis in the gold mines always extends after employees have left the mines due to the long latency of diseases after dust exposure (Nelson, 2013:90). In 2004 ten former Free State gold miners and their families, who contracted silicosis and phthisis launched a case against Anglo American Mining in the Johannesburg High Court (Meeran, 2005:206). Furthermore in August 1964 two houses disappeared down a sinkhole at Blyvooruitzcht. The occupants of one of the houses, the Oosthuizen family of four, perished (Louw, 2014) and in December 1962 a huge sinkhole swallowed the Driefontein crusher plant, killing 27 workers. In another incident it was reported that five miners died at Gold Fields' Driefontein mine in Carletonville on the West Rand after a fire broke out on Saturday night of 30<sup>th</sup> June 2012 (SAPA, 2012).

The epidemic of HIV/AIDS must surely be the greatest health challenge facing South Africa (Williams *et al*: 2002:15). The risk of contracting TB is two to five times higher if you have silicosis and are living with HIV (TAC, 2011). These diseases are bound up with the living and working conditions of miners, such as migrant labour, single sex hostels, undiagnosed and active TB, closed ventilation systems in underground mines, and dense living arrangements (Williams *et al*, 2000; Hermanus, 2007:535). In the broader context of sustainable development, healthy and safe working conditions are among the first expectations for sustainability, i.e. the expectation that risks in mining will not deprive workers of their livelihoods or of their quality of life (Hermanus, 2007:531). Life threatening diseases have contributed to major economic and social impact by leaving a legacy of orphanages, loss of income and

employment (UNDP, 2003:7). For example, over 100 000 children became AIDS orphans in South Africa in 1998 alone (Bollinger & Stover, 1999:4). The cost of HIV/AIDS, tuberculosis and malaria can be significant for a mining and metals company (ICMM, 2008:2). However the mining industry should take responsibility for improving living and working conditions, reducing this group's risk of contracting TB and supporting better access to health care, ensuring all miners have access to decent, lifelong health surveillance and health care (TAC, 2011).



Figure 3.3 House cracks resulting from vibrations in mining in the West Rand District Gauteng. Source: (Herald, 2011).



Figure 3.4 Sinkhole formations around mining around West Rand District Gauteng. Source: (Louw, 2011).



Figure 3.5 Excessive dust emissions from the tailings dam in West Rand District Gauteng.  
Source: (Self-taken, August 2014)

### **3.4.2.3 Social issues**

“We stand on a very precarious precipice at the moment. If we do not address the disparities between the haves and the have-nots in this country, we must prepare ourselves for violence and for further disruptions to our society”, (Njanji, 2014). Societies around the mining environments have been threatened by environmental exploitation bringing ongoing poverty, inequality, informal settlements and poor sanitation, poor infrastructure and water pollution just to mention a few (Mathee, 2011:37, NFSD, 2008).

#### **3.4.2.3.1 Drugs and alcohol abuse**

Drug use in South Africa is a major public health problem (Mertens, *et al.*2014:430) and is of great concern amongst women because it places women at high risk for adverse health outcomes like gender based violence; exchange of sex for drugs or money; and HIV infection (Dunne, *et al.*2014:288) which is further elevated by the prevalent trade of sex for money, drugs etc. HIV transmission rates have escalated exponentially (Shisana *et al.*: 2014:2). Drugs and alcohol abuse is also prominent in the mining communities, Frankel (2013:14) noted that some off-shift mine workers at Rustenburg Platinum Mines in Marikana township were found using marijuana as an antidote to relieve stress or depression. The South African miner’s lifestyle of staying apart their families for an extended duration encourages unhealthy alcohol consumption (Pick, *et al.*, 2003:58), which results in unhealthy lifestyles and diseases. In some instances polluted and non-potable water was leading people to quench their thirst with cheap home brewed beer (Frankel, 2013). Alcohol tests are conducted using breathalysers at the main entrances randomly in compliance with Section 4.7.1 of the MPRDA of 2002. However the workers are not tested for drugs. For this reason some employees use drugs at work.

Mining has impacted on the health and safety of mining communities for many decades (Cronje *et al*, 2013:2) and this legacy will still continue for decades to come.

#### **3.4.2.3.2 Society xenophobia and migration**

Mining belts generate massive employment and hence tend to attract labour from afar, resulting in haphazard settlements in mining towns or areas adjacent thereto (DME, 2007:22). Mining projects can bring along negative social impacts like disruption of traditional culture, migration of population to project location and can also create land conflicts (Boocock, 2002:7 and Williams *et al*, 2002:10). Most of the new projects pave the way for prospects which lead to an increase in population migration between provinces and countries and depletion of resources and services, coupled with competition with migrants for welfare services (Mdlongwa and Moyo, 2014:90). In Marikana township, located in the platinum belt of North West province, South Africa, traditional leaders agreed with the mines not to hire employees from a radius of more than 50km. However more than 40% of workers are from elsewhere (Frankel, 2013:14). People from other areas were hired resulting in increased intolerance amongst the citizens and leading to xenophobia (Mususa & Nyamnjoh, 2010 and Msabah, 2012). South Africa has been hit with repetitive xenophobic cases (Mdlongwa & Moyo, 2014:88), for example: in late 2011 and 2012 some 300 migrants were reportedly killed, several cases around Johannesburg, Alexander and Rustenburg/Marikana (Kupe *et al*, 2008 and Crush *et al*, 2013:12). South Africans furthermore made international headlines by embarking on violence against African migrants (Steenkamp, 2009:443). It was in some cases argued that the Somalis, Mozambicans and new comers are taking the opportunities and resources which are meant for the South Africans (Abdi, 2010).

#### **3.4.2.3.3 Strikes and protests**

The mining industry is fuelled with strikes, riots and protests (see Figure 3.6 below) which are conducted in the name of either demand for better wages, or better housing conditions (Jamasmie, 2012; McCulloch, 2013, Frankel, 2013). This in some instances leads to fatalities. In 2012 alone there were 60 fatalities and 150 injuries resulting from strike action in Marikana.



Figure 3.6 Miners protesting. Source: (Whittles, 2012).

#### **3.4.2.3.4 Illegal mining**

Illegal miners present a major risk to themselves and to the health and safety of the employees of legal mining operations. This unregulated mining has resulted in many deaths, attributable to falls of ground, exposure to emissions of noxious carbon monoxide and methane, fire, and attacks from rival gangs of illegal miners who are commonly referred to as Zama-Zama miners (Nhlengetwa & Hein, 2014). These operations are usually fueled by poverty, unemployment and large numbers of illegal immigrants. About 70% of all arrested illegal miners are illegal immigrants (CM, 2014:5). In Benoni, east of Johannesburg, 200 illegal miners were trapped underground on 16 February 2014 (Neuman, 2014 and Shoemaker, 2014). About 40 miners died underground at Roodeport on 1 March 2014 (Thornton, 2014:128). Recently, in October 2014, one of the Gold Mine operation had to close for more than a week due to threats posed by illegal miners, see Figure 3-8 below (Seccombe, 2014). Thirty-three men were arrested for illegal mining at Sibanye Gold Mine on the West Rand (SAPA, 2013). Illegal mining is costing the economy and jeopardising the jobs of mine employees (Seccombe, 2014).



Figure 3.7 Illegal Miners in an old gold mine in Benoni. Source: (Gasa, 2014).



Figure 3.8 Gold Mine closed due to illegal miners. Source: (Seccombe, 2014).

#### **3.4.2.4 Basic service provision and informal settlements**

Local government in South Africa plays a significant role in providing infrastructure. It is responsible for the provision of essential infrastructure services such as water, electricity, sanitation, roads, and sewerage (Liebig *et al*, 2008:1). According to Bossel (1999:19), infrastructure is the essential backbone of all economic and social activity. Access to drinking water, proper sanitation, adequate housing, energy and effective waste removal not only diminishes health and environmental risks but also contributes in many ways to economic development (UNDP, 2003). Hence if these services are jeopardised, the country's development will also be in jeopardy. Bond (2002) indicated that it is the responsibility of the State to provide infrastructure for development. The best way for a country to get more value from mining activities is to effectively control the related infrastructure (Labrum, 2013:38) as

this is considered the key to future growth. Frankel (2013:12) indicated that what mining houses provide or don't provide for their employees and their employee's dependants affects sustainability in the mining industry.

"Human settlement is not just about building houses. It is about transforming our cities and towns, and building cohesive, sustainable and caring communities with closer access to work and social amenities, including sports and recreation facilities" (Mathee,2011:39).

Most mining areas are associated with sprawling informal settlements where shacks are established due to lack of adequate housing see Figure 3-9 below of Khutsong township shacks. Amongst others the Nkaneng informal settlements of Marikana town in Rustenburg where people are obliged to stay in harsh conditions, contributed to the massacre for more than 30 people on 16 August 2012 in the North West province of South Africa (Frankel, 2013).



Figure 3.9 Shacks in Khutsong township around the West Rand District Mining area. Source: (Herald: 2014).



Figure 3.10 Shacks at Kokosi township in the West Rand District, Gauteng. Source: (Herald, 2014).

### 3.5 Sustainability Assessment Criteria

The term sustainability assessment was defined by Varey (2004:8) as a fundamental process of defining and applying sustainability. The key challenge with the assessment for sustainability

is to define appropriate sustainability criteria in the first place, as identified in (Pope, *et al.* 2005:299). Hacking and Guthrie (2006:342) described the criteria as the benchmark, rules of the game or levels of accepted practice which is established to evaluate the significance of impacts and to guide decision making.

There are several models which have been applied into sustainability assessment dating back in history (Pope *et al.*, 2005:293). The NFSD supports a systems approach to sustainability expressed as 'nested eggs' whereby economy is considered as a subset of socio-political systems, which in turn are dependent upon the integrity of ecosystem services and the integration of these three dimensions of sustainability is achieved through governance (NFSD, 2008). The "three-pillar" or Triple Bottom Line (TBL) model focuses on the environmental performance, social responsibility and economic contribution (Krajnc & Glavič, 2005:191) and this can lead to sustainable development objectives being set in separate biophysical, social and economic categories. Hence this model is criticised for being divisive and reductionist (Gibson *et al.* 2005:94; Pope *et al.* 2004:610). Some researchers advocate for two pillar sustainability assessment criteria which are ecological and socio-economic; others focus on three pillars which are ecological, social and economic; whilst others focus on five pillars which are ecological, social, economic, cultural and political (Gibson, 2001:10). The NEMA approach to sustainable development includes integration of social, economic and environmental factors into planning, implementation and decision making (NEMA, 1998:11). Gaudreau and Gibson reinvented the wheel by designing essential overall requirements/criteria for progress towards sustainability (Gibson, 2006a:4). The Gibson and Gaudreau model will be adopted in this study as motivated in the paragraph below.

### **3.6 Gibson Sustainability Criteria review**

It was noted in Kidd and Retief (1999) and Burger (2004) that the application of environmental assessment contributing to consideration of environmental aspects dates back in the 1970s where it was still undertaken as a voluntary process. Environmental assessments currently help us in assessing sustainability measures (Murombo, 2008:2). The Gibson Sustainability Assessment Criteria will be adopted as documented in Gibson *et al.* (2005). These criteria take an integrated approach that specifically avoids a breakdown of a triple bottom line on environmental and socio-economic categories like other approaches do (Morrison-Saunders & Retief, 2012:35). This study will adopt eight generic sustainability criteria as they present coverage of key requirements for progressing towards sustainability and they emphasise the interrelations of key elements for mutual gain (Gaudreau & Gibson, 2010). Furthermore these generic sustainability assessment criteria provide a base for assessment anywhere, on any scale and they have been used in several projects successfully (Gibson, 2006a and Gibson,

2011). The Gibson Sustainability Assessment Criteria will be abbreviated and referred to as the GSAC for simplicity in this study. The following eight GSAC will be used for the purpose of this study (Gibson *et al*, 2005):

- Criterion 1 Socio-ecological system integrity
- Criterion 2 Livelihood sufficiency and opportunity
- Criterion 3 Intragenerational equity
- Criterion 4 Intergenerational equity
- Criterion 5 Resource maintenance and efficiency
- Criterion 6 Socio-ecological civility and democratic governance
- Criterion 7 Precaution and adaptation
- Criterion 8 Immediate and long-term integration

The composition of these criteria gives sustainability assessment a broad focus spectrum to identify key issues that require attention, realities which must be respected and shared objectives which must be pursued (Gibson & Gaudreau: 2005). Some researchers promote the use of these criteria for universal application in the assessment of many undertakings (Pope *et al*, 2004; Gibson, 2006b). Gaudreau and Gibson took the eight high-level principles and created more detailed practical criteria which can be easily understood and applied for assessment. The modification and easy classification of the GSAC which are reflected in section 3.8.1 below has led to an adoption and application of these criteria internationally in different research projects and has been successful in assessing sustainability (Peti, 2012).

### **3.7 Sustainability assessment criteria for South African gold mines**

In Gaudreau and Gibson (2014:15) it's indicated that the desired end result of sustainability assessment is the achievement of net gains that are mutually reinforcing, fairly distributed and lasting, and to avoid all potentially significant adverse effects for the project or activity under concern.

This section will provide a detailed review of the Gibson Criteria using the Gaudreau and Gibson sub-criteria, which were designed for a biodiesel plant. The section reviews these criteria for their applicability to the gold mining industry. Each of the eight criteria with their respective sub-criteria will be reviewed with the assistance of the literature review in the previous sections to close any possible gaps. Qualifying criteria and sub-criteria will be adopted for this study and any criteria and sub-criteria which are not applicable to the gold mine case

will be motivated for non-applicability and be excluded during the analysis. Furthermore if any new and applicable site specific criteria and sub-criteria are identified, they will be brought into light and reviewed for assessment in the gold mine operation in South Africa to close any gap identified. The assessment on all GSAC and the new criteria and sub-criteria will then be summarised and tabulated to include the final criteria and sub-criteria applicable to a gold mine.

### **3.7.1 Gold mine criteria review**

#### **1. Criterion: Socio-ecological system integrity and resilience**

“The socio-ecological system integrity and resilience criteria aim to build human–ecological relations, establish and maintain the long-term integrity of socio-biophysical systems and furthermore protect the irreplaceable life support functions upon which human as well as ecological well-being depends” (Gaudreau & Gibson, 2010:235).

The following four sub-criteria have been adopted from (Gibson & Gaudreau 2010:238) and modified for applicability and case specific for a gold mine operation under criteria 1. All the sub-criteria will be adopted as they are applicable to this case study. The sub-criteria 1.1 will be modified to include alien and invasive species establishment as discussed in section 3.4.2.1.5 and sub-criteria 1.4 will be modified to include availability of gold resources as discussed in 3.4.1.1 above.

- 1.1 Capacity of the local ecosystem around the mine to deliver valued ecosystem services reliably into the future, effects of mining operations on water, air quality, wildlife habitat, alien and invasive species and soil (Gibson, 2010, Richardson and Wilgen, 2004:45, van der Walt *et al*, 2012:103, van Wilgen, 2008:336, Chamier *et al*, 2012:345, Eviner, *et al*, 2012, Wilgen *et al*, 1998).
- 1.2 Capacity of national and global ecosystems and socio-ecosystems to deliver valued services reliably into the future including effects that the mine operation activities will have on regional pollution levels, energy sources and transport systems.
- 1.3 Resilience of local and national socio-ecosystems on the issues relating to economic options, transportation, food, health systems, water and waste management.

- 1.4 Longer term availability of non-renewable and renewable resources such as gold (Gajigo *et al*, 2012:2).

## **2. Criterion: Livelihood sufficiency and opportunity**

“The livelihood sufficiency and opportunity criterion aims to ensure that everyone and every community has enough for a decent life and that everyone has opportunities to seek improvements in ways that do not compromise future generation’s possibilities for sufficiency and opportunity” (Gaudreau and Gibson, 2010:235).

The following five sub-criteria have been adopted from Gibson and Gaudreau (2010:238) and modified for applicability and case specific for a gold mine operation under criteria 2. All sub-criteria will be adopted as they are applicable to this case study. Sub-criteria 2.1 on employment will be modified to include current overall job provision as discussed in 3.4.1.2 and sub-criteria 2.2 on human health will be modified to include mining industry prone diseases like silicosis, drugs and alcohol consumption as discussed in 3.5.2 and 3.5.3.1 above. Sub-criterion 2.5 will be modified to include Local Economic Development (LED) and infrastructure provision (as discussed in 3.4.1.3) as gold mines lead most of these activities in their local communities as part of investment. One new sub-criterion will be added on LED and infrastructure provision as discussed in this section.

- 2.1 Opportunities for lasting employment and overall job provision from the operation and beyond (Kerr *et al*, 2013:1 and Triegaardt, 2008:480).
- 2.2 Human health impacts which include exposure to toxic substances, alcohol, drugs, mining dust and silica related diseases like Tuberculosis (TB), silicosis, Human Immune Virus (HIV) and Acquired Immune Deficiency Syndrome (AIDS), alcohol and drug abuse and sanitation provision (Williams *et al*, 2000; Hermanus 2007; DME, 2007; TAC, 2008; Nelson, 2013; Cronje, 2013; Dunne *et al*, 2014; Mertens *et al*, 2014; Harvey, 2014).
- 2.3 Availability of resources for others.
- 2.4 Learning and associated capacity building on local communities including the indirect effects on education and training by external bodies for local community and surrounding communities.

- 2.5 Potential for further investment in the area including Local Economic Development and infrastructure development (Nel, 2013; DMR, 2010; AngloGoldAshanti, 2013; Harmony, 2013 and CM, 2000).

### **3. Criterion: Intragenerational equity**

“The intragenerational equity criteria ensures that sufficient and effective choices for all are pursued in ways that reduce dangerous gaps in sufficiency and opportunity, health, security, social recognition, political influence and others between the rich and the poor” (Gaudreau and Gibson, 2010:235).

The following six sub-criteria have been adopted from (Gibson & Gaudreau, 2010:238) and modified for applicability and case specific for a gold mine operation from criteria 3. Five sub-criteria will be used as they are applicable to this case study. Sub-criteria 3.2 will be modified to include safety and fatalities of employees. Sub-criteria 3.5 will not be used as it has been deemed to be non-applicable to the mining operation because energy intensity provision to consumers is not done in this case study, hence this criteria cannot be used to measure the sustainability. An identified gap will be completed with two sub-criteria on xenophobia and migration; illegal mining; basic service provision and informal settlements and riots/strikes/protests within the mining areas as discussed in a previous section, as these factors are prone in the mining areas as discussed in section 3.4 above.

- 3.1 Unequal distribution of wealth, access to resources and its influence in community.
- 3.2 Equality of access to health, valued employment, respected knowledge and community security, safety and fatalities of employees (Meeran, 2005; Riemer & Durrheim, 2011).
- 3.3 Gender equality within the operation.
- 3.4 Distribution of wealth, wealth influence and access to resources between advantaged and disadvantaged communities which includes effects on revenue flows, dependency effects within and around the operation.

- 3.5 Material and energy intensity of consumer and other satisfactions for the wealthy. *This criterion was deemed not applicable to the mining environment and it will not be used in the assessment.*
- 3.6 Well-being of non-human species, habitat and quality of ecosystem services and stresses.

*Additional sub-criteria to complement intragenerational challenges in the gold mines:*

- 3.7 Xenophobia and migration of communities towards the mining operations during mining and post mining (Boocock, 2002; Kupe *et al*, 2008; Steenkamp, 2009; Abdi, 2011; Crush *et al*, 2013; Frankel, 2013).
- 3.8 Illegal mining (Nhlengetwa & Hein, 2014; CM, 2014; Neuman, 2014; Schoeman, 2014; Thornton, 2014).
- 3.9 Basic service provision and informal settlement (Frankel, 2013; Harvey, 2014; Liebig *et al*, 2008; Bond, 2002; Frankel, 2013; Labrum, 2013; Mathee, 2011).
- 3.10 Riots/strikes/protests (Jamasmie, 2012; Frankel, 2013, McCulloch, 2013; Harvey, 2014).

#### **4. Criterion: Intergenerational equity**

The intergenerational equity criteria ensure that all favours which present options and actions that are most likely to preserve or enhance the opportunities and capabilities of future generations to live sustainably are employed (Gaudreau & Gibson, 2010:235).

The following three sub-criteria have been adopted from Gibson and Gaudreau (2010:238) and modified for applicability and case specific for a gold mine operation from criterion 4. Two sub-criteria will be adopted in this study as the third one is not applicable to the case study. Criterion 4.3 will be modified to include legacy costs associated with climate change, waste, acid mine drainage, radioactivity and uranium; and rehabilitation impacts as discussed in section 3.4.2.1.1.2- 3.4.2.1.1.4 and 3.5.1.6.

- 4.1 Potential costs and benefits for future generations.
- 4.2 Transition towards a future energy supply.

*The above criteria did not reflect the conditions of a gold mine as the mine is not responsible for supplying energy to any part or surrounding communities and will not be assessed for the purpose of this research.*

- 4.3 Legacy costs and costs associated with climate change, waste, rehabilitation, acid mine drainage, radioactivity and uranium impacts (Winde, 2010; Vermulen, 2006; GDARD, 2011; Chavalala & Nhamo, 2014; Clarke, 2002 and Prasad, 2007; Van Zyl, 2006; Usher & Vermeulen, 2006; Akcil & Mudder, 2003; Strydom & King, 2009; DEAT, 2002; McCarthy, 2011 and Johnson *et al*, 2002).

## **5. Criterion: Resource maintenance and efficiency**

The resource maintenance and efficiency aim to provide for a larger base for ensuring sustainable livelihoods for all while reducing threats to the long-term integrity of socio-ecological systems by reducing extractive damage, avoiding waste and cutting overall material and energy use per unit of benefit (Gaudreau & Gibson, 2010:235).

The following seven sub-criteria have been adopted from (Gibson & Gaudreau 2010:238) and will be used in this case study.

- 5.1 Severity of damage from resource extraction compared to existing practices and to alternatives.
- 5.2 Net use of energy and energy sources including renewables and low impact sources.
- 5.3 Net use of water between ecosystem services and human consumption
- 5.4 Net use other materials and resources, and the potential hazardousness of direct and embodied pollution and other wastes.
- 5.5 Transition from non-renewable high impact energy and material to renewable and low impact sources.
- 5.6 Potential for rebound effects like savings in resource usage.

- 5.7 Potential for efficiencies that reduce desirable diversity, local suitability and redundancy.

**6. Criterion: Social–ecological civility and democratic governance**

“Build the capacity, motivation and habitual inclination of individuals, communities and other collective decision-making bodies to apply sustainability requirements through more open and better informed deliberations, greater attention to fostering reciprocal awareness and collective responsibility and more integrated use of administrative, market, customary and personal decision-making practices”, (Gaudreau and Gibson,2010:235).

The following four sub-criteria have been adopted from (Gibson & Gaudreau 2010:238) and will be used in the assessment of a case specific for a gold mine operation.

- 6.1 Social awareness of citizens and opportunities to create or strengthen social ties of mutual learning and assistance, and sensitivity to disadvantaged groups.
- 6.2 Ecological awareness of citizens about ecosystem functions and values they provide.
- 6.3 Social responsibility of market participants.
- 6.4 Capacity of participants to be actively involved in deliberations and decision making on issues which affect public.

**7. Criterion: Precaution and adaptation for resilience**

“Precaution and adaptation can be summarized as the respect uncertainty, avoid even poorly understood risks of serious or irreversible damage to the foundations for sustainability, and plan to learn, design and manage for adaptation” (Gaudreau and Gibson, 2010:235).

The following four sub-criteria have been adopted from (Gibson & Gaudreau 2010:238) and will be used in the assessment of a gold mine operation.

- 7.1 Risks of significant damage compared to existing practices and to alternatives.

- 7.2 Capacity for monitoring changes to the environment and communities around.
- 7.3 Adaptive and precautionary qualities of waste and energy systems.
- 7.4 Development of a context and culture of precaution and adaptation.

**8. Criterion: Immediate and long-term integration**

“This criterion encourages application of all sustainability principles at once, seeking mutually supportive benefits and multiple gains” (Gaudreau & Gibson, 2010:235).

The following sub-criteria have been adopted from (Gibson & Gaudreau, 2010:238) and modified for applicability and case specific for a gold mine operation. Gibson and Gaudreau identified four sub criteria under the main criteria defined above. All the sub criteria will be adopted in this study.

- 8.1 Delivery or potential for positive feedbacks and mutual reinforcement of desirable effects from the project and other current and anticipated.
- 8.2 Capacity to enhance these positive effects within the working environment and beyond.
- 8.3 Delivery or risk of negative feedbacks and mutually reinforcing effects.
- 8.4 Capacity to interrupt and reverse these negative effects.

Based on the literature review GSAC have been found to be applicable to a gold mine Operation. No new main criteria will be added to complement these criteria. However several gaps were identified under the sub-criteria included in GSAC and for this to be addressed several sub-criteria will be modified. This modification includes the elimination of other sub-criteria under main criteria and the addition of new sub-criteria under some main criteria under criterion 1, criterion 2, criterion 3 and criterion 4 as referenced above under each criterion to reflect that of a gold mine case study. For all the modified sub-criteria a justification has been provided for, as per literature references. A summary of all these will be tabulated in a simpler form in section 3.8.2 below.

### **3.7.2 Summary of gold mine criteria**

This section will tabulate a summary of each applicable sustainability assessment criteria and associated sub-criteria and provide for applicable source references. The table will be comprised of the criteria description column detailing all criteria and the reference column where all sources of new or modified criteria are provided.

Number	Criterion Description	Reference
1.	<b>Socio-ecological system integrity and resilience</b>	
1.1	EMPR or SLP indicators on the issues which may affect the capacity of the local ecosystem around the mining operation to deliver valued ecosystem services reliably into the future, and effects of mining operations on water, air quality, wildlife habitat, alien invasive species and soil	
1.1.1	Water	Gibson and Gaudreau 2010; Abiye <i>et al</i> , 2011, ICMM, 2012; Johnson <i>et al</i> , 2002; DEAT, 2002; Ramontja, 2011; Durand et al, 2010; Strydom and King, 2009 and Myers and Spoolman, 2014, Clarke <i>et al</i> , 2002, Boocock, 2002; Ramontja,2011; Johnson <i>et al</i> .2002; Strydom and King, 2009
1.1.2	Air quality	Gaudreau and Gibson 2010; Cohan and Winkler 2014; MDG 2006; DME 2007; Myers and Spoolman 2014; Clarke <i>et al</i> 2002.
1.1.3	Wildlife habitat, alien and invasive species	Gaudreau and Gibson 2010; Richardson and Wilgen, 2004:45, Van der Walt <i>et al</i> , 2012:103, Van Wilgen, 2008:336, Chamier <i>et al</i> , 2012:345, Eviner, <i>et al</i> , 2012, Wilgen <i>et al</i> , 1998
1.1.4	Soil	Gaudreau and Gibson 2010; Winde 2010

1.2	EMPR or SLP documentation on the capacity of national and global ecosystems and socio-ecosystems to deliver valued services reliably into the future including effects that the operation activities will have on regional pollution levels, energy sources and transport systems	
1.2.1	Pollution levels	Gibson and Gaudreau 2010; DME 2007
1.2.2	Energy sources	Gaudreau and Gibson:2010, Chavalala and Nhamo,2014)
1.2.3	Transport systems	Gaudreau and Gibson:2010
1.3	EMPR or SLP documentation and inclusion of aspects associated with the resilience of local and national socio-ecosystems on the issues relating to economic options, transportation, food, health systems, water and waste management	
1.3.1	Transportation	Gaudreau and Gibson:2010
1.3.2	Food	Gaudreau and Gibson:2010
1.3.3	Health and Safety	Gaudreau and Gibson:2010, Louw 2014, Felix <i>et al</i> 1990, Meeran 2005; DME 2007; Nelson 2013; MHSA 1996c; Myers and Spoolman 2014; TAC 2008; Hermanus 2007; UNDP 2003; Bollinger and Stover 1999 and ICMM 2008
1.3.4	Water and waste management	Gaudreau and Gibson:2010; Vermeulen 2006 and Eviner <i>et al</i> 2012
1.4	Longer term availability of non-renewable and renewable resource	
1.4.1	Non-renewable resources including Gold	Gibson and Gaudreau 2010; Gajigo <i>et al</i> ,2012; MPRDA,2000 and CM,2000
1.4.2	Renewables resources	Gibson and Gaudreau 2010

Number	Criterion Description	Reference
2	<b>Livelihood sufficiency and opportunity</b>	
2.1	EMPR or SLP documentation and provision on aspects relating to opportunities for lasting employment and current job	Gibson and Gaudreau 2010
2.2	Human health impacts which include exposure to toxic substances, alcohol, drugs, mining dust and silica related diseases like Tuberculosis (TB), Silicosis, Human Immune Virus (HIV) and Acquired Immune Deficiency Syndrome AIDS, Alcohol and Drug abuse and sanitation provision	
2.2.1	Diseases , Alcohol and Drug abuse	Williams <i>et al</i> ,2000; Gaudreau and Gibson, 2010; Hermanus 2007; TAC 2008; Nelson 2013; Myers and Spoolman 2014; Meran 2005; Frankel 2013; Martens <i>et al</i> 2014; Pick <i>et al</i> 2003; Cronje 2013 and Dunne <i>et al</i> 2014
2.2.2	Sanitation	Gaudreau and Gibson, 2010
2.3	Availability of resources for others	Gaudreau and Gibson, 2010
2.4	Learning and associated capacity building on local communities including the indirect effects on education and training by external bodies for local community and surrounding communities	Gaudreau and Gibson, 2010
2.5	Potential for further investment in the area including Local Economic Development and infrastructure development	Nel, 2013; DMR, 2010; AngloGoldAshanti, 2013; Harmony, 2013 and CM, 2000:24).

Number	Criterion Description	Reference
3	<b>Intragenerational Equity</b>	
3.1	Unequal distribution of wealth, access to resources and its influence in community	Gaudreau and Gibson, 2010
3.2	Equality of access to health, valued employment, respected knowledge and community security; safety and fatalities of employees	Gaudreau and Gibson, 2010; Meeran, 2005; Riemer and Durrheim, 2011
3.3	Gender equality within the operation	Gaudreau and Gibson, 2010
3.4	Distribution of wealth, wealth influence and access to resources between advantaged and disadvantaged communities which includes effects on revenue flows, dependency effects within and around the operation	Gaudreau and Gibson, 2010
3.5	Well-being of non-human species, habitat and quality of ecosystem services and stresses	Gaudreau and Gibson, 2010
<i>Additional sub criteria to complement intragenerational challenges in the mining operation</i>		
3.6	Xenophobia and migration of communities towards the mining operations during mining and post mining	Abdi, 2010; Msabah, 2012; Mdlongwa & Moyo, 2014; Boocock, 2000; Kupe <i>et al</i> , 2008; Crush <i>et al</i> , 2013; Steenkamp, 2009
3.7	Illegal mining	Nhlengetwa and Hein 2014; CM 2014; Neuman 2014; Schoeman 2014; Thornton 2014; Seccombe, 2014)
3.8	Basic service provision and informal settlement	Frankel, 2013; Harvey, 2014; Liebig <i>et al</i> , 2008; Bond, 2002; Frankel, 2013; Labrum, 2013; Mathee, 2011)
3.9	Riots/strikes/protests	Jamasmie, 2012; Frankel, 2013, McCulloch, 2013; Harvey, 2014

Number	Criterion Description	Reference
<b>4</b>	<b>Intergenerational equity</b>	
4.1	Potential costs and benefits for future generations	Gaudreau and Gibson, 2010
4.2	Legacy costs and other costs associated with climate change, waste, acid mine drainage, radioactivity and uranium; and rehabilitation impacts	Gaudreau and Gibson, 2010; (Winde, 2010; Vermulen, 2006; GDARD, 2011; Chavalala and Nhamo, 2014; Clarke, 2002 and Prasad, 2007; Van Zyl, 2006; Usher and Vermeulen, 2006; Akcil and Mudder, 2003; Strydom and King, 2009; DEAT, 2002; McCarthy, 2011 and Johnson <i>et al</i> , 2002)
Number	Criterion Description	Reference
<b>5</b>	<b>Resource maintenance and efficiency</b> Possible positive and negative impacts which the mining operation will have on the issues relating to the resource maintenance efficiency	
5.1	Severity of damage from resource extraction compared to existing practices and to alternatives.	Gaudreau and Gibson, 2010
5.2	Net use of energy and energy sources including renewables and low impact sources	Gaudreau and Gibson, 2010
5.3	Net use of water between ecosystem services and human consumption	Gaudreau and Gibson, 2010
5.4	Net use of other materials and resources, and the potential hazardousness of direct and embodied pollution and other wastes	Gaudreau and Gibson, 2010

5.5	Transition from non-renewable high impact energy and material to renewable and low impact sources	Gaudreau and Gibson, 2010
5.6	Potential for rebound effects like savings in resource usage	Gaudreau and Gibson, 2010
5.7	Potential for efficiencies that reduce desirable diversity, local suitability and redundancy	Gaudreau and Gibson, 2010
<b>Number</b>	<b>Criterion Description</b>	<b>Reference</b>
<b>6</b>	<b>Social–ecological civility and democratic governance</b>	
6.1	Social awareness of citizens and opportunities to create or strengthen social ties of mutual learning and assistance, and sensitivity to disadvantaged groups	Gaudreau and Gibson, 2010
6.2	Ecological awareness of citizens about ecosystem functions and values they provide	Gaudreau and Gibson, 2010
6.3	Social responsibility of market participants	Gaudreau and Gibson, 2010
6.4	Capacity of participants to be actively involved in deliberations and decision making on issues which affect public	Gaudreau and Gibson, 2010
<b>Number</b>	<b>Criterion Description</b>	<b>Reference</b>
<b>7</b>	<b>Precaution and adaptation for resilience</b>	
7.1	Risks of significant damage compared to existing practices and to alternatives	Gaudreau and Gibson, 2010
7.2	Capacity for monitoring changes to the environment and communities around	Gaudreau and Gibson, 2010
7.3	The adaptive and precautionary qualities of the waste and energy systems	Gaudreau and Gibson, 2010; MMSD,2012; Akcil and Mudder,2003; Nelson,2013; Cohan and Wrinkler, 2014; Chavalala and Nhamo,2014;, GDARD,2011

7.4	Development of a context and culture of precaution and adaptation	Gaudreau and Gibson, 2010
<b>Number</b>	<b>Criterion Description</b>	<b>Reference</b>
8.	<b>Immediate and long-term integration</b> Possible positive and negative impacts which the mining operation will have on the issues relating to immediate and long-term integration	
8.1	Delivery or potential for positive feedbacks and mutual reinforcement of desirable effects from the project and other current and anticipated activities and undertakings	Gaudreau and Gibson, 2010
8.2	Capacity to enhance these positive effects within the working environment and beyond	Gaudreau and Gibson, 2010
8.3	Delivery or risk of negative feedbacks and mutually reinforcing adverse effects	Gaudreau and Gibson, 2010
8.4	Capacity to interrupt and reverse these negative effects	Gaudreau and Gibson, 2010

Table 3.1: Summary of the status of Gold Mine Criteria review.

### **3.8 Literature conclusion**

From the literature reviewed above, it is evident that sustainable development or sustainability depends on elements of economic, environmental, society, governance (NEMA, 1998; Murombo, 2008). These elements are interlinked and also influence each other in achieving sustainability. The South African NFSD supports a 'nested eggs' systems approach to sustainability whereby economy is considered as a subset of socio-political systems, which in turn are dependent upon the integrity of ecosystem services (NFSD, 2008). This principle covers the Triple Bottom Line (TBL) dimensions which is taken as a crucial principle showing that ecosystem is represented by egg white and supports the yolk which includes people and economy (DEAT, 2008). Hence natural system must be preserved not to exceed the limits (Morrison-Saunders et al, 2015) to ensure that the nested egg is sustained. In Feris (2010:74) is clearly indicated that Informed decision making coupled with good governance by authorities and interaction with stakeholders by industries holds major stake into driving and achieving sustainability. Mining houses therefore must ensure that they fully outline their potential impacts, develop management measures, commit into and promote good governance towards the implementation of commitments in their SLP and EMP documents cooperatively with authorities.

The South African legal framework has furthermore enshrined the sustainability concept by making sure that the main elements of sustainability drive are included in the main pieces of legislation. Hence providing an enabling environment for the mining industry to implement and comply with sections provided for in the legislation.

It is evident that GSAC is multidisciplinary and vast, as most of the gold mining operational challenges and opportunities are covered within the spectrum of the main eight criteria. The criterion and sub-criteria elements had to be modified to establish an applicable Gold Mine Criterion, which was achieved. The establishment of a suitable criterion will assist in ensuring that all possible elements which may affect sustainability are recognised in the next chapter for the analysis of the incorporation of sustainability into the EMPR and SLP.

## CHAPTER 4: DATA ANALYSIS AND INTERPRETATION

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### 4.1 Introduction

This chapter will present the analysis of data and its interpretation from the working documents. Data analysis involve the interpretation of the research findings as one of the aspect described in Burnard (2008:431). The Sustainability Assessment Criteria were developed based on the GSAC. A review of Gibson's criteria was done to identify and complete gaps in the applicability of these criteria into a gold mine operation. It was found that eight of Gibson's criteria are applicable and only the sub-criteria were amended to suit this research case. All the sub-criteria which were not applicable have been excluded in the summary table in Chapter 3 and will not form part of this chapter. All applicable criteria will be analysed in a table format using a robot indicator technique. The green colour of the robot indicator will be represented with a green letter **A**, the orange colour of the robot indicator will be represented with an orange letter **B**, the red colour of the robot indicator technique will be represented by red letter **C**. The indicator for each sub-criterion will be justified based on the information acquired during the EMPR and SLP document review. Furthermore a document review section will be provided for referencing.

### 4.2 Assessment of the incorporation of Gold Mine Sustainability Assessment Criteria into EMPR and SLP

This section will entail a review of the case study working documents which are the EMPR and the SLP to analyse the incorporation of the GMSAC as established. The EMPR and the SLP documents will be fully reviewed against each and every sub-criterion. A robot indicator assessment technique will be used and furthermore the reference section will also be provided from which the information was extracted as indicated in Table 4.1 below. The justification for the incorporation of the selected sub-criteria will be provided based on the working document in which it is represented. Where the sub-criteria are documented in both the working documents, motivation will be provided from both documents.

#### 4.2.1. Criterion 1 – Socio-ecological system integrity and resilience

Socio-ecological system integrity and resilience		
Criterion elements	Robot Indicator	Justification
<b>1.1 Capacity of the local ecosystem around the mining operation to deliver valued ecosystem services reliably into the future, effects of mining operations and beyond mine closure on water, air quality, wildlife habitat, alien invasive species establishment and soil</b>		
1.1.1 Impacts on surface and ground water	<b>A</b>	<p>EMPR: Identified activities which can impact surface and ground water resources during commissioning, operation and closure of mine due to tailings and waste rock dumps, use of chemicals, and mine water Chapter 4, sections 4.4.2.1.8 and 4.4.2.1.9 page 127, sections 4.4.2.2.8, 4.4.2.2.9, 4.4.3.1.8 and 4.4.3.1.9 page 131, sections 4.4.3.2.8 and 4.4.3.2.9 page 136. Water management objectives on pollution prevention are documented in Chapter 4 section 4.5.1.8, 4.5.2.9 page 138 and sections 4.5.2.8 and 4.5.2.9 page 141 including proper chemical storage and use, maintenance of trenches and sumps. A monthly water monitoring programme has been stated in Chapter 5 section 4.14.3.4.1 page 275, which also includes licence compliance, monitoring, maintenance, inspections and geohydrology studies.</p> <p>SLP: Nothing was documented, since the SLP relates to social impacts only.</p> <p>Adequate information was provided</p>
1.1.2 Impacts on air quality	<b>A</b>	<p>EMPR: Potential air quality impacts have been identified from associated mining activities like tailings and waste rock dumps, gravel roads etc. and measures to address them are suggested in Chapter 4 sections 4.4.2.10 page 128; 4.4.2.2.10 page 131, and 4.4.3., 4.4.3.2 on page 134 and 136. Section 4.5 describes methods to be used to prevent and reduce dust pollution through watering and protective clothing for employees. Chapter 5 Table 44 measures the risk assessment on ambient air quality, risk assessment of radiation, review of public radiation protection programme, re-vegetation /rehabilitation and dust fall-out monitoring.</p>

		SLP: Nothing was documented, since the SLP relates to social impacts only. Adequate information was provided on air.
1.1.3 Impacts on wildlife habitat/biodiversity, alien and invasive species	A	EMPR: Potential biodiversity impacts have been identified on disturbance of the environment during construction in Chapter 4 sections 4.4.2.1.6 and 2.1.7 and 4.4.3.1.6 and 3.1.7. Management measures to conserve biodiversity and prevent and control alien and invasive species appear in section 2.6.4 page 59, section 4.6.5.4. page 241, preventing hunting, re-vegetate disturbed area and maintain biodiversity outlined in Chapter 4 section 4.5 page 138 and 4.6 page 143. Post closure objectives and monitoring measures are outlined in section 4.8 page 250 up to 4.14 page 265 to ensure proper rehabilitation and maintenance of ecosystems. This includes biodiversity management plans for conserving and protecting biodiversity, an alien and invader eradication programme, guidelines for pesticide and herbicide use control, a proper fire management plan and a flora and fauna study. SLP: Nothing was documented, since the SLP relates to social impacts only. Inadequate limited information was provided on animals.
1.1.4 Impacts on land or soil	B	EMPR: Potential impacts on land and soil have been identified and measures to address them recommended in section 4.4, 4.8 and 4.7. Sufficient measures to protect and manage soil impacts during operation and after closure include maintenance of vegetation to avoid erosion and prevention of spillages of chemicals into the soil as per section 4.8.2.2.3 page 251. The measures included in the documents do not provide for cumulative or future land use impacts. SLP: Nothing was documented, since the SLP relates to social impacts only. Inadequate information was provided on soil/land pollution.
<b>1.2 Capacity of national and global ecosystems and socio-ecosystems to deliver valued services reliably into the future including effects that the mine operation and mine closure activities will have on regional pollution levels, energy sources and transport systems.</b>		
1.2.1 Pollution levels	A	EMPR: Surface and ground water impacts and management measures have been identified in Chapter 4 section 4.5.1.9 page 139, minimising impact of decant water as it can have regional impact, vegetating tailings and rehabilitation of affected areas to avoid further contamination and increase of footprint. Chapter 4 sections 4.8.2.1.8

		<p>and 4.8.2.1.9 page 251 make provision for ensuring that monitoring requirements meet the required standards and that all affected water is contained within the operation.</p> <p>EMPR: Potential air quality impacts have been identified in Chapter 4 section 4.5.1.10 page 139 with measures to water down and re-vegetate/rehabilitated areas which generate dust, provide protective respirators to prevent dust impacts on employees. Section 4.8.2.1.10, provides for continuous monitoring of dust fall out levels.</p> <p>EMPR: Potential impacts on land and soil identified and management measures recommended in Chapter 4 sections 4.4 to 4.8.2.2.3 page 251 cover mining open areas with sufficient soil to prevent erosion and maintain the land for future use, cleanup and proper disposal of hazardous waste to prevent soil and water contamination downstream. Nothing was noted on the future energy supply in both the EMPR and the SLP. Adequate information was provided on water, air and soil/land pollution.</p>
1.2.2 Energy sources	<b>B</b>	<p>Mine uses electricity supplied by Eskom</p> <p>EMPR: Chapter 4 section 4.10.3 energy saving and renewable energy use is recommended. Chapter 3 section 3.1.2.12 page 94 noted that all radiation cleared wood is provided to communities for energy supply needs.</p> <p>SLP: In section 3.5.3 page 98 and section 3.7.11 page 120 it is noted that the mine can potentially provide for energy resources through the support of local municipality's Industrial Development Programme and related energy requirements.</p> <p>Nothing was noted on the future energy supply in either the EMPR or the SLP.</p> <p>Renewable energy source are not adequately provided for within the EMPR or the SLP.</p>
1.2.3 Transport system	<b>B</b>	<p>EMPR: Chapter 2 section 2.15.2.1 states that a transport system is provided by the local municipality association and the mine operation is interlinked with National Roads N12 and N14; section 3.1.12.1.2 page 106 states that mine buses are used to transport employees.</p> <p>SLP: Section 3.5.3 page 98 ensures employees are closer to work and have access to transport. In section 3.7.2 page 106, it is stated that all the mine villages and hostels are located closer to work and the main roads.</p>

		Limited information is provided on the maintenance of the road infrastructure and their existence after mine closure.
<b>1.3 Resilience of local and national socio-ecosystems on the issues relating to economic options on transportation, food, health systems, water and waste management.</b>		
1.3.1 Transport	<b>B</b>	EMPR: Chapter 3 section 3.1.12.1.2 page 106 covers mine buses that are used to transport employees. Mine support provision of transport infrastructure by municipality is covered as part of economic development. SLP: Section 3.7.2 page 106 ensures employees are closer to work and have access to transport. The information provided is limited as no future plans on transport systems are mentioned in either the SLP or the EMPR.
1.3.2 Food	<b>B</b>	SLP: Section 3.17.1 page 148 provides a nutritional plan for low income earners and covers quality checks on food provided in section 3.17.14 page 149. Nothing is mentioned on food provision for other employees and for low earners into the future in either the EMPR of the SLP.
1.3.3 Health and safety systems	<b>B</b>	EMPR: In Chapter 3 section 3.1.12 page 105 air quality health impacts are identified and the provision of primary health care is covered; section 3.2.1 page 109 documents that environmental health and safety awareness programmes will be offered. Chapter 4.5.1.10; section 4.4.3.1.14 page 134 notes that health services will be affected after mine closure. SLP: Availability of health hubs which are available for employees are documented in section 2.7.1 page 103, in section 3.20.1 page 158 measures addressing HIV/AIDS service provision, interventions on health talks and motivations at local clinics are documented; and furthermore section 2.15 page 47 provides details of safety gears to ensure safety of employees. No provision made for after mine closure.
1.3.4 Water management	<b>B</b>	EMPR: The operation uses water supplied by the local municipality as documented in Chapter 3 section 3.3.5. In the SLP mention is made of local boreholes that might be affected on the yield and pollution plume affecting the water

		<p>quality of nearby boreholes and water supply of boreholes. Section 4.4.2.1.9 page 127 and section 4.6.4 page 223 in the EMPR show facilities used for water management.</p> <p>No future arrangements documented for mine village water supply in case the area will be declared a township.</p>
1.3.5 Waste management	A	<p>EMPR section 3.1.2 page 94 and section 4.6 144-222 state that general wastes are collected in bins and disposed at Deelkraal landfill site, while hazardous waste is disposed of through an accredited waste disposer. Mine village and hostel general waste is disposed of at the local municipality landfill site. Section 4.10.1.3, page 257 addresses the responsible disposal of sewage sludge. Section 8.5.5 page 287 outlines the development of and compliance to an integrated waste management plan.</p>
<b>1.4 Longer term availability of non-renewable and renewable resources</b>		
1.4.1 Gold	C	<p>Gold is a non-renewable resource and when the reserves are depleted the mine will be closed. No alternative for other resource mining is documented in either the SLP or EMPR.</p>
1.4.2 Water	B	<p>EMPR: Chapter 4 section 4.8.2.1.8 page 251 documents measures to eliminate the contamination of surface water thus obviating the need to treat excessive quantities of polluted water in the future. Chapter 5 incorporates geohydrology studies. Closure objectives will focus on the regional closure strategy.</p>
1.4.3 Air	A	<p>EMPR: Chapter 4 section 4.4.3.1.10 page 134 documents re-vegetation of open areas and dumps and continuous monitoring of air quality after closure to ensure clean air and reduce its contamination.</p> <p>Air quality will be improved as the mine closes, providing quality air in future. No expectation for reduced air quality after mine closure if all measures are followed as stipulated.</p>
1.4.4 Biodiversity	B	<p>EMPR: Section 4.6.5.4 page 241 provides for alien invader identification and control and section 4.10.6 page 261 provides for maintenance of vegetation 18 months after closure. Chapter 5 page 276 provides for further alien eradication.</p> <p>Limited information is provided on fauna management.</p>
1.4.5 Soil	B	<p>EMPR: Chapter 5 page 276 provides for clean-up and rehabilitation of soil for future use.</p>

		Cumulative and residual impacts emanating due to future land use and possible decant of water were not considered.
<b>Overall Criterion Rating</b>	<b>B</b>	

Table 4.1: Criterion 1 - Socio-ecological system integrity and resilience assessment

#### 4.2.2. Criterion 2 – Livelihood sufficiency and opportunity

Livelihood sufficiency and opportunity		
Criterion elements	Robot Indicator	Justification
<b>2.1</b>	<b>How does the mining project create opportunities for lasting employment and current job provision from the operation and beyond?</b>	
2.1.1 Lasting employment rates/statistics of local community	<b>A</b>	<p>SLP: Section 2.2.2 page 25 documents employee training on self-employment skills like bricklaying, carpentry, basic electrical work, plumbing, farming, and fencing. Section 3.5 and 3.6 address recruitment of local communities and empowerment. Section 2.11.3 page 48 indicates total permanent employment as: skilled labourers 593; operators 1933; semi-skilled 2205. Sections 2.15 and 2.17 page 57 and 62 document women empowerment promotion, small business funding and local procurement is covered in section 3.2.2, and 3.19.2 pages 78 and 152.</p> <p>EMPR: Section 3.2.4 page 111 promotes skills development; section 4.5.1.1.4 page 140 covers facilitation of alternative employment after closure. Section 4.9.2.1.15 alerts that if SLP measures are not implemented well the employment of the community will be negatively affected.</p> <p>Adequate measures were provided for on lasting employment opportunities and employment rate around community.</p>
<b>2.2</b>	<b>Human health impacts which include exposure to toxic substances, alcohol, drugs, mining dust/silica related diseases like Tuberculosis (TB), silicosis, Human Immune Virus (HIV), Acquired Immune Deficiency Syndrome (AIDS), alcohol and drug abuse and sanitation provision</b>	

2.2.1	Toxic substances	B	EMPR: Chapter 4 section 4.4.2.2.3 page 129 provides for measures to minimise water and soil toxicity due to acid mine drainage and due to chemicals like cyanide, and sulphates and hydrocarbons in section 4.14.3.4.1 page 275. Section 4.4.2.1.10.2 page 128 documents issues of air toxicity which might result in cancer due to radioactivity and section 4.5.1.10 page 139 documents health impacts associated with air nuisance. Section 2.10.1.4 page 78 talks about toxic substances like CFCs, which can damage the environment. Methane impacts from the landfill site were not mentioned.  Nothing was documented on drugs and alcohol in either the SLP or the EMPR.
2.2.2	Diseases	A	SLP: Sections 3.7.11, 3.17 and 3.18 pages 148-151 document the nutrition plan and promotes vegetable gardens for low income earners. HIV/AIDS- and TB-associated disease prevention and management is discussed in sections 3.2.2.3 page 79, 3.5.5 page 90 and 3.20 pages 158 to 161 with the provision of associated medical hubs and health support.
2.2.3	Sanitation	A	SLP: Section 2.15 page 58 includes a commitment to invest in improving women change houses, ablution blocks and providing sufficient sanitary bins. Furthermore a sewage plant is being made available and is under maintenance. EMPR: Section 4.13.4 page 265 covers monitoring of impacts from sanitary facilities.  Adequate provision has been made to address sanitation related issues
<b>2.3 Availability of resources for others</b>			
	Resources availability	A	EMPR: Section 8.5 page 268 documents water preservation as per catchment management requirements. Sections 4.13 and 4.14 on page 275 state that air quality is to be monitored continuously including after closure. Section 4.10.2.4 page 259 documents rehabilitation and re-vegetation of affected sites to prevent dust and erosion. Sections 4.8 and 4.14 state that biodiversity is to be managed as per the conservation plan and re-vegetation strategy and to ensure provision of final land use.
<b>2.4 Learning and associated capacity building on local communities including the indirect effects on education and training by external bodies for local community and surrounding communities</b>			

Education and training	A	SLP: Sections 2.3.1 page 28 and 2.4 page 32, as well as sections 2.5 and 2.9 page 43 addresses the provision of Adult Based Education and Training (ABET) for employees and to local communities, sponsoring of a bridging programme and provision of learnership and internships to communities and relatives of employees and furthermore sponsoring of local schools. EMPR: Section 3.1.12.1.2 page 105 and section 3.2.4 page 111 address provision of ABET training facilities.
<b>2.5 Potential for further investment in the area , LED and infrastructure provision</b>		
Investment	A	SLP: Section 3.19.1 page 152 makes provision for skills development for women. Section 3.192 page 152 addresses support of local procurement, Small, Micro and Medium Enterprises (SMME) and Broad Based Black Economic Empowerment (BBBEE). Section 3.7 page 112 and section 2.8 page 41 provide for bursaries for local and national students. Section 3.7 page 72 documents community poverty eradication projects and LED.
<b>Overall Criterion Rating</b>	A	

Table 4.2: Criterion 2 Livelihood sufficiency and opportunity assessment

#### 4.2.3 Criterion 3 – Intragenerational equity

Intragenerational equity		
Criterion elements	Robot Indicator	Justification
<b>3.1 How does the operation affect the unequal distribution of wealth, access to resources amongst the community?</b>		

3.1.1 Unequal income distribution and wealth	A	SLP: Sections 2.112.19 pages 46–64 provides for implementation of employment equity; Section 2.4.1 page 30 encourages the achievement of equity targets. Promotion of LED and support of the municipality’s Integrated Development Programme (IDP) is covered. Section 3.1.3.14 pages 71-142 provides for SMME and BBBEE support. Section 3.19 page 151-158 provides for Historically Disadvantaged South Africans (HDSA). Adequate information was provided in order to achieve this element.
3.1.2 Access to resources	A	SLP: Section 3.4.4 page 95 promotes development of low cost housing and sections 3.15 and 3.16 pages 143-146 provide for promotion of home ownership; Section 3.19 pages 151-158 promotes access to business industry by the HDSA group. Section 3.20 page 158 provides for health care facilities and mobile health care facilities to remote communities. Section 3.2.2.2 page 79 provides for bridging schools and training facilities for local communities. Section 3.10-3.14 page 130-140 and section 5.4 page 183 provide for LED funding of some R13, 6 million to be used for basic resources like housing, schools, bursaries and infrastructure development. Adequate information was provided for to achieve this element.
<b>3.2 Equality of access to health, valued employment, respected knowledge and community security, safety and fatalities of employees</b>		
3.2.1 Access to health	A	SLP: Section 2.7.1 page 103 provides for health hubs, section 3.20.1 page 158 documents HIV/AIDS interventions on service provision, health talks and motivations at local clinics. Health services can be accessed by all, post closure measures are not provided for as they will be addressed by the local municipality.
3.2.2 Valued employment	A	SLP: Section 2.2.2 page 25 provides for training on self-employment skills like bricklaying, carpentry, basic electrical work, plumbing, farming and fencing. Section 3.5 and 3.6 address recruitment of local communities and empowerment. Section 2.11.3 page 48 indicates total permanent employment as: skilled labourers 593; operators 1933; semi-skilled 2205. Sections 2.15 and 2.17 page 57 and 62 document women empowerment promotion, small business funding and local procurement is covered in section 3.2.2, and 3.19.2 pages 78 and 152. This element is adequately addressed

3.2.3 Knowledge and community security, safety and fatalities of employees	B	<p>EMPR: Section 3.2 page 109 documents participation in various community forums and encourages public participation. Section 4.6.4.1 page 224 provides measures for access control in risky areas.</p> <p>SLP: Section 4.3 page 167 provides for the establishment of a mining future forum. Section 3.2.2 page 77 provides for security and promotion of community safety.</p> <p>Limited security measures are detailed to protect the community. No documentation on the fatalities of employees is provided in either the EMPR or the SLP.</p>
<b>3.3 Gender equality within the operation</b>		
3.3.1 Gender equity	A	<p>SLP: Section 2.15-2.18, pages 57-64 provides for the promotion of Women in Mining and achieving set targets in women appointment. Promotion of disabled people and HDSA engagement is mentioned in section 2.1.4 pages 54-56 and section 2.4, 2.11 – 2.19 pages 30, 46-64.</p> <p>This element has been identified and provided for.</p>
<b>3.4 Distribution of wealth, wealth influence and access to resources between advantaged and disadvantaged communities which includes effects on revenue flows, dependency effects within and around the operation</b>		
3.4.1 Wealth distribution and revenue distribution	B	<p>EMPR: Section 4.9.2.1.15 page 255 mentions the impact on socio-economic structure post mine closure, as the mine will no longer be a source of employment, revenue nor generate development of associated supply and service businesses.</p> <p>SLP: Section 1.2.10 mentions the employee revenue or salaries sent to communities is 30% monthly to help them when they return to their country of origin. The mine contributes to government tax revenue and royalties as stated in section 3.2.1.4 page 75 which help the unemployed, old aged and disabled through grants and housing and other basic services provided by government.</p> <p>The distribution and dependency of the community is not spelt out well.</p>
<b>3.5 Well-being of non-human species, habitat and quality of ecosystem services and stresses</b>		

Well-being stress on non-human species	<b>C</b>	EMPR chapter 5 identifies measures to manage impacts on water, air, biodiversity and soil. However the stress upon the well-being of non-human species was not assessed.
<b>3.6 Xenophobia and migration of communities towards the mining operations during mining and post mining</b>		
Xenophobic attacks and migrant labour handling	<b>B</b>	SLP: Section 1.2.10 page 21 provides for ensuring non-discrimination of migrant labour and providing them with equal opportunities with South African citizens. The possibility of xenophobic attacks and possible management measures were not identified.
<b>3.7 Illegal mining</b>		
Illegal miners	<b>B</b>	EMPR: section 4.6.5.5 page 242 identified illegal mining of dumps which might cause water, land and safety hazards and provides for notice boards and access control around the premises. Underground activities were not identified and nor were measures to manage them.
<b>3.8 Informal settlements establishment</b>		
Informal settlements	<b>B</b>	SLP: Section 3.4.4 page 94, informal settlement was identified as a major challenge around this mine community. Section 3.7 page 104 and 112 states that the mine will pursue the provision of low cost housing to combat informal settlement. EMPR: Chapter 2 section 2.15.2.4page 90 just noted that lack of clean water supply to the informal settlement may result in health impacts. This doesn't cater for lowest earners, as they still cannot afford houses and hence develop informal settlements.
<b>3.9 Riots / strikes/protests</b>		
Riots / strikes/protests	<b>C</b>	Nothing is documented on the SLP and EMPR.

<b>Overall Rating</b>	<b>Criterion B</b>	
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Table 4.3: Criterion 3 – Intragenerational equity assessment

#### 4.2.4 Criterion 4 – Intergenerational equity

Intergenerational Equity		
Criterion elements	Robot Indicator	Justification
<b>4.1 Potential costs and benefits for future generations</b>		
4.1.1 Potential benefits	<b>A</b>	<p>SLP: Section 2.7.1 page 103 provides for health clinics establishment. Section 2.2.2 page 25 provides for training in bricklaying, carpentry, basic electrical work, plumbing, farming, and fencing. Section 3.5 and 3.6 address recruitment of local communities and empowerment. Section 2.11.3 page 48 indicates total permanent employment as: skilled labourers 593; operators 1933; semi-skilled 2205. Sections 2.15 and 2.17 pages 57 and 62 address women empowerment promotion and small business funding. Local procurement is covered in sections 3.2.2 and 3.19.2 pages 78 and 152.</p> <p>LED and support of the municipality's IDP is provided for in sections 3.1 and 3.14 pages 71-142 and section 3.19 pages 151-158 provides for SMME, HDSA and BBBEE support. Low cost housing is provided for in section 3.4.4 page 95 and promotion of homeownership in section 3.15, and 3.16 pages 143-146. Infrastructure will not be demolished if it can benefit the community (it will be handed over to the community) as per section 4.10 page 206. Adequate information is provided for as experience, business development, housing ownership, rehabilitated land will benefit future generations.</p>

4.1.2 Potential costs	B	<p>EMPR: Chapter 4 section 4.10.6 page 261 and Chapter 6 page 278 makes provision for financial provision in a form of trust fund for rehabilitation and maintenance costs during closure and post closure.</p> <p>SLP: Section 3.4.4 page 95 provides for low cost housing and a home ownership scheme to reduce long term burden cost on employees after mine closure.</p> <p>Section 3.20 page 158 covers promotion of health interventions and support systems to prevent spread of HIV/AIDS and TB in the communities around the mine in the long term.</p>
<b>4.2 Legacy costs</b>		
4.2.1 Long-term waste storage	B	<p>EMPR: Section 4.6.2.11 page 175 identified asbestos, radioactive and other hazardous waste; furthermore documentation is provided on the landfill site, tailings dam and waste rock dump as this will affect the environment and increase cost of rehabilitation.</p> <p>Acid mine drainage, air pollutants legacy costs are identified in sections 4.4.2.1.3 page 125 and 4.5.2.9 page 141. Provision is made in the trust fund which was established in 2001 and is currently fully funded.</p>
4.2.3 Long-term diseases	B	<p>EMPR: Medical awareness and services are provided for to treat diseases like TB, silicosis and cancer or radiation related diseases identified in section 4.6.2.11 page 175. However no direct cost provision was made for such in the long-term.</p>
4.2.4 Job loses	B	<p>SLP: Section 4.5 page 174 documented the provision of portable skills training to benefit employees in other sectors / job creation and poverty alleviation through self-employment. Section 2.8 on page 40 provides for a bursary fund for students and a bridging scheme is provided for in section 2.8 page 44.</p> <p>EMPR: Section 3.2.1 provides for skills and training for future use.</p> <p>Nothing is described on sponsoring or supporting business in future; ex-employees might not get jobs or start their own businesses hence the skill provided might not be sustainable. Failure of implementation of above measures was not considered under legacy costs.</p>

<b>Overall Rating</b>	<b>Criterion</b>	<b>B</b>
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Table 4.4: Criterion 4 – Intergenerational equity assessment

#### 4.2.5 Criterion 5 – Resource maintenance and efficiency

<b>Resource maintenance and efficiency</b>		
<b>Criterion elements</b>	<b>Robot Indicator</b>	<b>Justification</b>
<b>5.1 Severity of damage from resource extraction compared to existing practices and to alternatives</b>		
Damage from resource extraction	<b>B</b>	EMPR: Section 4.9 page 253 documents the possibility of damage to the environment due to mining infrastructure, impact on future land use, soil quality, formation of sinkholes, and biodiversity loss on species which cannot re-establish.  The damage was identified in general.
<b>5.2 Net use of energy and energy sources including renewables and low impact sources</b>		
Use of energy	<b>B</b>	EMPR: Section 4.13.2 page 265 provides for monitoring of energy consumption within the operation. Section 2.1.2 page 96 covers provision of radiation cleared wood to local community for energy.  No efficiency measures or alternative low impact energy sources were mentioned on the EMPR or the SLP.
<b>5.3 Net use of water between ecosystem services and human consumption</b>		

Water usage	A	EMPR: According to section 3.1.6 page 101, the mine uses massive amounts of water for production and human consumption at the offices, hostels and mine village. Water is sourced from Rand Water and provided by the Merafong Municipality.  Section 4.6 from page 145 includes measures on pipe maintenance, fixing of water leaks to reduce water wastage and recycling of process water, efficient use of small showerheads to reduce Rand Water consumption. Section 4.4.3.1.8.2 page 134 documents reduction in water consumption during mine closure. Elements on water usage are adequately identified.
<b>5.4 Net use of other materials and resources, and the potential hazardousness of direct and embodied pollution and other wastes</b>		
Materials used hazards and potential pollution	A	EMPR: Section 4.13.4 page 265 and section 4.6.1 page 244 state that the mine utilises massive amounts of materials like timber, chemicals, cyanide, explosives which can lead to lead methane release during blasting, as well as lubricants, oil, diesel, petrol, refrigerants which contain CFCs and other gases which can cause explosion or exacerbate greenhouse gas release influencing climate change. Section 4.13.4 page 265 and page 78 identified potential health impacts from chemical usage like cyanide and hydrochloric acid. Section 3.1.2 page 96 and section 4.1.3.4 page 26 provides for explosives handling procedures and gas monitoring underground and at the landfill site. Section 2.10.1.4 page 78 provides for refrigerant gases recycling to limit and prevent pollution. Recyclable wastes like batteries, oil, papers and plastics are collected for recycling as per section 2.1.2 page 98.
<b>5.5 Transition from non-renewable high impact energy and material to renewable and low impact sources</b>		
Energy sources transition	C	No energy transition was mentioned in either the SLP or EMPR except for energy saving on current energy source.
<b>5.6 Potential for rebound effects like savings in resource usage</b>		
Energy savings and efficiencies	B	EMPR: Section 4.13.4 page 266 documents promotion of energy consumption monitoring on water cooling, ventilation, change houses and other sections.

		No efficiencies were documented in either the SLP or EMPR.
<b>5.7 Potential for efficiencies that reduce desirable diversity, local suitability and redundancy</b>		
<b>Potential efficiencies</b>	<b>B</b>	There is potential to improve efficiency through monitoring as per EMPR section 4.13.4 page 266. Resource consumption will be limited when the mine closes and recycling of materials will reduce redundancy. This was not directly stipulated in the EMPR or SLP.
<b>Overall Criterion Rating</b>	<b>B</b>	

Table 4.5: Criterion 5 – Resource maintenance and efficiency

#### 4.2.6 Criterion 6 – Social–ecological civility and democratic governance

<b>Social–ecological civility and democratic governance</b>		
<b>Criterion elements</b>	<b>Robot Indicator</b>	<b>Justification</b>
<b>6.1 Social awareness of citizens and opportunities to create or strengthen social ties of mutual learning and assistance, and sensitivity to disadvantaged groups</b>		
Social awareness	<b>A</b>	EMPR: Section 3.2 page 109 states the participation in various community forums and encourages public participation. Section 4.6.4.1 page 224 encourages the discussion of high risk areas like access controls with nearby communities. SLP: Section 4.3 page 167 documents the establishment and maintenance of future forums between the government and communities.

		These forums can provide adequate awareness to society.
<b>6.2 Ecological awareness of citizens about ecosystem functions and values they provide</b>		
Ecological awareness	<b>B</b>	EMPR: Section 4.13.4 page 265 provides for employees training on matters concerning safety, health and environment. Section 3.2 page 109 states promotion of awareness for local communities during participation in different forums. Section 3.2.4 page 111 gives provision for support of regional environmental management awareness campaigns or systems to ensure community empowerment.  The information provided does not provide for awareness to the citizen without exposure to different forums.
<b>6.3 Social responsibility of market participants</b>		
Social responsibility	<b>A</b>	SLP: Section 3.2.2 page 77 documents the involvement of the mine in implementing the Corporate Social Responsibility (CSR) plan to give back to communities in the form of education, library provision, bursaries, BBBEE, LED, sports and health facilities. Section 3.6 page 99 documents participation of the mine in the LED projects for infrastructure and service provision.  EMPR: Sections 3.2.4.5.2 pages 119 touch base on the mine compliance with the Johannesburg Stock Exchange Socially Responsible Investment (SRI) index to ensure they are responsible for their communities.  The SRI index is based around adherence to the concept of the triple bottom line.
<b>6.4 Capacity of participants to be actively involved in deliberations and decision making on issues which affect public</b>		
Participants decision making capacity	<b>B</b>	EMPR: Section 3.2 page 109 provides for capacitating internal parties through accredited training and internal awareness through induction at the training centre. Section 3.2 page 109 states promotion of awareness for local communities to empower them.  Capacitating external participants is not addressed in either the SLP or EMPR public participation process.
<b>Overall Criterion Rating</b>	<b>B</b>	

Table 4.6: Criterion 6 Social–ecological civility and democratic governance assessment

#### 4.2.7 Criterion 7 – Precaution and adaptation for resilience

Precaution and adaptation for resilience		
Criterion elements	Robot Indicator	Justification
<b>7.1 Risks of significant damage compared to existing practices and to alternatives</b>		
Significant risks	<b>A</b>	EMPR: Chapter 4 pages 125-283 provides for impact assessment conducted for commissioning, operational, decommissioning, closure and post closure and the risk register rating is available. Management measures to address impacts and associated costs are provided for in Chapter 5 page 276 and Chapter 6 page 278. SLP: Section 3.2.2 page 77, LED and social responsibility provide for damages of job losses and empower community with education and skills for future use.
<b>7.2 Capacity for monitoring changes to the environment and communities around</b>		
Monitoring changes to environment and community	<b>B</b>	EMPR: Chapter 4 section 4.13 pages 264,265 and sections 4.14.1 and 4.14.1 provide for monitoring of water, air, noise, land and biodiversity during the operation, decommissioning, closure and post-closure. Monitoring of invaders and alien species are covered on pages 267-268. No measures were documented in the SLP or EMPR on the provision of monitoring changes in communities.
<b>7.3 Adaptive and precautionary qualities of the mine waste and energy systems</b>		

Adaptive and precautionary qualities of waste and energy system	<b>B</b>	<p>EMPR: Chapter 4 section 4.3 page 143 makes provision for waste management, sorting and disposal at the salvage yard and landfill site. Section 4.6 provides for disposal of hazardous waste in designated landfill sites and recycling of waste. Section 4.13 page 265 covers monitoring of energy consumption.</p> <p>SLP: Section 3.5 page 98 mentions involvement of the mine in local energy projects.</p> <p>No information with specific energy management systems was provided in either the EMPR or SLP.</p>
<b>7.4 Development of a context and culture of precaution and adaptation</b>		
Context and culture precaution and adaptation	<b>A</b>	<p>SLP: Section 2.11 page 51 identified issues on establishing and maintaining an organisational culture that promotes better understanding and tolerance of the diverse backgrounds of all employees. Section 2.15 page 59 provides for the development of a diversity management plan that will ensure that women are integrated into a predominantly male environment in a manner that takes into account the diverse nature and culture of the mining industry. Section 3.2 page 78 provides for the roles and responsibility in supporting cultural activities.</p>
<b>Overall Criterion Rating</b>	<b>A</b>	

Table 4.7: Criterion 7 – Precaution and adaptation for resilience assessment

#### 4.2.8 Criterion 8 – Immediate and long-term integration

Immediate and long-term integration		
Criterion elements	Robot Indicator	Justification
<b>8.1 Delivery or potential for positive feedbacks and mutual reinforcement of desirable effects from the project and other current and anticipated activities and undertakings</b>		
Desirable effects	<b>B</b>	EMPR: Section 4.1 page 121 provides for implementation of remedial measures to reduce negative impacts or to enhance positive benefits.  SLP: Section 3.2.1.5 page 76 states the positive impacts anticipated from LED projects and in section 3.2.2 page 77 details positive impacts acquired from the social responsibility projects.
<b>8.2 Capacity to enhance these positive effects within the working environment and beyond</b>		
Positive effects enhancement	<b>A</b>	EMPR: Chapter 4 section 4.10.6 page 261 and Chapter 8 section 8.5.1 make provision for an adequate trust fund and the use of such trust fund for the maintenance of the rehabilitation and environmental elements during and post closure of the operation.  SLP: Section 3.2.2 page 77 documents the involvement of the mine in implementing the CSR plan to give back to communities (including labour sending countries) in a form of education, library provision, bursaries, BBBEE, LED, sports and health facilities. Section 3.6 page 99 documents participation of the mine in the LED projects for infrastructure and service provision.
<b>8.3 Delivery or risk of negative feedbacks and mutually reinforcing adverse effects</b>		
Negative feedbacks of adverse effects	<b>C</b>	Delivery or risk of negative feedbacks and mutually reinforcing adverse effects are not documented in the EMPR or SLP.

<b>8.4 Capacity to interrupt and reverse these negative effects</b>		
Interrupt and reverse negative effects	<b>A</b>	EMPR: Sections 4.14 and 4.5.18 page 139-141 provide for rehabilitation of affected areas and improving quality of affected elements and monitoring of conditions during rehabilitation and financial provision to deliver on the rehabilitation plan.  SLP: Section 3.19 and section 3.20 on page 162 and section 5.1 on page 181 provide for improvement and reversing of negative impacts through BBBEE promotion, SMME development, LED projects and CSR projects for affected communities.
<b>Overall Criterion Rating</b>	<b>B</b>	

Table 4.8: Immediate and long-term integration assessment

Scoring criteria: **A** = Fully incorporated; **B** = Limited incorporation; **C** = No incorporation

### 4.3 Conclusion

The results above indicated that the main component of the working documents does contain the information relating to the established GMSAC. The scores have been assigned in the rating above as described in the assessment methodology section 2.4.3 and summary of criteria scores shown below in Table 4.9. The scores indicate the strength and the weakness of the principles incorporation during the assessment done using the EMPR and SLP.

Criteria Number	Rating
Criterion 1	Partial Incorporation
Criterion 2	Full Incorporation
Criterion 3	Partial Incorporation
Criterion 4	Partial Incorporation
Criterion 5	Partial Incorporation
Criterion 6	Partial Incorporation
Criterion 7	Full Incorporation
Criterion 8	Partial Incorporation

Table 4.9: Summary of GMSAC score

During the criteria assessment it was evident that most criteria and sub-criteria elements are included in the working documents – either the EMPR or the SLP – and these criteria were rated **A**. Some sub-criteria were identified in either the EMPR or SLP however with limited information on how to manage the element, these were rated **B**. In rare instances the sub-criteria in criteria 1, 3, 5 and 8 were not addressed in either of the working documents. This has led to a **C** rating.

The EMPR document showed that most of the environmentally oriented sub-criteria are included in the environmental impact assessment section and in the management section of this document. Furthermore those issues were also considered in the closure and rehabilitation section. The SLP indicated that most of the socially oriented sub-criteria are documented however in some instances the SLP just notes the issues of concern with no management measures provided to address those issues.

Criterion 1 has been awarded a B score. Even if there is clear potential for the ecosystem to can still deliver valued services in the future with limited pollution levels the management

measures provided for lack resistance potential. Example being the future health services, the land contamination and uncontrollable longer-term availability of gold resources with no alternative resource provided for.

Criterion 2 scored A because the management measures provided for opportunities in health promotion and other long-term impacts have been addressed and provided for. Furthermore the capacity to educate and empower communities through local investment was also clear provided for.

Criterion 3 scored a B because the sub criteria elements indicated there was just a balance in area like the wealth distribution, access to facilities and positivity in addressing gender equity. However the issues around community knowledge of information and stability from riots, attacks were not taken into consideration.

Criterion 4 scored a B as it was evident that the community can potentially benefit from the mining activities positive legacy of infrastructure and some investment. However the negative legacy associated impacts like long-term diseases like HIV Aids, TB, waste and job losses might outweigh the benefits.

Criteria 5 scored a B because the resource maintenance in general doesn't provide long term sustainability on the resource used. Mining is detrimental to the environment and this can lead to exploitation in energy reserves, water availability, and might hinder the efficiency of the concerned ecosystem in maintaining or providing such services.

Criteria 6 scored a A because the documents provides and encourages the social awareness and the mine has also shown significant involvement in social responsibility in relation to local communities. However the involvement and participation of community in decision making lacks and this might impact significantly on sustainability developing community.

Criteria 7 was awarded an A score because the significant environmental and social risk has been identified. The documents provided for strong provisions in maintaining an organisational culture and to promote better understanding and tolerance of different employee's backgrounds. Taking into consideration that communities and environment might change hence affecting the adaptation level, this gap can be closed as major risks have been identified.

Criteria 8 was scored a B. The implementation of the recommended and suggested management measures can yield desirable effects to communities around the project area examples social development projects like waste recycling, vegetable gardens, business hives. However impacts which might results from cumulative impacts might outweigh the positives if not addressed adequately. The documents lacks the incorporation and balancing the possibility of adverse effects.

In summary two criteria showed an outstanding performance as the requirements were completely incorporated. Six criteria outlined most of the requirements however there was lack in either the clarity for particular elements or incorporation of such. The overall conclusion is the SLP and EMPR documents have incorporated the potential risks and significant aspects to be focused on. However in some instances there is lack in measures provided to address the risk and measure for adaptability into the future. Gaps identified in the working documents will help us in the provision of recommendations for improvement in the working documents and further research on the basis of such exclusion.

## CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

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### 5.1 Introduction

The discussion and recommendation chapter will provide a discussion of the research findings based on the data as analysed in the previous chapter to conclude if the objectives of the research have been achieved or not. Furthermore this chapter will also provide an overall conclusion of the research findings based on all criteria assessed and the new criteria which have been established. The recommendations will then be provided to ensure the gaps which have been identified can be filled in future research efforts and documentation provided.

The following section 5.2 will summarise the status of each objective and its achievement status based on the objectives as illustrated in Figure 5.1 below.



Figure 5.1: Research aim and objectives

### 5.2 Summary of results

The results will be summarised based on the data analysis and criteria review results in achieving the objectives of this research. The main aim of the research was to investigate the extent to which the sustainability principles are incorporated in the EMPR and SLP documents

of a specific gold mine in South Africa. For this to be achieved three objectives were set as outlined in the summary Table 5.1 below.

<b>Objective 1</b>	<b>Develop sustainability criteria relevant to gold mining industry in SA</b>
	<p>A variety of literature has been reviewed to ensure full documentation of relevant mine industry prone issues that can hinder sustainability. Furthermore the pieces of legislation like NEMA, MPRDA and others were also looked into to acquire a legal background and to support the mining sustainability status. The review concluded that the GSAC principles cover all the main aspects in mining. However some sub-criteria that are not applicable had to be modified or removed. In some instances, new sub-criteria were added. The final concluded criteria are illustrated in Table 4.1.</p> <ul style="list-style-type: none"> <li>• Criterion 1 was adopted with four sub-criteria. Sub-criterion 1.1 was modified to include alien/invader species establishment, 1.4 was modified to include Gold resource. Other sub-criteria were not modified.</li> <li>• Criterion 2 was adopted with the five sub-criteria. Sub-criterion 1.1 was modified to include current job provision; sub-criterion 2.2 was also modified to include mine prone diseases which are TB, HIV/AIDS, silicosis and drug and substance abuse. Furthermore sub-criterion 2.5 was modified to include LED involvement and infrastructure provision.</li> <li>• Criterion 3 was adopted with nine sub-criteria. It was modified to include four additional sub-criteria on 3.6 xenophobic attacks, 3.7 illegal mining, 3.8 basic service provision and informal settlement and 3.9 riots/strikes/protests.</li> <li>• Criterion 4 was adopted with two sub-criteria. Sub-criterion 4.2 was modified to include legacy costs on rehabilitation, acid mine drainage, climate change, uranium and radiation impacts.</li> <li>• Criterion 5 was adopted with its seven sub-criteria.</li> <li>• Criterion 6 was adopted with four sub-criteria.</li> <li>• Criterion 7 was adopted with four sub-criteria.</li> <li>• Criterion 8 was adopted with the four sub-criteria.</li> </ul> <p>To conclude, the literature was reviewed successfully to develop Gold Mine Sustainability Assessment Criteria.</p>

<p style="text-align: center;"><b>Objective 2</b></p>	<p><b>Assess the extent to which the sustainability criteria have been incorporated into the EMPR, SLP for one specific gold mine</b></p> <p>Embedded on first objective outcome, the new GMSAC had to be adopted and used for the sustainability assessment in a specific gold mine. The EMPR and SLP documents were taken for review against these criteria. Each sub-criteria and associated elements under each sub-criterion were assessed for incorporation into either the SLP or EMPR and a rating score was provided.</p> <p>The overall score for the incorporation of sustainability principles into the EMPR and SLP was concluded as a <b>B</b> due to the fact that most criteria scored a <b>B</b> as indicated in Tables 4.2.1 to 4.2.8 in the previous chapter. The incorporation of these principles are provided and documented in a limited medium scale. This is evident because some criteria elements were just mentioned in brief or one line and no further measures were included in the document to address the element in question. Most societal elements were included in a limited way in the SLP, whereas the EMPR tried to incorporate most of the elements. The existence of the required information in the working documents provides for opportunity for improvement which will be discussed in the summary of objective three achievements below.</p>
<p style="text-align: center;"><b>Objective 3</b></p>	<p><b>To provide recommendations to improve sustainability in a specific gold mine</b></p> <p>The assessment of the new criteria indicates that there are gaps and opportunities in the working documents to move towards sustainability. Therefore further steps need to be taken to fill the gaps as identified. The following recommendations are hereby presented:</p> <p>The research discovered that the elements of sustainability are not considered in full within the working documents – only basic information is provided.</p> <ul style="list-style-type: none"> <li>• Detailed information must be provided to ensure continuity and maintenance of sustainability impact issues in future.</li> <li>• Sustainability assessment elements must be continuously monitored to ensure identified gaps are addressed.</li> <li>• Overall, the established Gold Mine Sustainability Assessment Criteria must be tested in a different case study to improve sustainability assessment in mining and strengthen the concept.</li> </ul>
	<p>All research objectives were achieved.</p>

Table 5.1: Summary of research results based on the research objectives.

### **5.3 Research conclusion**

The review of different documents and the Gibson Sustainability Assessment Criteria has indicted several gaps on gold mine prone activities which were not completed in previous assessment criteria. The gaps identified were then completed with new mine prone elements to modify the criteria of the previous assessment. This aided the development and recognition of the Gold Mine Sustainability Assessment Criteria. This modified criterion was then adopted and used in the analysis of the working documents to assess the incorporation of the principles into such documents.

The analysis concluded that most criteria are included in the working documents, however this was found to be on a limited scale due to insufficient information being provided on the criteria of concern. Even though gaps were identified in the incorporation of sustainability in the EMPR and SLP working documents, the overall research study concluded that there are opportunities to close the gaps and achieve sustainable development.

### **5.4 Research recommendations**

Murombo (2003:21) indicated that South Africa is among the few developing countries that have seriously taken to implementing the concept of sustainable development. The following recommendations are provided to ensure that the country takes the sustainability concept beyond the limits of the current generations:

- Management should aim to include as many sustainability criteria as possible and continually improve in doing such
- Measures which promote avoidance of potential significant impacts and net benefits of the society and environment must be prioritized and widely implemented.
- Assessment criteria should be modified to include case specific issues to ensure all applicable elements are covered,
- Legal requirements must consider all possible factors which can affect sustainability to ensure the alignment of the working documents accordingly,
- Companies must assess their sustainability progression regularly,

- Collaboration and cooperative governance within mining operations and affected communities to ensure strategic regional management environmental challenges hindering sustainability,
- Government authorities should perform regular assessment and measurement of sustainability and promote regional cooperation.

### **5.5 Recommendations for further research**

The research on the investigation of the incorporation of sustainability assessment principles in the EMPR and SLP of a gold mine in South Africa was an adventure worth undertaking. It has revealed opportunities in the mine working documents that only few access and manipulate. This journey needs more explorers to take the investigation forward to ensure all issues pertaining to mining sustainability are identified, implemented and measured. The following recommendations are hereby presented for further research:

- Assessment of the extent to which sustainability principles are implemented,
- Critical evaluation of the incorporation of sustainability principles into the mine legal working documents and internal procedures, and
- Further expansion of research scope to include other mines around Gauteng and South Africa.

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