

Addressing critical water and waste issues in Environmental Impact Assessment (EIA): The case of coal mining in South Africa

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PREFACE

This mini-dissertation is submitted in partial fulfilment of the requirements for the degree Masters in Environmental Management at the Potchefstroom Campus of the North-West University. The research discussed in this document was conducted under the supervision of Professor F. P. Retief in the Natural Sciences Faculty, between January 2016 and July 2017.

This mini-dissertation is the original work of Liezel Louw and no part of this dissertation has been published previously.

I would like to thank my supervisor, Professor F. Retief for his time, valuable input and support throughout this period. Furthermore I would like to thank my husband and mother for their continuous support and motivation throughout the master's degree period.

ABSTRACT

Internationally, the assessment of mining related impacts has been a particular focus of environmental impact assessment (EIA) research and practice, with a wealth of literature on the subject. In light of the significant potential impacts of mining, specifically coal mining, it is vital for the environmental assessment report (EIR), which forms the legal basis for decision making and authorisation, to accurately communicate relevant impacts. This study investigated the extent to which critical water and waste issues are addressed in coal mining related EIAs in South Africa. Fifteen EIRs were evaluated using a review package adapted from the original *Lee and Colley Review Package* through placing the focus on water and waste. The results showed that 73% of the EIRs received a well-performed quality grade, however the analysis further revealed various area of weaknesses i.e. areas in the EIR that didn't receive sufficient attention. This study elaborates on the weaknesses and provides recommendations for improvement.

Keywords: *EIA, EIR, Lee and Colley, Mining*

TABLE OF CONTENTS

1	INTRODUCTION	8
1.1	Background	8
1.2	Problem statement	8
1.3	Research question.....	9
1.4	Structure of dissertation	9
2	SETTING THE CONTEXT – IN DEPTH REFLECTION ON ENVIRONMENTAL IMPACT ASSESSMENT.....	10
2.1	Introduction	10
2.2	Environmental Impact Assessment	10
2.2.1	Purpose and objectives of an EIA.....	10
2.2.2	EIA development history	11
2.2.3	EIA effectiveness	11
2.2.4	EIA in South Africa	15
3	COAL MINING IN SOUTH AFRICA	22
3.1	Coal mining role in South Africa	22
3.2	Coal mining impacts.....	22
4	RESEARCH METHODOLOGY	25
4.1	Introduction	25
4.2	Evaluation criteria	25
4.3	EIR sampling criteria.....	28
4.4	Data analysis and interpretation.....	28

5	RESEARCH RESULTS AND ANALYSIS	30
5.1	Introduction	30
5.2	General overview of EIR quality	30
5.3	Quality of EIRs for Review Area 1: Groundwater	33
5.4	Quality of EIRs for Review Area 2: Surface water	35
5.5	Quality of EIRs for Review Area 3: Waste	38
5.6	Summary of strengths and weaknesses of evaluated EIRs	41
6	CONCLUSION	43
6.1	Introduction	43
6.2	Conclusion	43
6.3	Recommendations.....	43
6.3.1	Recommendations to practice	44
6.3.2	Recommendations for future studies	44

LIST OF TABLES

Table 2-1:	Summary of the status of EIR quality appraisal research in South Africa.	18
Table 4-1:	Summary of the review areas, categories and subcategories tailored for the evaluation package.	26
Table 5-1:	Summarized overview of the assessment scores for all EIRs evaluated.	32
Table 5-2:	Quality ratings of review subcategories for Review Area 1	34
Table 5-3:	Quality ratings of review subcategories in Review Area 2	37
Table 5-4:	Quality ratings of review subcategories in Review Area 3	40

LIST OF FIGURES

Figure 4-1:	Evaluation package assessment levels	28
Table 4-2:	Collection of assessment symbols	29
Table 4-3:	Assessment symbols explanations.....	29
Figure 5-1:	Overall percentage assessment scores for the evaluated EIRs.....	30
Figure 5-2:	Distribution of assessment symbols for all three review areas.....	31
Figure 5-3:	Distribution of assessment scores for Review Area 1.....	33
Figure 5-4:	Distribution of assessment scores for Review Area 2.....	35
Figure 5-5:	Distribution of assessment scores for Review Area 3.....	39

CHAPTER 1

1 Introduction

1.1 Background

Internationally, the assessment of mining related impacts has been a particular focus of EIA research and practice, with a wealth of literature on the subject in the form of peer reviewed publications, best practice guidelines as well as policy and legislation (Castilla-Gomez & Herrera-Herbert, 2015; Chernaik, 2010; Katoria *et al.*, 2013). Environmental impact assessment (EIA) legislation in South Africa has changed significantly over the years. During the first era of EIA's in South Africa, under the Environment Conservation Act (ECA), a wide range of development activities required an EIA and concerns were raised that EIAs serve as a barrier to development (Kidd & Retief, 2006). Since then there have been three different iterations of EIA legislation under the National Environmental Management Act (Sutton-Pryce, 2015). A unique characteristic of the South African EIA system is that all mining related EIA's are submitted to- and approved by the Department of Mineral Resources (DMR) and not the national and provincial environmental authorities (Sutton-Pryce, 2015). With the sole mandate of the DMR being the promotion of mining activities in South Africa, it has been questioned if the DMR should also serve as the "watchdog" for environmental matters related to mining (Sandham *et al.*, 2008).

Coal mining specifically has significant environmental impacts such as: alteration of water quality, water pollution (Katoria *et al.*, 2013; Munnik *et al.*, 2010), destruction of habitat, removal of vegetation and loss of biomass (Huang *et al.*, 2015; Katoria *et al.*, 2013), destruction of soil structure and fertility, noise, vibration and fugitive dust generation (Katoria *et al.*, 2013; Munnik *et al.*, 2010). Some of the most significant impacts related to coal mining activities are on water resources (wetlands, acid mine drainage, storage of polluted water) and the generation and storage of large amounts of waste (hazardous waste, discard dumps) (Burchart-Korol *et al.*, 2016; Dontala *et al.*, 2015; Goswami, 2013).

1.2 Problem statement

In light of these significant potential impacts it is vital for the environmental assessment report (EIR), which forms the legal basis for decision making and authorisation, to accurately communicate relevant impacts. If EIA's are conducted appropriately and EIR's are compiled with all the information gathered during the EIA, it has the ability to inform management decisions to minimize, mitigate and, in some cases, even avoid these detrimental effects (Sutton-Pryce, 2015). Given that the EIR is a key outcome of the EIA process, and the legal

basis for the authorisation decision, a review of the EIR gives an indication of the potential influence of the EIA process (Sandham & Pretorius, 2008).

1.3 Research question

This research study aims to address the following research question: To what extent are critical water and waste issues addressed in coal mining related EIRs in South Africa?

1.4 Structure of dissertation

This dissertation is presented in six chapters. Chapter 1 introduces the background to this study and further outlines the problem statement and research question. Chapter 2 provides a critical review of EIA practice internationally and in South Africa followed by a review of various methods of quality assessment of EIRs. This chapter also delves into previous EIR quality studies done in South Africa and the EIA process in the South African mining industry.

Chapter 3 outlines the role of coal mining in South Africa followed by a review of potential impacts this industry has on the environment. Chapter 4 describes the research methodology employed for this study. It provides detail on the review package developed and used for the quality evaluation, as well as the EIR sampling criteria, data analysis and interpretation.

Chapter 5 presents the research findings of the extent to which critical water- and waste issues were addressed in the sample of 15 EIRs as well as a detailed discussion of the findings. The results are initially presented as an overall quality performance of the EIRs in all the review areas; the findings are then separated into each of the three review areas. This is followed by a summary of the key strengths and weaknesses of the reports.

Chapter 6 describes the conclusions made from the research study followed by recommendations to practice and for future studies.

CHAPTER 2

2 Setting the context – in depth reflection on Environmental Impact Assessment

2.1 Introduction

This chapter starts with a detailed description of the Environmental Impact Assessment process and makes reference to the purpose and objectives of an EIA. The development history, the topic of effectiveness and how EIR quality review relates to effectiveness, discussions surrounding EIA's and the review thereof in the mining industry of South Africa. This chapter provides an overview of coal mining and its potential impacts on the environment and society and lastly a concise problem statement and research objectives.

2.2 Environmental Impact Assessment

According to Morgan (2012) there are currently more than 200 countries world-wide which have some form of environmental assessment legislation, partially governing new development activities or changes to existing activities. The adoption of the EIA process boomed after the Rio Summit in 1992, seeing more and more countries, including various developing countries, developing legislation related to the EIA process (Lee, 2000; Pope *et al.*, 2013; Wood, 2003).

2.2.1 Purpose and objectives of an EIA

An EIA is a systematic process used to identify and assess, positive-, negative-, cumulative environmental- and social impacts of proposed developments before the commencement of such activities (Glasson *et al.*, 2005; Wood, 2003).

Other important objectives of an EIA are the supply of information on the potential consequences and benefits (environmental, social and economic) of the development activities to relevant parties (i.e. decision makers, interested and affected parties), as well as to clearly define the management and monitoring actions required during the implementation- and operational stages of a development activity (Kruger, 2012; Lee, 2000). The EIA process can be described as a tool used to reduce potential negative impacts of proposed developments, to further enhance identified positive impacts (Lee, 2000; Wood, 2003) and to promote sustainable development (Lee, 2000; Morrison-Saunders & Retief, 2012; Retief, 2013).

Although many see the EIA process as an expensive and time-consuming paper exercise, it can have numerous benefits if conducted and applied correctly (Jay *et al.*, 2007; Morrison-Saunders *et al.*, 2015). One major benefit is the access developers have to local- and cultural

knowledge during the Public Participation Process (PPP). In many cases this has proved invaluable to the project feasibility (Aucamp, 2015). By identifying negative impacts in the project planning- and design phase, additional alternatives can be investigated to eliminate or minimize these impacts. Alternatively, effective mitigation measures can be put in place to address any residual impacts (Lee, 2000). This in turn creates good relationships between developers, local communities, NGO's and authorising bodies (Glasson *et al.*, 2012).

2.2.2 EIA development history

The EIA process was initially introduced in 1969 in the United States of America under the National Environmental Policy Act (NEPA), and fully implemented by 1970. The process slowly developed in Australia, Canada, France, and Columbia etc., according to Morgan (2012) there are currently more than 200 countries world-wide which have mandatory environmental assessment legislation. The development of the EIA process in developing countries took place much later and at a slower pace, compared to developed countries. However after the Rio Summit in 1992 (issues such as climate change and water usage and supply were discussed) a wide expansion was noted (Lee, 2000; Wood, 2003).

The initial weaknesses of this system were addressed through the years and have since been implemented by most countries around the world (Glasson *et al.*, 2005; Hoffmann, 2007; Sowman *et al.*, 1995; Wood, 2003). It is seen as one of the most successful environmental policy developments of the past few decades (Azapagic, 2003; Glasson *et al.*, 2005; Wood, 2003).

Easy access to information has fuelled the improvement and expansion of the EIA process (Aucamp, 2015). The fact that environmental consequences of human activities can be broadcasted around the world almost instantaneously, has resulted in the increased public awareness of environmental matters. This in turn led to international conventions such as the Rio Summit for sustainable development and the adoption of various agendas and protocols by numerous developed and developing countries (Hoffmann, 2007; Wood, 2003).

2.2.3 EIA effectiveness

The effectiveness of the EIA process has been a cause of concern for practitioners' world-wide (Barker and Wood, 1999; Christensen *et al.*, 2005; Wood, 2003). The term *effectiveness* can be defined as "whether the EIA process achieved its purpose" or "whether the instrument works" (Pölönen *et al.*, 2010; Retief, 2007; Sadler, 2004).

Effectiveness of an EIA thus relates to the questions 1) if the process resulted in a quality environmental assessment report, 2) if the process supported the developer in identifying potential impacts and relating mitigation measures, 3) if the process resulted in the identification of monitoring and management requirements and 4) if the process aids in decision making? (Glasson *et al.*, 2012; Sadler, 1996). For the EIA to be an effective management tool it needs to address the mentioned effectiveness factors (Glasson *et al.*, 2012) and be cost effective, time efficient and evaluate impacts occurring throughout the project life cycle (construction, operation and decommissioning) (Glasson *et al.*, 2012; Talime, 2011; Sutton-Pryce, 2015).

One component of effectiveness relates to the quality of the report drafted from the EIA process conducted on a development activity. An existing argument states that poor quality reports would result in ineffectiveness, based on the fact that these reports contain the information which authorisation decisions are based on (Sandham *et al.*, 2008).

Numerous research studies (e.g. Hallat *et al.*, 2015; Mbhele, 2009; Sandham & Pretorius, 2008; Sandham *et al.*, 2008a; Sandham *et al.*, 2008b; Sandham *et al.*, 2013) into the quality of South African EIR's have been conducted over the years and as a result a number of improvement areas have been identified. Areas in need of improvement include: identification of the potential impacts of the development, the assessment of the significance and magnitude of impacts, identification of cumulative impacts, the mitigation of impacts, the identification of alternatives and monitoring and management requirements during the life cycle of the project (Sandham & Pretorius, 2008; Pope *et al.*, 2013).

2.2.3.1 EIA quality review purpose and functions

The purpose of a quality review assessment of an EIR is to conduct a gap- or best practice analysis. When gaps are identified, recommendations for improvements can be made; when best practice is identified it can be used as a template for the improvement of the content of an EIR (Sandham & Pretorius, 2008; Talime, 2011). These improvement- and best practice recommendations can be used as guideline documents indicating the required content of a good quality EIR.

Reviews usually commence once the report has been finalised (Sutton-Pryce, 2015) and are generally steered by panels of experts with their main objective to determine if the report contains sufficient information to inform decision-making (Sutton-Pryce, 2015).

If EIR's contain adequate information on all aspects relating to the proposed development it will aid decision making (Talime, 2011), build constructive relationships with interested and affected

parties (I&AP's), provide a guideline to developers on what to mitigate and manage, increase the developers credibility and have a positive impact on the developers reputation.

2.2.3.2 EIA quality review methods

Methods to determine the quality of EIR's have been the subject of extensive research in the past two decades and several methods have since been developed (Androulidakis & Karakassis, 2005; Glasson *et al.*, 2005; Jalava *et al.*, 2010; Lee & Colley, 1999). The most common method of assessing the quality of an EIR is through a review package. These packages generally consist of a series of questions formulated in a hierarchy, where areas are underpinned by categories, which are in turn underpinned by sub-categories. By awarding a grade to each category, an overall rating can be deduced (Sandham & Pretorius, 2008). Other commonly used review methods include checklists, either project specific or general EIA legislation compliance checklists (Pretorius, 2006; Sutton-Pryce, 2015), however checklists are concentrated on report completeness rather than quality (Sutton-Pryce, 2015). A collection of review methodologies is discussed below.

The Lee and Colley review package

A four tier review package was developed by Lee and Colley in 1989 and this package was specifically designed to assess the quality of EIR's in the United Kingdom (Lee *et al.*, 1999). This package is widely used and accepted as an "International best practice guideline" used by practitioners, NGO's, regulators and researchers to evaluate EIR's against determined criteria (Kruger, 2012; Sandham & Pretorius, 2008; Sutton-Pryce, 2015).

This package is easily adapted to suit a specific industry and country and the assessment criteria are clear and practical, making this a very popular and widely used assessment tool (Lee and Colley, 1992; Sandham & Pretorius, 2008). According to Lee *et al.* (1999), numerous review packages have been developed and adapted on the basis of the Lee and Colley review package.

To simplify the use of this review package, the assessment criteria have been arranged in a hierarchy. The review starts at Level 1 (lowest level) which contains simple criteria related to specific tasks, from here the assessment moves up the hierarchy (Level 2-3) which entails more complex criteria related to a wider range of tasks in the EIA process, until finally an overall quality assessment (Level 4) of the EIA report has been completed (Lee *et al.*, 1999). The scores for each level are recorded on a collation sheet.

National Environmental Policy Act (NEPA): Environmental Impact Statement Checklist.

This checklist was developed by the Department of Energy (DOE) Office of NEPA Policy and Assistance and is based on NEPA regulations and on the recommendations for the preparation of EIA reports by the DOE Office of Environment, safety and health (NEPA, 1997).

This checklist consists of two separate lists, one covering general requirements and the other specific resource requirements (NEPA, 1997; Tzoumis, 2007). Both lists contain columns for “Yes”, “No” and “N/A” options and a column for comments. The content of the lists are phrased in questions, with the preferable answer being “Yes”. Not all the questions will relate to all EIR’s, hence it is recommended that the checklist be adapted to the specific projects and relating legislation (NEPA, 1997). This checklist is used by report preparers and reviewers to identify if any required information was omitted.

The Oxford-Brookes review package

This review package was developed by J. Glasson and other scholars at Oxford University in the United Kingdom (Glasson *et al.*, 2012; Sutton-Pryce, 2015). This review package was originally developed for a research study into the changing quality of EIA’s and incorporates many criteria from the Lee and Colley review package (Glasson *et al.*, 2012; Pretorius, 2006; Sutton-Pryce, 2015).

These two packages are similar in the grading system used, however it differs in the fact that the Oxford-Brookes package has three review levels, compared to the four of Lee and Colley (Glasson *et al.*, 2012; Sutton-Pryce, 2015). The hierarchy consists of review categories divided into a number of review sub-categories and the scores are recorded on a collation sheet and finally an overall score is allocated to the report (Glasson *et al.*, 2012; Sutton-Pryce, 2015). This review package is generally used by consultants and academic researchers.

South African review checklist

This checklist was developed to determine the completeness of EIR’s in South Africa and not to assess the quality of the information contained in the report (DEAT, 2004a; Sutton-Pryce, 2015). This list is simple and easy to use and entails 8 sub-sections: 1) description of the project, 2) environment, 3) impacts, 4) the methods used to compile the report, 5) discussion of alternatives and 6) mitigation measures, 7) a non-technical summary and 8) a discussion regarding the general approach to the project report (DEAT, 2004a; Sutton-Pryce, 2015).

2.2.4 EIA in South Africa

EIA practice has been part of South Africa for the past four decades and for a number of years it was a voluntary practice, but became mandatory in 1997 with the promulgation of the EIA regulations under Sections 21, 22, and 26 of the Environment Conservation Act (Act no. 73 of 1989) (ECA) (Ridl & Couzens, 2010; Sandham *et al.*, 2008a; Sandham *et al.*, 2013; Sutton-Pryce, 2015).

2.2.4.1 South African EIA development history

EIA's started off as a voluntary practice in 1970's and formed part of the Integrated Environmental Management procedure (Kidd & Retief, 2009; Sowman *et al.*, 1995). In 1989 the Environment Conservation Act was promulgated. The EIA process was given formal recognition under this act, which made provision for the Minister of Environmental Affairs to promulgate EIA regulations. These regulations were published in 1997 under Sections 21, 22, and 26 of the Act.

These regulations listed the activities for which an EIA is required and the process to be followed had the following steps (GNR 1182 & GNR 1183, 1997):

1. Submit an application for the authorisation to undertake an activity.
2. Submit a Scoping report (contains details of the PPP and all details relating to the planned activity).
3. Submit an EIR (contains information regarding the 2nd PPP, specialist studies and a draft Environmental Management Programme report).
4. The competent authority conducts a review of the EIR and then approves or rejects the application based on the review.

These regulations had two major shortcomings: no timeframes were outlined for the main steps and no provision was made for follow-up after authorisation of the activity (Sutton-Pryce, 2015; Wood, 2003). Due to the requirements for a thorough PPP and no specified timeframes, the EIA process became a lengthy and expensive process. Another weakness emerged through time and was that the scoping report's content were extended beyond what was required for a scoping report, but less than what was required of an EIR and these reports were authorised as EIR's (Sutton-Pryce, 2015; Van Heerden, 2010).

These weaknesses were addressed when new EIA regulations was published in 2006 under the National Environmental Management Act (NEMA) (Act no. 107 of 1998). The main changes

in the new EIA system were the introduction of timeframes for the different stages, the stipulation of thresholds which excluded numerous activities from requiring an EIA and the most significant change was the distinction between two types of assessment processes i.e. a Basic Assessment and a Full Assessment. A Basic Assessment is an assessment required for smaller and less complex activities, which were listed in Government Notice R 386. A Full Assessment is an assessment required for larger-scale, more complex activities which have the potential to cause significant environmental harm. These activities were listed in Government Notice R 387 (Van Heerden, 2010) which simplified the screening process and gave clear guidelines on what process to follow.

In 2010 a second updated set of EIA regulations were published under NEMA which repealed those published in 2006. The 2010 regulations were basically a fine-tuned version of the 2006 regulations (Ridl & Couzens, 2010; Van Heerden, 2010). Small changes included the exclusion of certain time periods in which the PPP may not occur, stringent deadlines placed on authorising bodies, a listing notice specifically relating to activities occurring in predefined sensitive areas and a review of the activities listed in the existing two Government Notices.

The third set of EIA regulations promulgated under NEMA was published in 2014 to give effect to the “One Environmental System”. This system refers to a decision made by the ministers that all environmental aspects will be regulated by NEMA. The decisions made are, 1) the Minister of Environmental Affairs is responsible to set the regulatory framework, 2) the Minister of the DMR is now a competent authority for implementing these newly published regulations in mining related activities, 3) the Minister of Environmental Affairs will be the appeal authority for all rejected applications, including mining and 4) mandatory auditing after authorisation has been included and 5) the timeframes for the regulated processes were aligned (Tooley & Warburton, 2015). These drastically reduced and controlled timeframes now require the applicant to do much of the ground work before submitting the application and all activity related licenses can now be applied for concurrent to the EIA application.

The 2014 regulations were accompanied by appeal- and exemption regulations published separately, three listing notices and 7 appendices which entail a description of the objective, scope and content of the following documents: 1) Basic Assessment Report, 2) Scoping report, 3) EIA report, 4) Environmental Management Programme report, 5) Closure plan, 6) specialist reports and the 7) environmental audit report (Tooley & Warburton, 2015).

2.2.4.2 EIA in the mining industry

The first piece of legislation published related to the environmental impacts of the mining sector in South Africa was the Minerals Act (Act 50 of 1991), published by the Department of Minerals and Energy (DME) in 1991.

No formal legislation requiring EIA's to be conducted in the mining sector existed before 2002. In 2002 the Minerals act was repealed and replaced by the Minerals and Petroleum Resources Development Act (MPRDA) (Act 28 of 2002) and under this act Regulation 572 was promulgated and dealt with EIA in the mining sector (Sandham *et al.*, 2008a; Sandham *et al.*, 2013a; Sutton-Pryce, 2015). This was the first piece of legislation published which made EIA's a requirement in the South African mining industry. During this time all mining related EIA's were authorized under the MPRDA by the Department of Mineral Resources (DMR), previously known as the DME.

In 2013 the MPRDA Amendment Act was published and stated that no mineral activities are to commence without authorization under NEMA from December 2014 (Sutton-Pryce, 2015), thus this Amendment act shaped the movement from mining EIA's authorized under the MPRDA to it needing authorization under NEMA. With the publication of the 2014 EIA regulations, it is clearly stated that all mining related EIA's must be authorized under NEMA, however the DMR will remain the competent authority for mining, but the appeals authority will be DEA (GNR982, 2014).

The concern is that environmental impacts will be overlooked in the approval process. An existing argument states that there is a conflict of interest with the DMR approving the EIA's in the mining sector. Reasoning behind this argument is the fact that the DMR's mandate is the promotion of mining activities in South Africa, but they have been made the "watchdog" for environmental matters in mining (Nel, 2016). Critics argue that objectivity can't be maintained if the sole purpose of an institution is the promotion of mining activities, but they also possess the power of making decisions relating to environmental matters in mining which may prevent an activity from continuing (Nel, 2016).

2.2.4.3 EIA quality review in South Africa

Numerous review packages have been developed in South Africa, the majority of which are based on the adaptation of the *Lee & Colley review package*. These packages were applied to various studies which include:

Table 2-1: Summary of the status of EIR quality appraisal research in South Africa.

	EIR quality appraisal study	Key findings
2006	Sandham & Pretorius developed a review package to determine the quality of EIA's in the North West province, a total of twenty eight reports were assessed (Sandham & Pretorius, 2008).	Review Area 1 (description of the development) and Review Area 4 (communication and results) were the best performing areas with a 75% and 94% satisfactory rating, respectively. Review Area 3 (alternatives and mitigation) was the worst performing area with a 66% satisfactory rating. Specific reference was made to the poor performance of the waste related review category which only achieved a 58% satisfactory rating. Pretorius argues that at least 80% of the category should achieve a satisfactory rating, due to the severe waste related impacts that can develop over time.
2007	Sandham, Hoffmann and Retief developed a review package to assess the quality of mining EIR's in South Africa. Twenty reports were assessed, all of which were submitted in accordance with the MPRDA requirements. (Sandham <i>et al.</i> , 2008a).	The majority of the EIRs submitted are of an acceptable standard, however a number of weaknesses such as the identification of impacts, consideration of alternatives and impact magnitude, has the potential to undermine the effectiveness of the entire EIA process.
2008	The review package developed by Sandham & Pretorius was adapted by Van der Vyver, to suit the review of EIR's submitted in the explosives industry in South Africa. A total of four reports were assessed.	The overall quality of the reports were satisfactory however the areas dealing with waste, identification of impacts, consideration of alternatives and mitigation were inadequately addressed.

	(Sandham <i>et al.</i> , 2013).	
	The review package developed by Sandham & Pretorius adapted to assess reports for projects which can potentially impact wetlands in South Africa, a total of four reports were assessed. (Sandham <i>et al.</i>, 2008b).	The four reports were generally satisfactory, however the identification and evaluation of impacts were poorly performed.
2009	A third adaptation of the review package developed by Sandham & Pretorius took place for the assessment of housing EIR's submitted in the Nkangala district of the Mpumalanga province in South Africa. Fifteen reports were assessed during this study. (Mbhele, 2009).	73% of the EIRs were of a satisfactory quality, however inadequacies were noted in the areas dealing with alternatives and mitigation.
2010	Sandham, Carrol and Retief developed a review package to assess six approved reports relating to biological control measures. (Sandham <i>et al.</i>, 2010).	The quality of the reports were of a poor standard compared to international best practice with the areas of impact identification and evaluation, mitigation and monitoring being poorly performed.
	Sandham and Van Heerden developed a review package to assess the difference in quality of EIRs between the 1997 and 2006 EIA regimes in South Africa. (Van Heerden, 2010).	The study found that the overall quality of the EIRs submitted under the 1997 regime was satisfactory and that the overall quality of the reports didn't improve with the promulgation of the 2006 regulations.

2012	For the purpose of conducting a critical analysis on the quality of filling station EIR's in South Africa, Kruger developed a review package and assessed twenty reports. (Kruger, 2012).	The study found the overall quality of the EIRs for filling stations to be of a poor standard, with the exception of the review categories dealing with the identification of impacts, impacts magnitude and the assessment of impact significance were of a good quality.
2015	A study of the quality of coal mining and related infrastructure EIR's in South Africa was conducted by Sutton-Pryce during which eighteen reports were assessed based on the review package he adapted from Lee & Colley. (Sutton-Pryce, 2015). Hallat, Retief and Sandham conducted a study into the quality of biodiversity inputs to EIA in areas with high biodiversity value – experience from the Cape Floristic Region, South Africa. (Hallat <i>et al.</i>, 2015).	67% of the EIRs were of a satisfactory quality, however the detailed analysis of the results indicated various areas of weakness such as consideration of alternatives, impact significance and waste. “Significant weaknesses identified during the review were the lack of public participation and an insufficient evaluation of alternatives. Specialists also failed to develop adequate monitoring programmes. Furthermore, a very pertinent limitation was that, in general, assessments are conducted during inappropriate seasons and over insufficient time periods” (Hallat, 2014). However, a key strength that was identified relates to all specialist taking the precautionary approach to prevent harm to biodiversity and they incorporated ecological processes in the impact assessment (Hallat <i>et al.</i>, 2015).

In summary, these studies concluded that the majority of the reports were rated as satisfactory, a few were rated as well performed and the biological control study specifically revealed the EIR's were of very poor quality (Sandham *et al.*, 2013b).

Generally the review areas relating to the description of the development and receiving environment are well performed. However the areas which are generally neglected and of poor quality are the impact identification and magnitude determination, assessment of significance, consideration of alternatives and mitigation and the assessment of cumulative impacts (Glasson *et al.*, 2005; Lee *et al.*, 1999; Sandham & Pretorius, 2008; Sandham *et al.*, 2013).

Compared to the number of EIA's submitted annually in South Africa, the study of the quality of EIR's are limited. According to Retief *et al.* (2011), approximately 4000 EIA's are conducted annually in South Africa, all of which needs to go through the approval process. A study conducted by Jeanne Davidson in 2011, regarding EIA refusals in South Africa, indicated that although there are a small number of refusals (less than 1.5 % of the submitted EIR's) the reasoning behind the refusals go beyond what is legally required by competent authorities and thus constituted to notable prevention of potential detrimental environmental impacts (Davidson, 2011). This statement made by Davidson contradicts the perception that the EIA process is just a paper exercise which is weak in arguing the content of reports.

CHAPTER 3

3 Coal mining in South Africa

3.1 Coal mining role in South Africa

Mining has played an integral role in South Africa since the 1800's. Gold mining took centre stage with coal mining playing a supporting role of producing energy for the ever-growing gold mining industry (Munnik *et al.*, 2010; Nzimande & Chauke, 2012). The majority of coal mines were owned by the gold industry in order to keep the costs of their energy inputs as low as possible, rather than profiting from the coal industry (Munnik *et al.*, 2010). This drastically changed in the 1970's when the coal price improved significantly and consequently an export market opened up. Since then coal has been railed to the Richards Bay terminal and exported to various countries (Munnik *et al.*, 2010).

The method of coal mining used depends on the depth of the coal seams. Shallow reserves are mined by means of opencast methods and deeper reserves by means of underground methods (Katoria *et al.*, 2013; Munnik *et al.*, 2010; Nzimande & Chauke, 2012). On average, South African coal seams are between 15 and 100 meters below surface. The different types of mining methods each comes with different environmental- and social impacts.

3.2 Coal mining impacts

3.2.1.1 Water

Every step in the coal mining process requires the direct use of water (Greenpeace, 2012) which include processes such as coal washing, machine washing, dust suppression, change houses etc. Needless to say, coal mining can have significant effects on the surrounding water resources and uses substantial amounts of water, hence impacting both the quality (Katoria *et al.*, 2013) and quantity of water. In a water-scarce country like South Africa, the mining industry is in constant competition for water with other users (Baxter, 2016).

As part of the mining process, groundwater is pumped out of the area in order to access coal, resulting in a decrease in the groundwater levels, reduction in the flow of underground water streams and consequently water pollution (Greenpeace, 2012). Leachate from coal discard dumps, the discharge of mine impacted water and the erosion of soil and mine waste (Chernaik, 2010), all have an impact on the quality of the surrounding water resources.

When water comes in contact with the coal, there is a high risk of the water quality being altered (Katoria *et al.*, 2013). In the majority of cases coal mining activities are associated with the generation of acid mine drainage (AMD) (Chernaik, 2010; Katoria *et al.*, 2013; Munnik *et al.*, 2010). AMD can be treated through reverse osmosis, however this is an expensive venture (Greenpeace, 2012; Munnik *et al.*, 2010) and brine water is a by-product of the treatment process which in turn needs further treatment processes. A by-product of brine water treatment is toxic salts which need to be disposed of at a registered hazardous waste disposal facility.

Key impacts which will need assessment in coal mining EIA's are their impact on surrounding water sources (Chernaik, 2010; Sutton-Pryce, 2015) such as groundwater aquifers, surface water bodies and wetlands and a description of how these impacts will be mitigated and managed. Other aspects of water that need to be considered are the current water uses, the source of potable water and the storage of contaminated water and sewerage water. Good practice will be the re-use and treatment of dirty water.

3.2.1.2 Waste

Similar to water, the coal mining process produces waste in each step of the process (Chernaik, 2010), which includes domestic waste, hazardous waste, building rubble, discard material, scrap metal, coal slurry and rubber (Chernaik, 2010). All of which needs to be managed in an appropriate and responsible manner according to the National Environmental Management: Waste Act (NEMWA), act no. 59 of 2008.

It is important for the mining house to quantify the amount of waste that is predicted to be generated in each phase of the activity, in order to develop appropriate management measures. This estimation method should be documented and the percentage of uncertainty defined (Spitz & Trudinger, 2008).

This isn't a simple process due to the fact that mines often operate over decades, with changing mine plans and consequently changing waste quantities. However good planning and an understanding of the receiving ecosystem, can reduce the potential of ill management of waste (Spitz & Trudinger, 2008).

3.2.1.3 Land

Opencast coal mining operations have major detrimental effects on land, as compared to underground mining (Katoria *et al.*, 2013). The initial phases of opencast mining include: (1) the removal of vegetation, resulting in biomass loss and the release of carbon contained in the

vegetation (Chernaik, 2010; Huang *et al.*, 2015) and (2) the stripping of topsoil, resulting in the loss of soil structure and fertility.

Key aspects which should be contained in the EIA and EMP relating to land, will be the management measures to be implemented during mining, e.g. topsoil storage, the rehabilitation plan and planned subsidence management. Reference should be made to a mine closure plan.

3.2.1.4 Air

Coal mining is associated with the generation of fugitive dust; dust generating activities include: drilling, blasting, hauling, handling, transporting with conveyors, crushing, spontaneous combustion and storage (Chernaik, 2010; Katoria *et al.*, 2013; Munnik *et al.*, 2010). The burning of coal by power stations is another major source of air pollution (Munnik *et al.*, 2010) and is aggravated by the age and lack of maintenance of the power stations in South Africa.

Key aspects to be addressed in the EIA and EMP, regarding air quality would include the identification of surrounding communities which may be impacted by fugitive dust. Mitigation measures to be addressed are topsoil- and overburden management, dust suppression, dust barriers (Katoria *et al.*, 2013), to control the dust and monitoring measures to assess the effectiveness of the mitigation measures.

3.2.1.5 Socio-economic

Coal mining affects communities both in a positive- and negative manner, on multiple levels, depending on the phase of the activity (Chernaik, 2010; Katoria *et al.*, 2013):

Mine establishment: Displacement of some communities resulting in loss of livelihood (Chernaik, 2010; Katoria *et al.*, 2013), however the construction activities will create a number of employment opportunities.

Mine operation: Surrounding communities might be subjected to pollution- fugitive dust, vibration, noise and water (Chernaik, 2010; Katoria *et al.*, 2013). However various employment and skills development opportunities will arise and there will be an economic injection into the surrounding towns.

Mine closure: If a mine was to close, it will lead to a loss of income as well as an economic standstill, (Chernaik, 2010; Katoria *et al.*, 2013), however mining companies in South Africa have a legal obligation to ensure workers are re-skilled and communities are uplifted and left with opportunities after the mining operation has ceased.

CHAPTER 4

4 Research methodology

4.1 Introduction

This research was conducted through a document analysis of 15 coal mining EIRs in South Africa. The EIRs were obtained from assessment practitioners' websites and analysed through the application of a customised review package. The following steps were taken:

1. A literature review conducted on the critical water and waste issues related to coal mining.
2. Evaluation criteria developed to analyse the extent to which critical water and waste issues were addressed.
3. Case selection criteria applied for the identification and selection of 15 EIR's.
4. Evaluation criteria was applied to determine the extent to which critical water and waste challenges are addressed in the selected sample of 15 EIR's
5. Evaluation criteria applied and presented in graphs and percentage statistics.
6. Recommendations made for EIA practice related to coal mining and possible areas of further research highlighted.

4.2 Evaluation criteria

The Lee and Colley review model was used as basis for the development of evaluation criteria to assess the extent to which critical water and waste issues are addressed in coal mining EIA's. The evaluation criteria is tailored based on the critical water- and waste impacts of coal mining, as discussed in Chapter 3 and a review of the following literature:

- Lee and Colley review package (Lee *et al.*, 1999),
- Water use regulations under the National Water Act (NWA), Act 36 of 1998,
- Waste regulations under NEMWA,
- NEMA: Environmental Impact Assessment Regulations, 2010

It is recommended that at least two reviewers independently partake in the evaluation process, in order to reduce subjectivity (Lee & Colley, 2000; Wood, 2003). The developed evaluation package (see Annexure 1) was tested through its application to a single case study, with two independent reviewers. The reviewers compared the review findings, viewpoints were shared and consensus reached. The developed evaluation package was then applied to the remaining 14 EIR's by a single reviewer.

Table 4-1: Summary of the review areas, categories and subcategories tailored for the evaluation package.

Review Areas/ Category	Summary of all review areas		
1	Description of all groundwater related impacts	2.5.5	Effluent discharge
1.1	Aquifer classification and testing	2.6	Potable water
1.2	Groundwater qualities and levels	2.6.1	Source
1.2.1	Groundwater uses	2.6.2	Quantity
1.2.2	Mine inflow and dewatering rates	2.7	Impact management
1.2.3	Changes in groundwater levels during mining and after mine closure	2.7.1	Mitigation measures
1.2.4	Changes in groundwater quality during mining and after mine closure	2.7.2	Monitoring
1.3	Acid base accounting	2.7.3	Environmental management plan
1.4	Groundwater numerical modelling		
1.5	Cumulative impacts	3	Description of all waste related impacts
1.6	Impact management	3.1	Types and quantities of waste
1.6.1	Mitigation measures	3.1.1	Construction phase
1.6.2	Monitoring measures	3.1.2	Operational phase
1.6.3	Environmental management plan	3.1.3	Decommissioning phase
2	Description of all surface water related impacts	3.2	Description of the method used to obtain the quantities of waste
2.1	Wetlands		
2.1.1	Wetland delineation	3.3	Waste legislation review-applicable licensing
		2.5.3	Licensing
		2.5.4	Plant management

2.1.2	Wetland types
2.1.3	Wetland functions (importance)
2.1.4	Changes in wetland functions
2.1.5	Cumulative impacts
2.2	Surface water bodies
2.2.1	Catchment delineation
2.2.2	Identification of pollution sources
2.2.3	Surface water uses
2.2.4	Changes in surface water levels during mining and after mine closure
2.2.5	Changes in surface water qualities during mining and after mine closure
2.2.6	Cumulative impacts
2.3	Storage of contaminated water
2.3.1	Water balance
2.3.2	Dams
2.3.3	Clean and dirty water separation
2.4	Water legislation review-applicable licensing
2.5	Sewage
2.5.1	Treatment plant capacity
2.5.2	Plant grading

3.4	Co-disposal facility i.e. coal discard dump
3.4.1	Footprint of the dump
3.4.2	Lining of the dump
3.4.3	Clean and dirty water separation
3.4.4	Stability and seepage monitoring
3.5	Waste treatment and disposal
3.5.1	Construction phase
3.5.2	Operational phase
3.5.3	Decommissioning phase
3.6	Impact management
3.6.1	Mitigation measures
3.6.2	Monitoring measures
3.6.3	Environmental management plan

4.3 EIR sampling criteria

A total of 15 full EIR's directly related to coal mining in South Africa were reviewed/evaluated; all of which were authorized under the 2010- and 2014 NEMA: EIA Regulations. The sample size was selected based on existing literature on EIR quality appraisal in South Africa (Sutton-Pryce, 2015 – 18 EIR's specific to coal mining and related infrastructure; Kruger, 2012 – 20 EIR's specific to filling stations; Mbhele, 2009 – 15 EIR's related to housing in the Nkangala district; Sandham *et al.*, 2008a – 20 EIR's related to the mining sector in North West).

Given the limited time available and the difficulty in obtaining hardcopy EIR's from DEA, the EIR's were obtained in soft copy from the websites from a number of environmental assessment practitioners (EAPs). This method of obtaining EIR's is acceptable given the practice by EAP's in South Africa to use their websites as a platform for obtaining comments from the public (Sutton-Pryce, 2015). Annexure 1 presents the comprehensive list of EIR's reviewed for this research.

4.4 Data analysis and interpretation

The data acquired were evaluated for quality, with the use of the evaluation criteria developed specifically for this research study. The quality assessment started at the lowest level, moving to higher levels (levels two to four) until it was possible to deduce an overall quality score for the EIR. Figure 4-1 indicates the assessment levels used in this evaluation process.

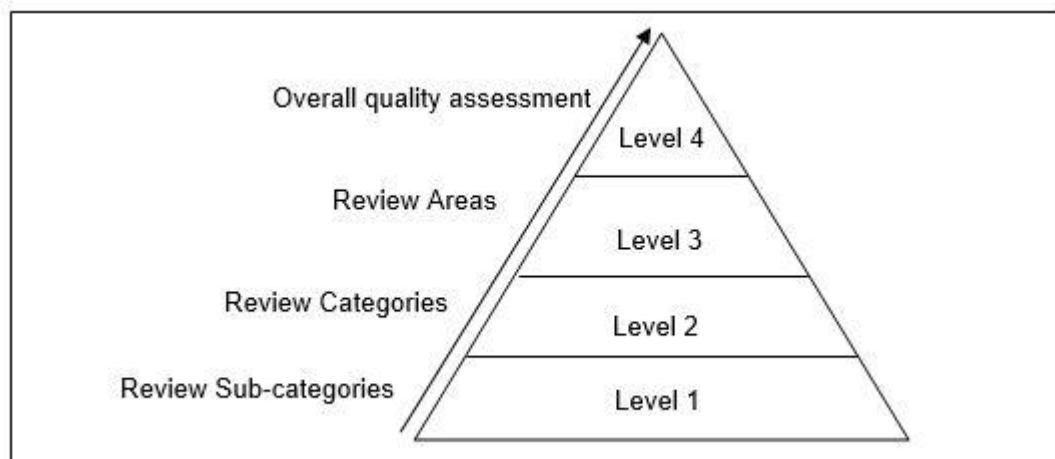


Figure 4-1: Evaluation package assessment levels

The quality assessment results are presented by means of tables and figures displaying how well or poorly the different tasks were performed. Table 4-2 and 4-3 shows the collection of assessment symbols to illustrate the quality ranking. EIR's achieving a rank between A to C are

generally regarded as of satisfactory quality, grades between D to F are consequently regarded to be of an unsatisfactory quality (Lee and Colley, 1999). With these symbols it is possible to identify the strengths and challenges of the respective EIR's.

Table 4-2: Collection of assessment symbols

Symbol	Collection	
A	Well-performed	Satisfactory
B		
C	Borderline	
D		
E	Poorly performed	Unsatisfactory
F		

Table 4-3: Assessment symbols explanations

Symbol	Explanation
A	Relevant tasks well performed, no important tasks left incomplete.
B	Generally satisfactory and complete, only minor omissions and inadequacies.
C	Can be considered just satisfactory despite omissions and/or inadequacies.
D	Parts are well attempted but must, as a whole, be considered just unsatisfactory because of omissions or inadequacies.
E	Not satisfactory, significant omissions or inadequacies.
F	Very unsatisfactory, important task(s) poorly done or not attempted.
NA	Not applicable. The Review Topic is not applicable or it is irrelevant in the context of this Statement.

CHAPTER 5

5 Research results and analysis

5.1 Introduction

This chapter provides an analysis and discussion of the research findings. The first section deals with the overall quality of the EIRs, which is then followed by the detailed performance of each review area. The final section of the chapter provides a summary of the strengths and weaknesses identified through the review.

5.2 General overview of EIR quality

The analyses of the overall quality of the sample of 15 EIRs revealed that 93% of them were conducted satisfactory (rating A-C).

Figure 5-1 presents the overall percentage scores of the examined EIRs and it indicates that only one (7%) of the EIRs scored a B-grade, which makes it the only report which is generally complete with minor omissions. Thirteen (86%) of the EIRs scored a C-grade which is regarded as just satisfactory despite omissions. One (7%) of the EIRs obtained a D-rating, indicating that parts of the report were well attempted, but overall it was of unsatisfactory quality.

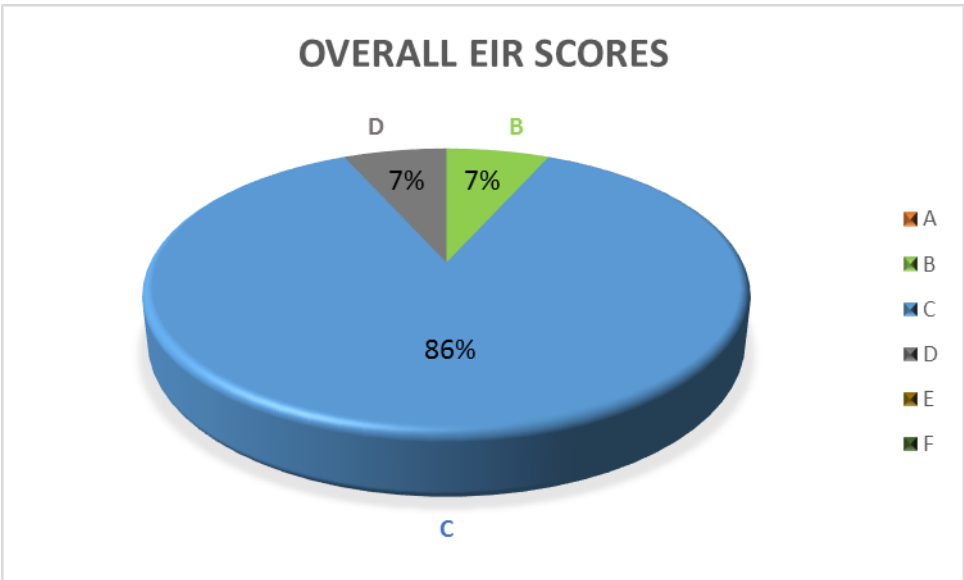


Figure 5-1: Overall percentage assessment scores for the evaluated EIRs.

Figure 5-2 presents the distribution of assessment symbols of the three review areas. It was found that EIRs in the coal mining industry of South Africa tended to achieve higher scores in Review Area's one and two with very low scores for Review Area three. The latter corresponds with comparative studies done in South Africa related to the mining and explosives industry, which also indicated waste related impacts were poorly addressed (Sandham *et al.*, 2008a; Sandham *et al.*, 2013; Sutton-Pryce, 2015).

All 15 EIRs achieved a satisfactory grade for review area one, concerning groundwater related impacts, with 93% of the EIRs regarded as well-performed for Review Area one and 7% of the EIRs had a borderline performance for this review area.

All 15 EIRs achieved a satisfactory grade for review area two, concerning surface water related impacts, with 80% of the EIRs regarded as well-performed for this review area and 20% of the EIRs had a borderline performance for this review area.

A mere 33% of the EIRs achieved a satisfactory grade for Review Area three, concerning waste related impacts, which points to 67% of the EIRs performing to an unsatisfactory quality in this review area . A total of 86% of EIRs achieved a borderline grading for Review Area three and an additional 7% is regarded as poorly performed.

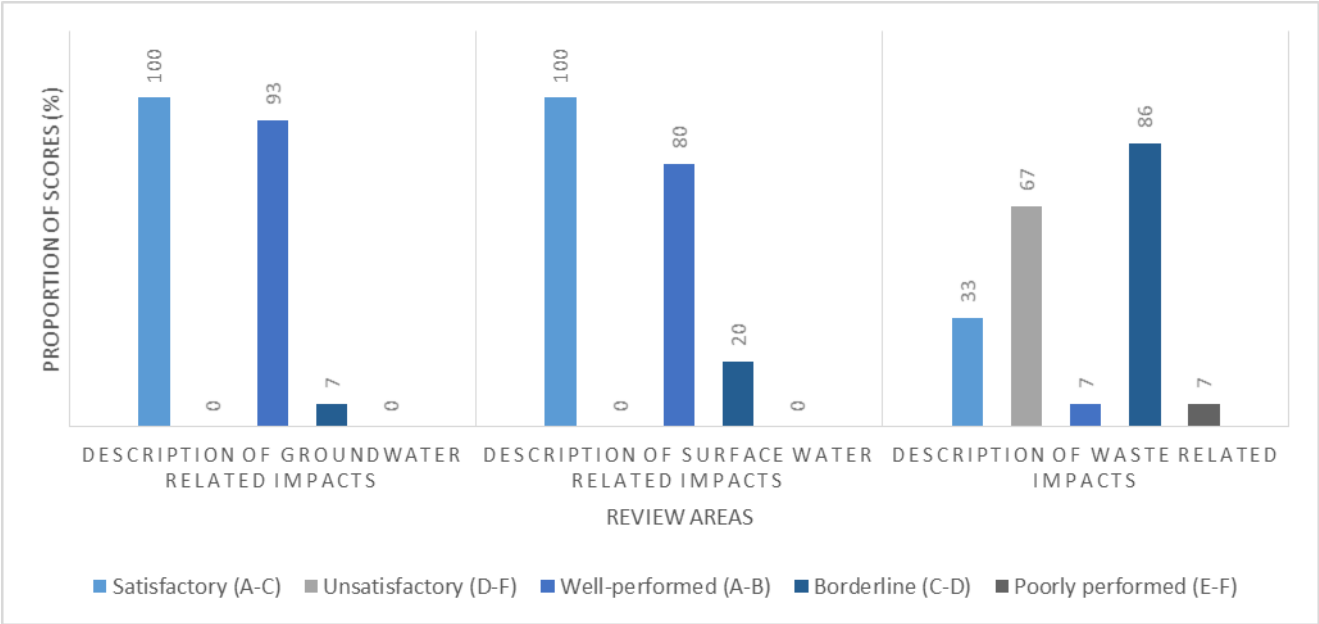


Figure 5-2: Distribution of assessment symbols for all three review areas.

Table 5-1 displays a summarised overview of the performance of all three the review areas. Both Review Area one- and two's review categories performed well, with the majority of quality ratings in the A-B (good) rankings. Review Area three on the other hand performed poorly, with the bulk of category quality ratings in the E-F (poor) ranking. A-B ranking ratings are considered as strengths and E-F ranking ratings as weaknesses.

Table 5-1: Summarized overview of the assessment scores for all EIRs evaluated.

SCORE SUMMARY- RA 1		A	B	C	D	E	F	NA	% A-C	% A-B	% C-D	% E-F
1.1	Aquifer yields	11	1	3	0	0	0	0	100	80	20	0
1.2	Groundwater qualities and levels	5	8	1	0	1	0	0	93	86	7	7
1.3	Borehole acid base counting	12	1	2	0	0	0	0	100	86	14	0
1.4	Groundwater model	12	2	1	0	0	0	0	100	93	7	0
1.5	Cumulative impacts	6	3	3	0	0	3	0	80	60	20	20
1.6	Impact management	9	6	0	0	0	0	0	100	100	0	0
SCORE SUMMARY- RA 2		A	B	C	D	E	F	NA	% A-C	% A-B	% C-D	% E-F
2.1	Wetlands	11	4	0	0	0	0	0	100	100	0	0
2.2	Surface water	5	10	0	0	0	0	0	100	100	0	0
2.3	Storage of contaminated water	2	3	3	1	1	3	2	62	38	31	31
2.4	NWA	12	3	0	0	0	0	0	100	100	0	0
2.5	Sewage	2	2	1	1	0	4	5	50	40	20	40
2.6	Potable water	5	0	3	2	0	4	1	57	36	36	28
2.7	Impact management	8	7	0	0	0	0	0	100	100	0	0
SCORE SUMMARY- RA 3		A	B	C	D	E	F	NA	% A-C	% A-B	% C-D	% E-F
3.1	Type and quantity of waste	0	1	0	1	2	11	0	7	7	7	86
3.2	Methods used to obtain quantities	0	1	0	0	2	12	0	7	7	0	93
3.3	NEMWA	9	2	2	1	0	1	0	87	73	20	7
3.4	Co-disposal facility	0	3	0	0	2	1	9	50	50	0	50
3.5	Treatment and disposal	0	10	4	0	0	1	0	93	60	33	7
3.6	Impact management	1	10	3	1	0	0	0	93	73	27	0

5.3 Quality of EIRs for Review Area 1: Groundwater

Figure 5-3 reveals that the best performing review categories were 1.2 (groundwater qualities and levels), 1.3 (borehole acid base counting), 1.4 (groundwater model) and 1.6 (impact management). These review categories scored the highest number of well-performed ratings (A-B). This not only indicates that sufficient attention was paid to obtain quality comprehensive baseline information, but also advanced technology and systems were used to make accurate predictions of future conditions. These results are positive as it indicates that a comprehensive investigation was done with regards to groundwater which allows for more accurate predictions (Surinaidu *et al.*, 2014).

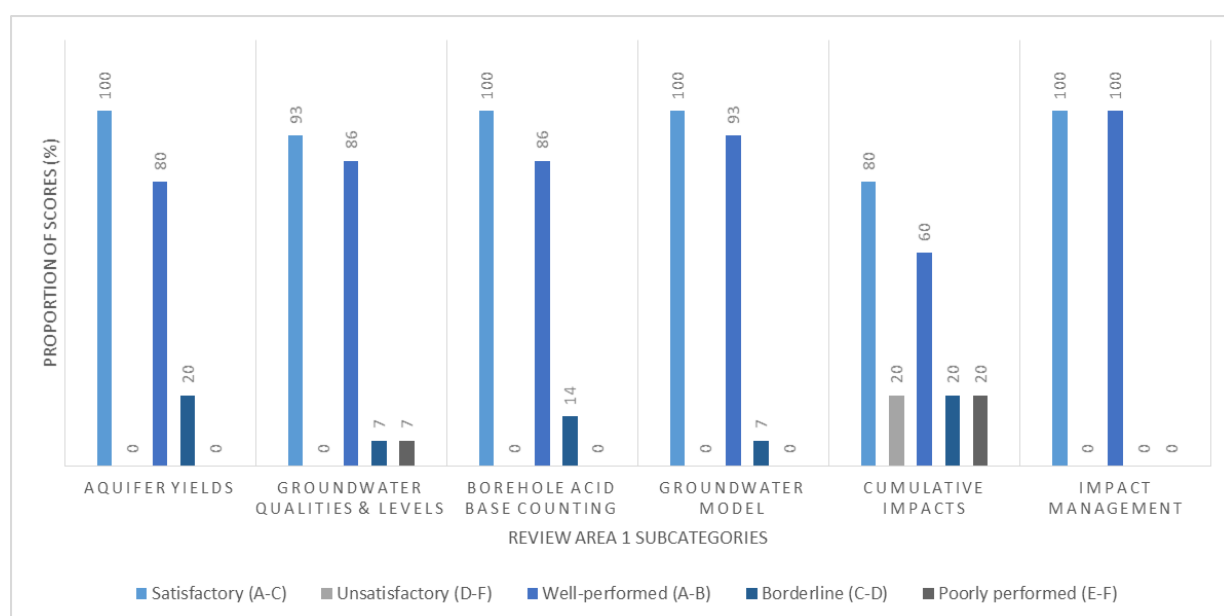


Figure 5-3: Distribution of assessment scores for Review Area 1

All (100%) coal mining EIRs achieved a satisfactory (A-C) quality rating for Review Category 1.1 (aquifer yields), with 80% of the 100% being of a well-performed (A-B) quality grade. The majority of EIRs (93%) achieved a satisfactory (A-C) quality rating for Review Category 1.2 (groundwater qualities and levels). The analysis of the review subcategories reveals a number of strengths and weaknesses within the category (see Table 5-2). For instance, Subcategory 1.2.3 (predicted changes in borehole quality) and 1.2.4 (predicted changes in borehole levels) performed the best with both subcategories receiving a 93% well-performed (A-B) quality score. Subcategories 1.2.1 (uses for groundwater) and 1.2.2 (predicted inflows) scoring 80% and 86% well-performed (A-B) quality rating, respectively.

The majority of EIRs scored a satisfactory (A-C) quality rating for Review Categories 1.3 (borehole acid base counting), 1.4 (groundwater model) and 1.5 (cumulative impacts). Review Categories 1.3 (borehole acid base counting) and 1.4 (groundwater model) achieved 86% and 93% well-performed (A-B) quality rating, respectively. This indicates that the potential for acid mine drainage (AMD) was assessed and that a model was used to predict impacts on the volumes, flow and quality of groundwater, which in turn provides the mines with an indication of appropriate management measures to implement as prevention for such impacts. The worst performing review category in Review Area 1 is Review Category 1.5 (cumulative impacts), which is in line with the conclusion made by Sandham *et al.* (2005) and Barker & Jones (2013): EAPss frequently struggle with aspects of the EIA that relates to the analyses of cumulative impacts.

All EIRs achieved a well-performed (A-B) quality rating for Review Category 1.6 (impact management), which drills down to Review Subcategories 1.6.1 (mitigation), 1.6.2 (monitoring) and 1.6.3 (EMP), all of which scored 100% well-performed (A-B) quality rating. The good performance of these review subcategories reveal that great consideration is given to the management of groundwater impacts. It also indicates that the specialist field of groundwater management is a well-known field in South Africa.

Table 5-2: Quality ratings of review subcategories for Review Area 1

SCORE SUMMARY- RA 1		A	B	C	D	E	F	NA	% A-C	% A-B	% C-D	% E-F
1.1	Aquifer yields	11	1	3	0	0	0	0	100	80	20	0
1.2	Groundwater qualities and levels	5	8	1	0	1	0	0	93	86	7	7
1.2.1	Uses of groundwater	6	6	0	1	0	2	0	80	80	7	14
1.2.2	Predicted inflows	7	6	1	0	1	0	0	93	86	7	7
1.2.3	Predicted changes in borehole quality	7	7	0	0	1	0	0	93	93	0	7
1.2.4	Predicted changes in borehole levels	5	9	0	0	1	0	0	93	93	0	7
1.3	Borehole acid base counting	12	1	2	0	0	0	0	100	86	14	0
1.4	Groundwater model	12	2	1	0	0	0	0	100	93	7	0
1.5	Cumulative impacts	6	3	3	0	0	3	0	80	60	20	20
1.6	Impact management	9	6	0	0	0	0	0	100	100	0	0
1.6.1	Mitigation	10	5	0	0	0	0	0	100	100	0	0
1.6.2	Monitoring	10	5	0	0	0	0	0	100	100	0	0
1.6.3	EMP	10	5	0	0	0	0	0	100	100	0	0

5.4 Quality of EIRs for Review Area 2: Surface water

Figure 5-4 reveals that the best performing review categories were 2.1 (wetlands), 2.2 (surface water), 2.4 (NWA) and 2.7 (impact management). These review categories scored the highest number of well-performed ratings (A-B). This graph gives an illustration of where the strengths and weaknesses in Review Area 2 are.

The NWA and related regulations placed a key focus on the importance of wetlands in South Africa. The fact that review category 2.1 scored exceptionally well, can be regarded as a success story, due to all EAPs paying much attention to the potential impacts on wetlands from the coal mining industry.

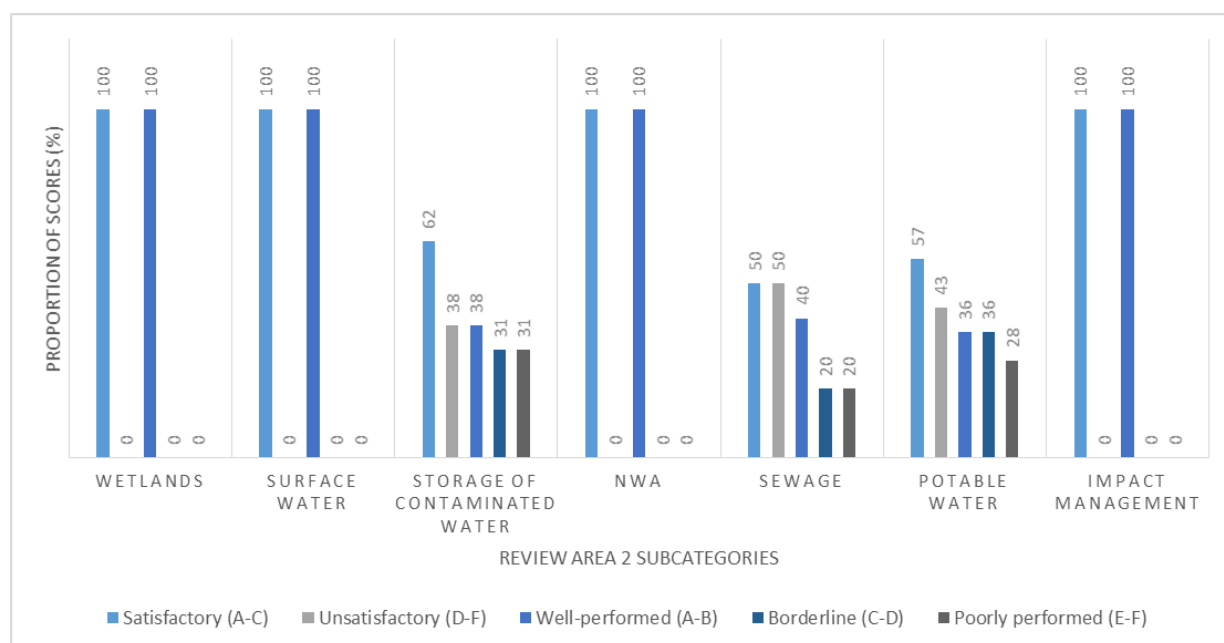


Figure 5-4: Distribution of assessment scores for Review Area 2

All 15 of the reviewed EIRs performed satisfactory (A-C) in Review Category 2.1, with the majority of the review subcategories achieving a 100% well-performed (A-B) rating. Only Review Subcategory 2.1.4 (potential changes in wetland function) and 2.1.5 (cumulative impacts) achieved a 93% well-performed rating (A-B) with a 7% borderline (C-D) rating. Although Review Subcategory 2.1.4 and 2.1.5 achieved a 7% (C-D) borderline rating, the overall assessment of impacts and related changes to wetland functions were well-performed and could thus provide sufficient information for decision making.

Review Category 2.2 which relates to surface water, performed well with all the EIRs achieving an A-B rating. The analysis of the review subcategories reveal that the majority of EIRs achieved a well-performed (A-B) rating. These results indicate that the potential sources of pollution in the coal mining industry is well-known, however the predicted changes to the quality and volume of water are poorly addressed and understood. The review subcategories achieving the highest percentage of borderline (C-D) rankings are Review Subcategory 2.2.2 (27%), 2.2.3 (34%) and 2.2.6 (20%). The only review subcategories scoring in the E-F range are Review Subcategory 2.2.2 (7%), 2.2.4 (7%) and 2.2.5 (7%). Overall the assessment of surface water impacts and predicted quality changes were well-performed.

Review Category 2.3 (storage of contaminated water) reveals that there is significant room for improvement, with all three review categories scoring high percentages in the C-D and E-F rankings. Only 46% of EIRs were of satisfactory (A-C) quality for Review Subcategory 2.3.1 (water balance). This review subcategory also scored the highest percentage of E-F quality scores (46%). Neither the design specifications of pollution control dams (2.3.2) nor the design of clean and dirty water separation system (2.3.3) were well discussed in the EIRs. The poor performance of Review Subcategory 2.3.2 and 2.3.3 can be explained by the poor performance of Review Subcategory 2.3.1, due to the fact that the site needs to know what their water make will be before being able to deduce the size of the pollution control dams required for water storage (Janowicz, 2011; Davies *et al.*, 2013). These results are quite concerning, based on the fact that these three measures form the basis of containing polluted water on site (Sutton-Pryce, 2015). All 15 EIRs consulted the National Water Act and displayed the intent to apply for the applicable water uses, hence the 100% well-performed (A-B) quality ranking for Review Category 2.4 (NWA). This performance indicates that EAPs are well aware of the requirement for the mining industry to apply for water use licenses (WULs).

Review Category 2.5 (sewage) is an overall poorly performed category with high percentages in the E-F quality ratings, ranging from 40% to 67%. The two review subcategories scoring the highest percentage in the satisfactory (A-C) quality ranking are Review Subcategory 2.5.1 (design of the plant) and 2.5.5 (effluent), both achieving 60%. The analysis of review subcategories reveals that there is a lack of consideration of the sewage treatment process and related infrastructure, permits and management measures, hence there is significant room for improvement.

Mines need to investigate a source of potable water which will be able to supply the required quantity of water throughout the life of the mine, not only for direct use in mining (e.g. production processes), but also for human consumption. Only 57% of the EIRs achieved a satisfactory (A-

C) quality rating for Review Category 2.6 (potable water). The sources of potable (2.6.1) water were discussed with great detail in 50% of the EIRs (A-C ranking), however 36% of EIRs gave little to no consideration to the source of potable water. Review Subcategory 2.6.2 (required quantity) performed even worse with 50 % of EIRs giving little to no consideration to the quantity of potable water required for the site. This is a very important factor that needs to be clearly determined before the mining process can begin. No mine can function without a source of potable water to fulfil the needs of employees and machinery.

All EIRs achieved a well-performed (A-B) quality rating for Review Category 2.7 (impact management), which drills down to Review Subcategories 2.7.1 (mitigation), 2.7.2 (monitoring) and 2.7.3 (EMP), all of which scored 100% well-performed (A-B) quality rating. The good performance of these review subcategories reveals that great consideration is given to the management of surface water impacts.

A concerning finding of this study is the fact that EIRs are approved without providing a clear indication of how polluted water will be stored and contained on site. Although there is clear indication of how impacts can be mitigated and managed, more attention should be given to prevention.

Table 5-3: Quality ratings of review subcategories in Review Area 2

SCORE SUMMARY- RA 2		A	B	C	D	E	F	NA	% A-C	% A-B	% C-D	% E-F
2.1	Wetlands	11	4	0	0	0	0	0	100	100	0	0
2.1.1	Wetland delineation	13	2	0	0	0	0	0	100	100	0	0
2.1.2	Wetland types	14	1	0	0	0	0	0	100	100	0	0
2.1.3	Wetland functions	14	1	0	0	0	0	0	100	100	0	0
2.1.4	Potential changes in function	5	9	1	0	0	0	0	93	93	7	0
2.1.5	Cumulative impacts	7	4	4	0	0	0	0	100	73	7	0
2.2	Surface water	5	10	0	0	0	0	0	100	100	0	0
2.2.1	Catchment delineation	12	2	1	0	0	0	0	100	93	7	0
2.2.2	Surface pollution sources	5	5	4	0	0	1	0	93	66	27	7
2.2.3	Surface water uses	4	6	5	0	0	0	0	100	66	34	0
2.2.4	Baseline levels and predicted changes	4	8	2	0	1	0	0	93	80	13	7
2.2.5	Baseline qualities and predicted changes	5	9	0	0	0	1	0	93	93	0	7
2.2.6	Cumulative impacts	8	4	3	0	0	0	0	100	80	20	0

2.3	Storage of contaminated water	2	3	3	1	1	3	2	62	38	31	31
2.3.1	Water balance	5	1	0	1	1	5	2	46	46	8	46
2.3.2	Design specs of PCD	3	2	3	1	1	3	2	62	38	31	31
2.3.3	Design of clean/dirty water system	3	2	3	1	1	3	2	62	38	31	31
2.4	NWA	12	3	0	0	0	0	0	100	100	0	0
2.5	Sewage	2	2	1	1	0	4	5	50	40	20	40
2.5.1	Design of plant	5	1	0	0	0	4	5	60	60	0	40
2.5.2	Grade of plant	2	1	0	0	0	6	6	33	33	0	67
2.5.3	Applicable permits	2	1	1	0	0	5	6	44	33	11	56
2.5.4	Management	2	1	2	0	0	5	5	50	30	20	50
2.5.5	Effluent	6	0	0	0	0	4	5	60	60	0	40
2.6	Potable water	5	0	3	2	0	4	1	57	36	36	28
2.6.1	Source of potable water	7	0	2	0	1	4	1	64	50	14	36
2.6.2	Required quantity	5	1	1	0	1	6	1	50	43	7	50
2.7	Impact management	8	7	0	0	0	0	0	100	100	0	0
2.7.1	Mitigation	8	7	0	0	0	0	0	100	100	0	0
2.7.2	Monitoring	7	8	0	0	0	0	0	100	100	0	0
2.7.3	EMP	7	8	0	0	0	0	0	100	100	0	0

5.5 Quality of EIRs for Review Area 3: Waste

Figure 5-5 reveals that the best performing Review Categories were 3.3 (NEMWA), 3.5 (treatment and disposal) and 3.6 (impact management). These review categories scored the highest number of well-performed ratings (A-B). This graph gives an illustration of where the strengths and weaknesses in Review Area 3 are.

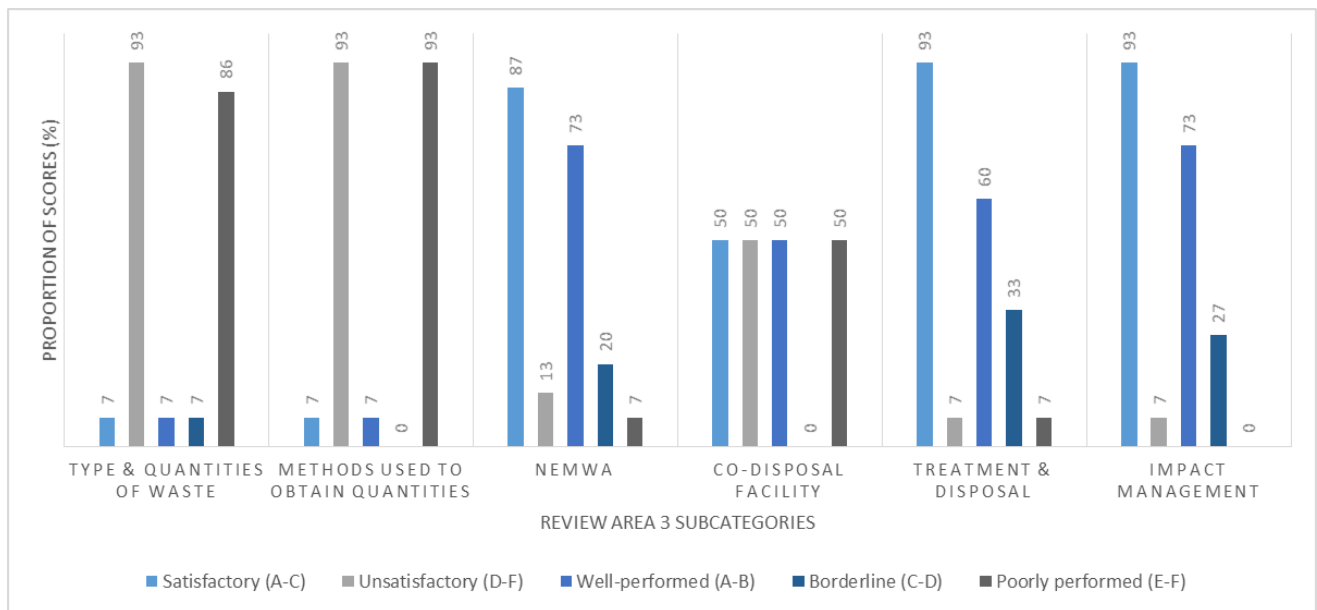


Figure 5-5: Distribution of assessment scores for Review Area 3

Review Category 3.1 (type and quantity of waste) was overall poorly performed, with all three review subcategories scoring an 86% E-F quality rating (see Table 5-4). Only 7% of the EIRs were of a satisfactory (A-C) quality. It is clear that little or no attention was given to the type and quantities of waste that will be generated throughout the phases of mining. This has been found in numerous other EIR quality evaluation studies (Kruger & Chapman, 2005; Sandham *et al.*, 2008a; Kruger, 2012) where a high percentage of EIRs perform poorly in review categories related to waste. The poor performance of Review Category 3.2 (methods used to obtain quantities of waste) is directly linked to the poor performance of Review Category 3.1 (type and quantity of waste). This indicates that EAPs aren't using appropriate methods to predict the quantities of waste. Various techniques for waste estimation exist for e.g. modelling techniques such as Generic weight generation data and Generation rates for specific waste types or Direct measurement techniques such as pilot studies or obtaining existing data from similar activities (DEAT, 2000).

It is important for the mining house to quantify the amount of waste that is predicted to be generated in each phase of the activity, in order to develop appropriate management measures. This estimation method should be documented and the percentage of uncertainty defined (Spitz & Trudinger, 2008). This isn't a simple process due to the fact that mines often operate over decades, with changing mine plans and consequently changing waste quantities. However good planning and an understanding of the receiving ecosystem, can reduce the potential of ill management of waste (Spitz & Trudinger, 2008).

Review Category 3.3 reveals that the National Environmental management: Waste Act (NEMWA) was consulted. Although the type and quantity of waste wasn't well addressed, the treatment and disposal thereof (Review Category 3.5) showed an improvement with 93% of the EIRs achieving a satisfactory (A-C) grade of which 60% is a well-performed (A-B) quality rating. Review Category 3.4 (Co-disposal facility) reveals that 50% of the EIRs addressed the aspects related to discard facilities well (A-B quality), however the other 50% of the EIRs performed poorly (E-F) in this category.

The majority of EIRs achieved a well-performed (A-B) quality rating for Review Category 3.6 (impact management), which drills down to Review Subcategories 3.5.1 (mitigation), 3.5.2 (monitoring) and 3.6.3 (EMP), all of which scored a 93% satisfactory (A-C) rating and a 73% well-performed (A-B) quality rating.

Table 5-4: Quality ratings of review subcategories in Review Area 3

SCORE SUMMARY RA 3		A	B	C	D	E	F	NA	% A-C	% A-B	% C-D	% E-F
3.1	Type and quantity of waste	0	1	0	1	2	11	0	7	7	7	86
3.1.1	Construction phase	0	1	0	1	2	11	0	7	7	7	86
3.1.2	Operational phase	0	1	0	1	2	11	0	7	7	7	86
3.1.3	Decommissioning phase	0	1	0	1	2	11	0	7	7	7	86
3.2	Methods used to obtain quantities	0	1	0	0	2	12	0	7	7	0	93
3.3	NEMWA	9	2	2	1	0	1	0	87	73	20	7
3.4	Co-disposal facility	0	3	0	0	2	1	9	50	50	0	50
3.4.1	Footprint of the dump	0	3	0	0	1	2	9	50	50	0	50
3.4.2	Lining of the dump	0	3	0	0	2	1	9	50	50	0	50
3.4.3	Clean and dirty water separation	0	3	0	1	1	1	9	50	50	0	50
3.4.4	Stability and seepage monitoring	0	3	0	2	1	1	9	50	50	0	50
3.5	Treatment and disposal	0	9	5	0	0	1	0	93	60	33	7
3.5.1	Construction phase	0	9	5	0	0	1	0	93	60	33	7
3.5.2	Operational phase	0	9	5	0	0	1	0	93	60	33	7
3.5.3	Decommissioning phase	0	9	5	0	0	1	0	93	60	33	7
3.6	Impact management	1	10	3	1	0	0	0	93	73	27	0
3.6.1	Mitigation	1	10	3	1	0	0	0	93	73	27	0
3.6.2	Monitoring	0	11	3	1	0	0	0	93	73	27	0

3.6.3	EMP	1	10	3	1	0	0	0	93	73	27	0
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5.6 Summary of strengths and weaknesses of evaluated EIRs

The data from the review provide an indication of the 'best' performed categories- having the highest percentage of A-C grading's, and 'worst'- having the lowest percentage of A-C grading's. All categories considered, a number of strengths can be identified, evident from the high number of A-C grades and not as many categories which can be regarded as weaknesses.

Considering the overall quality of the three review areas, only Review Area 3 performed unsatisfactorily. Review Area 1, relating to groundwater impacts, was the best performing review area, however Review Area 2, relating to surface water impacts, not falling far behind. This indicates that the tasks related to the analytical prediction of waste related impacts are an area of weakness.

Weaknesses were also identified in each in Review Area 2, although predominantly in Review Area 3.

- 2.5- Sewage
- 2.6- Potable water
- 3.1- Type and quantity of waste
- 3.2- Methods used to obtain quantities
- 3.3- Co-disposal facility

Key strengths were also identified. The issues that were addressed, with a score of more than 80% A-B, fall predominantly in Review Area 1 and 2.

- 1.1- Aquifer yields
- 1.2- Groundwater qualities and levels
- 1.3- Borehole acid base counting
- 1.4- Groundwater model
- 1.6- Impact management
- 2.1- Wetlands
- 2.2- Surface water
- 2.4- NWA
- 2.7- Impact management

The key findings of this study are:

- A hundred (100) percent of the EIRs achieved a satisfactory (A-C) rating, of which seventy three (73) percent was well-performed (A-B).
- The aspects related to surface- and groundwater issues in coal mining in South Africa were well addressed.
- The major area of weakness is related to waste aspects in coal mining.

The results from the reviewed EIRs generally correspond with previous studies done in South Africa on the quality of EIRs, with specific reference to review categories related to waste (Kruger & Chapman, 2005; Sandham *et al.*, 2008a; Kruger, 2012). It also adds new information regarding the detailed consideration of surface and groundwater related aspects in the South African coal mining industry.

CHAPTER 6

6 Conclusion

6.1 Introduction

This research study reviewed the quality of water and waste related aspects of a sample of EIRs specific to the South African coal mining industry. This chapter provides a summary of the conclusions from the study, followed by recommendations for future studies.

6.2 Conclusion

The effectiveness of the EIA process has been a cause of concern for practitioners world-wide (Barker & Wood, 1999; Christensen *et al.*, 2005; Wood, 2003) and has raised questions whether the information acquired during the assessment process is of a quality that can be used to inform developers and decision makers (Kruger & Chapman, 2005; Glasson *et al.*, 2012).

This study evaluated the extent to which critical water- and waste issues were addressed in 15 coal mining EIRs approved in South Africa under the 2010- and 2014 NEMA EIA regulations, through the use of a review package adapted from the original *Lee and Colley review package*. This study revealed that a 100% of the EIRs achieved a satisfactory quality rating (A-C), of which 73% were well performed (A-B).

When it came to the description and analysis of critical surface- and groundwater related aspects, the majority of the EIRs achieved a well-performed (A-B) quality rating. This indicates that EAPs spend much time and consideration on potential impacts coal mining may have on the water resources and how these can be controlled and mitigated.

Despite the fact that the majority of the results were positive, it became quite clear that there is a need for improvement in addressing waste related issues in coal mining EIRs. The poor performance of this review area is concerning as waste is an important aspect in any mining operation and if not dealt with appropriately significant impacts can accumulate over time and have detrimental impacts on the environment as well as the financial standing of the particular company (Sutton-Pryce, 2015).

6.3 Recommendations

Considering the number of coal mines in South Africa, the important role they play in the energy and economic sector of this country (Nzimande & Chauke, 2012) as well as their potential

impact on critical water resources and waste management practices (Sutton-Pryce, 2015), it becomes clear that the weaknesses identified in this research study need to be addressed.

6.3.1 Recommendations to practice

As mentioned, the major weakness identified in this study is related to waste, especially related to the prediction of the quantity of waste in each development phase and a description of the methods used to determine the values. Not a single EIR achieved a satisfactory (A-C) quality rating in the review categories related to the latter, hence there is a clear need for guidelines in determining the quantity of waste in development phases.

My recommendation is that different spheres of government and private sector come together and workshop these issues with the purpose of publishing a guideline document to assist EAPs in future with determining the quantity of waste in different development phases.

6.3.2 Recommendations for future studies

A valuable future study would be to assess the extent to which the issues addressed in the EIR were transferred to the EMPr and review related audit reports to check compliance to commitments made. This will potentially sketch a picture of how information gathered in the assessment phase was carried through to the operational phase of the development.

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ANNEXURES

ANNEXURE 1: EVALUATION PACKAGE

Evaluation criteria for the analysis of the extent to which critical water and waste issues are addressed in 15 coal mining EIRs in South Africa.

Review area 1: Description of all groundwater related impacts

Groundwater: the objective of this review area is to assess the potential impacts of the proposed mining activity on the groundwater regime.

- 1.1. All aquifers in the project area identified and yields determined
- 1.2. Groundwater qualities and levels
 - 1.2.1 The current uses of groundwater
 - 1.2.2 Description of the groundwater intersected (aquifers), the predicted inflow and dewatering rates.
 - 1.2.3 The number of boreholes assessed (existing holes and newly drilled holes), with details of the baseline qualities, predicted changes during and after mining, of each borehole.
 - 1.2.4 The number of boreholes assessed (existing holes and newly drilled holes), with details of the baseline levels, predicted changes during and after mining, of each Borehole.
- 1.3 All borehole samples assessed for acid generation (acid based accounting - geochemical).
- 1.4 Qualification of the potential impact of the mining activities on the groundwater environment through a numerical model.
- 1.5 Description of the potential cumulative impacts related to groundwater
- 1.6 Impact management
 - 1.6.1 Potential mitigation measures for identified impacts
 - 1.6.2 Monitoring measures for mitigation described
 - 1.6.3 Detailed Environmental Management Plan for identified impacts.

Review area 2: Description of all surface water related impacts

Surface water: the objective of this review area is to assess the potential impacts of the proposed mining activity on the surface water regime.

- 2.1 Wetlands
 - 2.1.1 Wetland delineation indicating the inflows
 - 2.1.2 Description of the different wetland types identified in and around project area
 - 2.1.3 Description of the functions of each wetland identified in the specialist study
 - 2.1.4 Description of the potential changes in the wetland function in each development phase (construction, operation, decommission)
 - 2.1.5 Description of the potential cumulative impacts related to wetlands

2.2 Surface water

2.2.1 Catchment delineation

2.2.2 Identification and description of potential surface pollution sources

2.2.3 Description of current surface water uses

2.2.4 The number of surface samples assessed with details of the baseline levels, predicted changes during and after mining.

2.2.5 The number of surface samples assessed with details of the baseline qualities, predicted changes during and after mining.

2.2.6 Description of the potential cumulative impacts related to surface water

2.3 Storage of contaminated water

2.3.1 Water balance illustrating water make and required storage capacity.

2.3.2 Design specifications for all proposed pollution control dams to be constructed, locations indicated on a map

2.3.3 Design specifications for the clean-and dirty water system; system indicated on a map

2.4 A review of the National Water Act listed activities and the intent to apply.

2.5 Sewage

2.5.1 Design of the proposed sewage plant, clearly indicating the capacity

2.5.2 Details regarding the grade of the treatment plant

2.5.3 A review of applicable permits and licensing and intent to apply

2.5.4 Details regarding the individual or company responsible for the management of the plant and their related requirements

2.5.5 Details regarding the discharge of effluent

2.6 Potable water

2.6.1 Identification and description of the source of potable water and their permission to supply

2.6.2 Details regarding the quantity of potable water required and the related calculations

2.7 Impact management

2.7.1 Potential mitigation measures for identified impacts

2.7.2 Monitoring measures for mitigation described

2.7.3 Detailed Environmental Management Plan for identified impacts.

Review area 3: Description of all waste related impacts

3.1 Types and quantities of waste

3.1.1 Description of the quantities of waste generated during the construction phase

3.1.2 Description of the quantities of waste generated during the operational phase (including discard dumps)

3.1.3 Description of the quantities of waste generated during the decommissioning phase (including discard dumps)

3.2 Detailed description of the method/s used to obtain the quantities of waste in each phase of the proposed activity.

3.3 A review of the National Environmental Management: Waste Act listed activities and the intent to apply.

3.4 Co-disposal facility i.e. coal discard dump

3.4.1 Footprint of the dump

3.4.2 Lining of the dump

3.4.3 Clean and dirty water separation around the dump

3.4.4 Stability and seepage monitoring (piezometer readings)

3.5 Waste treatment and disposal

3.5.1 Description of the treatment or disposal of waste generated during the construction phase

3.5.2 Description of the treatment or disposal of waste generated during the operational Phase (including discard dumps)

3.5.3 Description of the treatment or disposal of waste generated during the decommissioning phase (including discard dumps)

3.6 Impact management

3.6.1 Potential mitigation measures for identified impacts

3.6.2 Monitoring measures for mitigation described

3.6.3 Detailed Environmental Management Plan for identified impacts

ANNEXURE 2: LIST OF REVIEWED EIRS

<i>Number</i>	<i>EIR</i>	<i>Year</i>
1	Environmental Impact Assessment Report for Oogiesfontein Opencast Mine	2009
2	Environmental Impact Assessment Report for the proposed Xstrata Amersfoort underground coal mine	2013
3	Environmental Impact Assessment Report for the proposed Zonnebloem opencast coal mine	2014
4	Environmental Impact Assessment Report for the New Largo Colliery	2012
5	Environmental Impact Assessment Report for the proposed Brakfontein coal mine	2012
6	Environmental Impact Assessment Report for Bank Colliery Access Brown Shaft II	2013
7	Environmental Impact Assessment Report for Delmas Coal	2014
8	Environmental Impact Assessment Report for Landau Colliery: Navigation West South Block extension	2015
9	Environmental Impact Assessment Report for Vunene Colliery	2012
10	Environmental, Social and Health Impact Assessment Report for Khongoni Haaskraal Coal	2015
11	Environmental Impact Assessment Report for Klipspruit Extension: Weltevreden	2015
12	Environmental Impact Assessment Report for Anglo Operations (PTY) LTD: Kleinkopje Colliery	2016
13	Environmental Impact Assessment Report for the proposed expansion of Wolwekrans Colliery North	2016
14	Environmental Impact Assessment Report for Anglo American Inyosi Coal (PTY) LTD: Heidelberg South Rand Underground Mining Project	2015
15	Environmental Impact Assessment Report for Anglo American Thermal Coal: Proposed Life Extension of New Vaal Colliery	2015