Assessment of the Environmental Authorisation Processes and Mining Right Applications for Improved Environmental Outcomes

by

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Research Report

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DECLARATION

I, Maria Antoniades, declare that this research report is my own, unaided work. It is being submitted for the Degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other university.

30th day of July 2023 at Little Falls, Johannesburg

ABSTRACT

This study investigates alignment of South African mining right and environmental authorisation application processes to determine their adequacy in catering for optimised early mine planning seeking to achieve enhanced environmental outcomes. First the legislative requirements for mining right and environmental authorisation applications are evaluated. Results are critically analysed, including an assessment of process alignments and disjunctions. Secondly, integration of the application study processes in practice are investigated. The practical implications of the application requirements are qualitatively examined through key informant and case study analysis. It is shown that integrated planning is not a legislated requirement nor readily adopted by proponents. Environmental planning conforms to technical outputs as tick-box exercises rather than being iterative and co-operative. Workstreams misalignments result in poor planning to the detriment of environmental outcomes. Finally, a practical guidance is presented for early integrated study processes aimed at meaningful project design through parallel planning to optimise environmental results.

DEDICATION

In honour of my devoted, larger-than-life parents,
for whom no academic dream was too big

Antonakis Antoniades
1951–2021

and

Annalie Antoniades
1957–2010

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AEL	Atmospheric Emissions Licence
DFFE	Department of Forestry, Fisheries and the Environment
	(previously the Department of Environmental Affairs, DEA, and Department of Environment, Forestry and Fisheries, DEFF)
DME	Department of Minerals and Energy
DMRE	Department of Mineral Resources and Energy
DMR	Department of Mineral Resources
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
EAPASA	Environmental Assessment Practitioners Association of South Africa
EIA	Environmental Impact Assessment
EIA Regulations	National Environmental Management Act: Environmental Impact Assessment Regulations of 2014, as amended
EIR	Environmental Impact Report
EMP	Environmental Management Programme
EMPr	Environmental Management Programme Report
I&APs	Interested and Affected Parties
IWUL	Integrated Water Use Licence
IWWMP	Integrated Water and Waste Management Plan
MPRDA	Mineral and Petroleum Resources Development Act, No. 28 of 2002, as amended
MPRDA Regulations	MPRDA: Mineral and Petroleum Resources Development Regulations, as amended
MWP	Mining Work Programme
NEM:AQA	National Environmental Management: Air Quality Act, No. 39 of 2004
NEM:BA	National Environmental Management: Biodiversity Act, No. 10 of 2004

NEM:WA	National Environmental Management: Waste Act, No. 59 of 200
NEMA	National Environmental Management Act, No. 107 of 1998, as amended
NPV	Net Present Value
NWA	National Water Act, No. 36 of 1998
NWA Regulations	NWA: Regulations regarding the Procedural Requirements for Water Use Licence Applications and Appeals of 2017
OES	One Environmental System
RSA	Republic of South Africa
S&EIR	Scoping and Environmental Impact Report
SAMRAD	South African Mineral Resources Administration System
SAMREC Code	South African Code for Reporting of Mineral Resources and Mineral Reserves
SEMA	Specific Environmental Management Act
SLP	Social and Labour Plan

CHAPTER 1 : INTRODUCTION

1.1 Background and Research Motivation

Mining operations can commence once appropriate licences and permits have been issued in accordance with governing laws. Naturally occurring mineral resources in South Africa are recognised as the common heritage of all South Africans and are vested in the custody of the State. The rights to prospect for or mine these resources are administered principally through the Mineral and Petroleum Resources Development Act, No. 28 of 2002, as amended ("MPRDA", Republic of South Africa "RSA", 2002) and the National Environmental Management Act, No. 107 of 1998, as amended ("NEMA"; RSA, 1998a).

In the context of the legal regime relating to licensing for mining operations, exploitation of mineral resources is allowed through the issuance of a mining right in terms of Section 23 of the MPRDA, valid for a specific time period over a defined land area and for specified commodities. The gazetted MPRDA: Mineral and Petroleum Resources Development Regulations, as amended ("MPRDA Regulations"; DME, 2004), *inter alia,* prescribe the application requirements for mineral rights.

Section 24 of the NEMA requires that an Environmental Authorisation ("EA") be obtained by the entity for the proposed mining operations, driven by the triggering of listed activities impacting the environment (RSA, 1998a). Listed activities are identified in terms of NEMA Section 24 (2)(a)&(d), regulated by the NEMA: Environmental Impact Assessment Regulations of 2014, as amended ("EIA Regulations") and listed in the gazetted NEMA Listing Notices 1, 2 and 3 (DEA, 2014).

Mining by its very definition directly disturbs the natural environment (Lechner et al., 2017). Therefore, projects that will result in more extensive and prominent environmental impacts require an EA supported by a Scoping and Environmental Impact Report ("S&EIR") process, with activities listed in Listing Notice 2 (RSA, 1998a; DEA, 2014). Meanwhile, operations that are projected to produce comparatively lesser potential environmental impacts require an EA supported by a Basic Assessment, with associated activities listed in Listing Notices 1 and 3 (DEA, 2014).

Mining activities frequently have profound water requirements and impacts on water bodies. Section 21 of the National Water Act, No. 36 of 1998 ("NWA") lists water uses that trigger the requirement for an Integrated Water Use Licence ("IWUL") if certain thresholds are exceeded, or a General Authorisation if certain thresholds are not exceeded (RSA, 1998b). Owing to the intensive impacts that mines often have on water, a proposed mining project often requires an IWUL. The IWUL forms a critical component of the authorisation requirements for a mining project. For a large mining project, waste generation and management are a crucial consideration and triggers listed activities in terms of the National Environmental Management: Waste Act, No. 59 of 2008 ("NEM:WA"; RSA, 2008). In such cases, an IWUL application is incorporated with an application for an Integrated Water and Waste Management Plan ("IWWMP"), guided by the requirements of the NWA (RSA, 1998b). The NWA is regulated by the NWA: Regulations regarding the Procedural Requirements for Water Use Licence Applications and Appeals of 2017 ("NWA Regulations").

The One Environmental System ("OES"), which came into force on 08 December 2014 via the National Environmental Management Laws Amendment Act, No. 25 of 2014 (RSA, 2014), acts as a synchronised regulatory system for the processing of EA applications between the MPRDA and NEMA and promotes investment into the industry (Mpinga, 2017). In terms of the OES, the Department of Mineral Resources and Energy ("DMRE"; previously the Department of Mineral Resources, "DMR", and Department of Minerals and Energy, "DME") issues NEMA EAs for mining rights, while the Department of Forestry, Fisheries and the Environment ("DFFE"; previously the Department of Environmental Affairs, "DEA", and the Department of Environment, Forestry and Fisheries, "DEFF") acts as the appeal authority (RSA, 2014). The Minister of Water and Sanitation remains as the administrator for the NWA, and the Department of Water and Sanitation ("DWS") remains as the licensing authority for the IWUL. The OES is thus ultimately aimed at streamlining environmental approvals, monitoring and enforcement for mines in South Africa (Humby, 2015).

Through the amended MPRDA Section 22, companies are required to apply for an EA and a mining right simultaneously. An EA can only be granted once the Environmental Impact Assessment ("EIA") and Environmental Management Programme ("EMP") have been approved. Notably, a mining right may only be awarded once the EA has been granted.

As part of the mining right application, the technical aspects of a proposed mine must be defined and designed, including but not limited to mineral resources and mineral reserves, mine and infrastructure plan, processing methodology and economic analysis. These are presented in a Mining Work Programme ("MWP") prepared in terms of Section 23(a) of the MPRDA. The MWP is a tool essentially constituting the mine planning process as presented for authorisation, and as such, provides the basis for investigating environmental impacts and opportunities.

It is recognised that technical experts are required for mining right, EA and IWUL processes. However, in this research report the term *technical* is used as it refers specifically to the engineering and geological fields. The professionals responsible for the drafting of the MWP are typically experts in mining practices and include mining engineers and geologists. These technical skills may be sourced internally from within the mining company. Alternatively, the specialists may be commissioned by the applicant of the EA and mining right to undertake and detail technical geology, mining, processing and valuations in the format prescribed for an MWP. Figure 1 depicts the prerequisites for the issuing of a mining right, including three separate EA application processes (EA, IWUL, waste management licence or IWWMP). These are undertaken in terms of different laws and result in the issuing of separate authorisations.

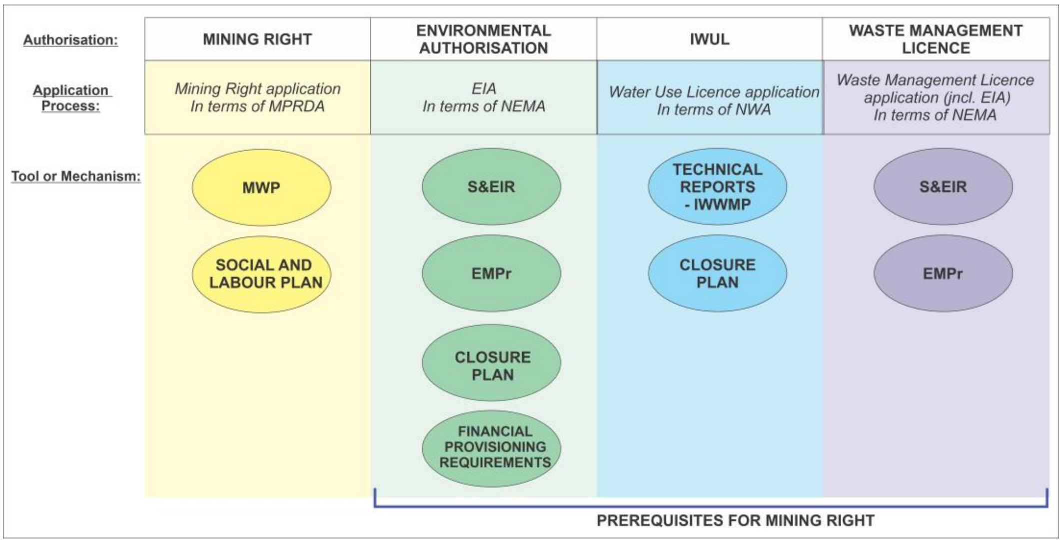

Figure 1: Simplified prerequisites for issuing of a mining right

The compilation of the EA application components is conducted by professionals in the respective fields of environmental science, co-ordinated by a single registered Environmental Assessment Practitioner ("EAP") in terms of NEMA (RSA, 1998a). The S&EIR and IWWMP must reflect the technical design and MWP work. Notably, the design of the operational layout and the technologies to be employed guide the identification of triggered listed activities. They provide the basis for the assessment of the impact on the environment. A subtle distinction is made in this research regarding the environmental component, namely assessment and application. To avoid confusion in this study, assessment can be regarded as twofold: the review of the current environment or baseline studies, and the assessment of the impacts of the proposed operations on the environment. The application incorporates the duality of these assessments and targets the most appropriate authorisations for the project.

An opportunity exists for the technical aspects of a new mine to be designed in such a way that promotes environmental conservation and preservation. Two workstream scenarios in compiling the mining right and EA applications are possible. The first is that the MWP and technical design are undertaken prior to the assessment of the environment or independent of environmental studies. The second is the simultaneous development of the mining right (notably MWP) and EA processes that are not only targeted at permitting approvals but also aim to produce optimised total (integrated) strategy.

A framework integrating the mining right and EA application processes is currently restricted to prescribed timelines, which the workstreams and government reviews and approvals must adhere to in terms of the OES (Humby, 2015). Understanding the processes towards developing an aligned approach would be beneficial in formulating improved strategies early in a project so as to ultimately achieve improved environmental outcomes (Edwards et al., 2013).

South Africa presents voluminous laws and regulations relating to mining and environmental studies in the application phase. It is recognised that the legislated and practical mining right and EA application workstreams do not definitively prescribe co-ordinated planning and design. Integrated planning workstreams achieve better outcomes and facilitate better decision-making processes by competent authorities (Fourie & van Niekerk, 2001; Sánchez et al., 2014). However, there is not a prescriptive government legislation or guideline that adequately bridges the gap in the planning stages between mining and environmental experts through the authorisation processes. Consequently, mine design is not rigidly optimised within the greater environmental framework, failing to meet environmental and sustainability goals as it attempts to conform to designs strictly presented in the MWP. Additionally, the study level forming the basis of the MWP fails to support detailed technical EIA and may trigger additional work by the MWP authors.

Although the integration of processes may incur additional time and monetary expenses at the onset of mine planning, it is likely that these expenses would be mitigated through coherent and aligned process development. Notably, the mining right application process as a whole provides a premium platform for enhanced environmental responsibilities and aligned strategies that would be carried through the project execution phase and ultimately throughout the life of mine and post-closure (Asr et al., 2019). The specific integration of study work processes during the planning and mining right application phase of a mining project in South Africa is not reviewed congruently in publications.

This research study focuses on the alignment of the technical inputs and the study development of the mining right and EA application components to achieve improved environmental outcomes, with focus on the S&EIR. This study is of particular significance in that it aims to close the gap in understanding and mitigating alignment versus fragmentation of the legal processes relating to the information that feeds into the mining right and EA application components.

1.2 Aims and Objectives

The research project aims to investigate the alignment between technical and environmental studies necessary for new mines and their mining right and EA applications for enhanced environmental outcomes. These outcomes are defined as improved plans for the protection of the environmental aspects associated with the implementation of a proposed mining project, with specific focus on the natural biophysical environment. The research investigates both legislative driving factors related to the mining right and EA applications, and technical study work supporting the applications.

The objectives of the study are to:

1) Evaluate the alignment between the legislative requirements for mining right and EA applications.
2) Determine the integration of the mining right and EA application study processes in practice.
3) Develop practical guidance on how the integration of the mining right and EA application processes can contribute to improved environmental outcomes.

1.3 Study Limitations

1.3.1 Definition of the Environment

The official definition of environment in terms of NEMA (RSA, 1998a) is as follows:

> *“"environment" means the surroundings within which humans exist and that are made up of-*
>
> *(i) the land, water and atmosphere of the earth;*
>
> *(ii) micro-organisms, plant and animal life;*
>
> *(iii) any part or combination of (i) and (ii) and the inter-relationships among and between them; and*
>
> *(iv) the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being.”*

Environmental outcomes in the research are defined as relating to the biophysical environment. This research thus specifically focuses on points (i), (ii) and (iii) of the NEMA definition. Social and economic factors are recognised as key features of the total environment related to a mining operation. The principles are deeply embedded in the construction and provisioning of the MPRDA and NEMA and effected through instruments such as the Social and Labour Plan ("SLP") required as part of the mining right application process. In particular, social responsibilities are prominent in the South African context, supplemented by additional legislation. Although the importance of these factors in developing optimal mine planning is recognised, they are excluded from this study as core focus areas. The magnitude of socio-economic aspects may warrant their own dedicated research assignment. In the context of this report, they are presented only within the authorisation processes in which they occur. Economic factors are only discussed in the context of the economic viability of a proposed mining operation that would drive the applications for a mining right and EA.

1.3.2 Specific Environmental Management Acts

Under the auspices of NEMA, there are Specific Environmental Management Acts ("SEMAs"), which place additional permitting obligations on mines where they are applicable. The SEMAs are namely:

- NWA
- NEM:WA;
- National Environmental Management: Air Quality Act, No. 39 of 2004 ("NEM:AQA");
- National Environmental Management: Biodiversity Act, No. 10 of 2004 ("NEM:BA");
- National Environmental Management: Protected Areas Act, No. 57 of 2003; and
- National Environmental Management: Integrated Coastal Management Act, No. 24 of 2008.

Although the SEMAs must be considered for new mines, they are only induced in this research as they relate to the total mining right and EA application processes. For example, a project may require an Atmospheric Emissions Licence ("AEL") in terms of the NEM:AQA. The requirements relating to the application for these licences are not reviewed in depth. It is noted, however, that although the NWA and NEM:WA are considered each to be a SEMA, they forms an important part of the development of an IWUL and IWWMP towards obtaining an EA for a substantial mining project. As such, they is considered to a limited extent in this research.

1.3.3 Mineral Type

The research is focused on the authorisation processes for a mining operation and environmental outcomes as they relate only to solid minerals. The study does not investigate liquid, petroleum and gaseous resources. Although the results of the research may overlap in totality or partially with the processes and environmental outcomes related to these, it is not inferred that such overlaps exist.

1.4 Organisation of the Report

The research report is structured into six discrete chapters.

Chapter 1: Introduction
This chapter introduces the research topic, including the basis of the study and the problem statement. The chapter provides justification for and limitations to the research. The aims and objectives associated with the research study questions are described.

Chapter 2: Literature Review
A survey of published literature relevant to the research topic is presented in this chapter, with research gaps identified warranting this research investigation. The literature review explores the significance of environmental studies in mining-related fields, specifically towards an understanding of the practicality of the processes in formulating the applications for a mining right and EA.

Chapter 3: Methodology
This chapter describes the methodology followed in fulfilling this research in relation to the discrete aims of the study. The procedures followed and the purpose of each are detailed.

Chapter 4: Results
The analytical results and interpretations for each procedure are discussed in this chapter. The interrelations of the results are analysed and compared. A dual analysis is presented to contextualise the legal framework as well as the practicality of the processes. This culminates in the development and presentation of a guideline for applicants and experts for practical application.

Chapter 5: Discussion
This chapter provides a critical review of the interpretations and discusses their relevance to the research topic. Alignments and inadequacies in the mining right and EA application processes are identified and discussed.

Chapter 6: Conclusions and Recommendations
In this final chapter, the research question is resolved, and the conclusions of the completed research are presented.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

Literature has been reviewed to provide insights into the impacts that mining has on the environment, including ecosystems and non-mineral resources, pollution, changes in land use and climate change. To understand the importance of mine planning incorporating environmental factors, available literature has been surveyed. Legal requirements for mine planning and environmental permitting as described in publications both internationally and in the South African context have been reviewed, as have the benefits of integrating processes. The literature review is structured to support examination of this research.

2.2 Environmental Impacts of Mining

Mining is disruptive to the natural environment through its invasion into and removal of natural resources, as well as through the establishment of infrastructure to support the extraction activities. The environmental impacts of mining operations occur at various stages, from the onset and beyond the exhaustion of the life of mine (Environmental Law Alliance Worldwide, 2010). Effects on biodiversity and natural habitats, water resources, soil resources, air quality, land use and health (Environmental Law Alliance Worldwide, 2010; Nuss & Eckelman, 2014; Asif & Chen, 2015; Dong et al., 2019), *inter alia*, are widespread. The impacts of mining are frequently adverse, occurring from within the immediate mine site to indirect regional disturbances (Walker & Johnston, 1999; Lechner et al., 2017), and thus require thorough definition. Negative impacts may become cumulative (Walker & Johnston, 1999), as demonstrated by Kori and Mathada (2012) at a gravel mining site. These authors showed that destruction of habitat, change in land use, compromise of river bank integrity and ponding in the floodplain due to mining activities contributed to the multiplier effect, and functionality of the greater valley environment was compromised.

The effects of mining on the natural environment vary with activities, mining and processing methods, salient characteristics of the latent environment, and management and execution of the operations. Environmental impacts are commonly identified throughout the lifecycle of a mine (Environmental Law Alliance Worldwide, 2010), namely through prospecting, the broad phases of construction, operation and decommissioning (de Barros Gelli, 2021). In all phases, activities have the most profound environmental impacts when they occur in close proximity or within areas of ecological sensitivity (Environmental Law Alliance Worldwide, 2010).

Asif and Chen (2015) investigated the existing impacts of mineral extraction activities as well as management and monitoring practices. Although regulated variably under the laws of the country of operations, the principles of impacts through mineral exploitation are not confined to sites or international jurisdictions. Many EIAs show recurring themes, with magnitude and duration usually being project specific. In addition, the themes regularly persist across multiple mine phases, such as biodiversity loss due to habitat loss (Kruger & Pohlo, 2022).

Surface mining is considered one of the most environmentally destructive forms of mining, while underground mining methods are considered less destructive (Environmental Law Alliance Worldwide, 2010). In both broad mining method themes, the immediate and lateral surface activities are associated with additional spectrums of negative impacts on the environment. The frequency and variety of negative effects demonstrate not only their permanence, but also poor management that may be related to poor planning (Asif & Chen, 2015). It is identified that there is a notable lack of publications that review environments prior to mining or make comparisons to pre- and post-mining sites.

2.2.1 Ecosystem Quality and Resource Depletion

The quality of ecosystems is dependent on the quality of their habitat. Activities across all phases of the mining lifecycle have the potential to degrade the natural environment and inhibit ecosystem functionality.

Immediate destruction and removal of habitats are seen during the pre-construction phase in preparation for infrastructure development. Clearing land by removing topsoil and vegetation directly destroys that habitat and its functionality (Li et al., 2018) and hinders the potential for later re-establishment. Moreover, ecosystems may be disrupted and fragmented with the establishment of access roads (Kruger & Pohlo, 2022). The construction of mine facilities and waste disposal sites can result in habitat destruction, deforestation and soil erosion (Kruger & Pohlo, 2022). In particular, surface mining removes entire upper portions of land that support habitats (Environmental Law Alliance Worldwide, 2010). It depletes soil resources that are essential to the establishment of vegetation (Nehring & Cheng, 2016).

In the construction and operating stages, the displacement of fauna into other suitable habitat areas leads to increased competition. As a cumulative effect described by Walker and Johnston (1999), these displaced species' competition for natural resources may lead to amplified mortality rates. This can result in a reduced abundance of species and potentially further biodiversity loss.

Kruger and Pohlo (2022) showed that alien invasive floral species frequently encroach on disturbed areas, which are inevitably always associated with mining activities throughout the various stages. The authors describe that this limits habitat availability for indigenous species, causing them to be outcompeted for natural resources.

Soil compaction from the movement of heavy vehicles and site activities during preparation reduces the soil's ability to support vegetative growth over time (Environmental Law Alliance Worldwide, 2010). The potential introduction of pollutants into the soils and air (Environmental Law Alliance Worldwide, 2010) from construction, operation and decommissioning activities diminish the quality of these resources, further reducing their ability to support healthy ecosystems. Degraded soils from any type of mining-related functions may hamper later rehabilitation efforts and thus compromise faunal habitat re-establishment. Ecologically degraded areas are particularly difficult to rehabilitate. This proven by Oladipo et al. (2014), who studied three mine sites in Nigeria. The authors demonstrated direct ecological degradation across all three sites, with each having limited potential for reversal. Degraded habitats are unable to support healthy biodiversity, and greater ecosystem functionality is compromised.

Soil erosion (Li et al., 2018; Kruger & Pohlo, 2022) may lead to surface water sedimentation and a reduction in aquatic habitat quality. Failure of native vegetation to re-establish itself due to soil compaction and pollution will promote soil erosion and sedimentation of surface water bodies (Nehring & Cheng, 2016). Soil compaction further promotes surface water runoff and sedimentation of freshwater systems. Kori and Mathada (2012) showed that mining of stream aggregates degrades water channels and reduces water quality. It hinders the functionality of aquatic ecosystems, exacerbated through instream habitat sedimentation and water contamination. This leads to compromised riparian habitats in the immediate and downstream settings and may result in the loss of sensitive aquatic species.

Alterations to drainage systems through surface water diversion and locations of operations directly disrupt immediate habitats reliant on these systems (Kruger & Pohlo, 2022). Topsoil and vegetation stripping may contribute to increased surface water runoff, changing the dynamics of surface water flow, and reducing ground infiltration, leading to reduced aquifer recharge (Li et al., 2018). In some instances, water systems such as rivers may be altered and diverted (Kruger & Pohlo, 2022). Surface mining activities directly alter topography and drainage patterns (Nehring & Cheng, 2016). This may lead to increased erosion of the new drainage line channels that are not adapted to high volumes of surface water flow. Surface and groundwater quantity may be impacted by abstraction or reduced recharge due to operational activities and infrastructure placement (de Barros Gelli, 2021), leading to a reduction in catchment yield.

The removal of large amounts of water from rivers and streams for use in mineral processing activities impacts aquatic and downstream ecosystems in that there may be less water resource availability. Madlala et al. (2021) demonstrated that while wetland water levels in a coal mining area in Mpumalanga, South Africa, reflected seasonal influxes, mine expansion negatively affected wetland persistence as well as water quality.

In the decommissioning phase, further soil compaction and/or erosion can occur. Rehabilitation efforts should aim to remove environmental threats residual from the mining operations and re-establish viable land use and ecosystem services (Costanza, 2017). While Edwards et al. (2013) described threats to biological endemism in Central Africa stemming directly from mining activities, they present potential positive outcomes, such as the establishment of offset areas and conservation zones. It is shown that these require active planning, most appropriately initiated early in the EIA phase of a mining project.

2.2.2 Pollution

Increased dust and vibration levels and greenhouse gas emissions are typical of the construction and operational phases (Environmental Law Alliance Worldwide, 2010). Once the operational phase commences, waste rock and tailings are generated, which may result in air and water pollution and the release of toxic substances, such as heavy metals and sulphuric acid (Li et al., 2018).

The use of heavy machinery in all phases increases ambient noise and dust levels, compacts soils and releases greenhouse gases (Environmental Law Alliance Worldwide, 2010). Stockpiled soils and tailings may generate dust in windy conditions (Environmental Law Alliance Worldwide, 2010).

Oil or hydrocarbon spills in all mining phases may contaminate water resources. Both groundwater and surface water quality may be impacted by pollutants (de Barros Gelli, 2021). Ingestion of pollutants by faunal species through water and contaminated plant matter reduces their health and may cause species loss. Cumulatively, toxin transfer may occur from prey to predator species (Walker & Johnston, 1999). The impacts are thus not contained within the immediate receiving mine site, with downstream water and extended terrestrial species and ecosystems also affected.

AL-Ani et al. (2019) demonstrated that microorganisms in soil are critical for sustaining soil health through processes such as nutrient cycling, breakdown of organic matter and humus formation. They also contribute to the stability of soil structure (AL-Ani et al., 2019). Preservation of the health and diversity of soil microorganisms plays a critical role in maintaining an ecosystem that can support flora. The introduction of pollutants into the soil is harmful to its optimal survival and ability to sustain soil fertility.

After mining operations cease, there can be long-term impacts post-closure, such as the ongoing release of contaminants from waste storage facilities and the acidification of waterways due to residual sulphuric acid in mine tailings (Li et al., 2018). Soils from ancient gold and iron mining and smelting sites such as those in Poland and Italy are continually shown to retain excessively high pollution levels (Karczewska et al., 2013; Becker et al., 2019). Further persistent impacts are described by Demková et al. (2017) relating to waste and tailing deposits from mineral extraction at a site in Slovakia. They demonstrated that for over 20 years, heavy metals and toxic substances have continued to accumulate in and contaminate underlying soils. A similar study by Pourret et al. (2016) showed similarly high pollutants in soils from mining in the Katanga region of the Democratic Republic of the Congo. Continued acid mine drainage from a pyrite mine site in Portugal that ceased operations in 1988 is still evidenced in associated river systems (Luís et al., 2011). Persistent impacts from continued acid mine drainage on water sources are also described by Ochieng et al. (2010) for South African gold mines.

2.2.3 Land-use Change

Extensive changes in land use are triggered by the establishment of mining activities. As described by Sonter et al. (2014), changes are caused by direct and indirect mining activities. Changes are frequently abrupt (Sonter et al., 2014) where land use is immediately replaced with mining operations from the onset of the construction phase. Dominant uses such as farming, forestry, wilderness, residential are either displaced or obliterated. Sonter et al. (2014) demonstrated extensive deforestation, urbanisation, mine expansion and plantation enlargement over a 20-year period in an iron mining area in Brazil.

Mining operations are usually associated with negative impacts on the environment, such as degradation of land, depletion of natural resources, loss of biodiversity and displacement of livelihoods (Sonter et al., 2014). Land-use changes frequently result in considerable and enduring alterations to ecosystem functionality and capital (Simmons et al., 2008). Changes in land use over a 14-year period in an active mining region in Ghana were examined by Basommi et al. (2016). The authors demonstrated that bare ground areas and open grasslands increased, while closed woodlot vegetation significantly decreased. In addition, farming scale reduced, with people turning towards mining-related activities as their main source of income. The study illustrated change in land use by means of changes in vegetation type and socio-economic support.

Simmons et al. (2008) investigated changes in ecosystem structure and function in rehabilitated coal mining sites in the United States. The original land areas supported forests and were reclaimed into grassland areas. The study proved major soil biogeochemical changes, with significantly reduced carbon, nitrogen and phosphorous pools. This was largely attributed to the removal of woody biomass. Further, the study demonstrated much lower groundwater infiltration rates at the mined sites. Changes in soil geochemical functionality and vegetation type decomposition were shown to impact streams in the receiving environment, altering the community structure of aquatic macroinvertebrates.

Land-use changes may be considered in positive terms as well. A study by Sonter et al. (2014) showed a move towards high profitability land use through the establishment of mines as well as lateral trigger expansion of plantation expansion in support of global resource demands.

2.2.4 Climate Change

Multiple mining activities are associated with the release of greenhouse gases into the atmosphere, including heavy machinery and processing units. Azadi et al. (2020) showed that emissions can be direct, such as the burning of fuel and electricity for transportation, or indirect, such as the release of carbon dioxide through carbonate mineral decomposition, which is utilised to reduce environmental impacts in copper mining. The authors estimate that in 2018, around 10% of energy-related greenhouse gas emissions globally were associated with mining and metal production.

While authors such as Azadi et al. (2020) explored the contribution of mining activities to climate change, Loechel et al. (2013) and Pearce et al. (2020) explored the symptomatic impacts of climate change on existing mines that assumed a stable climate when they were commissioned. A number of case studies by Pearce et al. (2020) showed that climate change exacerbates adverse impacts generated by operations, such as reduced water availability and increased dust emissions. Consequently, a multiplier effect is triggered; for example, as alternate resource sources such as water are tapped into, dependent habitats are affected.

Khorramdel et al. (2013) showed that a soil ecosystem that functions at high-capacity acts as an active carbon sequestration element through its interaction with the carbon cycle. This directly serves as a climate change mitigation mechanism. The degradation of soil health through activities associated with mining projects and changes in vegetation cover compromises this functionality, as proven by Simmons et al. (2008).

2.3 Mine Planning and Environmental Considerations

The manner in which an ore deposit will be extracted over the life of mine is determined by a structured mine planning process (Holloway & Cowie, 2019). Newman et al. (2010) and

Asr et al. (2019) discussed that the mine design and planning process considered numerous technical and economic aspects aimed at exploiting the economic viability of the proposed project. The long-term strategy of the mining company drives tactical planning in the shorter-term horizon through the mine planning process (Holloway & Cowie, 2019). Fourie and van Niekerk (2001) distinguished that mine design refers to the design of typical engineering subsystems, while mine planning considers the integration and co-ordination of all subsystems in alignment with the total operational strategy. A mine planning process is a comprehensive method of designing and operating a mining operation.

Dagdelen (2001) concisely described the objective of mine planning based on open-pit mining, but the principles are applicable to all types of mining, including underground methods. The author discusses that the basic aim of mine planning is to determine whether the defined geological model can and should be mined, when and how it should be mined, and how the ore is to be processed. This is compounded within the legal and regulatory framework of the operation (Fourie & van Niekerk, 2001). The overall purpose of mine planning is to define ideal monthly or annual scheduling around production, sequencing and cost constraints to produce the best net present value ("NPV") (Dagdelen, 2001).

The foundation of any mine planning process is geological data (Holloway & Cowie, 2019) that informs the construction of a three-dimensional geological, or mineral resource, block model of the distribution of the in-situ deposit's grade and tonnage (Madowe, 2013; Mai et al., 2016). A typical mine planning process commences with an analysis of the mineral deposit, surrounding rock types (Madowe, 2013) and the surrounding area. Notably, the depth of the orebody guides the selection of whether a surface or underground mining method would be most suited for extracting the mineral resource. Trade-off studies are employed to further refine the methodology selected to the most efficient extraction method.

Mine design criteria are the guidelines used to determine the layout and plan for a mining operation (Fourie & van Niekerk, 2001). These include items such as the location of the mine access points, the placement of equipment and infrastructure, and the methods used to extract minerals. The goal of the mine design process is to create a plan that maximises mineral recovery while also ensuring the safety of workers and minimising negative impacts on the environment.

Once the mine design criteria are defined, benchmark costs and geotechnical parameters (Madowe, 2013) are utilised to inform a pit optimisation analysis for an open-pit project, and a mine stope optimisation analysis for an underground operation. Optimisation is applied with the aim of elevating the success and performance of the mine plan by reducing inputs such as equipment and mining, treatment and capital (stay-in-business and expansion) costs (Madowe, 2013; Musingwini, 2016) and improving outputs such as reduced mining of waste material and enhanced capital returns (Dagdelen, 2001; Musingwini, 2016). The design of the mine incorporates mining dilution, ore loss and mining recovery, and considers plant recovery and capacity (Madowe, 2013). Mining schedules are prepared to determine the life of mine, as well as detailed capital and operating cost estimations associated with the mine plan (Fourie & van Niekerk, 2001).

Infrastructure planning and layout must consider all support items for the mine and haul road design (Madowe, 2013), the scheduled production profile and the overall requirements for the planned operation. The designs and financial modelling must consider commodity prices and markets, royalties and discount rates (Madowe, 2013). The plan should be refined based on feedback and further analysis.

There is an increasing emphasis on the requirement for consideration of impacts on surrounding environments by mining activities and inter-disciplinary interactions (Lechner et al., 2017). Integrated planning is multidisciplinary (Fourie & van Niekerk, 2001), consolidating information from all fields relating to the proposed operation, including, *inter alia* geology, geochemistry, geohydrology, geotechnics, hydrology, mining engineering, mechanical engineering, logistics, metallurgy, process engineering, waste management, tailings management and marketing (Holloway & Cowie, 2019). Notably, effective planning considers the physical, social and economic environments, rehabilitation planning and mine closure early on (Holloway & Cowie, 2019). Key environmental considerations are limited to known factors at the stage of mine planning. Detailed environmental studies may not have been conducted at this point, and site-specific environmental sensitivities that have not been identified will thus not be considered in the mine design.

The process of designing and planning a mining operation provides an optimal opportunity for consideration of the total environment and planning of alternative technologies, processes and layouts (Sánchez et al., 2014) that can mitigate adverse impacts on the natural environment and promote cleaner production (Dong et al., 2019). In order to plan for these alternatives or modifications in the mine planning process, however, the environment must be completely defined and understood in its baseline context so as to predict the effects of any operational activity. The EIA allows for upfront identification and mitigation of impacts that can be incorporated into mine planning, and also informs closure planning. Through integrated planning from the onset of project conceptualisation, designs can be modified to achieve optimal operations as well as optimal environmental protection.

2.4 Legal Requirements and Processes

2.4.1 The International Stage

Global opinion towards mining has shifted to include consideration of the environmental impacts of the operations. Investors are also increasingly preferentially supporting projects that incorporate sustainability principles. Since the implementation of the US National Environmental Policy Act in 1970, the requirement for an EIA prior to high-impact project development has been enacted in many countries globally through laws, regulations and directives (Arts et al., 2012; Betey & Godfred, 2013). Typically, the EIA process is triggered by a government permission or licensing procedure for activities that impact the environment, guided by legal frameworks. The EIA process is a preceding phase to granting of a licence and is used to assess the feasibility of a proposed project based on its environmental setting (de Barros Gelli, 2021; Kruger & Pohlo, 2022). Countries such as Chile, Peru, Australia (Western Australia), China and Canada (British Columbia) require an EIA in order to receive a permit to mine (Thomashausen et al., 2018). Academic literature, however, is largely aimed at describing the quality of laws and authority regulation of activities that are already active (e.g., Söderholm et al., 2015; Thomashausen et al., 2018), with a limited description of the early permitting processes, including study work requirements.

Legislative requirements of EIAs vary greatly throughout countries internationally (United Nations Environment Programme, 2018), yet the dominant theme of EIAs is the assessment of the natural and social environments through the authorisation process of a proposed project prior to final decision-making. According to United Nations Environment Programme (2018), the connection of the EIA and permitting procedures aims to manage conflicting interests, ensure compliance with government laws, and facilitate compliance with EIA approval conditions and the implementation of enforcement measures. A typical EIA across most jurisdictions comprises the elements as summarised in Table 1.

Table 1: EIA Report Contents Typically Covered (United Nations University Online, 2007 as presented in de Barros Gelli, 2021)

Content	Description
Proposal objectives	A clear statement of the proposal goals and why the project is needed for.
Legal, policy and administrative framework	Summary of the legal and policy framework related to the proposal in question.
Project description	Description of the project proposal and its alternatives (infrastructure, sites, technologies). It encompasses the principal elements and activities that will occur during the project phases of construction, operation, and decommissioning.
Establishment of Environmental Baseline	Description of the biophysical and socio-economic aspects of the environment that will be affected by the project. Key aspects include: 1) spatial and temporal boundaries; 2) biophysical, land use and socio-economic aspects; 3) significant trends and anticipated future conditions; 4) environmental areas and valued resources that may need more careful protection.
Public consultation results	If public involvement occurred at the scoping stage, a comprehensive statement of the consultation results should be described.
Impact Assessment	This section of the EIA report assesses the potential impacts (positive or negative) for the project proposal, for its alternatives and the environmental components identified in the project's terms of reference. Impacts are described in terms of their magnitude, duration, severity, etc. The effects of any residual impact that cannot be mitigated should be clearly stated.
Analysis of alternatives	In this section, the project proposal and its alternatives are compared in terms of the negative and positive impacts and effectiveness of the proposed mitigation measures. The identification of the environmentally preferred options is given, together with the reasons for such a choice.
Environmental Management Plan and Monitoring Plan	As an impact management resolution, these plans serve to ensure that the proposed mitigation and monitoring measures will be translated into actions.

Pettersson et al. (2015) and Söderholm et al. (2015) showed that environmental regulation and EIA processes for mining in Finland and Sweden are substantial, while Russia requires less robust assessments. In Mongolia, mining is included in EIA legislation through special content requirements, even incorporating a parallel process to the EIA in the form of a separate cumulative impact assessment that more meaningfully considers stakeholder input, although the execution of this has not been widely implemented (United Nations Environment Programme, 2018).

While EIA content requirements are documented, the specific inputs of mine planning are not documented in published literature for the EIA processes. The systems indicate consideration of mine planning in the environmental planning processes. However, certain government bodies such as Indonesia and Nigeria authorise mine project execution without the approval of the EIA (United Nations Environment Programme, 2018). In China, the general permitting and EIA procedures are now independent and can occur simultaneously. Although this is favourable for minimising permitting delays, once mine construction has commenced or the project permit has been awarded, there is less opportunity for the EIA process to influence project design and the environmental impact of the activity (United Nations Environment Programme, 2018). In these instances, it is certain that mine planning and environmental approvals are not integrated through the processes. This was proven in Sweden, where despite rigid legislation regarding mining and the environment, objectives and system designs conflict (Pettersson et al., 2015). Here, it was demonstrated by Pettersson et al. (2015) that licensing processes continue to be driven by the Mineral Act of the country that aims to exploit resources.

A commonality described in the literature is that poor permitting procedures result in inadequate EIA processes, which ultimately result in poor integrated planning of mining within the natural environment globally. Permitting processes are shown to be largely driven by economic outputs relating to mine developments, according to Leonard (2017) and Insarullah (2019). These authors show that weak regulation and licensing protocols lead to poor outcomes in the natural environment. For example, through their investigation of water networks in coal mining areas, Kori and Mathada (2012) identified the requirement for implementing improved environmental regulations and guidelines in South Africa to reduce impacts on aquatic systems. Elsewhere in Africa, Edwards et al. (2013) discussed the requirement for policy reform in central African countries related to mining and the environment to improve planning that critically incorporates environmental factors. Furthermore, although Oladipo et al. (2014) concluded their investigation by stating that mining policy reform in Nigeria is required, they fail to fully qualify this. No authors present practical evidence of positive outcomes based on improved policy, particularly for the mining industry.

2.4.2 South African Context

The 1990s saw the South African government commence the integration of environmental topics and requirements into the laws and regulations of the mining industry (Humby, 2015). Fragmented, complicated and sometimes conflicting systems (Humby, 2015) that did not allow for sufficient authoritative intersection in technical and environmental permitting considerations were developed. The systems were recalibrated through the OES, which aims to achieve co-operative governance between government departments and synchronisation of the MPRDA and NEMA processes and legal requirements. (Humby, 2015; Mpinga, 2017).

Prior to the OES implementation, the MPRDA was administered by the DMRE, and the NEMA was administered by the now DFFE. New mines required a mining right and an MPRDA EMPr from the DMRE. They also required an EA and EMP in terms of NEMA from the DFFE, not for the mining activity, but only for related activities, such as linear developments including supporting infrastructure development. The DMRE authorisations essentially acted as the environmental consent for mining operations (Mpinga, 2017). Through the OES and law reform processes, mining-related environmental management provisions were removed from the MPRDA and regulated through NEMA (Mpinga, 2017), although the DMRE is still the responsible authority.

This was necessary to improve environmental enforcement, especially with the introduction of requirements for additional licences for mining operations under NWA, NEM:WA and NEMAQA (Humby, 2015). Notably, NEMA Section 28 placed “a statutory duty of care” to the DFFE (Humby, 2015). Humby (2015) shows that the initiation of the OES allows for the streamlining of co-operative governance through which environmental authorities can enforce rectification actions and place accountability on the mining operators. The author describes that the system facilitates mining companies through the licensing process by reducing misaligned timelines and participation processes. It is further shown that the OES removes contradicting conditions in the authorisations and sets more consistent procedural standards and integrity (Humby, 2015).

As with a number of other government systems, as reviewed by United Nations Environment Programme (2018), in South Africa, the EIA is a precursor to environmental permitting. Mine planning is regulated by the DMRE, which is responsible for the administration of mineral rights and the regulation of mining activities. The DMRE issues mining and prospecting rights and mining permits, enforces mining regulations, and oversees the environmental management of mining operations. In addition, the NEMA and its associated rules also play a role in regulating the environmental impact of mining activities in South Africa. The applications for a mining right and EA are supported mainly by the MPRDA and NEMA legislations. Further MPRDA, NEMA and NWA regulations stipulate the required information in the application documentation.

Section 5A(a) of the MPRDA (which became effective on 7 December 2014) states that no person may mine for and produce any mineral or commence with any work incidental thereto without an EA (RSA, 2002). An EA is defined in Section 1 of the MPRDA to have the meaning ascribed to the term in the NEMA, and the NEMA (RSA, 2014) defines the term to mean an authorisation by a competent authority of a listed or specified activity in terms of the NEMA and includes a similar authorisation contemplated in a SEMA.

The environmental aspects of mining operations are governed in terms of Chapter 5, Sections 23 and 24 of the NEMA (RSA, 1998a). The S&EIR process is regulated in terms of the EIA Regulations Part 3, regulations 21 to 24 (DEA, 2014). The S&EIR process is subdivided into two broad and distinct parts, namely the Scoping Process (regulations 21 and 22) and the EIA Process (regulations 23 and 24; DEA, 2014). The objectives and content of the Scoping and EIA Processes are defined in Appendix 2 and Appendix 3, respectively, of the EIA Regulations.

The MWP, required in terms of the MPRDA Section 23(a) (RSA, 2002), is regulated in terms of regulation 11 of the MPRDA Regulations (DME, 2004). The IWUL or IWWMP applications are guided by the requirements of the NWA (RSA, 1998b) and corresponding regulations.

A further refinement of the information required is detailed in the guidelines and templates provided by the DMRE, DFFE and DWS (DMR, 2010a, 2010b, 2011, 2014; DEA, 2013b, 2017; DEFF, 2020; DWS, 2021), available through the DMRE online application platform named South African Mineral Resources Administration System ("SAMRAD") (DMRE, 2020). The application forms for a mining right, EA and IWUL provide additional guides for requirements. The integration of considerations in terms of NEMA and NEM:WA for an EA application is transparently provided for in the EA Application Form that can be accessed through SAMRAD (DMR, 2015), where the form draws on triggers from the NEMA and the NEM:WA.

A summary of the guiding documents for content requirements for the various mining right and EA application documents is shown in Table 2. This is provided together with the sources of guiding information available from the government departments.

Table 2: Summary of South African mining right and EA application legislation, guiding documentation and content requirements

Item	**Mining right - MWP**	**EA - EIA**	**IWUL (with reference to IWWMP)**	**Waste Management Licence (in reference to IWWMP)**
Decision-making Competent Authority	DMRE	DMRE	DWS	DMRE
Laws	[1]MPRDA Chapter 4 s22,23 – Mining Right Application and Granting	[2]NEMA Chapter 5 s23,24 – Integrated Environmental Management [4]NEM:WA	[3]NWA Part 7 s40–42 – Individual Applications for Licences	[4]NEM:WA [2]NEMA s28
Regulations	[5]MPRDA Regulation 11 – MWP	[6]EIA Regulations 21–24 – S&EIR	[7]NWA Regulations	[8]NEM:WA Regulations 2013 [9]NEM:WA Regulations 2015
Content Guides / Requirements	[10]DMRE Guideline – MWP	[6]EIA Regulations Appendix 2 – Scoping Process [6]EIA Regulations Appendix 3 – EIA Process [11]NEMA Procedures for Reporting on Identified Themes GG1150 – 2020	[8]NWA Regulations Annexure C – Application checklist [8]NWA Regulations Annexure D – Table of contents of Technical Reports	[12]NEM:WA Norms & Standards 2013 [13]NEM:WA Norms & Standards 2017
Templates	[14]DMRE – MWP Report	[15]DMRE – Scoping Report [16]DMRE – S&EIR and EMP Report	[17]DWS – WULA Summary Report	-
Study Content Requirements	Location of property	Property location and project description (activities)	Property and project description (activities)	Classification of waste
	Description of mineral deposit and resources	Description of listed activities	Description and location of water uses	Sources of waste
	Analysis of products and markets	Description of environmental attributes of the project footprint	Description of environment	Types of waste
	Description of infrastructure requirements	Description of policy and legislative context	Description of policy and legislative context	Storage facility designs in terms of relevant regulations and by-laws for construction and

Item	Mining right - MWP	EA - EIA	IWUL (with reference to IWWMP)	Waste Management Licence (in reference to IWWMP)
				development of structures
	Description of mining method	Motivation for project need and desirability	Motivation for project need and desirability	
	Description of mining equipment and activities – details and costing	Assessment of alternatives	Assessment of alternatives	
	Definition of timelines for implementation and production scheduling	Description of project structures and infrastructure	Description of water supply, demand, management activities and facilities	
	Forecast of operating cost (years 1–10)	Specialist studies results, integration and impact on project	Description of waste resource management activities and facilities	
	Estimation of capital costs	Plans of environmental sensitivities with project layout plan	-	
	Description of processing methodology	Impact management objectives and outcomes for EMPr	Description of monitoring and compliance	
	Description of processing equipment and activities – details and costing	Impact and risk assessment including ranking	Impact and risk assessment on water resources including ranking	Impact and risk assessment in terms of NEMA
	Definition of skills and labour requirements and costing (years 1–10)	Description of mitigation measures	Description of mitigation measures	
	Forecast of revenue and cash flow	Public participation process	Public participation process	
		Details of EAP	Description of strategic importance of the water use for project	
		Mine closure and rehabilitation plan	Mine closure and rehabilitation plan	
		EAP opinion on whether the project should be authorised	Stormwater management plan	

Sources: [1]RSA (2002), [2]RSA (1998a), [3]RSA (1998b), [4]RSA (2008), [5]DME (2004), [6]DEA (2014), [7]DWS (2017), [8]DEA (2013a), [9]DEA (2015), [10]DMR (2011), [11]DEFF (2020), [12]DEA (2013b), [13]DEA (2017), [14]DMR (2010a), [15]DMR (2010b), [16]DMR (2014), [17]DWS (2021).

Prior to the initial submission of the applications, technical study work and preliminary environmental work, including drafting of both the MWP and the scoping report, must be undertaken. The timelines for these are at the discretion of the applicant. The MPRDA prescribes timelines for decision-making of the mining right application (RSA, 2002). For example, in terms of Section 22, within 14 days of application submission, the DMRE Regional Manager must acknowledge receipt of the application and flag non-compliances if required. Within 14 days of acceptance, the applicant must be notified to conduct an EIA process. The MPRDA and associated regulations do not prescribe milestones for technical studies in the form of the MWP.

Part 3 of the EIA Regulations (DEA, 2014) prescribes timelines over which the components of the S&EIR must be completed and submitted, as well as timelines for reviews and decision-making by authorities. Namely, within 44 days of the application, a scoping report inclusive of a public participation process must be submitted, after which the competent authority must provide acceptance or rejection for continuation. Once the scoping report is accepted, the applicant has 106 days to complete and submit a full EIA and EMPr inclusive of a public participation process – this may be extended with an additional 50 days. Within 107 days thereafter, the competent authority must grant or reject the application.

The mining right and EA application processes are procedurally linked through the OES; thus, the total application process is governed by the NEMA requirements over the total period of 300 days commencing from the application lodgement date to the date of announcement of a decision by the DMRE, including departmental processing time (Humby, 2015). Upon lodgement of the complete application via SAMRAD ONLINE (DMRE, 2020), a mining right reference number is immediately generated and provided to the applicant. All submission must be made in mandatory formats provided on this platform.

The EA process integrates public opinion, and decisions by the authorities on granting of the required licences and permits take cognisance of the incorporated technical information, socio-economic and environmental strategies, and public sentiment. Throughout the EA process, public participation with interested and affected parties must be undertaken. Comments and concerns raised must be addressed and incorporated into the S&EIR. Substantial time is allowed through NEMA for review of the scoping and EIR reports by stakeholders.

Although not yet gazetted, DWS has aligned the processing of the IWUL to 90 days, reduced from the 300 days prescribed by DWS (2017), following a declaration in the February 2021 State of the Nation Address by President Cyril Ramaphosa (DWS, 2021). Applications that were submitted prior to 1 April 2021 are processed in line with the 300-day timeframe, while those submitted from 1 April 2021 are processed in terms of the 90-day turnaround time (DWS, 2021). As with the mining right and EA application, this period must be preceded by pre-application activities, including the compilation of the technical report, for which timelines are not prescribed.

The EA application must simultaneously be submitted with the mining right application (DMRE, 2020), indicating an expected alignment of the procedures supporting the individual documentation. As part of the mining right application, a Social and Labour Plan must be approved in terms of the MPRDA, as well as the Environmental Impact Report ("EIR") with the Environmental Management Programme Report ("EMPr"). In parallel, applications for other authorisations such as an IWUL (or IWWMP) are drafted for submission to relevant government departments.

Figure 2 illustrates the application processes for a mining right and EA in terms of timelines. The information is as described, in summarised format, by the MPRDA and NEMA for the MWP and S&EIR processes. The figure illustrates that pre-application study work is required prior to the submission of the applications, after which content and processes are regulated. Timelines for the S&EIR process are as gazetted via the EIA Regulations (DEA, 2014). The image aims to demonstrate the parallel activities that should occur in the application process, guided largely by the S&EIR timeframes.

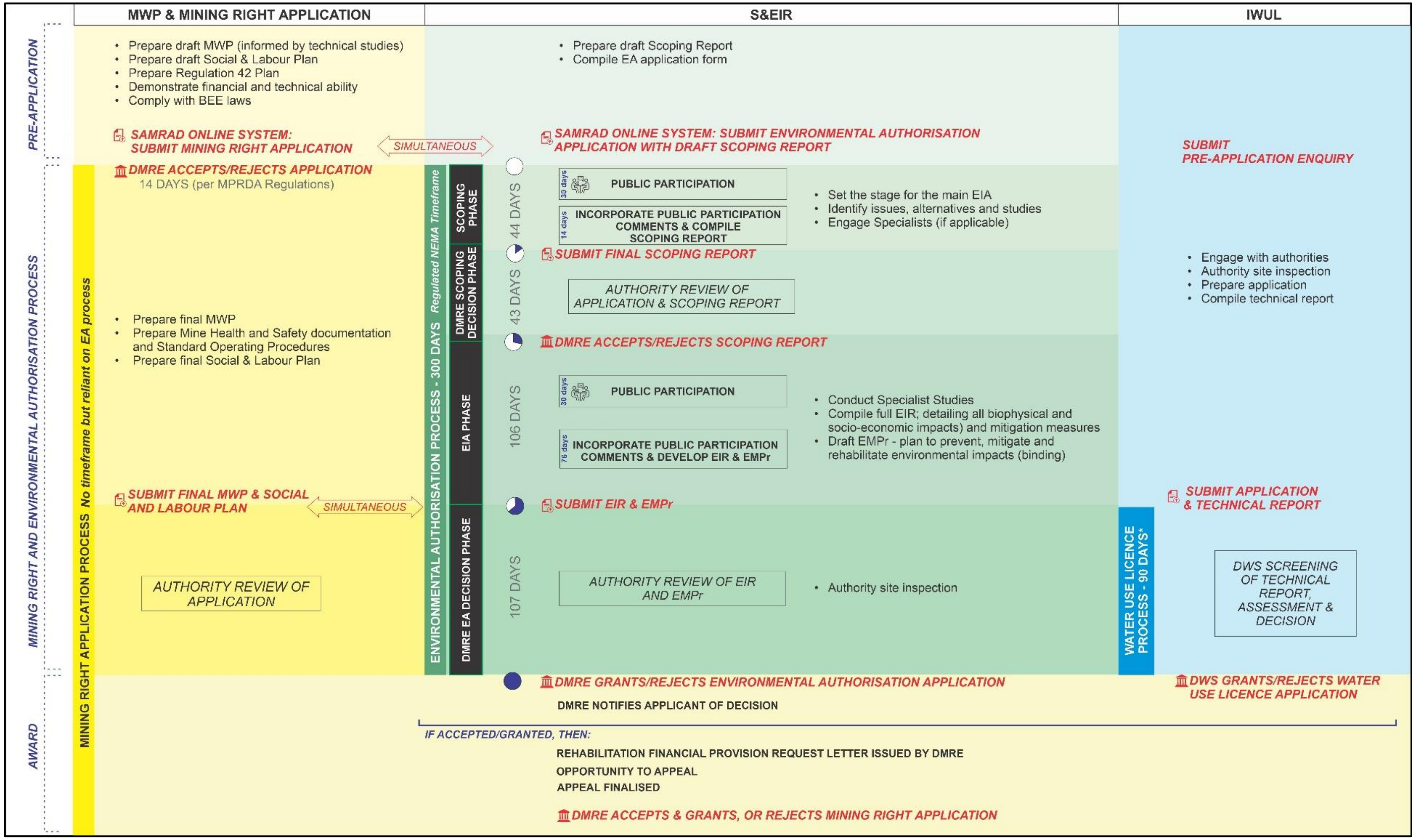

Figure 2: Summary of application process and timelines

The DMRE is the competent authority for mineral right applications under the MPRDA, environmental authorisations under NEMA, and waste management licences under NEM:WA (Humby, 2015). DWS is the competent authority for IWUL applications (Humby, 2015). The decision of the DMRE to grant or reject the mining right application is dependent on the completion of the EA and IWUL processes. If either of the latter applications is rejected, the mining right cannot be awarded.

Through the Constitution, the South African government retains responsibility as the environmental guardian (Swart, 2003). The OES in South Africa is intended to provide balanced development across the spheres of mining, the economy and sustainable development (Humby, 2015). However, there remains a persistent prejudice against environmental outcomes and enforcements during the application process (Leonard, 2017). This is despite the implementation of the MPRDA, NEMA and OES. Sandham et al. (2013) further demonstrate a reduction in the quality of reports produced with the modifications to the EIA Regulations, which were intended to improve effectiveness. Though the authors did not conclude what this is specifically attributed to, they did note that identification and evaluation of impact, alternatives and mitigation were poorly described in EIA reports.

The legal framework of mining and the environment in South Africa are described by authors such as Rogerson (2011), Murombo (2013), Humby (2015), Leonard (2017), and Toxopeüs and Kotzé (2017). However, the themes explored mainly include stakeholder participation processes, socio-economic justices and the physical construct of laws and regulating authorities specifically around environmental management. They do not provide accounts of how the effects of the legal construct guide meaningful environmental planning. Though the OES promotes cooperative governance, political and professional integrity of implementation and enforcement officers require improvement to uphold the virtues of environmental guardianship (Humby, 2015).

2.5 Benefits of Integration

There is a lack of literature describing case studies that have adopted the approach of integrated mine and environmental planning. Authors such as Nehring and Cheng (2016) and Asr et al. (2019) demonstrated that the economic outputs of a mining project over its life of mine can be improved through an integrated approach to design that considers the environmental aspect by reducing risk and post-closure liabilities.

The EIA aims to develop integrated tools to promote and protect the environment throughout the project life. The assessment is constructed as a systematic process (Kozlowski, 1990; Northmore & Hudson, 2022) designed to determine baseline conditions of the biophysical environment (Dalal-Clayton, 1993) against which impacts of project development and mitigation strategies can be measured. A major objective of the process is to predict and assess potential impacts on the environment once the mining project is implemented. The assessment further serves as an environmental risk management and governance tool structured to promote environmental awareness and incorporate environmental protection principles into project planning (Arts et al., 2012), ultimately aimed at the achievement of sustainable development (Betey & Godfred, 2013).

Brent and Petrick (2007) investigated EIA effectiveness in the raw materials processing industry in the energy sector, which aligns with those of mining projects. The authors demonstrate that EIA execution occurs too late in the project lifecycle and should be considered early in the planning process to achieve improved project operating efficiencies, quality assurance, and operating and closure costs. Operational design that assimilates environmental constraints achieves more effective design that is mindful of predetermined strategic objectives (Fourie & van Niekerk, 2001; Holloway & Cowie, 2019). Environmental goals benefit from synchronised mine and environmental planning and improvement on EIA processes upon which later management practices can be based (Edwards et al., 2013).

The assessment of sustainable development is now frequently incorporated into the process (Devuyst, 2000; Morrison-Saunders & Retief, 2012), either as a legislative prerequisite or on the back of global awareness and public endorsement of a project. The opportunity for sustainability planning through the EIA process was noted by Koff (2021), who also showed initiative to incorporate the United Nations Sustainable Development Goals into the process.

Asr et al. (2019) showed that the general mine planning phase for an operation presents a pivotal opportunity for optimal decision-making that takes cognisance of environmental conservation and sustainability directives. Phalan et al. (2017) discussed the mitigation hierarchy as a tool for reviewing environmental impacts. The framework should be used in making decisions by preferentially avoiding impacts, then reducing them, and then offsetting unavoidable impacts as a final measure. The authors show that avoidance should be prioritised and is better considered during the early planning stages. In achieving aligned workstreams, improved decision-making will be realised, and the mining company will demonstrate cognisance of its responsibility to the environment and sustainability (Sánchez et al., 2014).

Holloway and Cowie (2019) validated that the diligent alignment and integrity of foundational information from the multitude of disciplines demanded by a potential mining operation are imperative for the total success of the project. This is in support of Fourie and van Niekerk (2001) who showed that mining and environmental planning processes should ensure that proposed mining activities are compatible with the protection of the environment and the well-being of the local community. Relevant government agencies play a central role in this process by ensuring that all environmental regulations are met and that the public has an opportunity to provide input. Ultimately, integrated mine and environmental planning aims to ensure a balance between the economic benefits of mining and environmental protection by ensuring that minerals are extracted in a sustainable and responsible manner that minimises harm to the environment (Fourie & van Niekerk, 2001).

In South Africa, mine planning and environmental planning are integrated through various laws and regulations, including the NEMA and the MPRDA (Humby, 2015). These laws require mining companies to obtain EAs and comply with environmental regulations, such as conducting environmental impact assessments, managing waste and emissions, and rehabilitating mined areas (Sandham et al., 2013). The DMRE and the DFFE are responsible for enforcing these laws and regulations. Integration of mine planning and environmental planning is also facilitated through collaboration between mining companies, government agencies (Humby, 2015), and other stakeholders, such as local communities and environmental organisations, to ensure sustainable mining practices that balance economic and environmental objectives.

CHAPTER 3 : METHODOLOGY

3.1 Introduction

The research methodology employs mixed qualitative data approaches to examine the interactions between mining and the natural environment in which its setting is hosted, the way planning takes cognisance of multiple expert fields, and the legal drivers behind the process for application that guide the planning spheres. The objective of the research topic is most appropriately investigated through contextualisation and review of design outputs and their consequences in reality, which in this context cannot be quantified (Queirós et al., 2017; Al Amaren et al., 2020; Hennink et al., 2020). No quantitative research has been employed as no statistical data was obtained, and none of the approaches utilise or produce tangible data sets of significant sample sizes to which data analysis can be applied (Hennink et al., 2020).

A desktop review of the legislative requirements for the mining right (particularly the MWP) and EA application processes has been undertaken to ascertain the basis of the research. This is considered a doctrinal legal research methodology (Al Amaren et al., 2020) providing the status quo of the legal framework governing technical mine design and environmental planning in the mining right and EA application processes. A comparative methodology (Bhat, 2015) has been applied to investigate the intersections of these laws and regulations.

This has been followed by the investigation of current practices, including interviews with appropriate experts relating to the topic and a review of a case study. The utilisation of interviews is identified as an in-depth interview method (Hennink et al., 2020), and both content analysis and thematic analysis have been applied to interpret the data with the aim of a more transparent output (Vaismoradi et al., 2016).

The case study method investigated the mining right and EA process utilising participant observation (Hennink et al., 2020). The data has been examined by thematic analysis to identify and analyse emerging themes (Vaismoradi et al., 2016; Bell et al., 2022).

The outcomes of the preceding methodologies were utilised to inform the development of a guidance procedure for industry. Notably, themes from the research items were utilised to develop the practical guidance aimed to improve environmental outcomes through integration of the mining right and EA application processes.

All data obtained is textual and the analysis is interpretive, falling within the realm of qualitative research as described by Hennink et al. (2020). The overarching analytical methodology employed for this research topic is deemed to be mixed thematic and content

(Vaismoradi et al., 2016). Validity, credibility (Hammarberg et al., 2016), and various ethical factors have been considered.

3.2 Evaluation of the Alignment between the Requirements for Mining Right and EA Applications

To meet the objective of evaluating the alignment of the requirements between the mining right and EA applications, the legal framework for a mining right application and an EA application (including IWUL) has been mapped. This was done to provide a contextual understanding of the requirements for the MWP, EA and IWUL processes as prescribed in legislation and as evaluated by the authorities.

The regulated requirements for each of these items in context of the South African mining environment have been identified and described in order to establish a holistic understanding of the processes required. The relevant gazetted legislation related to the application of a mining right and EA, including IWUL and IWWMP, has been sourced from publicly available government institution websites. Primary focus has been given to the MWP and S&EIR.

The following legislation and regulations have been reviewed as the primary focus:

- MPRDA (RSA, 2002)
- NEMA (RSA, 1998a)
- MPRDA Regulation (DME, 2004)
- EIA Regulations (DEA, 2014)

Consideration has been given to the NWA (RSA, 1998b) and NWA Regulations (DWA, 2017). Only a limited review of the NEM:WA (RSA, 2008) and NEM:WA Regulations (DEA, 2013a, 2014, 2015) has been undertaken, and only in the context to which it may be related to an IWWMP and technical study work requirements.

The dataset has been analysed as follows:

- The requirements as provided in governing laws for the compilation of each component of an MWP and EIA applications have been identified.
- The regulated timeframes for each outcome throughout each process have been outlined.
- The overlaps in required data and information between the MWP and EIA have been identified. This has been consolidated into a flow diagram to support the identification of alignment or deficits in the required workstreams.

- Comparisons and disparities between each component have been outlined, informing a review of the success in fulfilling mandates to simultaneously promote environmental protection in mine designing for mining right and EA application.
- The required study level and design accuracy prescribed by governing legislation for an MWP in relation to the EA application have been examined.

The analysis describes the work and the prescribed study-level detail for each component of the mining right and EA application process. Moreover, it highlights the processes in terms of the interplay between all components and the extent of their reliance on each other.

This evaluation ultimately establishes the status quo legal requirements triggered by mining right and EA applications, and assesses whether the processes currently required by law are beneficial to providing a premium environmental strategy for a mining project and fulfilling the mandate of the OES.

3.3 Determination of Integration of Mining Right and EA Applications in Practice

To determine the integration of processes in reality, a two-phase methodology has been completed, namely conducting interviews and the evaluation of a case study.

3.3.1 Interviews

Key informant interviews have been conducted to provide a basis for understanding the execution of the processes in practice. The interviews provided insight into the extent to which the EA and MWP processes are aligned and the requirement for experts to work in synergy to develop a conceptual mining project.

In accordance with the research requirements of the University of the Witwatersrand for the involvement of human participants, ethics clearance was applied for through the School of Mining Ethics Committee constituted under the University Human Research Ethics Committee (Non-Medical) for the execution of this research method. The application was approved unconditionally, and a clearance certificate was obtained with protocol number EMINN/2021/10. The certificate is provided in Appendix A.

In compliance with the requirements under the ethics clearance, each identified interview participant was provided with a Participant Information Sheet describing the research topic, the interview process, and the nature and purpose of their proposed involvement. The Participant Information Sheet is provided in Appendix B. Prior to the interviews, each participant was provided with a consent form for consideration and signature, a sample of which is provided in Appendix C.

In total, six key informant interviews were conducted. The professionals interviewed included three registered environmental practitioners with experience in acting as EAPs for compiling and submitting EA applications for new mining projects in terms of the OES, and three technical experts with experience in compiling MWPs in support of mining right applications. The interviewees are registered with engineering, scientific and environmental professional bodies and each have a minimum of five years relevant experience. They are deemed to thus be relevantly qualified and experienced experts in their respective disciplines.

Attempts were made to interview at least three professionals employed at relevant government institutions (notably the DMRE) to review and process the applications for mining rights and EAs. All requests were denied.

It was recognised that insights from mining companies that have successfully completed a full EA process in their application for a mining right would be valuable. Two such companies were approached for inclusion in this research process but declined participation.

Interviews were conducted on a one-on-one basis in person or via the online Microsoft Teams meeting platform. Each interview was concluded within 35 to 60 minutes and was not recorded on digital devices. Detailed notes, including the opinions and arguments of the interviewees, were recorded. A guiding questionnaire with open-ended questions was utilised as a catalyst for additional discussion avenues. This questionnaire is provided in Appendix D.

Although the nature and basis of the research and interviews were described to the participants, they were not afforded an opportunity to prepare for the targeted questions presented or discussions instigated so as to obtain an authentic and personal response regarding their experiences. A sample transcript of an interview is provided in Appendix E.

The results have been assessed as stand-alone interviews and fields of expertise, namely technical and environmental. Key themes, highlights and differences emerging from the interviews have been identified. These have been used to determine if the processes optimally promote the mining project while taking cognisance of the environment, with designs tailored to improving or conserving the natural environment. The results have further been used to indicate the extent to which experts are aware of alignments, inadequacies or opportunities in the application processes.

3.3.2 Case Study

A practical anonymised example of a new proposed mining project for which the application processes have been completed but were misaligned was identified. Permission to conduct the case study was obtained from the CEO of the company, and access to relevant documentation and employees provided. The permission was conditional on anonymity.

The project occurs within the boundaries of an existing gold mining right. The original mining right was awarded for underground operations. However, additional gold mineralisation was identified at a completely new location within the right area. Following exploration of this new target area, mineral resources were delineated and quantified. Technical studies, including a concept and feasibility studies, were undertaken, identifying the most appropriate means of extraction through open-pit mining methods.

The case study project occurs in a mountainous area of eastern South Africa close to a major water course dominated by subtropical foliage. The gold mineralisation was targeted through open-pit mining, effectively removing entire portions of mountains. Initially, mining investigated two adjacent pits (Pit 1 and Pit 2). Further investigation into mineralisation occurrences identified the potential for a third discrete, nearby pit (Pit 3) for development. The mineralised reefs are barren of uranium and mainly occur as pyritic quartz-carbonate veins. The predominant host rock is dolomite, which has a buffering effect on groundwater quality and mine water drainage. Ore was to be treated at an existing nearby plant for which refurbishment and upgrades were required. A historical tailings storage facility is located adjacent to the site of the pits.

The identified new operation targeted gold mining via open-pit methods. This differed from the basis on which the existing right was awarded – the original right targeted gold mineralisation at a different location, designed for extraction via underground mining methods. This triggered the requirement for a new MWP and EA with S&EIR from the DMRE, warranting an amendment application to the existing right according to Section 102 of the MPRDA (RSA, 2002) to include the open-pit activities at the new location. The application process was treated as an application for a new mining right.

The applications for the amendment, including the MWP, EA and IWUL, were submitted to the competent authorities. Full S&EIR and IWUL processes were completed and submitted, including revisions as described in the sections to follow. Ultimately, however, the applications were withdrawn by the applicant prior to a decision being passed by the authorities following a revised business strategy.

The pre-application and application processes were drawn out due to technical and environmental studies running independently, and later concurrently. Later environmental studies identified that numerous planned mining-related sites were not viable, requiring numerous revisions to mine planning, pushing back timelines, and incurring significant additional costs to the applicant.

The project has been utilised as a case study to review the application process practices and then note if there were misalignments. If there were misalignments, investigations would determine why they occurred and identify their ramifications.

Email and large file-sharing online platforms from the gold mining company acting as the applicant were used to source project information, specifically:

- A list of the names and qualifications of the experts appointed to conduct the technical design, compile the MWP, undertake environmental studies and act as the EAP;
- Minutes of project-related meetings; and
- Completed applications with supporting reports and documentation for the mining right, IWUL and EA.

A timeline of the engagements of the experts and project developments was established through a review of the documentation. The documentation, workstreams and timelines were reviewed. The process was followed for the EA and MWP and the required deliverables for the case study were compared with the legal requirements. The broad content of the documents developed was reviewed in terms of their level of detail describing the proposed activities and their planned environmental deliverables. The sufficiency of detail produced was investigated against prescribed outcomes as set out by the governing legislation. The MWP and S&EIR details were further compared against each other. The outcome of the analysis would be to identify alignments and gaps in the requirements for the MWP versus environmental workstreams, as well as whether these are functions of regulation or practical execution.

The case study has been assessed in terms of the execution of the process and the analysis of the execution. The example provides insights into how the inputs of an MWP prescribed by regulations drive the conceptual development of a mining project towards an environmentally sustainable outcome. It further evaluates the expert roles in synthesising an optimal mining project that retains sound technical and environmental design. The study did not aim to propose technical or environmental design improvements but to evaluate the processes followed against the legislation. To this end, the case study is deemed appropriate for analysing the practical integration of the mining right and EA applications, both in terms of legislature and professional studies.

3.4 Development of Practical Guidance for Process Integration

Positive attributes and shortcomings of the legislative and study workstreams supporting mining right and EA applications based have been identified. These have been considered derivatives of the analyses of the preceding methodologies, namely the outcomes of the literature survey, the responses from the interviewees and the analysis of the case study.

The successes and failures identified have been collated and compared against the legislative requirements. A compartmentalised approach to major topics through the mining right and EA application processes has been adopted and disjoints have been flagged. These have been utilised as the foundations for improvement opportunities of the total mining right and EA process.

Based on the outputs and assessment of the preceding analyses, a simplified practical guide has been developed for use by applicants, mining experts, engineers and environmental practitioners assigned to developing mining right and EA applications. The guidance provides a basis for the commissioning of work phases to the applicant, as well as informing technical and environmental practitioners about optimal process alignment and the importance of integration. It is structured to show integration of workstreams in the compartmentalised view to improve the processes so that the resulting environmental solution is optimised.

CHAPTER 4 : RESULTS

4.1 Alignment between the Requirements for Mining Right and EA Applications

This section presents the results of analysing the legal requirements upon which mining right and EA applications are made. The outcomes set out below are in support of objective 1.

4.1.1 Study Requirements

a) MWP

The description of the project is formulated through technical work, which, in terms of the MPRDA, is presented in the form of the MWP. The MWP describes the mineral deposit in terms of its geological setting and contained mineral resources. It presents the design of the mine, associated infrastructure and planning of the operations. There are no government publications or notices identified that prescribe the qualifications of the authors of the MWP. Only the author of the mineral resource statement must be identified with their professional registration, but there is no requirement to disclose the basis of the mineral resource estimation or compliance with any international mineral reporting standards or regulatory codes such as the South African Code for Reporting of Mineral Resources and Mineral Reserves ("SAMREC Code"). The study-level detail required is only guided by the MWP template published by the DMRE. The published provisions for the remaining content of the MWP are detailed and imply a requirement of competency of the authors in the areas of geology, mining engineering, mechanical engineering and processing.

Primary focus is given in terms of costing. Multiple components of the MWP requirements are presented in terms of financing and the value of the planned operation (MWP Regulation 11(g)), notably the mining and processing descriptions. Although this is presented in summary format for the MWP and may be indicative of the economic drivers for mining right applications, the information presented must be justified by sound engineering and technical study work.

The final mining product must be defined, together with a description of the markets associated with the commodity. The proposed mining activities must be described in terms of the extraction method, fleet requirements, implementation timing and production scheduling. The processing methodology must be described along with the equipment requirements. Infrastructure design and footprints must also be presented. Labour requirements and costing for the total operation must be provided for at least the first 10 years of operation, including operating costs. Capital costs for the operation must be detailed. All costing must be analysed and developed into a revenue forecast and cash flow for the operations to demonstrate viability. Regulatory and rehabilitation costs should be incorporated and must align with those described in the S&EIR. There is no requirement for the MWP to be preceded and supported by feasibility studies.

b) S&EIR

In terms of Section 24(h) of the NEMA, the S&EIR process must be undertaken by an EAP registered with the registration authority (RSA, 1998a), which is recognised as the Environmental Assessment Practitioners Association of South Africa ("EAPASA"). In order to register as an EAP, an individual must prove competency in EIAs and related processes and demonstrate sufficient experience as lead in these projects. Notably, the individual must have acted as a lead in at least three EIAs, Basic Assessments, or Section 24G applications (EAPASA, 2022).

The project and operational description sets the foundation for the scoping process. As directed by the NEMA Notice No. 960 of 5 July 2019 (DEA, 2019), a screening report must be submitted with the EA application utilising the National Web Based Environmental Screening Tool. This screening tool produces a high-level screening of the project and surrounding area for environmentally sensitive areas (DFFE, 2021). The tool draws on national databases of various delineated topics and sensitivity rankings, assessing the proposed project footprint across low, medium-high and very-high sensitivity ratings. Themes reviewed include agriculture, animal species, aquatic biodiversity, archaeological and cultural heritage, civil aviation, defence, palaeontology, plant species and terrestrial biodiversity.

A screening report, referred to in Regulation 16(1)(b)(v) of the EIA Regulations (DEA, 2014), is automatically generated by the Screening Tool (DFFE, 2021). The screening report is required to be submitted with the EA application (DMRE, 2020; DFFE, 2021). It assesses the site in terms of sensitivities relating to impact themes that are drawn from government databases. The themes include agriculture, archaeology, palaeontology, terrestrial biodiversity, aquatic biodiversity, noise, radioactivity, plant species and animal species. The sensitivity indicator outcomes of the themes must be assessed by the EAP under various protocols. The screening report results are also used to indicate which specialist studies would be mandatory for this EA application.

By visualising the project footprint through the Screening Tool, the EAP is able to formulate an initial understanding of the site environment and the effects it will have on the project and vice versa. This provides a basis for the compilation of the scoping report, which guides the EIA process and the identification of required specialist studies.

The scoping phase provides an opportunity for Interested and Affected Parties ("I&APs") to review the proposed project and share concerns with the EAP to inform the studies evaluated in the EIA phase. The scoping phase identifies the NEMA-listed activities that are triggered by assessing the project description together. The results of the screening tool may support the identification of the listed activities. These activities must be fully assessed in both the scoping and EIA processes and described in the output scoping and EIR reports.

In terms of the EIA Regulations, both the scoping and EIA reports must provide full descriptions of the property, including the location, current site infrastructure and land use, a description and extent of the proposed operations, and the requirements for the activities, from construction to execution and decommissioning. The EAP is required to identify all relevant policies and legislations that must be met. A motivation must also be provided describing the proposed project in terms of the local, regional and/or national economic need and desirability. Specific reference must be given to the preferred site location.

An assessment of alternative project scenarios must be presented, together with a full motivation and description of the preferred site, layouts and proposed development. Relevant plans must include the proposed mining-related footprint (as per the MWP) superimposed on current land use structures and activities and must reflect environmentally sensitive areas. An assessment of the current biophysical and socio-economic environment attributes must be made. The preferred activity locations, as guided by NEMA objectives, should coincide with the area of least environmental sensitivity.

Owing to the basis of the process, the scoping study can only present an assessment of the current environment in terms of the available information in the public domain. This is frequently on a regional level. The requirement for specialist studies to define site-specific baseline characteristics must be identified during the scoping phase and initiated for the EIA. The specialist studies must be integrated into the EIA study and results, thereby refining the descriptions of the baseline environment in the EIR and providing a sounder assessment of impacts and risks.

An important requirement for the S&EIR is the integration of a substantial and quantified impact and risk assessment process. Immediate and cumulative impacts relating to each alternative footprint layout must be identified, assessed and ranked. The impacts must inform the selection of the preferred alternative option. For the preferred option, the activity impacts on the site must be assessed in terms of their type, significance, effects, magnitude, period and likelihood of occurrence. A full assessment of the manageability and mitigation of each impact must be provided. The impacts must also be assessed in terms of their reversibility and irreversible resource loss. Residual risks requiring management and monitoring must be identified. Furthermore, the objectives for impact management must be defined together with suitable mitigation measures.

As part of the EIA process, an EMPr must be developed to ensure that the applicant makes suitable provisions for impact mitigation and management throughout all phases of the mining project (DEA, 2014). The S&EIR requires the presentation of a mine closure plan, including closure objectives. Rehabilitation planning must be described in detail. Costs for both closure and rehabilitation must be calculated. Finally, the EAP is required to provide an unbiased opinion on whether the project should be authorised or not, with due justification. The OES presents a strict submission timeline for various applications and supporting documents, which implies that technical and environmental studies need to run simultaneously and that the processes should, in essence, overlap.

c) IWUL

Water studies and activities are described in detail through the IWUL process. The requirements for the IWUL overlap in principle with the S&EIR requirements, where descriptions of the environment are replaced with water uses. In the same fashion, policy and legislative context must be defined, NWA-triggered activities specified, the baseline environment described and the motivation for the application provided. Alternative options must be assessed, and a rehabilitation plan must be compiled in the same fashion as the S&EIR. Impacts and risks must be quantified, and management, monitoring and mitigation measures should be presented.

The person submitting the IWUL application and technical report must be identified, and, if applicable, their registration with a professional body and registration number must be provided. It is not, however, a mandated requirement for the author to be of a certain affiliation or have a minimum applicable experience.

4.1.2 Regulated Study Timeframes

All applications must be preceded by pre-application activities. Timelines are not prescribed for this and must be executed at the discretion of the project proponent. Once the application processes have been triggered through the submission of the applications, there is no specifically regulated timeframe for technical studies and the MWP. The S&EIR process is regulated by the timeframes provided by NEMA through the EIA Regulations (DEA, 2014) over a 300-day period. Through this timeline as well as the applications submitted via SAMRAD, allowance is made for a first draft MWP submission. With the development of the S&EIR and impact assessments, there is opportunity for rework of the MWP through the 300-day process, with the final MWP required to be submitted with the final S&EIR. It is not, however, mandatory that any MWP revision be done. It is only implied that the environmental studies may trigger redesigns as environmental impacts are identified.

Similar to the MWP, the IWUL application process has limited timeframe regulations, restricted only to the 90-day processing period by the DWS (DWS, 2021). No study work is regulated by timelines.

4.1.3 Process Interaction – Alignments, Overlaps and Comparisons

This section investigates the requirements and interactions of study processes. The overlaps of themes required to be assessed are identified across the MWP, EIA, IWUL and IWWMP, as summarised in Figure 2.

The mining right, EA and IWUL application processes are procedurally integrated. The MWP essentially lays the foundation for proposed operations, providing identification of a mineral deposit and project definition. The project design, equipment list, and extraction and processing strategies are provided while reviewing the forecasted economic viability.

The NEMA and OES system processes are designed to ultimately improve environmental and catchment management by providing an integrated proponent and regulator system. Based on the identification of the project, the listed activities and basis for EA and IWUL applications are identified in terms of the NEMA and the NWA, respectively. The site layout is utilised as the basis for baseline environmental (and water) studies, specialist studies and impact and risk assessments. This motivates the identification of the preferred layout and water use scenario.

Rehabilitation, management and monitoring planning for the IWULA may be incorporated into the planning for the EA requirements. An integrated rehabilitation plan and EMPr that include water use aspects are common and appropriate for a mining project, given the extent of impacts on all aspects of the environment that a mining operation poses.

The quantum for rehabilitation is calculated based on the preferred site layout and identified footprint areas, as well as the rehabilitation and closure planning objectives formulated in the S&EIR processes. These costs are fed back into the cash flow analysis of the proposed operation, as presented in the MWP.

Figure 3 illustrates that the EA processes are significantly dependent on inputs from the MWP, notably location, project activities and operational design. Legislation and regulation do not require environmental considerations to be developed into the mine planning and design document – the MWP – other than the feedback of rehabilitation costing into the cash flow forecasting. Although not included in this research, SLP costs would also feed back into the cash flow as presented in the MWP.

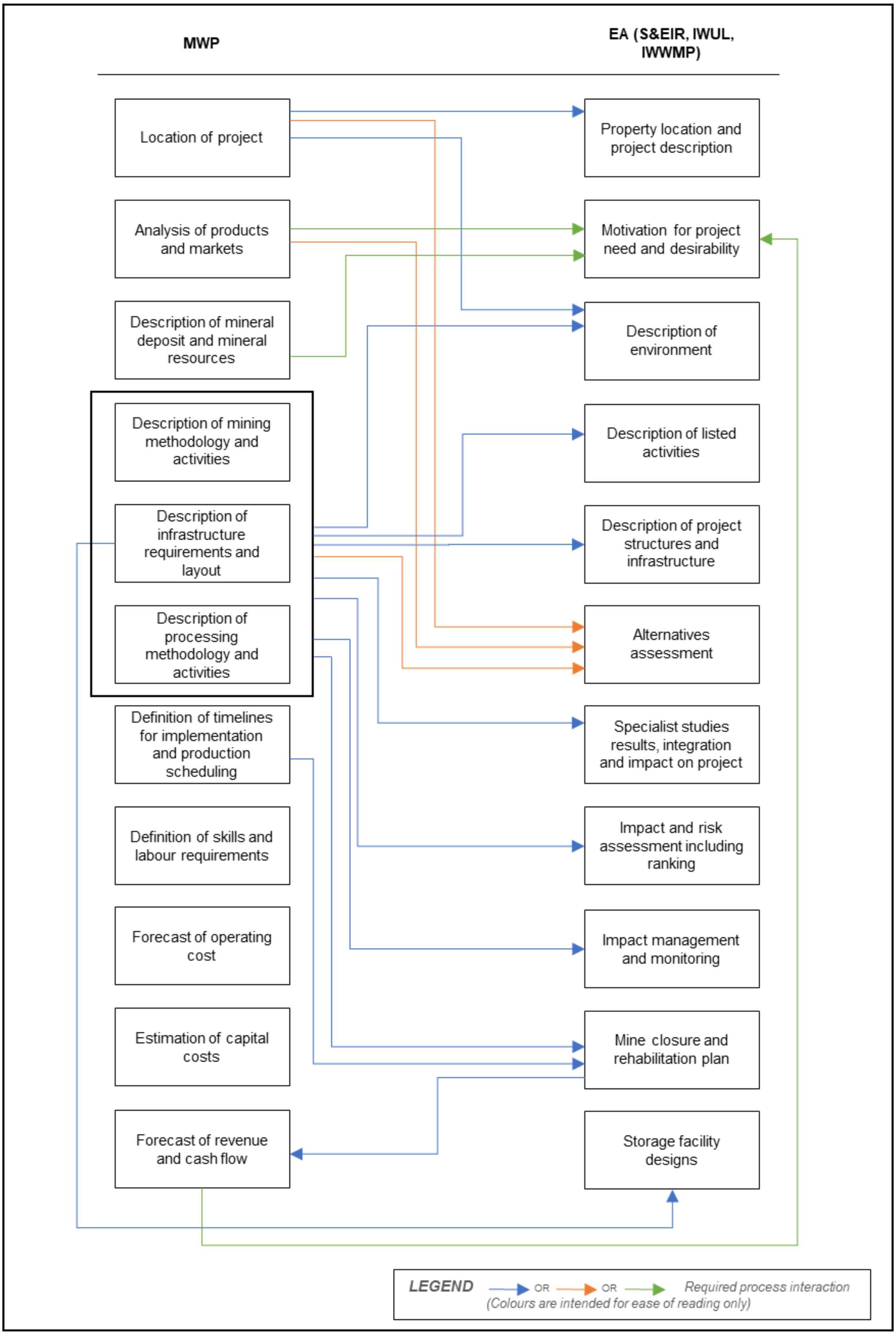

Figure 3: Simplified flow diagram of direct feedback study requirements between the MWP and EA components

As an expansion to Figure 3, Figure 4 presents the workflow, including the interactions between all the individual components of the MWP and S&EIR. The image reiterates that the processes do not require much interaction between the technical and environmental workstreams, even though it can be considered that this is alluded to. It is noted that legal frameworks should be presented without ambiguity or opportunity for interpretation. In addition, it is clearly shown that processes are misaligned with the technical studies, notably running almost entirely independently of the S&EIR.

There is provision made in the application process for the submission of a draft MWP with the initial application, with finalisation during the EA process and submission of a final document with the submission of the final S&EIR. This allows for revisions of the technical work within a scope that will not dramatically affect the scope of the environmental work, which is based on the technical project description. There is, however, no legislative guidance on the revision of the MWP based on information sourced from environmental studies.

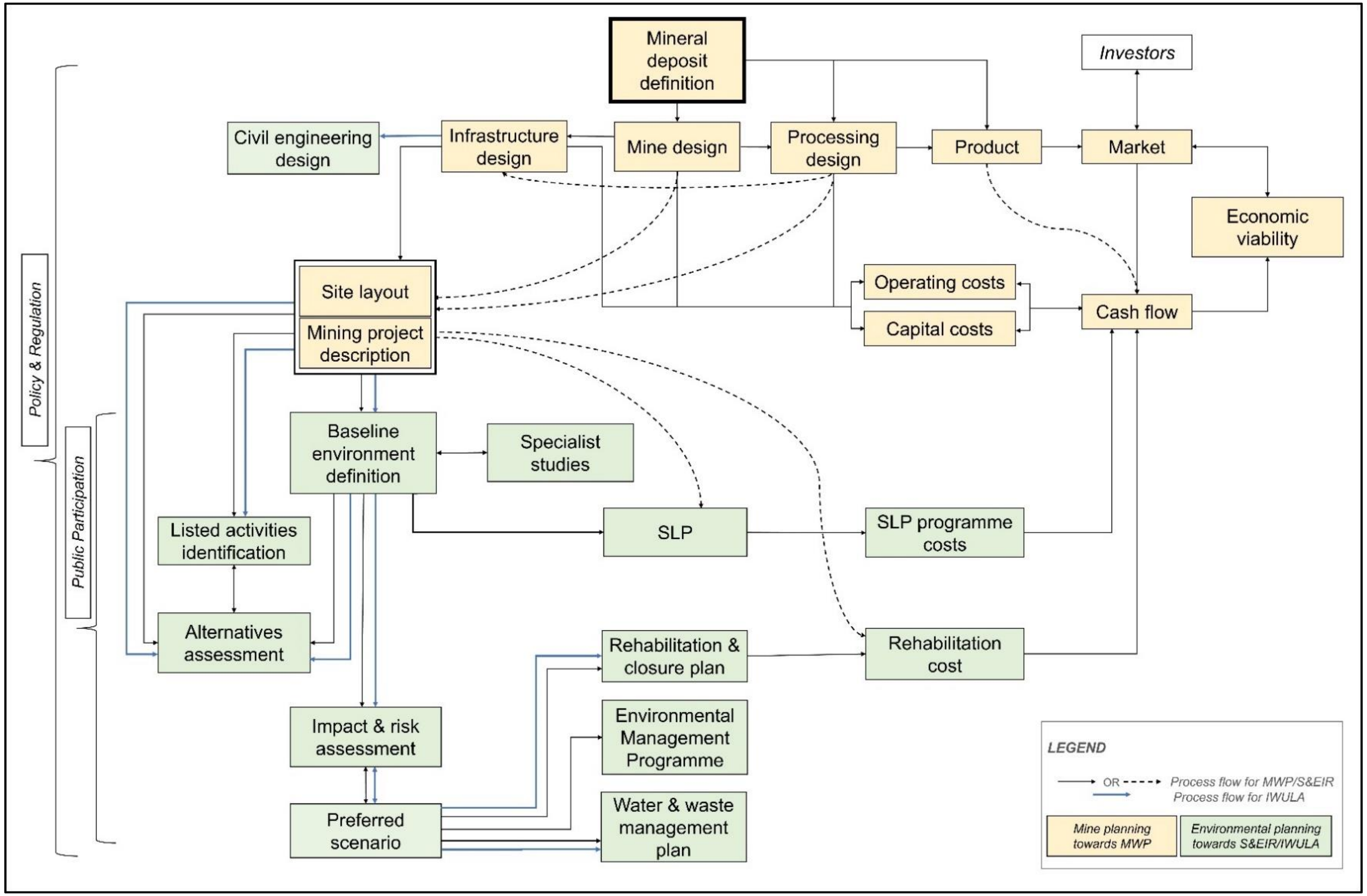

Figure 4: Flow diagram of total study requirements and processes

4.1.4 Study Level Sufficiency

The content requirements across the required studies have been assessed to determine if they are sufficient to populate related documentation in other studies (such as the MWP into the EIA). The term sufficient is used as a broad term to indicate that enough detail is provided to support another dependent study area, that is that there is sufficient overlap between the requirements of the MWP, EIA, IWUL and waste management licence application. This is an indicator for gaps in the processes that should ensure improved environmental outcomes.

Detailed content requirements are provided in the content drivers for the MWP, S&EIR and IWUL (with IWWMP). From the legislated requirements, the studies presented in the MWP are sufficient to populate the S&EIR and IWUL, limited to the scenario defined as the basis of the MWP.

The S&EIR and IWUL application processes are far more detailed than the MWP. Prominent deficiencies are identified in the MWP, showing a lack of integration of environmental considerations into technical designs:

- Detailed civil engineering designs and waste classification are only required as part of the IWWMP and IWUL application. These are not required for the MWP, although they will be based on the identification of the design requirement extents and capacities presented in the MWP. The MWP is not required to reflect these detailed designs or to incorporate them into infrastructure designs.
- In a similar fashion, infrastructure design requires consideration of water and waste management systems. It is not stipulated that these should be of an executable level supported by civil engineering designs.
- No impact or risk assessment is provided in the MWP. Only the analysis of the market alludes to a presentation of market-related risks, but this theme is only guided by the heading in the MWP template from the DMRE and is not necessarily required to be detailed.
- There is no requirement to present, and thus to consider, environmentally sensitive areas or mine closure objectives.
- Alternatives are not required to be presented, and thus to be considered. It is ambiguous to assume that alternative plans and designs have been considered without direct guidance from the legislation. It may be assumed that pre-application studies towards MWP have robustly considered alternatives, but failure to incorporate this into official guidance is also ambiguous.

The EAP is the only fixed author throughout the application process required by law to have a minimum professional registration and experience manifest. The IWUL and the MWP may be compiled by any author, with no specific requirements for demonstrable experience or qualifications. This reflects a preferred quality of outputs by the authorities based on professional accountability – where the S&EIR is held at a higher level. A summary of the identified sufficiency across each workstream output is provided in Table 3.

Table 3: Sufficiency of content requirements between application workstreams

Sufficiency	**MWP**	**EIA**	**IWUL Application (with reference to IWWMP)**	**Waste Management Licence Application (in reference to IWWMP)**
Sufficient	Description of mineral deposit and resources, infrastructure requirements, mining method, mining equipment and activities, processing methodology and equipment, costing	Description of baseline environment, triggered project listed activities Incorporation of specialist study results Alternatives assessment Impact and risk assessment Formulation of mitigation measures Incorporation of final mine closure objectives *Additional to content requirement: Minimum author experience, designation and registration with professional organisation (EAP)*	Minimum author experience Description of environment, triggered water uses Incorporation of specialist study results Assessment of alternatives Impact and risk assessment Formulation of mitigation measures Incorporation of final mine closure objectives	Storage facility designs Impact and risk assessment Incorporation of final mine closure objectives
Insufficient	Detail regarding infrastructure design specifications Consideration of waste classification and related requirements for infrastructure Incorporation of water and waste management systems in infrastructure design Alternatives assessment Incorporation of environmental specialist study results Consideration of final mine closure objectives Impact and risk assessment *Additional to content requirement: Minimum author experience, designation and registration with professional organisation*	-	*Additional to content requirement: Minimum author experience, designation and registration with professional organisation*	*Additional to content requirement: Minimum author experience, designation and registration with professional organisation*

4.1.5 Accountability through Authority Review

Through personal experience, once a mining right and EA application developed in line with the OES is submitted on SAMRAD, it is then assigned by the DMRE to its applicable regional office. Various departments or sub-directorates of the regional office are assigned to review different sections of the application, including:

- Mineral Regulation – review of the application in terms of the requirements of the MPRDA and regulations.
- Environmental Regulation – review of the environmental study work of the proposed project and alignment with environmental legislation and regulations, including NEMA.
- Mining Economics – review of the marketing and financial considerations of the proposed project, including a review of the rehabilitation quantum and funding mechanisms.

The planning of the proposed mine as presented in the MWP is reviewed by the Mineral Regulation Department of the DMRE regional office. Feedback is provided to the project proponent, upon which improvements to mine planning can be made through the EA process.

Once a mining right has been awarded, the DMRE conducts site inspections throughout the life of the project, through which alignment to the approved plans, including the MWP, is reviewed. Similarly, inspections by the DFFE and DWS are conducted for projects and operations, noting misalignments between activities, planned EIA processes and mitigation measures, and laws. These may be executed by environmental management inspectors, tasked under the auspices of Section 31 of NEMA to enforce compliance with NEMA. Non-compliances with plans or laws and regulations trigger directives issued to project owners, to which the project must be realigned within a stipulated timeframe and may trigger the issue of fines (RSA, 1998; Humby, 2015).

Subjection to enforcement actions if regulations are not followed, and the monitoring and reporting on mining and environmental performance effectively act as the mechanisms to regulate mine planning and environmental impacts of mining. However, it is identified that authority review is only triggered once the project has advanced and may not provide feedback that is meaningfully considered by the proponent and incorporated into the technical designs. The 300-day timeframes provide additional constraints to authority feedback incorporation.

4.1.6 Gaps and Alignment

The first objective of this research was to evaluate the alignment between the legislative requirements for mining right and EA applications. As demonstrated, there is some alignment in the requirements of the components. It is minimal, largely restricted to an inter-dependency between studies for population of limited content. Notably the MWP informs the EA work. Gaps exist particularly in the level of design detail presented in the MWP, upon which EA processes are reliant. While the EA studies are very much dependent on the mine planning aspects presented in the MWP, there is very limited requirement for the MWP to assimilate environmental considerations, especially in the formulation of the proposed operational plan. Further executable engineering designs are required for the IWUL and IWWMP, but are not required for the MWP.

4.2 Practical Integration

The manner in which application workstreams are executed in practice, against the foundation of legal expectations, has been assessed. The results of objective 2 are set out below.

4.2.1 Expert Experience

This section investigates the integration of the processes and requirements based on the practical experience of technical and environmental practitioners, as described in the key informant interviews.

a) Regulated Process

All interviewees described that the mining right, inclusive of the MWP, EA and IWUL application processes, are simultaneous. The interviews all demonstrated a sound understanding of the OES and timeframes.

There was unanimous agreement that the MWP is the link to the EA studies, providing the basis for triggered activities and authorisations required for the proposed project. The environmental requirement for a mining right needs to include detailed studies pertaining to the mining activities, which are presented in the MWP. The MWP was described by one respondent as the backbone to the project. Detailed engineering and geotechnical studies and designs are required to incorporate this into the EA and notably into the DWS requirements. One respondent noted that NEMA requires more substantial detail than is presented in the MWP. As described by another EAP:

> *"The mining right needs to include all the environmental, social, physical and economical aspects of the mining land. These three are then linked to the EIA in*

which they are assessed to determine the impacts of the mining right on the environment. The mine design needs to include the environmental aspects before applying for a mining right. The mining layout plan needs to be superimposed onto the environmental aspects of the specific area that will be mined."

The interviewees who are EAPs were all in agreement that the S&EIR process is robust, and the study requirements are thoroughly regulated through legislation and by the appropriate competent authorities. The interviewees who are technical authors of the MWP shared the sentiment that the MWP template and the mine planning-related guidelines and regulations are generally inclusive of all technical considerations of the operational design. It was highlighted that detailed engineering designs are not required for an MWP, although the outputs of such investigation may be presented at a high level in the report.

One EAP noted that the environmental standards are very rigid and thorough. The respondent highlighted that there is opportunity for the same rigidity to be applied to the technical standards in the MWP through improved authority review and enforcement through the application process supported by regulation. A MWP author respondent indicated that officials at the DMRE who review submitted MWPs occasionally request further information. The interviewee noted that some items that may be requested are implied as requirements through MWP regulations and guides, but are not outright stipulated. An example of this is a request from the DMRE to describe the mineral reserves in a submitted MWP, but only mineral resources are required to be provided. In instances where requests for further information are made but not supported by regulation or template guides, the interviewee noted that a letter justifying exclusion on this basis is prepared and has, to date, never been rejected by the DMRE.

The immediate issuance of a mining right identity upon submission of an application via SAMRAD ONLINE (DMRE, 2020) can be deemed to mean that the application has been received by the DMRE. Through the EIA Regulations (DEA, 2014), this implies that the S&EIR timeline is triggered. However, all respondents agreed that in their experience, the timeline is, in reality, only triggered by the issuance of an acceptance letter for a mining right and environmental authorisation by the DMRE. It was amplified particularly by the EAPs that this letter may at times only be issued months after submission, usually due to administrative backlogs at the DMRE.

b) Alignment of Study Workstreams

When asked about the interface between the expert workstreams, the respondents generally experienced that it is insufficient and is initiated too late in the application process. Instructions for the interface are required from the client, as the different components are often done by different consulting companies. The introduction of environmental experts is commonly done once all the designs have been largely finalised. This leads to extensive changes in the designs required, as the impact of the environmental aspects needs to be adhered to as part of the design. Technical respondents were also of the opinion that, in their experience, environmental processes for purposes of obtaining the EA are adapted to technical work that has already been completed and that aims to obtain improved NPVs. That is, environmental work needs to conform to mine planning outputs rather than being executed in parallel.

All interviewees experienced generally poor communication between the two sets of experts, as most companies see these as separate entities and expertise. This leads to poor integration of outputs. However, in order to apply for a mining right, both fields are assessed for the DMRE to make an informed decision. A common theme emerging from the interviews was the identified necessity for continuous interactions. Both specialist fields need to run in parallel in order to ensure successful designs and permitting applications, but this seldom happens.

There was a general consensus that the first draft of the MWP does not consider the environment and that the EAP is engaged after this has already been written up. The consequence is poor mine planning that does not include environmental planning. Most interviewees indicated the requirement for the draft MWP to be updated using the outcomes of the S&EIR process, particularly specialist studies. One EAP estimated that 60% of the EA processes she has been involved in have required material changes to the MWP based on the outcome of the environmental studies. Misalignments usually identified in the scoping phase but are highlighted with the progression of specialist studies. Major revisions are noted to occur when feasibility studies have not been undertaken prior to the application process. The interviewees indicated that this results in the applicant's expenditure of more time and money.

Through their experience, the EAPs noted that the initial project description tends to be more general and is refined with the progression of the S&EIR process. This often needs to be incorporated into the MWP, as all final documentation must be submitted simultaneously and aligned.

One technical respondent revealed that he is highly cognisant of environmental concerns related to mining operations. Without formal training or guidance in the environmental sphere, he attempts to make his own high-level investigations of the land based on available satellite imagery in early mine planning. His investigations are thus very limited, most often attempting to identify watercourses so as to design infrastructure plans to minimise impact on these. He discussed that his attempts are crude and rudimentary, emphasising his frustration that formal environmental studies are rarely presented to him timeously for meaningful incorporation into design work.

Alternatives to project design are only considered in the EA process, and these may not be feasible, as noted by one EAP. The feasibility of the project as it relates to the application process is a conundrum. A technical respondent highlighted that applicants are wary of spending money on environmental studies before knowing that a project is feasible, but also highlighted the need for incorporation of environmental feedback into early mine planning, which is reflected in feasibility studies.

The majority of the EAPs discussed that more upfront environmental work and interaction with technical teams should be undertaken so as to minimise revisions and produce improved operational scenarios that can demonstrate viability. One technical respondent volunteered that in his belief, environmental studies should be underway in the concept study level phase of the project. This would allow better consideration of alternatives and allow for mitigation and redesign early in the process. Once this has been completed, more critical and refined environmental studies can take place.

It was noted by most interviewees that they are frequently engaged by the applicant on very limited timeframes for submission, restricted primarily to those of the OES through NEMA. This is not only limited to the EIA portions but also the MWP compilation. It was highlighted that clients only initiate mining right and EA application processes based on regulated time periods before a prospecting right on the property lapses, acknowledging that the process is only a tick-box exercise. These respondents all agreed that in such cases, the MWP and S&EIR processes are notably misaligned with little to no interaction between technical and environmental experts. Most highlighted that in such cases, numerous revisions, sometimes complete redoing, of studies and designs are required.

c) Internal versus External Studies

The EAPs interviewed noted that when the technical studies and MWP are done in-house by the applicant, the processes are better integrated with the EA work, even though the EA process is done externally, as required by law. This is because it is easier to interface one set of practitioners (environmental) with an in-house team that is already very knowledgeable about the project. Internal teams comprise diverse expertise, and due to their direct exposure to a project, they are all aware of and aligned with the bigger strategy. Additionally, plans can more readily be adapted due to less time and financial expenditure constraints that are typically associated with consultants. Both environmental and mining plans are developed in unison, with technical studies taking cognisance of environmental feedback early in their conceptualisation. A project manager is frequently employed, and the technical experts are willing to adjust the MWP based on the outcomes of the EA process.

The EAPs highlighted that when the technical studies are done externally via a consultant, there are almost always very little environmental study inputs from the EA process into the designs. In these instances, the technical and environmental studies are executed largely independently of one another. Information is filtered between the workstreams through the client. Critical information is thus sometimes not adequately provided to the receiving experts. Consequently, the documents are often not factually aligned, and there is no integration with the larger project strategy. The EA process is then adapted to the final designs of the MWP rather than providing input to them, and the MWP is infrequently adjusted to consider environmental study work outcomes. The respondents noted that, as a result, planning is poorly developed to meaningfully improve environmental impacts. Opportunities to include improved impact planning are not promoted.

4.2.2 Case Study

The following section provides an overview of the mining planning and EA processes followed for the case study mining right and EA applications.

a) Key Role-players

In preparation for the Section 102 mining right application, it was identified that activities from Listing Notices 1, 2 and 3 were triggered by the planned activities, requiring a full S&EIR study to be undertaken. The project also triggered activities defined by the NWA and NEM:WA and their respective regulations, requiring an IWUL from the DWS and IWWMP from the DMRE.

In order to assess the process, the main participants in compiling the application have been identified and are listed in Table 4, with their main mandated roles. The expert participants were all external consultants appointed for the project, and not considered a single team. Broadly, they were grouped into the following teams:

- Applicant team (internal): project manager, project leader, legal director
- S&EIR team (external consultants): EAP, IWUL specialist, social specialist
- Technical team (external consultants): geologist, mining engineer, mechanical engineer, process engineer, financial valuator

An engineering design team comprising civil engineers was introduced late in the process. A Project Advisor, external to the applicant and technical and environmental teams, was appointed to provide guidance for the execution of the entire processes (technical and environmental workstreams) based on the project strategy defined by the applicant. An external Environmental Strategic Advisor was appointed with a similar function but with a specific focus on formulating guidance for the planning based on the environmental outcomes of the project. Neither of these roles is specifically required by the MPRDA or the NEMA, but both were appointed as additional support for the application processes to achieve optimised outputs.

Table 4: Application process key role-players

Role-player	**Composition**	**Responsibility**	**Deliverable**
Client (Applicant) Team	Chief Executive Officer/Project Manager	Manage overall project programme	-
	Project Leader	Co-ordinate and align technical and environmental application teams, provide regulatory costs for MWP	-
	Legal Director	Guide application requirements, provide socio-economic and SLP provision cost estimates for MWP, submit mining right and EA applications	-
Project Advisor	Individual	Track total project progress, advise on mining and environmental strategies, estimate rehabilitation cost	
Environmental Strategic Advisor	Individual	Assist as internal environmental specialist, provide strategic environmental input	-
EAP	Individual	Conduct S&EIR process, compile EIA and EMP, co-ordinate specialist studies, conduct Public Participation processes, engage with competent authorities and stakeholders, submit EA application	EIA, EMP, EA Application, IWWMP Application
IWUL Specialist	Individual	Compile IWUL and IWWMP application, co-ordinate water specialist studies	IWUL Application
Social Specialist	Individual	Conduct Public Participation processes, advise on social aspects for consideration	-
Technical Team	Geologist	Prepare geological description of project and resource statement	MWP
	Mining Engineer	Conduct mine design, planning and scheduling; assess equipment requirements, operating and capital mining costs	
	Mechanical Engineer	Define engineering design criteria; develop infrastructure plan and layout; assess equipment requirements, operating and capital mining costs; define labour requirements	
	Process Engineer	*Compile inputs from external processing consultants as appointed by the applicant*	
	Financial Valuator	Analyse commodity market; assess economic viability, valuation; forecast project costs, revenue, cash flow	
Engineering Design Team	Civil Engineers	Conduct detailed civil engineering designs based on MWP-prescribed infrastructure for IWWMP and IWUL	Civil Engineering Designs

An overview of the application and submission process timeline is provided in Table 5. The table presents the timeframes for when each team participated in terms of the project phase as well as the output for the application.

Table 5: Simplified timeline of the application processes

			Role-player input					
Phase	**Month**	**Application output**	**Applicant**	**Advisors**	**Technical Team**	**S&EIR Team – EAP + Social Specialist**	**S&EIR Team – IWUL Specialist**	**Civil Engineering Team**
Pre-application	1	**Concept Study** (technical)						
	2-3	**Initial MWP**						
	4	Water specialist studies initiated						
	5	**Draft MWP**						
		Environmental specialist studies initiated						
	6	**Revised Draft MWP**						
Initial Scoping	7-8	**First Draft Scoping Report**						
		Initial application submitted						
	9	Technical Feasibility study completed						
Scoping	10-12	**Second Draft Scoping Report**						
	13	**Final Scoping Report submitted**						
EIA	14-16	**First Draft EIA/EMPr**						
		First Draft IWULA						
	17-18	**Final MWP**						
	19-21	**Second Draft EIA/EMPr**						
	22	**Second Final MWP**						
		Civil engineering studies						
	23	**Third Draft EIA/EMPr**						
	24-25	***Final S&EIR submitted***						
		Second Draft IWULA & IWWMP						
Completed application	26	***Final IWULA submitted***						

The applicant appointed all experts for the studies and served as the co-ordinator for introductions. The applicant acted as the decision-maker and was actively involved throughout every step of the process. The function of the project manager was to ensure the interfacing of the application expert workstreams, although this role did not function optimally.

The technical team appointed to compile the MWP had previously completed concept and feasibility studies for the project. The processing method and associated designs and costing were completed by third parties and incorporated into the technical studies.

An appointed EAP, as required by Section 24(h) of NEMA (RSA, 1998a), ultimately drove the process with key inputs from all experts and specialists. The application for the EA and IWWMP was prepared and submitted by the EAP. A social specialist was appointed to guide the public participation process. The applications for the IWUL were prepared and submitted by an IWUL specialist, who also provided key inputs to the IWWMP.

Initially, the technical team functioned entirely independently of the S&EIR team. Only with the maturation of the application process from month 6 were the MWP and S&EIR functions conducted simultaneously. It was only at this point that the two teams worked together.

Based on the designs produced by the technical team, civil engineers were appointed later from month 22 to produce civil designs in accordance with the regulations and by-laws for construction and structural development.

b) Initial Mine Planning

The concept of the mining project was investigated by the technical team initially only for the two-pit scenario. A concept study was completed in September 2018. The concept study planned the following on an accuracy level of +25%-30%:

- mining engineering, including trade-off studies, the development of mine design criteria, mine design and schedule;
- processing plant and associated infrastructure design, including the development of process design criteria;
- engineering and infrastructure design, including the development of engineering design criteria and design of the infrastructure layout;
- capital cost estimation;
- operating cost estimation;
- financial analysis; and
- project risk assessment.

Based on the results of the concept study, the Client decided to proceed with a Section 102 amendment application to the existing mining right to extract the orebody. An initial MWP was compiled in November 2018 for this amendment application by the same technical team based on this two-pit scenario. It was guided solely by the minimum requirements as prescribed in the MPRDA Regulations (DME, 2004), DMRE MWP Guideline (DMR, 2011) and MWP template (DMR, 2010a).

The third pit was investigated later, with pit design scenarios and extractability reviews indicating viability. The third pit was then included in the total project. No environmental studies had taken place on the site at this stage, nor had an environmental strategy been developed; thus, the technical work did not incorporate such expert considerations. Instead, the environmental factors incorporated into the MWP were limited to water sourcing and infrastructure siting based on a high-level review with limited resources and knowledge of the area by the technical team. This was done by reviewing the topographic constraints on satellite imaging platforms such as Google Earth. Water sources were identified based on satellite expressions of surface water.

The applicant provided no instruction for these considerations and treated the technical studies as isolated expertise limited to the fields of mining, engineering and economic evaluation.

c) Introduction of Environmental Experts

Following the initial MWP, owing to the close proximity of the project to a perennial and key water system, the applicant engaged the IWUL specialist at this time to initiate the IWUL process. The specialist identified the requirement for water-related specialist studies, and specialists were engaged to begin the following investigations:

- Freshwater Ecological Assessment
- Hydrology and Freshwater Assessment
- Groundwater Assessment

The initial results of these water specialist studies were not communicated to the technical team, nor were the water and technical experts introduced to each other. The processes were thus run entirely independently, and a subsequent feasibility study commenced without detailed considerations about water occurring in the natural environment.

The technical team did not undertake a pre-feasibility study. Based on the availability of sufficient technical data and information, a feasibility study commenced. By conducting site visits and utilising satellite imagery, the technical team identified early that limited options were available for the placement of required mining infrastructure sites, given the nature of the surrounding terrain with numerous peaks and incised valleys.

Following initiation of the feasibility study, the Project Advisor, Environmental Strategic Advisor, EAP and Social Specialist were then engaged to support the preparation for the application of the environmental authorisation. On advice from the project advisors based on widespread knowledge that the project is located in an environmentally sensitive area, the EAP identified the requirement for specialist studies to be conducted in support of the application. The Screening Tool (DFFE, 2021) was not yet available or a requirement for application (DEA, 2019). At this point, all experts were introduced, and the technical team shared all the design and planning details with the full team.

Desktop study reviews identified potentially high sensitivities for animal species, aquatic biodiversity, plant species and terrestrial biodiversity within the proposed footprint area. Proposals and quotations were sought for the following:

- Floral Terrestrial Ecological Assessment
- Faunal Terrestrial Ecological Assessment

- Social Economic Assessment
- Soil, Land Use and Land Capability Assessment
- Heritage Impact Assessment
- Air Quality Assessment
- Noise Impact Assessment
- Climate Change Impact Assessment
- Visual Impact Assessment

The proposals were provided to the Client to make decisions regarding which consultants to engage for each of these studies. They were engaged, and the processes were managed through the EAP. The water specialists remained involved and continued their assessments based on technical adjustments. Although the water specialists were not part of the environmental team, their processes and observations were, by definition, tied to the environment. Their assessments formed part of the specialist study reporting package delivered with the EA application.

d) Integration of Technical and Environmental Workstreams

Realising the difficulty that the location provided in terms of constrained footprint areas and proximity to sensitive environmental receptors, the Client initiated broad strategy sessions from month 6 with the full team of experts. This was done to understand the basis of the feasibility study scenarios, mining strategy and placement of infrastructure, waste rock dumps and tailings storage facilities. With inputs from environmental experts, different options and scenarios could be identified that would meet the requirements of the proposed mine and reduce environmental impacts. The rationale was that mine planning could then be adapted to this to achieve better environmental outcomes while maintaining a positive project NPV.

Potential high-risk environmental areas were initially identified by the environmental experts. It was immediately established that a significant portion of the mine planning was sited on, or directly impacted, extremely environmentally sensitive areas. Most notably, the highest-grade portion of Pit 3 occurs directly in a restricted area that hosts critically endangered faunal species. The development of this pit as designed in the feasibility study would completely remove their habitat and be catastrophic to this species community. These high-risk environmental factors were relayed to the technical team.

The early commencement of specialist studies offered the ecology specialists the opportunity to conduct site assessments over two seasons (summer and winter). In parallel, the EAP and Project Advisor commenced initial consultations with relevant competent authorities, including the regional office of the DMRE, DWS and municipal bodies in preparation for the submission of the applications. This was done in order to advise the authorities of the intended applications and to ascertain preliminary feedback.

The ecological studies confirmed that the proposed mine footprint development would impact threatened ecosystems, resulting in significant and critical biodiversity area loss. Initial results from the specialist investigations further found that adverse impacts on sensitive water bodies and aquatic ecosystems would be realised by the planned operational activities. Buffer zones were applied to critical biodiversity areas and sensitive water bodies to accommodate for potential infrastructure creep. They further confirmed that indigenous forests would be impacted on, although these are somewhat degraded and host abundant invasive alien plants. Mine planning was modified to avoid these areas as far as possible, and the MWP was again adjusted to incorporate these determinations. To further mitigate these impacts, the Project Advisors and EAP undertook detailed planning for compensation measures and biodiversity offset areas that were incorporated into the S&EIR.

The project area is in an eco-tourism hotspot, and careful planning was considered to limit the visual effects of obvious terrain modification. Multiple mining sequences with concurrent backfilling options and infrastructure site layouts were investigated to achieve a balance between feasible orebody extraction and minimal environmental impacts.

The MWP was entirely revised to include all three pits based on the outputs of the feasibility study and to incorporate the feedback from the environmental experts. Site layouts were reworked to try to limit the footprint to within already disturbed areas. In addition, Pit 3 was entirely redesigned to avoid the areas of critical faunal biodiversity, that is, by excluding the most economically significant portion (highest-grade) of the orebody. The mining right amendment, EA and IWUL applications were based on the three-pit scenario, and rehabilitation quantum calculations aligned with this.

Following the MWP revision, it was acknowledged that the disciplines were fragmented and that the complexities of the project required an integrated expertise approach. Weekly meetings with key representatives from each team were initiated to track progress and integrate operational strategies prior to initial application. Planning from both broad pathways was workshopped with the full team to try to produce improved plans. The workshop also aimed to determine siting options that would satisfy both operational requirements and environmental outcomes.

The ecological and hydrological-related studies became pivotal to the total forward planning for this proposed project, and the specialists became core to the planning adjustments, working closely with the technical team, EAP, Project Advisor and

Environmental Strategic Advisor. The first draft scoping report was prepared and completed by the EAP based on initial specialist findings that were completed over two months, and the draft MWP revised.

e) Mining Right and EA Application

In April 2019, the draft scoping report and all application documentation for the Section 102 mining right and EA – as required by the MPRDA, NEMA and their accompanying regulation – were completed, and the application was lodged on SAMRAD by the EAP. No DMRE acknowledgement letter was received.

In accordance with regulations, the team commenced the S&EIR processes in accordance with the NEMA-regulated timelines. With the initiation of the scoping phase, the first draft scoping report was distributed for public review to afford I&APs the opportunity to provide comments and raise concerns about the project to inform further study work.

Around one month after submission of the application, the applicant was informed by the DMRE that the regional office under which the application jurisdictionally fell was closed due to administrative investigations. Consequently, the regional office was not receiving or processing applications. Recognising the disruption to the S&EIR-regulated timeframes and the potential future ramifications of this on the decision-making process, the applicant withdrew the application as well as the scoping report that was out for public review.

Concurrently, the feasibility study was finalised. The EAP and Social Specialist continued to engage with key stakeholders during this hiatus period. The IWUL specialist commenced the drafting of the IWUL report for the DWS.

The DMRE regional office recommenced their mandate in July 2019, and the application was relodged. The draft scoping report was redistributed, and the 30-day public review period was completed. Comments were incorporated into the final scoping report, which was submitted in August 2019. DMRE’s acknowledgement of receipt was received within eight days, and the acceptance was received 75 days later, in November 2019, triggering the commencement of the EIA phase. The EAP commenced compilation of the draft EIA/EMPr during the waiting period.

Although EIA Regulations (DEA, 2014) require specialist investigations during the EIA phase, for this application, the studies continued from the pre-application phase and were refined as the proposed project planning developed further.

Three EIA review phases were undertaken for this application. A first draft EIA/EMPr was compiled and distributed for further stakeholder review from November 2019 to January

2020. Then, the first draft of the IWUL report was distributed for public review and commentary in January to February 2020. Revised mine planning and a final MWP were completed in February 2020, drawing on commentary from the EAP during the EIA/EMPr public review period as well as additional findings from the specialist investigations.

An updated draft EIA/EMPr report incorporated stakeholder comments, and the document was submitted again for public comment as well as the DMRE's comment in March 2020. The review period was impacted by the nationwide COVID-19 lockdown implemented on 27 March 2020, following the declaration of a national state of disaster on 15 March 2020 (Department of Co-operative Governance and Traditional Affairs, 2020a), and the publication of a government notice on 18 March 2020 (Department of Co-operative Governance and Traditional Affairs, 2020b) relating to the Disaster Management Act, No. 57 of 2002. Accordingly, the public review period was suspended. Field studies were also suspended, and team meetings were aborted.

In early June 2020, following direction from the DFFE, a public participation plan was compiled and submitted to the DMRE, obtaining approval later in the month. The second draft EIA/EMPr was again published for review for an eight-day period ending in early July 2020.

Simultaneously on the technical side, civil engineers were engaged, and detailed civil engineering designs were drafted. The detailed civil engineering planning and design works were supported by geotechnical investigations. Civil engineering work targeted the refinement of infrastructure design, clean and dirty water management, drainage and landform integrity. The process was vital for developing engineering controls in this environmentally sensitive landscape. Critically, it also aimed at minimising or reducing potential adverse impacts, either to an acceptable level or entirely.

The civil engineering work identified impracticalities with some of the technical team work completed as in the final MWP, impacting some infrastructure footprints and the mining schedule. The technical mine planning designs were revised based on the civil planning results, and the MWP was again revised into a final MWP 2, with a third revised site layout plan and recalculated rehabilitation costs.

The changes warranted further specialist investigations to be incorporated into an updated third draft EIA/EMPr. A further 30-day public participation extension was requested for public review of the changes, which was granted by the DMRE. The updated third draft of the EIA/EMPr was distributed for public review from mid-July 2020 to mid-August 2020. The changes were also incorporated into a second draft IWUL report, incorporating an IWWMP, which was submitted for public commentary simultaneously.

All comments received during all the revisions submitted for public comment were consolidated in the final EIA/EMPr. The full S&EIR process was completed and submitted to the DMRE, with the final MWP 2 and waste management licence reporting in late August 2020. The DMRE did not provide feedback. The final IWUL submission to DWS occurred in October 2020.

A negative record of decision was issued by DWS for the waste management licence based largely on the non-compliance of civil engineering designs with NEMA:WA and its regulations. The IWUL application was withdrawn by the applicant on the same basis. Ultimately, the applicant shifted business focus to other mineral projects in their portfolio and, at the date of this research, has not pursued this application further. The mining right amendment and EA applications have not been withdrawn from the DMRE, but they have also not been rejected.

The process as described above is presented in Table 6. Key engagements and general processes with outputs are presented in terms of the application processes, from pre-application to final application submission.

Table 6: Executed case study mining right and EA application processes

Phase	Month	Application Process	Technical Studies		Environmental Studies		Water Studies	
			Process	Output	Process	Output	Process	Output
Pre-application	1		**Concept Study** (2-pit scenario) - Mine design and planning					
	2							
	3		Compilation of MWP	**Initial MWP**	Engagement of EAP, Project Advisor, Environmental Strategic Advisor, Social Specialist		Engagement of IWUL specialist	
	4		3-pit scenario investigated through pit optimisations		High-level rehabilitation costing		Water specialist studies initiated	
	5	Project Announcement	Commencement of Feasibility Study (3-pit scenario)	**Draft MWP**	- Desktop review of environment - Specialist studies initiated			
	6	Competent authority meetings initiated	Incorporation of specialist study results, redesign	**Revised Draft MWP**	Environmental planning and rehabilitation costing			
			Weekly strategy meetings initiated - full team representatives					
	7				Compilation of First Draft Scoping Report			
Initial Scoping	8	***Initial application submitted***				**First Draft Scoping Report for public review**		
-	9	Application withdrawn	Feasibility study completed incorporating environmental factors and strategies				Drafting of IWUL documentation	
	10							
Scoping	11	***Application relodged***						
	12	- ***Final Scoping Report submitted*** - DMRE acknowledgement of receipt received				**Second Draft Scoping Report for public review**		
	13				Final Scoping Report completed	**Final Scoping Report submitted**		
	14	***IWULA application***			Compilation of First Draft EIA/EMPr		Compilation of First Draft IWULA	
	15	DMRE acceptance of Final Scoping Report						

Phase	Month	Application Process	Technical Studies		Environmental Studies		Water Studies	
			Process	Output	Process	Output	Process	Output
EIA	16					**First Draft EIA/EMPr for public review**		
	17		Revised mine planning incorporating additional specialist study results and adjusted environmental strategies					**First Draft IWULA for public review**
	18			**Final MWP**	Revised environmental planning and rehabilitation costing			
	19	*(COVID-19 restrictions commence)*			Compilation of Second Draft EIA/EMPr			
	20	Plan for revised PPP timeframes submitted				**Second Draft EIA/EMPr for public review**		
	21							
	22	Plan for revised PPP timeframes accepted	Revised site layout plan based on civil engineering designs	**Second Final MWP**	Revised environmental planning and rehabilitation costing		Civil engineering planning and design	
	23	Additional 30-day PPP plan requested and approved				**Third Draft EIA/EMPr for public review**		
	24	***Final submission S&EIR***				**Final EIA/EMPr + Waste Management Licence**		**Second Draft IWULA and IWWMP for public review**
Completed Application	25							
	26	***Final submission IWULA***						**Final IWULA**

f) Analysis of the Process

The application process drew upon expert knowledge beyond what is legislatively required. The only expert required by law to be engaged is the EAP. Nevertheless, the applicant engaged teams of highly experienced professionals. The technical team alone comprised individual specialists in each theme area who were able to provide thorough investigations and outputs as defined to them. The EAP typically undertakes the I&AP engagement, but a Social Specialist was employed to champion the process. The engagement of a Project Advisor and an Environmental Strategic Advisor demonstrated a commitment by the applicant to deliver a well-defined strategy and design. The Environmental Strategic Advisor was a fundamental driver of the alignment between the technical reworking and the environmental studies.

The development of the project was initiated as a design-oriented process (Buchanan, 2019) that focused on the technical work supporting an economically viable operation. As the project developed, the environmental risk assessment identified a number of adverse effects with a high likelihood of occurring based on the initial mine and infrastructure design.

The MWP in all its revisions complied with at least the minimum technical detail, and in the format required by the MPRDA Regulations (DME, 2004), DMRE MWP Guideline (DMR, 2011) and MWP template (DMR, 2010a). The basis of the initial MWP was the mining concept study, which is not alluded to in any manner as being unacceptable in terms of any regulated requirements by the DMRE as listed in Table 2 (the summary of South African mining right and EA applications legislation, guiding documentation and content requirements). However, it is observed that this version was premature in the application process. The later revision based on the feasibility study is also entirely acceptable legislatively. However, while the completed backing studies produced a sound engineering plan and strategy for a profitable operation, they only considered non-detailed parameters relating to surface water impacts that could be seen on satellite and modelling imagery. The technical team did not consider any other impacts on the receiving environment. An execution of the plan based on initial mine planning and without specialist environmental input would have been detrimental to the immediate and adjacent environment. In particular, the critical biodiversity area would have been entirely obliterated. This would have been a devastating ecological loss had the plans proceeded on this basis.

It is shown that even when done by experts, independent mine planning and designing without the proper understanding and consideration of environmental factors is not sufficient for an environmentally conscious and sustainable project. The mine planning undertaken prior to the involvement of environmental experts was poor in terms of total strategy and catastrophic in terms of future environmental outcomes through project development. The case study highlights that without detailed environmental inputs, designs cannot be optimised for proper consideration of impacts on the environment. It is noted that this case study would have benefitted from the availability of the Screening Tool, which would have provided very early caution regarding the environmental sensitivities of the site.

The environmental study results initiated major project delays and incurred significant additional costs for the application. Major considerations for the designs were communicated to the technical team, and many revisions to the designs and rehabilitation planning and costing were required. Based on the numerous revisions to the mine planning and design once environmental experts had commenced their investigations, the project would have benefitted from the early, perhaps simultaneous, engagement of all experts, at the very least the EAP and advisors. Critically, the project would have benefitted from the integration of the total project planning workstreams. Considering all technical and environmental factors would have produced better plans from the onset.

Time would have been saved from the reworking of the designs on numerous occasions. The Client would have also saved on costs, as the multiple revisions required excessive expenditure on technical expert inputs and reporting. The process of mine planning does require refinement with new information being identified (Fourie & van Niekerk, 2001), and the MWP is initially submitted as a draft to allow for adjustment with the results of environmental studies and I&AP feedback, but in this instance, entire re-strategy and redesigns were required.

Although this project would have benefitted most from the very early integration of workstreams from the concept or feasibility stages, the engagement of specialists prior to the commencement of the S&EIR process was advantageous. In terms of the NEMA-regulated timeframes, the guidance is that specialist studies are undertaken in the EIA phase. As this case study shows, the specialists provided crucial guidance in the development of the project up to the application submission and throughout the S&EIR phases. The early engagement also allowed for assessments in both summer and winter. For this project, seasonality in terms of ecology and water delivers different study results, and thus, it is imperative that field investigations occur in both the summer and winter seasons. If the specialists had only been engaged in the prescribed EIA phase, the project would have only been surveyed in one season. The sessions provided a solid bridge that closed the fragmentation gap between workstreams and planning principles to deliver a better outcome overall.

The corporate strategy of the Client was driven by the indicative economic results of the concept and feasibility studies. The high-grade portion of the orebody was a major contributor to this. The requirement to revise the plans and eliminate this portion from the design due to the site's proximity to the critical biodiversity area prompted a change in strategy regarding the project from a corporate level, as reworked financials proved a less economically attractive project.

Civil engineering and geotechnical designs are only required for the IWULA. Thus, although capacities and minimum requirements for certain infrastructure aspects are identified through the mine planning process, the practical design of the items within the physical environment may not be practical. The relatively late engagement of civil engineers quickly identified the requirements for changes in the mine and layout designs. Technical designs are only required for the execution of the IWUL and IWWMP applications; they are not required for the mining right and EA applications, and thus were not initiated sooner. This shows that full design work considerations from early in the total planning process are paramount and must commence much earlier prior to the triggering of the S&EIR timelines. The rejection of the IWWMP by the DWS further justifies that this work must be incorporated in early planning, so as to allow time to produce sound, practical and executable civil designs based on mine designs that can be modified to achieve better results. The process highlighted an inadequacy in the level of detail presented as part of the MWP and required by civil engineers for the IWUL application.

From the assessment of the technical mine planning and environmental planning processes executed in the case study, it is shown that misalignments and gaps are functions of both legislated requirements and practical execution. Therefore, interdisciplinary interaction between experts and project drivers must be initiated concurrently early in the process.

The multitude of revisions in layouts, designs and mine plans are identified as positive steps towards proper environmental planning. The extensions requested and executed for the S&EIR process allowed the reworking of plans for optimisations that significantly reduced the impacts of proposed activities on the environment. The requirement for the extensions suggests that the NEMA-regulated timeframes for process execution are not sufficient to allow specialist studies to be meaningfully included in the process.

Ultimately, the alignment of workstreams, albeit later than preferred, allowed for a pit optimisation rerun for all scenarios and the mining schedule consciously considered environmental impacts throughout the life of the proposed operation. The final mine design was selected considering input from the various technical and environmental specialists. The design chosen would, at current market conditions, prove to be a profitable operation achieving the preservation of important environmental systems and consciously employing strategies sensitive to immediate and long-term impacts. The process highlights that notwithstanding constricted regulatory timelines, planning for improved environmental scenarios is possible through disciplined and integrated workstream alignment.

This research report does not review the effectiveness of government bodies such as the DMRE. It is pertinent to observe, however, that irregularities such as the temporary closure of the regional office of the DMRE hampered project schedules. This impacted timeframes and incurred costs to the applicant in retaining technical teams and the EAP. The 75-day period in which the DMRE accepted the draft scoping report highlights that the DMRE may not live up to its legislated mandate and that processing delays could be realised, also impacting project schedules.

4.3 Practical Guidance on Integration of the Mining Right and EA Application Processes towards Improved Environmental Outcomes

The procedures delegated by the MPRDA, the NEMA and their respective regulations and procedures aim to achieve the mandates of the DMRE, DFFS and the Constitution. Although they provide a basis for the planning of systems and projects by way of listed requirements, these quickly become compartmentalised and isolated workstreams in their practical execution.

Feedback from mining and environmental experts are analysed with the results of the initial application processes executed in the case study. They demonstrate that an approach guided solely by legislative requirements and timeframes translates to fragmented planning procedures. Without early interdisciplinary planning, the environmental protection objective of the Constitution, as bestowed upon a project proponent, is crippled from the onset. Environmental considerations are frequently treated as an impact to be mitigated, rather than meaningfully assimilated into forward-planning strategies and thus avoided. This ultimately leads to project designs that cannot be optimised, with the focus remaining on mining and economic optimisation. The result is poor environmental planning and negative outcomes that persist throughout the mining lifecycle.

Legislated requirements for new mining projects begin to allude to the design approach as defined by Buchanan (2019). Inter-reference to one another in the sentiments of the MPRDA and NEMA through the OES suggests a systems approach. As demonstrated by the case study, the adoption of an integrated system and design approach from early planning will allow for holistic and dynamic project planning. This will achieve improved planning targets across the sum of all the mining, engineering, economic and environmental spheres.

An improved approach to the execution of the mining right and EA application support processes is presented in Figure 5. IWUL application processes are not specified and would repeat several items represented in the process with different output applications.

The image purposefully appears complex in order to demonstrate the iterative interactions between experts, for which provisions are alluded to in the MPRDA and NEMA timelines. Arrows indicate feedback. Key aspects of the proposed mechanisms are the following:

1. Early incorporation of sound environmental planning into the process achieves improved total planning that meaningfully considers the environment as a project feature, not an impact base. The site layout and preferred scenario must be viewed as a product of combined, integrated mine and environmental planning.
2. The infrastructure and site layout planning is a critical item that requires a substantial understanding of the receiving environment. The mining and processing methods are also crucial. From the investigations, the expanse of infrastructure layouts and activities trigger the most listed activities. Notable deviations from the typical procedure are the incorporation of civil engineering designs early in the process, with opportunities for inputs to infrastructure planning.
3. Reliance on sound project management practices is essential for more efficient and cohesive mining and environmental plans and designs.
4. The process represents active and interactive planning. Planning activities must be fluid and dynamic, allowing for adjustments based on feedback from other spheres in order to achieve an optimised total project plan.

Technical and environment experts are needed as per the requirements set out by the MWP and S&EIR laws, regulations and guidances. Their workstreams should be integrated from the onset of the idea of a project application, that is, in the pre-application phase prior to the triggering of the NEMA timeframes. Early integration will allow for more sensible impact mitigation, with meaningful opportunities to accomplish this through design alterations.

Planning and strategy development should occur as a combined effort, guided by the requirements of the applicant and the eventual total project outcomes, including mining economics and environmental impacts. Their engagement should be continuous throughout the process, from pre-application to final submission, in order to develop optimised, well-rounded designs. Timeframes should be adopted by the applicant beyond NEMA, with considerable work efforts occurring prior to application submission. The appointment of effective project managers and advisors would be greatly beneficial to the integration of the processes.

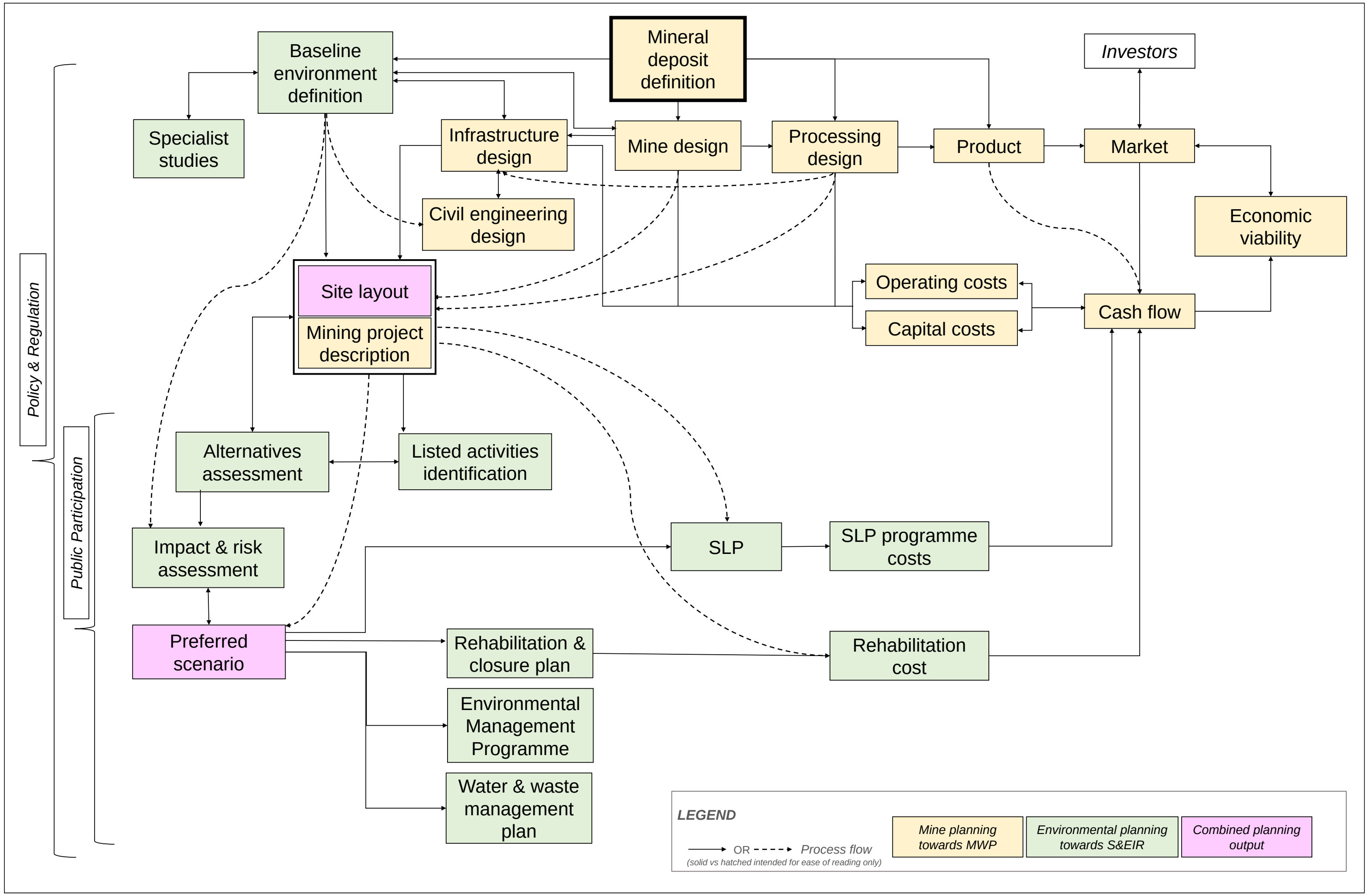

Figure 5: Proposed integrated planning process

The process is intended to be adaptive and flexible, continually drawing from parallel disciplines to refine options for improved planning. Mine planning should utilise environmental planning and EIA study work in order to develop an integrated and sustainable plan.

CHAPTER 5 : DISCUSSION

5.1 Introduction

The intention of this study was to investigate the alignment between technical and environmental studies necessary for new mines and their mining right applications for enhanced environmental outcomes. Academic studies notably explore environmental themes relating to the site at which mining is already in process or has ceased. Monitoring and quantification of prolonged impacts are reviewed extensively. However, published literature is starkly deficient in the study processes directly linking the technical formulation of mine and infrastructure design and planning to inform the planning of the natural environment impacted by mine establishment, particularly in South Africa.

By researching legislated requirements and investigating actual processes executed in the compilation of technical and environmental study work towards permitting applications for a proposed mine, emerging themes have been identified. These are discussed in the context of the literature.

5.2 Consequences of Not Integrating Processes

The case study reviewed for this research mirrors the results of the interviews conducted. They reveal that the misalignment of mining right and EA application processes has an assortment of undesirable impacts on both the execution of the application process by the proponent and on plans developed.

Technical study work is required for the proponent of a new mine to decide to move forward with the application for a mining right. This decision is based on whether the project demonstrates economic viability, which is assessed through initial mine planning and evaluation. The investigations presented in this study reveal that the initial design and mine planning occurs with only input from technical design teams. It rarely introduces environmental planning early on. Although guides such as the SAMREC Code require consideration of environmental aspects as modifying factors in the conversion of Mineral Resources to Mineral Reserves (thus determination of economic viability), the drafting of mine plans for permitting purposes do not require the utilisation of such guides as a base. Environmental planning is adopted as an impact-analysis mechanism based on the technical designs, rather than being incorporated as a guide to operational designs. Key environmental factors are only identified once a mine plan has been adopted and studies review the impacts of the layouts and processes.

Consequently, multiple revisions to the mine plan are required to incorporate major factors, and environmental impacts are re-reviewed with each adjustment. The multiple iterations are costly to the applicant in terms of both time to rework the studies, and finances as fees are payable to the EAP and to the technical teams. Further time and cost accumulations may arise from the extended retention of environmental specialists, who also are required to review the impacts of amendments. The incorporation of initial environmental study work at least at the scoping level, in parallel with early mine planning, allows for foundational decision-making to be undertaken earlier in the process, preferably in the pre-application phase. Early impact mitigation is achievable through environmental integration in the early project or mine planning phases, as reviewed by Brent and Petrick (2007), Asr et al. (2019) and Dong et al. (2019).

EIA principles should form the basis on which a mining project is designed and implemented to achieve maximum reduction in environmental risks and promote positive conclusions. Alignment of the MWP and EIA processes for mine permitting presents opportunities to integrate concepts and planning that achieve and maintain the economic viability of the operations and optimised environmental scenarios. Integration of processes brings value from both broad perspectives of the technical mining business and the preservation of environmental integrity, as described by the likes of Fourie and van Niekerk (2001) and Holloway and Cowie (2019). Again, failure to properly integrate the workstreams supports the notion that environmental studies are aimed at the impact mitigation of adopted mine plans rather than the incorporation of environmental goals. As a result, poor mining plans are developed, negatively affecting the environment.

Co-planning and multidisciplinary alignment, as stated by Holloway and Cowie (2019) and Lechner et al. (2017), are crucial for holistic strategy development. Integration will result in a multiplier effect aimed at achieving improved, sustainable planning that intends to promote and adopt better environmental outcomes from the onset, as reflected by Devuyst (2000) and Morrison-Saunders and Retief (2012).

5.3 Inadequate Legislation

The research study has thoroughly investigated the laws and regulations governing the content and process prescriptions for an EA application. The requirements and processes are found to be structured and transparent, as outlined in Chapter 5 of the NEMA (RSA, 1998a) and Part 3 of the EIA Regulations (DEA, 2014). This is aligned with the findings of Kozlowski (1990), Dalal-Clayton (1993) and Northmore and Hudson (2022), who all describe the systematic nature of the EIA process. Typically, deficient EIA processes are preceded by procedural inadequacies in EIA permitting and regulation, as described by Murombo (2013) and Humby (2015). It is found that the South African structure allows for thorough consideration of the biosphere through the permitting process. However, this does not purport in any manner that the quality of the EIA and mine planning supporting the licence applications are required to be of a certain standard.

The level of detail required in the EIA phase, as guided by the EIA Regulations, relies on being informed by somewhat advanced mining and infrastructure design information. Components supporting the IWUL specifically require the sign-off of designs by a registered engineer. The mining right application process only formally requires an MWP presented in a stipulated template, which requires an understated level of work detail that is not fully congruent with the requirement for the EA. The lower level of detail needed for the MWP is misaligned with the detail required for the same applications in downstream EA processes. While the EIA must draw on inputs from the design planning as presented in the MWP, there is a restricted backflow of environmental work into the MWP. The procedures are designed ambiguously, such that mine planning feedback into the EIA is compulsory, while environmental study feedback into the MWP is not mandatory but rather a function of best practice.

Detailed geotechnical and engineering designs are required only in some portions of the EA as they relate to the IWWMP and the IWUL. Detailed engineering designs are not a legislated requirement and thus not typically conducted for an MWP. Rigid EA structures are shown to be in contrast with high-level planning as prescribed in the MWP.

The provision for a first draft MWP submission and later finalisation upon completion of the S&IER is found to be the only indication of a prompt to incorporate environmental planning into the mine planning. Environmental planning integrated into mine planning has been proven by Nehring and Cheng (2016) and Asr et al. (2019) to reduce post-closure environmental risks and liabilities, as well as improve mine economics. The legislation can thus be considered as failing to optimise mine planning and failing to optimise environmental protection according to the Constitution, as highlighted by Swart (2003).

The OES as described by Humby (2015) and Mpinga (2017) intends to bridge the divide between the MPRDA and NEMA mandates in obtaining authorisations to develop a new mine. The research has shown that the principle of a bridging agent is required, which the OES identifies as such, but for the requirements of content and decision-making, the system only acts as a procedural bridge. There is no identified addition of value to the planning outputs for a mining project aided by the OES or by its mechanical cogs, *i.e.*, the MPRDA, the NEMA and their supporting regulations. It is found that there is allowance in the templates and guides for the inclusion of the multitude of themes that support planned exploitation of a mineral deposit, as described by Newman et al. (2010) and Asr et al. (2019). The guidelines and templates made available by the DMRE for application purposes attempt to provide additional guidance. This is achieved, but it still falls short of allowing for the integration of the content rather than just the processes. The OES thus serves solely as a regulatory system. In addition, the stark deficiencies identified in the MWP study detail allude to the entire legislated application process being developed in support of preferred mining outcomes without aligning with environmental outcomes.

The study shows that legislation is fragmented and inadequate when it comes to ensuring improved environmental outcomes. This is recognised by the government, hence the introduction of the OES. However, it is shown that this translates purely to a permitting exercise and does not adequately address proper outcome planning for mining projects. Environmental Law Alliance Worldwide (2010) showed that the environment is impacted by operational activities throughout a mine's lifecycle. The OES and its mechanisms support the procedure of obtaining licensing to commence mine development and operational activities. Failing prescriptive legal requirements for mine and environmental planning integration, however, allows for project licensing that does not meaningfully engage channels to develop sustainable project solutions from project conception to post-closure.

The existing literature does not describe the required experience or qualifications of technical and environmental study authors, yet it is generally assumed that these individuals should at least hold a reasonable level of expertise in the given field. The MWP, which is the platform through which mine planning is presented in a mining right application, comprises a multitude of subjects, including geology, engineering and economic analysis. It is shown in this study that no legislation related to the application for a mining right in South Africa makes reference to the requirement for the authors of such a programme to have any professional experience or registration. There is also no requirement for an MWP to be supported by a minimum study level, thus allowing the author to effectively complete the MWP in any manner that may be presented as comprehensive but may not be practical or realistic. The S&EIR, however, must be compiled by an EAP registered in terms of Section 24(h) of the NEMA (RSA, 1998a). The duties of an EAP are thus far more onerous than those of the technical experts. Through the required registration with a professional body, the outputs of the EAP are likely to be crafted far more diligently with the aim of achieving better environmental outcomes. The converse is unlikely to be true for mine planning teams, with the drive rather earn the best profit from the operation.

Although the systems demand sound environmental investigations and planning, Sandham et al. (2013) demonstrated that EIA reports in South Africa are of poor quality. Leonard (2017) showed that the effects of this are amplified by inadequate enforcement and environmental prejudices. This translates to the execution of poor practices throughout a project, as they are based on poor assessments. Ultimately, this cannot be considered an adequate basis for forward planning through any stage of the mining project. The case study assessed reveals that a mining right and EA applicant must go beyond legal compliance to ensure adequate environmental protection. This is especially true for sensitive environments. EIA investigations should commence early in the process to provide meaningful guidance in project planning and reduce adverse environmental impacts. However, the adoption of the NEMA timeframes frequently sees applications only considering environmental studies to achieve a successful licence application, with inadequate timing or process interactions prescribed.

United Nations Environment Programme (2018) described that the perception of EIA processes – being the first steps towards environmental permitting – is often a hurdle to simply obtaining permits to commence operations. They should instead be a vital starting point for improving outcomes for the environment. As it stands, the current process based solely on the prescriptions of the MPRDA and NEMA is insufficient to produce robust, multidimensional planning that considers all theme interactions with equal consideration. Although all items are required to be assessed and described, there is a distinct lack of any specific requirement to marry them, with the project proponent frequently assuming that responsibility. If the applicant does not employ savvy project management practices and drive an integrated process, the outputs are consequential rather than strategically devised.

5.4 Beyond Tick-box Exercises

The positive sentiments of integrated planning are expressed by Fourie and van Niekerk (2001), Asr et al. (2019), and Holloway and Cowie (2019). However, the literature does not describe the planning processes as integrated models adequately supported by practical demonstrations. To verify the application of the procedural requirements and their triggers for interdisciplinary interaction, this research study reviewed the experiences of experts together with a practical example.

The results of the investigation into the legislated and practical alignments of the mining right and EA application processes show that two scenarios are plausible. The first is that the MWP and technical planning feed into and form the basis of the EA study work and processes. This is shown to not be a legislated requirement. The second is that the technical planning and environmental planning are integrated from project onset. The latter yields better planning results, improved viability and enhanced overall success of the mining project, as demonstrated by this research study. This also allows for sustainability principles to be meaningfully incorporated, as shown by Sánchez et al. (2014), to improve the responsibility assumed by a project proponent to protect the environment. It further allows for risk reduction and improvements on post-closure objectives and liabilities aligned with Nehring and Cheng (2016) and Asr et al. (2019).

It is illustrated by the case study as well as the shared experience of the key informants that the first scenario is almost always adopted. Mining right (and related EA) applicants rely almost exclusively on the NEMA timeframes prior to the instigation of environmental studies. Technical study work is largely completed before the employment of EA practitioners. Legislation and regulation guide the development and execution of the planning processes, as discussed thoroughly by Fourie and van Niekerk (2001). It has been found that the processes are guided very distinctly by the NEMA timeframes as well as by the requirements set in regulations, templates and guidelines.

The interview results revealed that initial mine planning always forms the basis of the EA studies, with no reflections on preceding environmental considerations in the first renditions of MWPs. The technical content presented in the MWP always guides application processes. This was reflected in the case study, where the positive economic results of the typical mine planning process, as discussed by Dagdelen (2001) and Madowe (2013), triggered the Client to proceed with the mining right and EA applications.

This research clearly demonstrates that a perception is created by legislation that the EIA process is simply a tick-box exercise to obtain a legal licence to operate, with no benefits to the project. This is amplified by the attitude of the project proponents, to whom the proposed mine is a cash-generator. Only the orebody is seen as a valuable resource, disregarding the value of the natural environment. A predicament is encountered, as the decision to move forward with permitting applications to develop a mine must be supported by the demonstrated viability of the project. This was discussed by Fourie and van Niekerk (2001) and Holloway and Cowie (2019), where a structured mine planning process is required upfront. Understandably, a project owner will not proceed to engage additional experts and incur additional costs until a project has demonstrated feasibility.

A duty of care is however retained by the DFFE, DMRE and mining right holders to protect natural resources, notably including the natural environment. EIAs are developed as plans to define and primarily protect the environment (Betey & Godfred, 2013), but they are also essential planning tools to highlight project risks. In the case study, the rejection of the IWUL and abandonment of the mining right and EA applications due to flawed designs illustrates that upfront environmental work and continuous, parallel interaction with technical teams, including civil engineers, are critical to the successful permitting and execution of a project. It also demonstrates that although the baseline environment was only fully considered later in the project, in this case, the law did act as a sufficient backstop for a loosely strategised mining project located in a high-risk receiving environment.

Due to the reliance on legislation and regulation by project proponents for the execution of the processes, there is a perception that planning processes are linear. The research shows that it should be an iterative process; hence, the two processes need to run in parallel. The OES and its constituents provide a relatively sound mechanism for permitting that is aligned with its mandate. However, the research results show that the mechanisms are frequently adopted by project proponents as the only execution mechanisms. The legislation does not allow interactive planning across environmental and technical themes but instead treats them as separate processes. EIA development should not just adapt to the requirements for permitting and their processes, as it is proven that this results in poor integrated planning and a less meaningful assimilation of the biophysical setting into designs.

In the practical integration of mine and environmental planning, the interfacing of experts occurs late in the process, once a mining project has already been defined in terms of its operational design and viability. This allows for the restricted incorporation of baseline biophysical concerns into the concept development and subsequent designing. Further restrictions are based on constricted timeframes imposed by both project applicants and the OES through NEMA. Very limited opportunity for meaningful co-planning and co-strategising is available. Typically, the planning is regarded as two separate processes: one for mine design and operational planning, and another for aligning environmental outcomes to these plans. The consideration of a biodiversity offset area in the case study is deemed, in limited terms, to be positive in line with the findings of Edwards et al. (2013). In terms of the mitigation hierarchy, however, offsets should only be considered as a last resort, and planning should rather aim to achieve impact avoidance and reduction (Phalan et al., 2017). This can only be achieved through parallel and intersecting planning workstreams.

Adequate workstream alignment and integration were shown by Nehring and Cheng (2016) and Asr et al. (2019) to be economically and strategically beneficial for a mining project. The continued practical separation of the processes driven strongly by mine design and NPV does not allow for meaningful planning that aims to achieve balanced economic and environmental outcomes. The late introduction of environmental planning leads to a repetitive, costly and time-consuming scramble of replanning to find a best-fit solution. This is frequently to the detriment of environmental protection and conservation. The consideration of alternatives in the mine planning process is done through trade-off studies and optimisations, with the best-fit solution pushing higher returns. The consideration of alternatives in the environmental planning process, where the EIA requires the selection of the lowest environmental risk scenario as the preferred option, can easily be dismissed through non-feasibility and manipulated to align with the preferred mining option.

It is imperative that the definition of environmental parameters be done early to allow for their early integration into the mine planning process and thus achieve better environmental outcomes. To do so, the applicant must step away from the blinkers of the permitting processes. Upfront impact identification through the EIA can guide improved mitigation controls being built into the mine planning and design. This way, planning can be modified so as to reduce potential environmental risks and improve mitigation strategies, as described by Phalan et al. (2017). An example is the modification of the planned infrastructure footprint to avoid ecologically sensitive areas, or the adoption of cleaner technologies to reduce the risk of pollutants. Early consideration of environmental items also effectively acts as a control for the mining engineering component that frequently aims to only attain maximum monetary value from the mineral deposit as a commodity. Additionally, effective closure planning can be achieved through the integration of processes in the early project stages, in which technical, financial, environmental and social targets can be harmoniously realised.

Apart from the mine design process ideally benefiting from environmental study integration into planning, concept mine planning outcomes should guide the development of the more advanced environmental studies required for the proposed project, as it defines the mining method and project footprint, amongst others, which in turn guides the assessment of the disturbance types as presented in the EIA. Environmental goals will benefit from synchronised mine and environmental planning and the improvement of EIA processes, upon which later management practices can be based (Edwards et al., 2013). Outcomes can also be steered towards positive effects. Given the extensive potential for negative impacts, these must be identified early and appropriately managed to be mitigated. Overall, it is important for mining companies to implement sustainable practices and properly manage the impacts of mining to minimise their environmental footprint. This must be adopted above and beyond the requirements for simply obtaining licences to operate.

Strong project management, as described by Brent and Petrick (2007), can adequately bridge the gap between external experts and allow for early EIA processes in the planning cycle. A compartmentalised review of project outputs and strategies is isolated and does not allow for optimal planning. Notably, environmental planning is ultimately most affected. In the case study example, the strategy sessions where all experts shared ideas and developed new strategies were in line with the sentiments of effective and strategic mine planning (Holloway & Cowie, 2019). The engagement of the additional advisors in the execution of the processes demonstrates that more experts are required, or someone needs to be responsible for the integration process. The case study suggests that this may be the environmental person.

Sánchez et al. (2014) showed that mine planning presents a perfect opportunity for the integration of environmental planning. This reflects the sentiment of Fourie and van Niekerk (2001), Edwards et al. (2013) and Holloway and Cowie (2019) about synchronised planning producing more effective designs that achieve better environmental outcomes and improved strategic project targets. In line with the findings, cohesive planning is encouraged through the adoption of an inclusive, dynamic and multi-lateral disciplinary approach. An abandonment of a linear design approach is proposed, allowing planning development to be more encompassing rather than driven by legislated processes. The research results show that improved mine planning practices in this approach ultimately achieve improved environmental outcomes. It allows for embodiment of sustainable principles from the onset. Early consideration of the environment will achieve improved and more resilient mine plans. Continuous collaboration of technical and environmental experts would promote unbiased and transparent reporting, as well as improved presentation to the authorities of all relevant information relating to the mining project in order to facilitate decision-making processes, in addition to stimulating integrated environmental management principles.

CHAPTER 6 : CONCLUSIONS AND RECOMMENDATIONS

This research has been undertaken to examine alignment of the study requirements for new mining projects on the basis of obtaining the required mining right and EA for improved environmental outcomes. Specifically, the research aimed to qualitatively investigate the technical and environmental studies and planning, and explored their success at achieving improved environmental outcomes. Three major conclusions have been reached, namely 1) inadequate alignment of legislation, 2) poor integration of processes, and 3) the need to move beyond tick-box exercises in the practical application of processes.

Evaluation of the mineral deposit, together with planning of the methodologies and supporting activities to extract the deposit, provides a basis for a project owner to decide whether to move towards obtaining licensing to undertake the activities. The licensing structure in South Africa is viewed on a broad, two-fold basis in this study. Engineering, geology, mining, processing and financial evaluations are considered technical components and deliver the technical descriptions required for a mining right application. The constructs of the natural biological and physical setting of the mineral deposit and operational activities, together with interdependent lateral areas, are considered the environmental component. The environmental component delivers an evaluation of the baseline setting, an assessment of the impacts and risks of a proposed project, and a presentation of mitigation and management planning throughout the life of the proposed mine.

Integrated planning is pivotal to producing effective systems that support sustainable practices, from project concept to post-closure. The MPRDA and NEMA requirements are a fair starting point for the processes and provide a guiding base for the merging of environmental themes into mine planning. The processes informing the MWP and EIA outputs should be overlapping and allow for integrated planning; however, they are structurally presented as compartmentalised items by way of the application construct. The development of the mining right and EA application mandates largely run as separate processes. Additional studies are only triggered later, as system gaps are identified at the culmination of the application processes. Inherently, this cripples foundational sustainable development planning that requires meaningful integration.

The legal framework presents a basis for restricted parallel planning with cross-feeding systems through the technical and environmental components, but it should only be utilised as guidance for planning development. By design, it does not promote integrated plan development in real-world execution.

Technical elements are considered the starting point of driving processes towards mining right and EA applications. This is typically considered foundational, but better planning requires it to be adaptable. Project planning that adequately assimilates environmental outcomes is only effective if the biophysical setting is properly defined and incorporated early in the mine planning process. Planning should also be expanded to incorporate sound engineering designs that are practically executable. Project management effectively implemented as a change agent for corporate strategy in markets that are increasingly sensitive to the promotion of healthy biospheres will drive better planning processes and realign disciplines.

Failure to align the technical and environmental components ultimately compromises planning outputs, typically to the detriment of the environment and will in turn affect the mining operation. Continued multidisciplinary interactions allow for the integration of ideas and the co-development of plans and designs that satisfy the full scope of the OES mandate to achieve positive outcomes beyond the licensing process. It promotes planning for healthy environments and sustainability nuances that are executable. Isolated workstreams should be dissolved so that adequate consideration may be diverted away from mining profits and towards balanced total strategy profits that embody environmental safety and stable investability.

The current literature is mainly aimed at providing insights into jurisdictional permitting frameworks, describing the effects of already operational mines and their management systems. There is a need to improve research to properly investigate the effects of early mine planning on environmental outcomes. Academic investigations relating to the EIA are more abundant than those investigating mine planning. Starkly, they seldom interface at a focal point that is earlier than current or post-mining. It is recommended that future research work aim to prove the beneficial effects of early-stage planning on the development of a real mine.

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APPENDIX A – ETHICS CLEARANCE CERTIFICATE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

SCHOOL OF MINING ETHICS COMMITTEE
CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE | **PROTOCOL NUMBER: EMINN/2021/10**

PROJECT TITLE | Assessment of the Environmental Authorisation Processes and Mining Right Applications for Improved Environmental Outcomes

INVESTIGATOR | Ms M Antoniades

SCHOOL/DEPARTMENT OF INVESTIGATOR | School of Mining

DATE CONSIDERED | 09 July 2020

DECISION OF THE COMMITTEE | Approved unconditionally

RISK LEVEL | MINIMAL RISK

EXPIRY DATE | 12 October 2023

ISSUE DATE OF CERTIFICATE 13 August 2021

CHAIRPERSON ____________________
(Mr H Thomas)

cc: Supervisor: Mrs I Watson

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am are authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

____
Signature

Date 07 / Oct / 2021

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

APPENDIX B – PARTICIPANT INFORMATION SHEET

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

INFORMATION SHEET

Dear Sir / Madam,

My name is Maria Antoniades and I am a Masters student in Environmental Science at the University of the Witwatersrand, Johannesburg. As part of my studies, I must undertake a research project, and I am investigating the South African Environmental Authorisation and Mining Right application processes for improved environmental outcomes, under the supervision of Ms Ingrid Watson. The aim of this research project is to find out if the Mining Works Programme and Environmental Authorisation processes are aligned in terms of legal requirements for applications and in practice for development of optimized mining environmental solutions.

As part of this project, I would like to invite you to take part in an interview potentially followed up with further verbal or email communication with reference to the interview discussion. This activity will involve a single interview with myself conducted on a virtual meeting platform such as MS Teams or Zoom and will take around sixty (60) minutes. With your permission, I would also like to video- and audio record the interview using the built-in recording service of the chosen meeting platform, which I shall then download. This recording together with data obtained will be stored in a password protected computer and only the researcher will have access to this recording. It will be deleted after two years. Should I require any further clarification on any of the topics discussed during the interview, I may request such via a telephonic conversation or an email.

There will be no personal costs to you if you participate in this project, you will not receive any direct benefits from participation but there are no disadvantages or penalties if you do not choose to participate or if you withdraw from the study. You may withdraw at any time or not answer any question if you do not want to. The interview will be completely confidential. As I am approaching you directly for participation as an expert in regulation, and thus know your name and identifying information, anonymity during the interview is not possible. The information you give to me will be held securely and not disclosed to anyone else. I will be using a pseudonym (false name) to represent your participation in my final research report. If you experience any distress or discomfort at any point in this process, we will stop the interview or resume another time.

If you have any questions during or afterwards about this research, feel free to contact me on the details listed below. This study will be written up as a research report. If you wish to re ceive a summary of this report, I will be happy to send it to you. The data collected from this research project will be stored electronically on my personal password protected computer and backup device and will be kept for two years. If you have any concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

Yours sincerely,

Researcher:
Maria Antoniades
331131@students.wits.ac.za
0822538466

Supervisor:
Ingrid Watson
Ingrid.Watson@wits.ac.za
0117177054

APPENDIX C – CONSENT FORM

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

CONSENT FORM

TITLE OF PROJECT: Assessment of the Environmental Authorisation Processes and Mining Right Applications for Improved Environmental Outcomes

NAME OF RESEARCHER: Maria Antoniades

I, ……………………………………….., agree to participate in this research project. The research has been explained to me and I understand what my participation will involve. I agree to the following:

(Please circle the relevant options below).

I agree that my participation will remain anonymous in the resulting research report	YES	NO
I agree that the researcher may use anonymous quotes in his / her research report	YES	NO
I agree that the interview may be audio recorded	YES	NO
I agree that the interview may be video recorded	YES	NO
I agree that the information I provide may be used in an anonymized format after this project has ended, for academic purposes by other researchers, subject to their own ethics clearance being obtained.	YES	NO

…………………………………… (signature)
…………………………………… (name of participant)
…………………………………… (date)

APPENDIX D – INTERVIEW QUESTIONS

1. What are your professional qualifications, and with which professional bodies are you registered?
2. What role are you currently employed in, and what is your contracted work function?
3. How does your role at your organisation intersect with the application for a mining right? Please describe your job function in relation to this.
4. How many South African mining right application processes have you directly been involved in, and for which commodities?
5. Does your role in the application for a mining right only consider a [given] environmental aspect, or do you consider the details of an MWP? Alternatively, does your role in the application for a mining right only consider the MWP, or do you also consider the details of the application for the environmental aspects of a mining right?
6. What is your understanding of the environmental requirements for a mining right application, and of the required level of detail for an MWP?
7. For mining experts: In your job function as it relates to a mining right application, how much consideration is given to the environmental aspects of the land in developing the mining project?
8. For environmental experts: In your job function as it relates to a mining right application, how much consideration is given to the mine design developed for a project?
9. For mining experts and environmental experts: In your experience, how much interaction has there been between mining and environmental experts in developing the mining and environmental studies and designs? Has this interaction fed into your own studies and designs for the project, and to what extent?
10. For mining experts and environmental experts: In your experience, at what point of the project are you typically introduced to the other mining/environmental experts?
11. Have you personally identified a need for mining experts and environmental experts to work closely in developing a project? Are the workstreams generally aligned with good communication and consideration of the other, or have you noticed any disjunctures?
12. How frequently have there been major revisions required to your work due to a lack of communication and holistic design considerations between the mining experts and environmental experts?