

Air Quality Impact Assessment Report

Viljoen'shof Diamond Mine

Report Compiled By
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TITLE AND AUTHORISATION

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Executive Summary

An air quality impact assessment was conducted for activities planned for the Viljoen'shof Diamond Mine near Boshof in Free State Province. The main objective of this study was to quantify the extent to which existing ambient pollutant levels will change as a result of proposed mining operation and its related activities over the life of mine (LoM). The impact study then informed the air quality management and mitigation measures recommended as part of the Air Quality Management Plan (AQMP).

The air quality impact assessment included a study of the receiving environment and the quantification and assessment of the impact of Viljoen'shof Diamond Mine on the environment and human health. The receiving environment was described in terms of local atmospheric dispersion potential, the location of potential quality sensitive receptors (AQSRs) in relation to proposed activities as well as ambient pollutant levels and dustfall rates. The following was found:

- The study area is dominated by winds from the north. Long term air quality impacts are therefore expected to be the most significant to the south of the operations.
- Several farm houses or farmsteads are situated within a few kilometers from the proposed activities. The nearest residential area is Boshof which lies to the south-east of the proposed mine.
- This report is still in a preliminary stage, given the fact that no site activities has started, ambient air quality monitoring for Viljoen'shof Diamond mine indicated ambient PM10 levels are still within the National Ambient Air Quality Standards (NAAQSs). We will only know once site access is granted and mining operation started if the proposed activities will result in the ambient air quality that is compliant with NAAQS.
- Dustfall rates emanating from the proposed mining activities are not known at this stage, and whether they are compliant with National Dust Control Regulations (NDCR). There's almost no other industrial or mining activities in the area, therefore no other potential sources to non-compliance with the NDCR.

It is proposed that once site access is granted and that mining operation has started, a comprehensive atmospheric emissions inventory be taken for the various operational phases of the proposed mine. Pollutants to be quantified should include those most commonly associated with mining i.e. particulate matter (PM) and total suspended particulate matter (TSP).

Estimated emissions along with information on the receiving environment were used as input to an atmospheric emissions dispersion model which simulated ground level pollutant concentrations and dustfall rates. Simulated ground level pollutant concentrations and dustfall rates were screened against NAAQSs and NDCRs. The main findings of the impact study are listed below.

- The following operational phase PM emissions (PM2.5, PM10 and TSP) will be quantified and used in simulations post the granting of the Environmental Authorisation (EA), and start of mining operations.
- Simulated PM2.5 and PM10 concentrations were compliant with air quality criteria at all of the identified AQSRs, but exceeded the daily NAAQS at the southern boundary.

- Dustfall rates were complaint with NDCR at all of the identified AQSRs.

Three distinct emission scenarios were identified:

- Scenario 1: 2023-24 pilot mining phase (year with maximum handled of 91.6 Mtpa, approximately 12.7 Mtpa of ore and 78.9 Mtpa of waste).
- Scenario 2: 2024-25 ramping up phase (year with maximum ore handled at the main pit, approximately 11.6 Mtpa of ore and 57.4 Mtpa of waste).
- Scenario 2A: 2026 and beyond (year with maximum ore handled at the main pit, approximately 11.6 Mtpa of ore and 57.4 Mtpa of waste).

To ensure the lowest possible impact on AQSRs and the environment, it is recommended that the air quality management plan as set out in this report should be adopted. In summary, this includes:

- The mitigation of sources of emissions. Special attention should be paid to the mitigation of dust from unpaved haul roads and areas with windblown dust potential (such as the waste dumps); and
- Continued ambient air quality monitoring, including:
 - Gravimetric sampling of PM10 and PM2.5 concentrations.
 - Dustfall sampling at existing locations around operations.

ABBREVIATIONS AND ACRONYMS

ABBREVIATION/ACRONYM	EXPLANATION
AERMIC	AMS/EPA Regulatory Model Improvement Committee
APPA	Air Pollution and Prevention Act
AQIA	Air Quality Impact Assessment
AQMP	Air Quality Management Plan
AQSR	Air Quality Sensitive Receptor
ASTM	American Society for Testing and Materials
DEA	Department of Environmental Affairs (South Africa)
DFFE	Department of Forestry, Fisheries and the Environment (South Africa)
DMS	Dense Medium Separation
DSO	Direct Shipped Ore
EHS	World Bank Group Environmental, Health and Safety Guidelines
EIA	Environmental Impact Assessment
GLC	Ground Level Concentration
IFC	International Finance Corporation
LoM	Life of Mine
NAAQS	National Ambient Air Quality Standards (South Africa)
NEMAQA	National Environmental Management Air Quality Act
NDCR	National Dust Control Regulation
NMES	National Minimum Emission Standard
PM	Particulate matter
PM10	Thoracic particulate matter with an aerodynamic diameter of less than 10m
PM2.5	Inhalable particulate matter with an aerodynamic diameter of less than 2.5m
RoM	Run of Mine
SA	South Africa(n)
TSP	Total Suspended Particulates
VKT	Vehicle kilometres travelled
µg	Microgram
µg/m ²	Micrograms per square meter
AEL	Atmospheric emission licence
CO	Carbon monoxide
CO ₂	Carbon dioxide
DBSA	Development Bank of Southern Africa
ECO	Environmental Control Officer
EHS	Environmental, Health, and Safety
EIA	Environmental Impact Assessment

EMPr	Environmental Management Programme
ESS	Environmental and Social Sustainability
ESSS	Environmental and Social Safeguard Standards
Ha	Hectares
km²	Kilometre squared
NAAQS	National Ambient Air Quality Standard
NEM: AQA	National Environmental Management Act: Air Quality Act (Act no. 39 of 2004)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
PM₁₀	Particulate matter with an aerodynamic diameter of less than 10 µm
PM_{2.5}	Particulate matter with an aerodynamic diameter of less than 2.5 µm
Ppm	Parts per million
Project	Boshof Diamond Mine
SANS	South African National Standard
SHEQ	Safety Health Environmental and Quality
WHO	World Health Organisation

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1 Introduction

1.1 The Proponent

Invest In Property 126 (Proprietary) Limited (the “Applicant”) is a privately owned South African registered and based company with a focus on diamond mine exploration, development and operation. Invest In Property 126 (Pty) Ltd, has applied for a Mining Right (MR) covering Diamond kimberlitic and Diamond in general through the Department of Mineral Resources and Energy [Free State Region]. The application was lodged in terms of Sec (27) of the Mineral Petroleum Resources Development Act, Act 28 of 2002 [Herein referred to as the Act] as amended by section 23 of Act 49 of 2008.

1.2 Project Introduction

1.2.1 Project Description

Invest In Property 126 (Proprietary) Limited is proposing to develop and operate a diamond mine and related activities over the remaining extent (R/E) of the farm Viljoen’shof 1655, situated within Tokologo Local Municipality part of Lejweleputswa District Municipality. The project area is approximately 3 389 hectares (ha) in extent and will be leased from the current owners for the duration of the mining operation. The first phase of the proposed Project involves securing of the Mining Right from DMRE.

The applicant has appointed Biomental Services, as independent environmental consultants, Willow Tree Capital has been appointed by Biomental Services to undertake specialist Air Quality Impact Assessment Study, of the proposed Viljoen’shof Diamond Mine development.

1.2.2 Project Location and Extent

The location and extent of the Mining Operation is described in Table 1 and illustrated in Figure 1-1.

The proposed mining operation layout is provided in Figure 1-2 and 1-3. The proposed Project is located to the north of Boshof town in Free State Province

Table 1-1: Location and extent

Location and Extent of the proposed Diamond Mine	
Description of the Site	Portion (R/E) of the farm Viljoen’shof No. 1655
Coordinates of Approximate Centre of Operations (m)	-28.608188S, 25.056499E
Extent (ha)	3 373.80
Elevation above mean sea level (m)	1260m
Province	Free State Province
Local Municipality	Tokologo Local Municipality
District Municipality	Lejweleputswa District Municipality

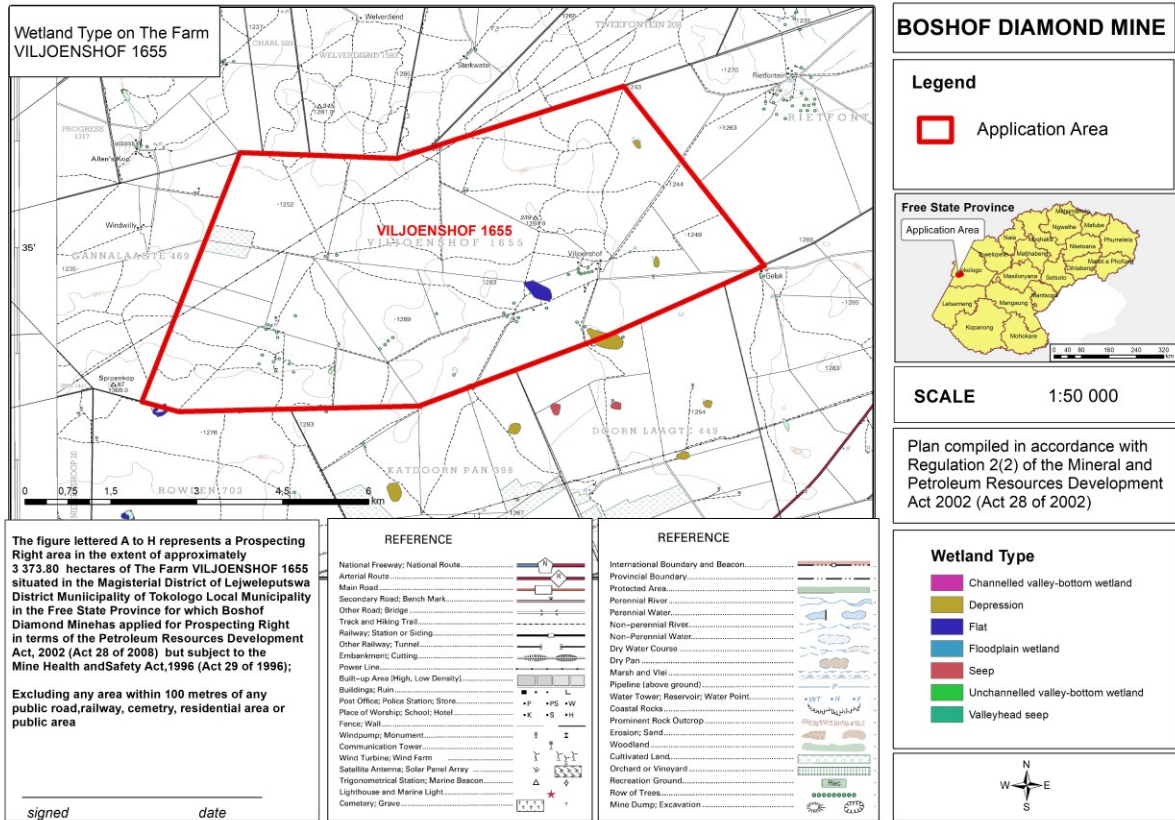


Figure 1-1: Location of the site on a 1:50 000 Topo-Cadastral Map

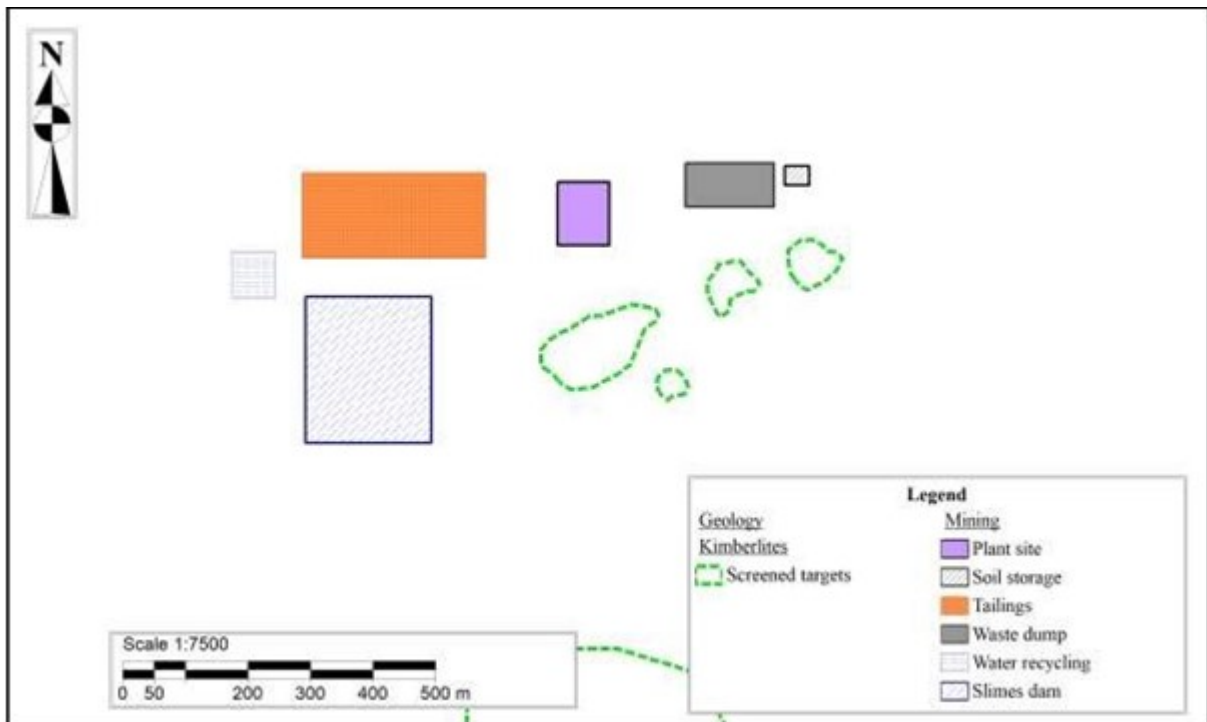


Figure 1-2: Viljoen'shof Diamond Mine Layout

1.3 Description of Activities from an Air Quality Perspective

The Viljoen'shof Diamond Mine consists of various mining and processing activities, including support infrastructure and equipment all aimed at achieving desired diamond production output, business and stakeholder requirements and possible expansions.

The proposed mining activity will be aimed at targeting various kimberlite pipes within the Viljoen'shof Mining Area, this will result in production levels at the mine to be ramped up and maintained at a certain level, and the mining of the larger pit means that the LOM is can be extended for 10 years.

Proposed Mining Operations layout and site support infrastructure and equipment is essential to sustain the desired production levels. The entire mining area includes also some diamond reserves within the targeted kimberlite pipes. Conventional open cast mining methods will be employed where ore and waste rock is drilled and blasted, loaded to haul trucks for transport either to waste rock dumps or the beneficiation plant. At the beneficiation plants (2 plants operational at any time - the main direct shipping ore (DSO) plant and a Dense Medium Separation (DMS) plant, ore will be stockpiled, crushed and screened and diamonds recovered.

Airborne emissions may occur during all phases of the mining cycle. The most notable sources of fugitive PM include drilling, blasting, ore and waste rock handling, and windblown dust from exposed surfaces such as stockpiles as well as traffic on haul routes. Fugitive emissions refer to emissions that are spatially distributed over a wide area and not confined to a specific discharge point as would be the case for process related emissions (IFC, 2007). Gases from the storage and combustion of fuels in stationary and mobile equipment also add to airborne emissions but to a lesser extent.

In the discussion, regulation and estimation of PM emissions and impacts a distinction is made between different particle size fractions, viz. TSP, PM10 and PM2.5. PM10 is defined as particulate matter with an aerodynamic diameter of less than 10 µm and is also referred to as thoracic particulates. Inhalable particulate matter, PM2.5, is defined as particulate matter with an aerodynamic diameter of less than 2.5 µm. Whereas PM10 and PM2.5 fractions are taken into account to determine the potential for human health risks, total suspended particulate matter (TSP) is included to assess nuisance dustfall. Combustion emissions include PM10 and PM2.5, carbon monoxide (CO), nitrogen oxides (NOx), sulphur dioxide (SO₂), and volatile organic compounds (VOCs). PM emitted from diesel combustion will mostly be in the form of black carbon, commonly referred to as diesel particulate matter or diesel exhaust (DPM or DE). Additional diesel fuel storage may result in volatile organic compounds (VOC) emissions. These are however assumed to be insignificant compared to the fugitive dust and have not been included in this assessment.

2 Approach and Methodology

2.1 Methodology

The approach to, and methodology followed in the completion of tasks completed as part of the scope of work are discussed.

2.1.1 The Identification of Regulatory Requirements and Health Thresholds

In the evaluation air emissions and ambient air quality impacts reference was made to the following (as set out in the National

Environmental Management Air Quality Act (Act No. 39 of 2004) (NEMAQA)):

- ❖ National Minimum Emission Standards (NMES);
- ❖ National Ambient Air Quality Standards (NAAQS) and;
- ❖ National Dust Control Regulations (NDCR).

2.1.2 Study of the Receiving Environment

Physical environmental parameters that influence the dispersion of pollutants in the atmosphere include terrain, land cover and meteorology. Existing ambient air quality in the study area was also considered.

An understanding of the atmospheric dispersion potential of the area is essential for an air quality impact assessment. Use will be made of on-site meteorological data, still to be collected during the construction and operational phase.

2.1.3. Determining the Impact of the Diamond Mine on the Receiving Environment

The establishment of a comprehensive emission inventory formed the basis for the assessment of the air quality impacts from the mine's emissions on the receiving environment. In the quantification of emissions, use was made of emission factors which associate the quantity of a pollutant to the activity associated with the release of that pollutant. Emissions were calculated using comprehensive sets of emission factors and equations as published by the United States Environmental Protection Agency (US EPA) and Australian National Pollutant Inventory (NPI).

Three distinct emission scenarios were identified Table 2-1:

- ❖ Scenario 1: 2023-24 pilot mining phase (year with maximum handled of 91.6 Mtpa, approximately 12.7 Mtpa of ore and 78.9 Mtpa of waste).
- ❖ Scenario 2: 2024-25 ramping up phase (year with maximum ore handled at the main pit, approximately 11.6 Mtpa of ore and 57.4 Mtpa of waste).

- ❖ Scenario 2A: 2026 and beyond (year with maximum ore handled at the main pit, approximately 11.6 Mtpa of ore and 57.4 Mtpa of waste).

Table 2-1: Scenarios Selected for the Dispersion Modelling

In the simulation of ambient air pollutant concentrations and dustfall rates use was made of the US EPA AERMOD atmospheric dispersion modelling suite. The Department of Forestry, Fisheries and the Environment (DFFE) prescribes the use of AERMOD for regulatory purposes. It is a Gaussian plume model best used for near-field applications where the steady-state meteorology assumption is most likely to apply. AERMOD is a model developed with the support of the AMS/EPA Regulatory Model Improvement Committee (AERMIC), whose objective has been to include state-of-the-art science in regulatory models (Hanna, Egan, Purdum, & Wagler, 1999). AERMOD is a dispersion modelling system with three components, namely:

AERMOD (AERMIC dispersion model), AERMAP (AERMOD terrain pre-processor), and AERMET (AERMOD meteorological pre-processor).

2.1.4 Compliance Assessment

Compliance was assessed by comparing simulated ambient criteria pollutant concentrations (PM2.5, PM10) and dustfall rates to NAAQS’s and NDCR’s.

2.1.5 The Development of an Air Quality Management Plan

The findings of the above components informed recommendations of air quality management measures, including mitigation and monitoring.

2.2. Assumptions, Exclusions and Limitations

Several assumptions regarding the mine plan and process had to be made in the study. These, along with other limitations are listed below and should be noted when interpreting the outcomes of the study:

- The quantification of sources of emission was restricted to proposed operations at Viljoen’shof Diamond Mine.
- Project information required to calculate emissions for operations were provided by Biomental Consulting and the consulting geologist as contained in the Mining Works Programme. Where necessary, assumptions were made based on the specialist’s experience and previous studies done for similar operations.

- Only routine operational phase emissions were estimated and simulated.
- The impact assessment was limited to airborne particulates (including TSP, PM10 and PM2.5). The impact of CO, NOx, VOCs and SO2 was assumed to be negligible.
- Information pertaining to fuel storage was limited. Diesel storage VOC emissions could therefore not be quantified.
- Even though the storage of diesel on-site is considered a listed activity under NEMAQA if total storage capacity exceeds 1 000 m³, VOC emissions from such operations are negligible.
- Construction and decommissioning/closure phase impacts were not quantified. Impacts associated with this phase are highly variable and generally less significant than operational phase impacts. Mitigation and management measures recommended for the operational phase are however also applicable to the construction/closure phase.

3 Legal, Policy and Administrative Framework

Prior to assessing the impact of proposed activities at Viljoen'shof Diamond Mine on human health and the environment, reference needs to be made to the environmental regulations governing the impact of such operations i.e. emission standards, ambient air quality standards and dust control regulations.

Emission standards are generally provided for point sources and specify the amount of the pollutant acceptable in an emission stream and are often based on proven efficiencies of air pollution control equipment.

Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality standards and guideline values indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Air quality guidelines and standards are normally given for specific averaging or exposure periods.

This section summarises national legislation for criteria pollutants relevant to the current study and dustfall.

3.1 National Environmental Management: Air Quality Act

3.1.1 Minimum Emissions Standards

The minister must in accordance with the NEMAQA (Act No. 39 of 2004) publish a list of activities which result in atmospheric emissions and which is believed to have significant detrimental effects on the environment and human health and social welfare. All scheduled processes as previously stipulated under the Air Pollution Prevention Act (APPA) are included as listed activities with additional activities being added to the list. The most recent Listed Activities and NMES's were published on the 22nd of November 2013 (Government Gazette No. 37054).

Only the on-site storage of diesel may be considered a listed activity. Subcategory 2.4, 'the storage and handling of petroleum products', are however only applicable to permanent immobile liquid storage facilities at a single site with a combined storage capacity of more than 1 000 m³

3.1.2 National Ambient Air Quality Standards

Criteria pollutants are considered those pollutants most commonly found in the atmosphere, that have proven detrimental health effects when inhaled and are regulated by ambient air quality criteria. South African NAAQS for CO, NO₂, PM₁₀ and SO₂ were published on the 13th of March 2009. On the 24th of December 2009 standards for PM_{2.5} were also published. The standards applicable for this assessment are listed in Table 3-1

Table 3-1: South African NAAQS for Criteria Pollutants

Pollutant	Average Period	Limit Value ($\mu\text{g}/\text{m}^3$)	Limit Value (ppb)	Frequency of Exceedance	Compliance Date
PM2.5	24 hour(a)	40	-	4	Currently enforceable
	24 hour	25	-	4	1 Jan 2030
	1 year(a)	20	-	0	Currently enforceable
	1 year	15	-	0	1 Jan 2030
PM10	24 hour	75	-	4	Currently enforceable
	1 year	40	-	0	Currently enforceable

3.1.3 National Dust Control Regulations

NDCRs were published on the 1st of November 2013 (Government Gazette No. R827).

Table 3-2: Acceptable Dustfall Rates

Restriction areas	Dustfall rate (D) in mg/m^2 -day over a 30 day average	Permitted frequency of exceedance
Residential areas	$D < 600$	Two within a year, not sequential months.
Non-residential areas	$600 < D < 1\ 200$	Two within a year, not sequential months.

The regulation also specifies that the method to be used for measuring dustfall and the guideline for locating sampling points shall be ASTM D1739 (1970), or equivalent method approved by any internationally recognized body. It is important to note that dustfall is assessed for nuisance impact and not inhalation health impact.

A revised Draft National Dust Control Regulations were published on 25 March 2018 (Government Gazette No. 41650) which references the same acceptable dustfall rates but refers to the latest version of the ASTM D1739 method to be used for sampling

3.2 International Finance Corporation

3.2.1 IFC Performance Standard 1

IFC's Sustainability Framework articulates the Corporation's strategic commitment to sustainable development, and is an integral part of IFC's approach to risk management. The Sustainability Framework comprises IFC's Policy and Performance Standards on Environmental and Social Sustainability, and IFC's Access to Information Policy. The Policy on Environmental and Social Sustainability describes IFC's commitments, roles, and responsibilities related to environmental and social sustainability. IFC's Access to Information Policy reflects IFC's commitment to transparency and good governance on its operations, and outlines the Corporation's institutional disclosure obligations regarding its investment and advisory services.

The Performance Standards are directed towards clients, providing guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and manage risks and impacts as a way of doing

business in a sustainable way, including stakeholder engagement and disclosure obligations of the client in relation to project-level activities. In the case of its direct investments (including project and corporate finance provided through financial intermediaries), IFC requires its clients to apply the Performance Standards to manage environmental and social risks and impacts so that development opportunities are enhanced. IFC uses the Sustainability Framework along with other strategies, policies, and initiatives to direct the business activities of the Corporation in order to achieve its overall development objectives.

Performance Standard 1 (IFC, 2012) establishes the importance of (i) integrated assessment to identify the environmental and social impacts, risks, and opportunities of projects; (ii) effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and (iii) the client's management of environmental and social performance throughout the life of the project.

In addition to meeting the requirements under the Performance Standards, clients must comply with applicable national law, including those laws implementing host country obligations under international law.

The World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines) are technical reference documents with general and industry-specific examples of good international industry practice. IFC uses the EHS Guidelines as a technical source of information during project appraisal. The EHS Guidelines contain the performance levels and measures that are normally acceptable to IFC, and that are generally considered to be achievable in new facilities at reasonable costs by existing technology. For IFC-financed projects, application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets with an appropriate timetable for achieving them. The environmental assessment process may recommend alternative (higher or lower) levels or measures, which, if acceptable to IFC, become project- or site-specific requirements. The General EHS Guideline contains information on cross-cutting environmental, health, and safety issues potentially applicable to all industry sectors. It should be used together with the relevant industry sector guideline(s).

When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternative performance level is protective of human health and the environment.

3.2.1.1 Requirements

Environmental and Social Assessment and Management System:

The client, in coordination with other responsible government agencies and third parties as appropriate, will conduct a process of environmental and social assessment, and establish and maintain an ESMS appropriate to the nature and scale of the project and commensurate with the level of its environmental and social risks and impacts. The ESMS will incorporate the following elements: (i) policy;

(ii) identification of risks and impacts; (iii) management programs; (iv) Organizational capacity and competency; (v) emergency preparedness and response; (vi) stakeholder engagement; and (vii) monitoring and review.

Policy

The client will establish an overarching policy defining the environmental and social objectives and principles that guide the project to achieve sound environmental and social performance. The policy provides a framework for the environmental and social assessment and management process, and specifies that the project (or business activities, as appropriate) will comply with the applicable laws and regulations of the jurisdictions in which it is being undertaken, including those laws implementing host country obligations under international law. The policy should be consistent with the principles of the Performance Standards. Under some circumstances, clients may also subscribe to other internationally recognized standards, certification schemes, or codes of practice and these too should be included in the policy. The policy will indicate who, within the client's organization, will ensure conformance with the policy and be responsible for its execution (with reference to an appropriate responsible government agency or third party, as necessary). The client will communicate the policy to all levels of its organization.

Identification of Risks and Impacts

The client will establish and maintain a process for identifying the environmental and social risks and impacts of the project. The type, scale, and location of the project guide the scope and level of effort devoted to the risks and impacts identification process. The scope of the risks and impacts identification process will be consistent with good international industry practice, and will determine the appropriate and relevant methods and assessment tools. The process may comprise a full-scale environmental and social impact assessment, a limited or focused environmental and social assessment, or straightforward application of environmental siting, pollution standards, design criteria, or construction standards.

When the project involves existing assets, environmental and/or social audits or risk/hazard assessments can be appropriate and sufficient to identify risks and impacts. If assets to be developed, acquired or financed have yet to be defined, the establishment of an environmental and social due diligence process will identify risks and impacts at a point in the future when the physical elements, assets, and facilities are reasonably understood. The risks and impacts identification process will be based on recent environmental and social baseline data at an appropriate level of detail. The process will consider all relevant environmental and social risks and impacts of the project, and those who are likely to be affected by such risks and impacts.

The risks and impacts identification process will consider the emissions of greenhouse gases, the relevant risks associated with a changing climate and the adaptation opportunities, and potential trans boundary effects, such as pollution of air, or use or pollution of international waterways.

Where the project involves specifically identified physical elements, aspects, and facilities that are likely to generate impacts, environmental and social risks and impacts will be identified in the context of the project's area of influence. This area of influence encompasses, as appropriate:

- The area likely to be affected by: (i) the project and the client's activities and facilities that are directly owned, operated or managed (including by contractors) and that are a component of the project; (ii) impacts from unplanned but predictable developments caused by the project that may occur later or at a different location; or (iii) indirect project impacts on biodiversity or on ecosystem services upon which Affected Communities' livelihoods are dependent.
- Associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable.
- Cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.

In the event of risks and impacts in the project's area of influence resulting from a third party's actions, the client will address those risks and impacts in a manner commensurate with the client's control and influence over the third parties, and with due regard to conflict of interest.

Where the client can reasonably exercise control, the risks and impacts identification process will also consider those risks and impacts associated with primary supply chains.

Where the project involves specifically identified physical elements, aspects and facilities that are likely to generate environmental and social impacts, the identification of risks and impacts will take into account the findings and conclusions of related and applicable plans, studies, or assessments prepared by relevant government authorities or other parties that are directly related to the project and its area of influence. These include master economic development plans, country or regional plans, feasibility studies, alternatives analyses, and cumulative, regional, sectorial, or strategic environmental assessments

Where relevant. The risks and impacts identification will take account of the outcome of the engagement process with Affected Communities as appropriate.

Where the project involves specifically identified physical elements, aspects and facilities that are likely to generate impacts, and as part of the process of identifying risks and impacts, the client will identify individuals and groups that may be directly and differentially or disproportionately affected by the project because of their disadvantaged or vulnerable status. Where individuals or groups are identified as disadvantaged or vulnerable, the client will propose and implement differentiated measures so that adverse impacts do not fall disproportionately on them and they are not disadvantaged in sharing development benefits and opportunities.

Management Programs

Consistent with the client's policy and the objectives and principles described therein, the client will establish management programs that, in sum, will describe mitigation and performance improvement

measures and actions that address the identified environmental and social risks and impacts of the project.

Depending on the nature and scale of the project, these programs may consist of some documented combination of operational procedures, practices, plans, and related supporting documents (including legal agreements) that are managed in a systematic way. The programs may apply broadly across the client's organization, including contractors and primary suppliers over which the organization has control or influence, or to specific sites, facilities, or activities. The mitigation hierarchy to address identified risks and impacts will favor the avoidance of impacts over minimization, and, where residual impacts remain, compensation/offset, wherever technically and financially feasible.

Where the identified risks and impacts cannot be avoided, the client will identify mitigation and performance measures and establish corresponding actions to ensure the project will operate in compliance with applicable laws and regulations, and meet the requirements of Performance Standards 1 through 8. The level of detail and complexity of this collective management program and the priority of the identified measures and actions will be commensurate with the project's risks and impacts, and will take account of the outcome of the engagement process with Affected Communities as appropriate.

The management programs will establish environmental and social Action Plans, which will define desired outcomes and actions to address the issues raised in the risks and impacts identification process, as measurable events to the extent possible, with elements such as performance indicators, targets, or acceptance criteria that can be tracked over defined time periods, and with estimates of the resources and responsibilities for implementation. As appropriate, the management program will recognize and incorporate the role of relevant actions and events controlled by third parties to address identified risks and impacts. Recognizing the dynamic nature of the project, the management program will be responsive to changes in circumstances, unforeseen events, and the results of monitoring and review.

Organizational Capacity and Competency

The client, in collaboration with appropriate and relevant third parties, will establish, maintain, and strengthen as necessary an organizational structure that defines roles, responsibilities, and authority to implement the ESMS. Specific personnel, including management representative(s), with clear lines of responsibility and authority should be designated. Key environmental and social responsibilities should be well defined and communicated to the relevant personnel and to the rest of the client's organization. Sufficient management sponsorship and human and financial resources will be provided on an ongoing basis to achieve effective and continuous environmental and social performance.

Personnel within the client's organization with direct responsibility for the project's environmental and social performance will have the knowledge, skills, and experience necessary to perform their work, including current knowledge of the host country's regulatory requirements and the applicable requirements of Performance Standards 1 through 8. Personnel will also possess the knowledge, skills, and experience to implement the specific measures and actions required under the ESMS and the methods required to perform the actions in a competent and efficient manner.

The process of identification of risks and impacts will consist of an adequate, accurate, and objective evaluation and presentation, prepared by competent professionals. For projects posing potentially significant adverse impacts or where technically complex issues are involved, clients may be required to involve external experts to assist in the risks and impacts identification process.

Emergency Preparedness and Response

Where the project involves specifically identified physical elements, aspects and facilities that are likely to generate impacts, the ESMS will establish and maintain an emergency preparedness and response system so that the client, in collaboration with appropriate and relevant third parties, will be prepared to respond to accidental and emergency situations associated with the project in a manner appropriate to prevent and mitigate any harm to people and/or the environment. This preparation will include the identification of areas where accidents and emergency situations may occur, communities and individuals that may be impacted, response procedures, provision of equipment and resources, designation of responsibilities, communication, including that with potentially Affected Communities and periodic training to ensure effective response. The emergency preparedness and response activities will be periodically reviewed and revised, as necessary, to reflect changing conditions.

Where applicable, the client will also assist and collaborate with the potentially Affected Communities and the local government agencies in their preparations to respond effectively to emergency situations, especially when their participation and collaboration are necessary to ensure effective response. If local government agencies have little or no capacity to respond effectively, the client will play an active role in preparing for and responding to emergencies associated with the project. The client will document its emergency preparedness and response activities, resources, and responsibilities, and will provide appropriate information to potentially Affected Community and relevant government agencies.

Monitoring and Review

The client will establish procedures to monitor and measure the effectiveness of the management program, as well as compliance with any related legal and/or contractual obligations and regulatory requirements. Where the government or other third party has responsibility for managing specific risks and impacts and associated mitigation measures, the client will collaborate in establishing and monitoring such mitigation measures. Where appropriate, clients will consider involving representatives from Affected Communities to participate in monitoring activities. The client's monitoring program should be overseen by the appropriate level in the organization. For projects with significant impacts, the client will retain external experts to verify its monitoring information. The extent of monitoring should be commensurate with the project's environmental and social risks and impacts and with compliance requirements.

In addition to recording information to track performance and establishing relevant operational controls, the client should use dynamic mechanisms, such as internal inspections and audits, where relevant, to verify compliance and progress toward the desired outcomes. Monitoring will normally include recording information to track performance and comparing this against the previously established benchmarks or requirements in the management program. Monitoring should be adjusted according to performance experience and actions requested by relevant regulatory authorities. The

client will document monitoring results and identify and reflect the necessary corrective and preventive actions in the amended management program and plans. The client, in collaboration with appropriate and relevant third parties, will implement these corrective and preventive actions, and follow up on these actions in upcoming monitoring cycles to ensure their effectiveness.

Senior management in the client organization will receive periodic performance reviews of the effectiveness of the ESMS, based on systematic data collection and analysis. The scope and frequency of such reporting will depend upon the nature and scope of the activities identified and undertaken in accordance with the client's ESMS and other applicable project requirements. Based on results within these performance reviews, senior management will take the necessary and appropriate steps to ensure the intent of the client's policy is met, that procedures, practices, and plans are being implemented, and are seen to be effective.

Stakeholder Engagement

Stakeholder engagement is the basis for building strong, constructive, and responsive relationships that are essential for the successful management of a project's environmental and social impacts. Stakeholder engagement is an ongoing process that may involve, in varying degrees, the following elements: stakeholder analysis and planning, disclosure and dissemination of information, consultation and participation, grievance mechanism, and ongoing reporting to Affected Communities. The nature, frequency, and level of effort of stakeholder engagement may vary considerably and will be commensurate with the project's risks and adverse impacts, and the project's phase of development.

External Communications and Grievance Mechanisms

External Communications

Clients will implement and maintain a procedure for external communications that includes methods to (i) receive and register external communications from the public; (ii) screen and assess the issues raised and determine how to address them; (iii) provide, track, and document responses, if any; and (iv) adjust the management program, as appropriate. In addition, clients are encouraged to make publicly available periodic reports on their environmental and social sustainability.

Grievance Mechanism for Affected Communities

Where there are Affected Communities, the client will establish a grievance mechanism to receive and facilitate resolution of Affected Communities' concerns and grievances about the client's environmental and social performance. The grievance mechanism should be scaled to the risks and adverse impacts of the project and have Affected Communities as its primary user. It should seek to resolve concerns promptly, using an understandable and transparent consultative process that is culturally appropriate and readily accessible, and at no cost and without retribution to the party that originated the issue or concern. The mechanism should not impede access to judicial or administrative remedies. The client will inform the Affected Communities about the mechanism in the course of the stakeholder engagement process.

Ongoing Reporting to Affected Communities

The client will provide periodic reports to the Affected Communities that describe progress with implementation of the project Action Plans on issues that involve ongoing risk to or impacts on Affected Communities and on issues that the consultation process or grievance mechanism have identified as a concern to those Communities. If the management program results in material changes in or additions to the mitigation measures or actions described in the Action Plans on issues of concern to the Affected Communities, the updated relevant mitigation measures or actions will be communicated to them. The frequency of these reports will be proportionate to the concerns of Affected Communities but not less than annually.

4 Description of the Proposed Mining Project

4.1 Project Description

Invest In Property 126 (Proprietary) Limited is proposing to develop and operate a diamond mine on certain portion R/E of the farm Viljoen’shof 1655 Boshof, in Boshof Free State Province to be known as the “Viljoen’shof Diamond Mine”. The operation will begin with a pilot mining stage employing identified contractor with readily available plant and earthmoving equipment.

The goals of the pilot mining stage are:

- Open complete area of the kimberlite body (ies) and cut first two benches into kimberlite;
- Process different kimberlite types separately and determine the grades and diamond quality variations;
- Carry out metallurgical studies of the ore for final design of the plant;
- During this stage geophysical survey and diamond core drilling will be implemented to study ore bodies’ morphology with depth.

The outcome of (4) will be used for long term mine design and principal decision on open pit versus underground mining method to be used.

4.2 Project Location

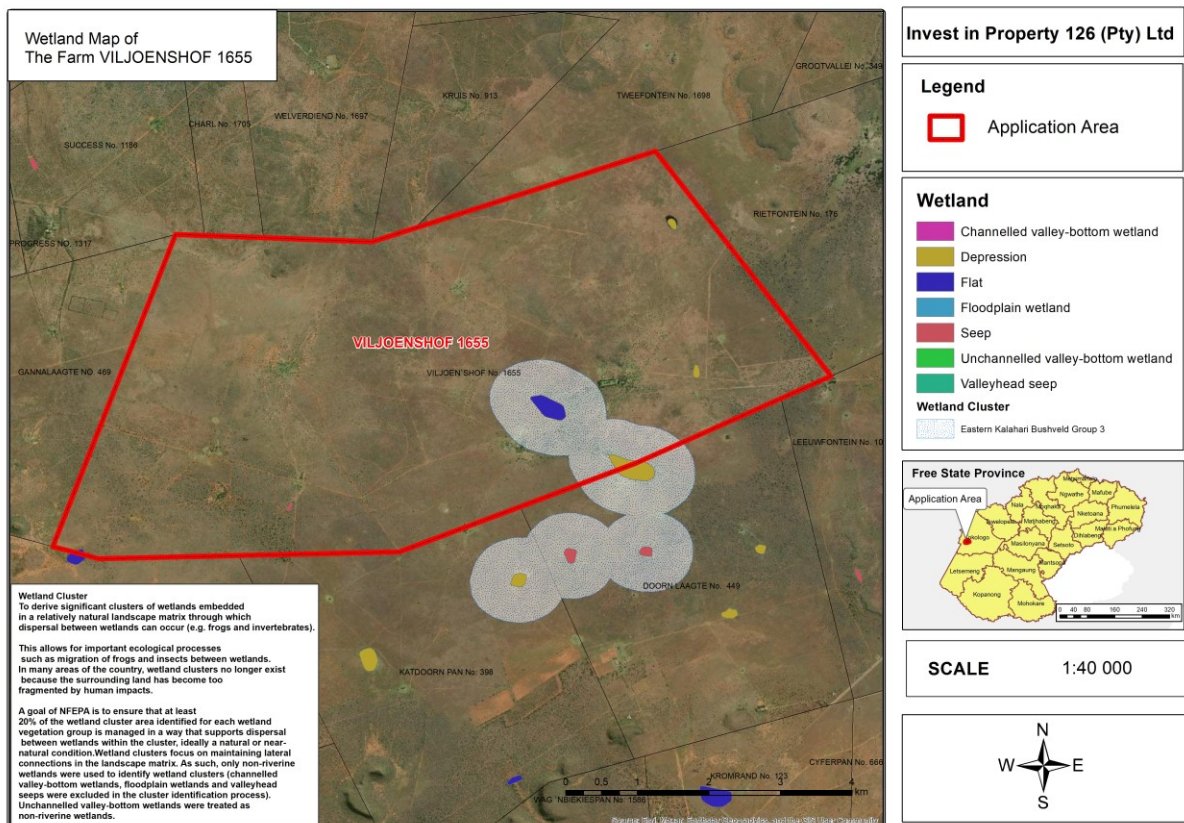


Figure 4-1: Locality of the Proposed Diamond Mine

5 Description of the Proposed Mining Project

5.1 Air Quality Sensitive Receptors

A study area, determined from the expected impact area, of 20 km east-west by 16 km north-south with the project located centrally was included. The study area is shown in Figure 3-1 with identified scattered AQSR indicated. AQSRs generally include places of residence and areas where members of the public may be affected by atmospheric emissions generated by mining/industrial activities. The nearest residential area is Postmasburg which lies 11 km north-east of the project.

The land use in the area comprises primarily of agricultural activities and open natural areas.

5.2 Atmospheric Dispersion Potential

Physical and meteorological mechanisms govern the dispersion, transformation, and eventual removal of pollutants from the atmosphere. The analysis of hourly average meteorological data is necessary to facilitate a comprehensive understanding of the dispersion potential of the site. Parameters useful in describing the dispersion and dilution potential of the site i.e. wind speed, wind direction, temperature and atmospheric stability, are subsequently discussed along with terrain and land use.

5.2.1. Land Use and Topography

The topography is characterised by flat plains 1260m above mean sea level (amsl). No topography was included in dispersion simulations

5.2.2. Surface Wind Field

To be undertaken during the construction and operational phase

Figure 5-1: Mining boundary and AQSRs

5.2.3. Temperature

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the emission plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers.

Monthly mean and hourly maximum and minimum temperatures are given in Table 5-1. Temperatures ranged between -7°C and 38°C. The highest temperatures occurred in December and the lowest in July. During the day, temperatures increase to reach maximum at around 14:00 in the afternoon. Ambient air temperatures decrease to reach a minimum at around 06:00 i.e. just before sunrise.

Table 5-1: Monthly Temperature Summary

Hourly Minimum, Hourly Maximum and Monthly Average Temperatures (°C)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum												
Maximum												
Average												

5.2.4. Rainfall

Precipitation is important to air pollution studies since it represents an effective mechanism of removing pollutants from the environment. On its way to the surface rain water combines with lots of pollutants in atmosphere; this process may alter the composition of rain by making it acidic but this also means that the pollutants are removed from the atmosphere which may reduce the impacts on human health. There is no reliable ambient rainfall data available for the Kapsteveld station, however precipitation here is low and averages 319 mm.

5.3. Ambient Air Pollutant Concentrations and Dustfall Rates

The region is characterised by being a relatively dry, arid and dusty region. It is expected that various local and far-a-field sources are expected to contribute to suspended fine particulate (PM_{2.5} and PM₁₀) concentrations in the region. Local sources include wind erosion from exposed areas, fugitive dust from agricultural activities and mining activities, vehicle entrainment from roadways and veld burning. Long range particulates can result from remote tall stack emissions and from large scale biomass burning in countries to the north of South Africa. These have been found to contribute significantly to background fine particulate concentrations over the interior of South Africa ((Andreae, 1996), (Garstang, 1996), (Piketh, Annegarn, & Kneen, 1996)).

The proposed Viljoen'shof Diamond Mine currently has no monitoring stations, it is proposed that there should be at least four monitoring stations (refer to Figure 4-1). The data recorded will include hourly PM₁₀, PM_{2.5}, SO₂ and NO₂. SO₂ and NO₂ results will be analysed in accordance with relevant evaluation criteria. A dust monitoring network should be installed.

Dustfall Sampling

A sampling campaign for the capture of dustfall shall be undertaken once site mobilisation and establishment get started.

6 Impact of Proposed Mine on the Receiving Environment

6.1 Atmospheric Emissions

The establishment of a comprehensive emission inventory shall form the basis for the assessment of the air quality impacts from the mine's operations on the receiving environment.

Sources of emission and associated pollutants considered in the emissions inventory to include:

- Crushing and Screening RoM at the main DSO plant – PM2.5, PM10 and TSP
- Drilling – PM2.5, PM10 and TSP
- Handling of RoM, waste rock and product ore – PM2.5, PM10 and TSP
- Transport of RoM, product ore and waste rock – PM2.5, PM10 and TSP
- Windblown dust from the stockpile areas – PM2.5, PM10 and TSP

All emissions would be determined through the application of emission factors published by the US EPA and the Australian NPI.

6.2 Atmospheric Dispersion Modelling

The assessment of the impact of the proposed mine's operations on the environment is discussed in this Section. To assess impact on human health and the environment the following important aspects need to be considered:

- The criteria against which impacts are assessed;
- The potential of the atmosphere to disperse and dilute pollutants emitted by the mine; and
- The methodology followed in determining ambient pollutant concentrations and dustfall rates.

The potential impact on human health as a result of PM2.5 and PM10 emissions from the proposed mining operations and related activities are discussed. The impact of dustfall on the environment, as a result of TSP emissions, is discussed.

The impact of operations on the atmospheric environment was determined through the simulation of dustfall rates and ambient pollutant concentrations. Simulated air quality impacts represent those associated with the mine's operations only.

Dispersion models simulate ambient pollutant concentrations and dustfall rates as a function of source configurations, emission strengths and meteorological characteristics, thus providing a useful tool to ascertain the spatial and temporal patterns in the ground level concentrations arising from the emissions of various sources. Increasing reliance has been placed on concentration estimates from models as the primary basis for environmental and health impact assessments, risk assessments and emission control requirements. It is therefore important to carefully select a dispersion model for the purpose.

6.2.1 Dispersion Model Selection

Gaussian-plume models are best used for near-field applications where the steady-state meteorology assumption is most likely to apply. One of the most widely used Gaussian plume model is the US EPA AERMOD model that will be used in the study during mining operation. AERMOD is a model developed with the support of AERMIC, whose objective has been to include state-of-the-art science in regulatory models (Hanna, Egan, Purdum, & Wagler, 1999). AERMOD is a dispersion modelling system with three components, namely: AERMOD (AERMIC Dispersion Model), AERMAP (AERMOD terrain pre-processor), and AERMET (AERMOD meteorological pre-processor).

AERMOD is designed to predict pollution concentrations from continuous point, flare, area, line, and volume sources. It offers new and potentially improved algorithms for plume rise and buoyancy, and the computation of vertical profiles of wind, turbulence and temperature however retains the single straight line trajectory limitation. AERMET is a meteorological pre-processor for AERMOD. Input data can come from hourly cloud cover observations, surface meteorological observations and twice-a-day upper air soundings. Output includes surface meteorological observations and parameters and vertical profiles of several atmospheric parameters. AERMAP is a terrain pre-processor designed to simplify and standardise the input of terrain data for AERMOD. Input data includes receptor terrain elevation data. The terrain data may be in the form of digital terrain data. The output includes, for each receptor, location and height scale, which are elevations used for the computation of air flow around hills.

A disadvantage of the model is that spatial varying wind fields, due to topography or other factors cannot be included. Input data types required for the AERMOD model include: source data, meteorological data (pre-processed by the AERMET model), terrain data, and information on the nature of the receptor grid and pre-development or background pollutant concentrations or dustfall rates.

6.2.2 Meteorological Requirements

In terms of the study it is proposed that an hourly on-site data from the proposed data stations be collected and used over a twelve month period (i.e. January to December).

6.2.3 Source Data Requirements

The AERMOD model is able to model point, jet, area, line and volume sources. Potential sources at Viljoen'shof Diamond Mine will be modelled as follows:

- Crushing and materials handling – modelled as volume sources;
- Activities in the pit – modelled as open pit sources;
- Unpaved roads and windblown dust – modelled as area sources.

6.2.4 Modelling Domain

The dispersion of pollutants expected to arise from proposed mining operation and its related activities will be modelled for an area covering 15-25 km [east-west] by 10 km [north-south]. It is proposed that the area be divided into a grid matrix with a resolution of 250 m, with the proposed Viljoen'shof

Diamond Mine located centrally to the grid. Further to that, the residences must be included as AQSR. AERMOD calculates ground-level (1.5 m above ground level) concentrations and dustfall rates at each grid and discrete receptor point.

6.2.5 Presentation of Results

Dispersion modelling will be undertaken to determine highest daily and annual average ground level concentrations and dustfall rates for each of the pollutants considered in the study. Averaging periods to be selected so as to facilitate the comparison of predicted pollutant concentrations to relevant ambient air quality as well as dustfall regulations.

It should be noted that ambient air quality criteria applies to areas where the Occupational Health and Safety regulations do not apply, thus outside the property or lease area. Ambient air quality criteria are therefore not occupational health indicators but applicable to areas where the general public has access i.e. off-site.

Dustfall will be assessed for nuisance impact on the environment and not inhalation health impact.

6.3 Screening of Simulated Human Health Impacts

6.3.1 Simulated Ambient PM10 Concentrations

To be undertaken during construction and operational phase

6.3.2 Simulated Ambient PM2.5 Concentrations

To be undertaken during construction and operational phase

6.4 Analysis of Emissions' Impact on the Environment

6.4.1 Simulated Dustfall Rates

To be undertaken during construction and operational phase

6.5 Comparison between Measured and Simulated

To be undertaken during construction and operational phase

7 Impact Significance Rating

Upon successful granting of an Environmental Authorisation (EA), and the Mining Right, before construction and throughout operational phase, the significance of environmental noise impacts will be assessed according to the methodology adopted by EXM.

The significance of the operational phase of the proposed Viljoen'shof Diamond Mine operations will be undertaken in accordance with the criteria below (Table 7-1).

Table 7-1: Significance Rating for Operation Phase without Mitigation

SIGNIFICANCE	RATING
Intensity = Medium: impact is of medium magnitude	
Duration = Long-term: impact occurs over the operational life of the proposed extension	
Extent = Small: impact extends to the whole farm portion	
Severity = (intensity + duration) / 2	
Consequence = (severity + extent) / 2	
Probability = Probable: the impact will probably occur	
Impact significance = (consequence x probability) = Moderate	

Table 7-2: Significance Rating for Operation Phase with Mitigation

SIGNIFICANCE	RATING
Intensity = Medium: impact is of medium magnitude	
Duration = Long-term: impact occurs over the operational life of the proposed extension	
Extent = Small: impact extends to the whole farm portion	
Severity = (intensity + duration) / 2	
Consequence = (severity + extent) / 2	
Probability = Probable: the impact will probably occur	
Impact significance = (consequence x probability) = Moderate	

8 Recommended Air Quality Management Measures

The management measures given below align with the IFS performance standards. Some of requirements for the performance standard include; monitoring and review, stakeholder engagement, ongoing reporting to communities.

8.1 Air Quality Management Objectives

The main objective of the proposed air quality management measures for the proposed Viljoen'shof Diamond Mine is to ensure that mining operation and related activities result in ambient air concentrations and dustfall rates that are within the relevant ambient air quality standards off-site.

In order to define site specific management objectives, the main sources of pollution needed to be identified. Sources area ranked based on source strengths (emissions) and impacts (concentrations). Once the main sources have been identified, target control efficiencies for each source can be defined to ensure acceptable cumulative ground level concentrations.

8.2 Source Ranking

The ranking of sources serves to confirm the current understanding of the significance of specific sources, and to evaluate the emission reduction potentials required for each. Sources of emissions at the proposed Viljoen'shof Diamond Mine operations are ranked based on:

- Emissions; based on the comprehensive emissions inventory established for the operations, and,
- Impacts; based on the predicted dustfall levels and particulate concentrations

8.2.1 Ranking of Sources by Emissions

On average, sources of emission are ranked as follows from most to least significant:

- Vehicle entrained dust from unpaved haul roads
- Windblown dust
- Materials Handling
- Crushing
- Drilling & blasting

8.2.2 Ranking of Sources by Impact

On average, sources of impact are ranked as follows from most to least significant:

- Vehicle entrained dust from unpaved haul roads
- Materials Handling
- Windblown dust
- Crushing
- Drilling & blasting

8.2.3 Conclusion with Regards to Source Ranking

From the preceding it can be concluded that measures aimed at reducing emissions from unpaved roads, wind erodible exposed areas and materials handling must be considered to most significantly reduce impacts on the environment. In the following section, source specific management and mitigation measures are recommended specifically for unpaved roads as well as windblown dust. Other sources of emission are also addressed in general.

8.3 Source Specific Recommended Management and Mitigation Measures

8.3.1 Dust Control Options for Unpaved Haul Roads

Three types of measures may be taken to reduce emissions from unpaved roads:

- Measures aimed at reducing the extent of unpaved roads, e.g. paving;
- Traffic control measures aimed at reducing the entrainment of material by restricting traffic volumes and reducing vehicle speeds; and
- Measures aimed at binding the surface material or enhancing moisture retention, such as wet suppression and chemical stabilization extracted from (Cowherd, Muleski, & Kinsey, 1988).

The main dust generating factors on unpaved road surfaces include:

- Vehicle speeds;
- Number of wheels per vehicle;
- Traffic volumes;
- Particle size distribution of the aggregate;
- Compaction of the surface material;
- Surface moisture; and
- Climate

According to a number of studies conducted recently locally and internationally, an increase in vehicle speed of 10 miles per hour resulted in an increase in PM10 emissions of between 1.5 and 3 times. The control efficiency obtained by speed reduction can be calculated by varying the vehicle speed input parameter in the predictive emission factor equation given for unpaved roads. An evaluation of control efficiencies resulting from reductions in traffic volumes can be calculated due to the linear relationship between traffic volume, given in terms of vehicle kilometres travelled, and fugitive dust emitted. Similar affects will be achieved by reducing the truck volumes on the roads.

Water sprays on unpaved roads is the most common means of suppressing fugitive dust due to vehicle entrainment at mines, but it is not necessarily the most efficient means extracted from (Thompson & Visser, 2000). Thompson and Visser (2000) developed a model to determine the cost and management implications of dust suppression on mine haul roads using water or other chemical palliatives. The study was undertaken at 10 mine sites in Southern Africa. The model was first developed looking at the reapplication frequency of water required for maintaining a specific degree of dust palliation. From this the cost effectiveness of water spray suppression could be determined and compared to other strategies. Factors accounted for in the model included climate, traffic, vehicle speed and the road aggregate material. A number of chemical palliative products, including hygroscopic salts,

lignosulphonates, petroleum resins, polymer emulsions and tar and bitumen products were assessed to benchmark their performance and identify appropriate management strategies. Cost elements taken into consideration included amongst others capital equipment, operation and maintenance costs, material costs and activity related costs. The main findings were that water-based spraying is the cheapest dust suppression option over the short term. Over the longer term however, the polymer-emulsion option is marginally cheaper with added benefits such as improved road surfaces during wet weather, reduced erosion and dry skid resistance (Thompson & Visser, 2000).

Chemical suppressant has been proven to be effective due to the binding of fine PM in the road surface, hence increasing the density of the surface material. In addition, dust control additives are beneficial in the fact that it also improves the compaction and stability of the road. The effectiveness of a dust palliative include numerous factors such as the application rate, method of application, moisture content of the surface material during application, palliative concentrations, mineralogy of aggregate and environmental conditions. Thus, for different climates and conditions you need different chemicals, one chemical might not be as effective as another under the same conditions and each product comes with various advantages and limitations of its own. In general, chemical suppressants are given to achieve a PM10 control efficiency of 80% when applied regularly on the road surfaces (Stevenson, 2004).

There is however no cure-all solution but rather a combination of solutions. A cost-effective chemical control programme may be developed through establishing the minimum control efficiency required on a particular roadway, and evaluating the costs and benefits arising from various chemical stabilization practices. Appropriate chemicals and the most effective relationships between application intensities, reapplication frequencies, and dilution ratios may be taken into account in the evaluation of such practices.

Spillage and track-on from the surrounding unpaved areas may result in the deposition of materials onto the chemically treated or watered road resulting in the need for periodic “housekeeping” activities (Cowherd, Muleski, & Kinsey, 1988). In addition, the gradual abrasion of the chemically treated surface by traffic will result in loose material on the surface which would have to be controlled. The minimum frequency for the reapplication of watering or chemical stabilizers thus depends not only on the control efficiency of the suppressant but also on the degree of spillage and track-on from adjacent areas, and the rate at which the treated surface is abraded. The best way to avoid dust generating problems from unpaved roads is to properly maintain the surface by grading and shaping to prevent dust generation caused by excessive road surface wear (Stevenson, 2004).

One of the main benefits of chemical stabilisation in conjunction with wet suppression is the management of water resources (MFE, 2001).

8.3.2 Options for Reducing Windblown Dust Emissions

The main techniques adopted to reduce windblown dust potential include source extent reduction, source improvement and surface treatment methods:

- ❖ Source extent reduction:
 - Disturbed area reduction.
 - Disturbance frequency reduction.
 - Dust spillage prevention and/or removal.
- ❖ Source Improvement:
 - Disturbed area wind exposure reduction, e.g. wind fences and enclosure of source areas.
- ❖ Surface Treatment:
 - Wet suppression
 - Chemical stabilisation
 - Covering of surface with less erodible aggregate material
 - Vegetation of open areas

The suitability of the dust control techniques indicated will depend on the specific source to be addressed, and will vary between dust spillage, material storage and open areas. The NPI recommends the following methods for reducing windblown dust:

- ❖ Primary rehabilitation - 30%
- ❖ Vegetation established but not demonstrated to be self-sustaining. Weed control and grazing control - 40%
- ❖ Secondary rehabilitation - 60%
- ❖ Re-vegetation - 90%
- ❖ Fully rehabilitated (release) vegetation - 100%

8.3.3 Materials Handling Dust Control Options

Control techniques applicable to materials handling are generally classifiable as source extent reduction, source improvement related to work practices and transfer equipment, and surface treatment. These control options may be summarised as follows:

- ❖ Source extent reduction:
 - Mass transfer reduction
- ❖ Source improvement:
 - Drop height reduction
 - Wind sheltering
 - Moisture retention

- ❖ Surface treatment:
 - Wet suppression
 - Air atomising suppression

The efficiency of these controls may be estimated through the relationships between climatic parameters, material properties and quantities of material transferred demonstrated in the predictive emission factor equation.

Good operational practices frequently represent the most cost effective and efficient means of reducing emissions. The variation of the height from which stacking occurs to suit the height of the storage pile would limit drop heights and therefore reduce the potential for the entrainment of fines by the wind.

Wet suppression systems use either liquid sprays or foam to suppress the formation of airborne dust. Emissions are prevented through agglomerate formation by combining fine particulates with larger aggregate or with liquid droplets. The key factors which affect the extent of agglomeration and therefore the efficiency of the system are the coverage of the material by the liquid and the ability of the liquid to "wet" small particles. The only wet suppression systems considered in this section is liquid sprays.

Liquid spray suppression systems may use only water or a combination of water and a chemical surfactant as the wetting agent. Surfactants reduce the surface tension of the water thus allowing particles to more easily penetrate the water particle and reducing the quantity of water needed to achieve the control efficiency required. General engineering guidelines which have been shown to be effective in improving the control efficiency of liquid spray systems are as follows:

- of the various nozzle types, the use of hollow cone nozzles tend to afford the greatest control for bulk materials handling applications whilst minimising clogging;
- optimal droplet size for surface impaction and fine particle agglomeration is about 500 μm ; finer droplets are affected by drift and surface tension and appear to be less effective; and,
- application of water sprays to the underside of conveyor belts has been noted by various studies to improve the efficiency of water suppression systems and belt-to-belt transfer points.

The control efficiency of pure water suppression can be estimated based on the US EPA emission factor which relates material moisture content to control efficiency. It is important to note that the improvements in dust control efficiencies are marginal following increases in material moisture contents by 400%. To obtain control efficiencies of greater than 90%, it would be more feasible and cost effective to consider either alternative systems (e.g. foam suppression) or supplementary methods (e.g. addition of chemical surfactants to water).

8.4 Performance Indicators

Key performance indicators against which progress of implemented mitigation and management measures may be assessed form the basis for all effective environmental management practices. In the definition of key performance indicators careful attention is usually paid to ensure that progress towards their achievement is measurable, and that the targets set are achievable given available technology and experience.

Performance indicators are usually selected to reflect both the source of the emission directly (source monitoring) and the impact on the receiving environment (ambient air quality monitoring). Ensuring that no visible evidence of windblown dust exists represents an example of a source-based indicator, whereas maintaining off-site dustfall levels to below 600 mg/m²-day represents an impact- or receptor-based performance indicator.

Except for vehicle/equipment emission testing, source monitoring at mining activities can be challenging due to the fugitive and wind-dependant nature of particulate emissions. The focus is therefore rather on receptor based performance indicators i.e. compliance with ambient air quality standards and dustfall regulations. It is recommended that NAAQS listed in Table 8-1 and dustfall regulations in Table 8-2, be adopted by Viljoen'shof Diamond Mine as receptor-based objectives.

8.4.1 Ambient Air Quality Monitoring

Ambient air quality monitoring can serve to meet various objectives, such as:

Compliance monitoring;

- Validate dispersion model results;
- Use as input for health risk assessment;
- Assist in source apportionment;
- Temporal trend analysis;
- Spatial trend analysis;
- Source quantification; and,
- Tracking progress made by control measures

It is recommended that, as a minimum, Viljoen'shof Diamond Mine continuous dustfall, PM10 and PM2.5 as well as meteorology, NO₂ and SO₂ sampling be part of the mine's air quality management plan. Careful screening of data and maintenance of monitoring stations is recommended.

The ambient monitoring station locations must be informed by air dispersion modelling results on sensitive receptors and weather conditions, such as prevailing wind directions. The requirements of the site permits/licenses must be reflected in the design of the monitoring system. Daily emissions must be managed via Trigger Action Response Plans (TARP's) using the monitoring results and visual observations of emissions. The monitoring equipment must have a formal maintenance and servicing programme in place, with an annual data capture target of ninety percent (90%) as a minimum for each real-time monitoring station.

8.5 Record-keeping, Environmental Reporting and Community Liaison

Periodic inspections and external audits are essential for progress measurement, evaluation and reporting purposes. It is recommended that site inspections and progress reporting be undertaken at regular intervals (at least quarterly), with annual environmental audits being conducted. Annual environmental audits should be continued at least until closure. Results from site inspections and monitoring efforts should be combined to determine progress against source- and receptor-based performance indicators. Progress should be reported to all interested and affected parties, including authorities and persons affected by pollution.

The criteria to be taken into account in the inspections and audits must be made transparent by way of minimum requirement checklists included in the management plan. Corrective action or the implementation of contingency measures must be proposed to the stakeholder forum in the event that progress towards targets is indicated by the quarterly/annual reviews to be unsatisfactory.

8.5.1 Liaison Strategy for Communication with I&As

Stakeholder forums provide possibly the most effective mechanisms for information dissemination and consultation.

Management plans should stipulate specific intervals at which forums will be held, and provide information on how people will be notified of such meetings. For operations for which un-rehabilitated or partly rehabilitated impoundments are located in close proximity (within 3 km) from community areas, it is recommended that such meetings be scheduled and held at least on a bi-annual basis.

8.5.2 Financial Provision

The budget should provide a clear indication of the capital and annual maintenance costs associated with dust control measures and dust monitoring plans. It may be necessary to make assumptions about the duration of aftercare prior to obtaining closure. This assumption must be made explicit so that the financial plan can be assessed within this framework

Costs related to inspections, audits, environmental reporting and I&AP liaison should also be indicated where applicable. Provision should also be made for capital and running costs associated with dust control contingency measures and for security measures. The financial plan should be audited by an independent consultant, with reviews conducted on an annual basis.

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Appendix A – Locality, Site and Other Maps

Appendix B – Significance Rating Methodology

APPENDIX B – SIGNIFICANCE RATING METHODOLOGY

The methodology used for assessing the significance of the impact was obtained from EXM. The significance of the impact is dependent on the consequence and the probability that the impact will occur.

	impact significance = (consequence x probability)
Where	
	consequence = (severity + extent)/2
And	
	severity = (intensity + duration)/2

Each criterion is given a score from 1 to 5 based on the definitions given in Table B-1 to Table B-3. Although the criteria used for the assessment of impacts attempts to quantify the significance, it is important to note that the assessment is generally a qualitative process and therefore the application of this criteria is open to interpretation. The process adopted will therefore include the application of scientific measurements and professional judgement to determine the significance of environmental impacts associated with the proposed project. The assessment thus largely relies on experience of the environmental assessment practitioner (EAP) and the information provided by the specialists appointed to undertake studies for the EIA.

Where the consequence of an event is not known or cannot be determined, the “precautionary principle” will be adhered to and the worst-case scenario assumed. Where possible, mitigation measures to reduce the significance of negative impacts and enhance positive impacts will be recommended. The detailed actions, which are required to ensure that mitigation is successful, will be provided in the EMPR, which will form part of the EIA report. Consideration will be given to the phase of the project during which the impact occurs. The phase of the development during which the impact will occur will be noted to assist with the scheduling and implementation of management measures

Table B-1: Criteria for Assessing the Impact Significance (Severity Criteria)

INTENSITY = MAGNITUDE OF IMPACT	RATING
Insignificant: impact is of a very low magnitude	1
Low: impact is of low magnitude	2
Medium: impact is of medium magnitude	3
High: impact is of high magnitude	4
Very high: impact is of highest order possible	5
DURATION = HOW LONG THE IMPACT LASTS	RATING
Very short-term: impact lasts for a very short time (less than a month)	1
Short-term: impact lasts for a short time (months but less than a year)	2
Medium-term: impact lasts for the for more than a year but less than the life of operation	3
Long-term: impact occurs over the operational life of the proposed extension	4
Residual: impact is permanent (remains after mine closure)	5
EXTENT = SPATIAL SCOPE OF IMPACT/ FOOTPRINT AREA / NUMBER OF RECEPTORS	RATING
Limited: impact affects the mine site	1
Small: impact extends to the whole farm portion	2
Medium: impact extends to neighbouring properties	3
Large: impact affects the surrounding community	4
Very Large: The impact affects an area larger the municipal area	5

Table B-2: Criteria for Assessing the Impact Significance (Probability)

PROBABILITY = LIKELIHOOD THAT THE IMPACT WILL OCCUR	RATING
Highly unlikely: the impact is highly unlikely to occur	0.2
Unlikely: the impact is unlikely to occur	0.4
Possible: the impact could possibly occur	0.6
Probable: the impact will probably occur	0.8
Definite: the impact will occur	1.0

Table B-3: Criteria for Assessing the Impact Significance (Impact Significance)

Negative Impacts		
≤ 1	Very Low	Impact is negligible. No mitigation required.
$> 1 \leq 2$	Low	Impact is of a low order. Mitigation could be considered to reduce impacts. But does not affect environmental acceptability.
$> 2 \leq 3$	Moderate	Impact is real but not substantial in relation to other impacts. Mitigation should be implemented to reduce impacts.
$> 3 \leq 4$	High	Impact is substantial. Mitigation is required to lower impacts to acceptable levels.
$> 4 \leq 5$	Very High	Impact is of the highest order possible. Mitigation is required to lower impacts to acceptable levels. Potential Fatal Flaw
Positive Impacts		
≤ 1	Very Low	Impact is negligible.
$> 1 \leq 2$	Low	Impact is of a low order.
$> 2 \leq 3$	Moderate	Impact is real but not substantial in relation to other impacts.
$> 3 \leq 4$	High	Impact is substantial.
$> 4 \leq 5$	Very High	Impact is of the highest order possible.