


Climate Change Impact Assessment Commissioned By

NSOVO ENVIRONMENTAL CONSULTING

Project Reference 1119-P017-NSO DCM West CCIA

Date 3 April 2020

This report documents the results and findings of a climate change impact assessment in support of the current operations and proposed expansion of the Dorstfontein West Mine located in the eMalahleni Local Municipality of the Mpumalanga Province.

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EXECUTIVE SUMMARY

EHRCON (Pty) Ltd was commissioned by Nsovo Environmental Consulting (Nsovo Environmental) to assess the climate change impact associated with the current operations and proposed expansion of the Dorstfontein West Mine (Pty) Ltd, also known as Dorstfontein Coal Mine (Pty) Ltd (DCM West), located in the eMalahleni Local Municipality of the Mpumalanga Province.

DCM West operated by Exxaro Coal Central (Pty) Ltd (Exxaro) is currently mining 2 and 4 Seam via bord and pillar underground mining method on the western portion of their mining right area. DCM West proposes to further mine 4 Seam, which will extend the Life of Mine (LOM) to 23 years. The proposed expansion will result in Run of Mine (ROM) increasing to approximately 150 000 tonnes per month over the subsequent 15 years. An additional discard dump facility is required to accommodate the disposal of the discard and slurry for the LOM. The construction of a conveyor belt and associated service road are required to transport beneficiated coal from DCM West to Dorstfontein Coal Mine East (DCM East).

The assessment considered a review of the relevant climate change framework, protocol, legislation, regulations and strategies. A process description and a greenhouse gas (GHG) inventory were compiled. A global, national and regional climate change synopsis was provided. Assessments of the contribution and outcome of the current mining operations and the expansion project's effects on climate change were conducted. The climate change impact of the GHG emissions was benchmarked against South Africa's national emissions inventory and the global greenhouse gas inventory.

A climate change vulnerability assessment assessed the potential impact of climate change on DCM West's current mining operations and the expansion project. A climate baseline was provided and future climate change scenarios were identified. Potential climate related risks were identified, scored and prioritised. Management and mitigation measures were proposed for the identified risks.

The climate change impact assessment conclude the following:

- The project falls within the Nkangala District Municipality of the Mpumalanga Province. The Mpumalanga Climate Change Adaptation Strategy Report and the Nkangala District Municipality's Climate Change Vulnerability Assessment and Response Plan have been developed.
- A total GHG emission rate of 16 186.89 tCO_2e was calculated for the current operations. Scope 1 GHG emissions amounted to 1 648.61 tCO_2e (10.18%) and Scope 2 GHG emissions totalled 14 538.27 tCO_2e (89.82%).
- The expansion project's total GHG emission rate was calculated at 239 127.80 tCO_2e for the LOM. Scope 1 GHG emissions amounted to 70 126.87 tCO_2e (29.33%). Scope 2 GHG emissions totalled 169 000.93 tCO_2e (70.67%).
- DCM West's calculated GHG emissions inventory for current operations amounts to 0.0004% of South Africa's carbon budget (4,410 Mt CO_2e).
- The expansion project's calculated GHG emissions inventory amounts to 0.0054% of South Africa's carbon budget (4,410 Mt CO_2e).
- The magnitude of GHG emissions from the current operations and the expansion project is considered minor, as GHG emissions are less than 0.02% of the South Africa's carbon budget.
- The impact of GHG emissions from current coal mining and beneficiation operations was rated medium with or without mitigation measures.
- The impact of GHG emissions from the expansion project was rated medium with or without mitigation measures.
- DCM West's GHG emissions although minor, will still contribute to local Industrial Process and Product Use Sector and global energy related GHG emissions.
- The project's GHG emissions will contribute to anthropogenic climate change. Climate change is likely to be accelerated and extended as GHG emissions accumulate in the atmosphere.
- Potential climate risks identified, based on the climate threat outlined, include increased temperature, reduced rainfall, extreme events and wind impacts.

- The identified climate risks will have a direct and indirect impact on DCM West's current operations and expansion project.
- Potential climate risks that have been assessed as highly significant include water scarcity and drought that can constrain exploration, processing and site rehabilitation; floods, cyclones and storms that may cause damage to infrastructure and facilities and floods, cyclones and storms that may cause reduced accessibility due to flooding of roads.
- All other potential climate risks have been assessed as medium without and with mitigation measures.
- Although mitigation will not alter the impacts of GHG emissions in terms of the extent, duration or probability of the impact, the intensity of the impact can be reduced, notably by reducing the quantity of GHG emissions.
- Basic mitigation strategies and specific tactics and actions have been outlined to reduce GHG emissions from the coal mining activities.
- Risk mitigation / adaptation measures have been proposed for the identified climate risks.

DECLARATION

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- it acts as an independent specialist.
- all results and related data have been obtained through careful and precise execution of recognised methods of evaluation and are related to the scope of work covered in this report and of prevailing conditions at the time of the assessment.
- the opinions and interpretations are embraced through judgment, discernment and comprehension to the best of available knowledge and are outside the scope of any accreditation.
- it performed the work relating to this project in an objective manner, notwithstanding the results, views and findings.
- it has expertise in conducting the specialist report relevant to this project, including knowledge of the framework, protocol, legislation, regulations and strategies that may have relevance.
- it complies with the applicable framework, protocol, legislation, regulations and strategies.
- it has no, and will not engage in, conflicting interests in the undertaking of the activity.
- it undertakes to disclose to the client and authorities all material information it possesses that reasonably has or may have the potential of objectively influencing any decision based on the results and finings of this project.
- all the particulars furnished by EHRCON in this report are true and correct; and any false declaration is a punishable offence.

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1. INTRODUCTION

1.1 PROJECT OUTLINE

EHRCON (Pty) Ltd was commissioned by Nsovo Environmental Consulting (Nsovo Environmental) to assess the climate change impact associated with the current operations and proposed expansion of the Dorstfontein West Mine (Pty) Ltd, also known as Dorstfontein Coal Mine (Pty) Ltd (DCM West), located in the eMalahleni Local Municipality of the Mpumalanga Province.

DCM West operated by Exxaro Coal Central (Pty) Ltd (Exxaro) is currently mining 2 and 4 Seam via bord and pillar underground mining method on the western portion of their mining right area. DCM West proposes to further mine 4 Seam, which will extend the Life of Mine (LOM) to 23 years. The proposed expansion will result in Run of Mine (ROM) increasing to approximately 150 000 tonnes per month over the subsequent 15 years. An additional discard dump facility is required to accommodate the disposal of the discard and slurry for the LOM. The construction of a conveyor belt and associated service road are required to transport beneficiated coal from DCM West to Dorstfontein Coal Mine East (DCM East).

The report was compiled with due consideration of all process information and specific conditions outlined by DCM West and Nsovo Environmental.

1.2 PROJECT DESCRIPTION

DCM West is located in the eMalahleni Local Municipality, within the Nkangala District Municipality of the Mpumalanga Province. Current land use is dominated by residential, farming, power generation and mining. DCM West is situated approximately 5 kilometres north-east of Ga-Nala (Kriel) on the R547 (See **Figure 1**).

The assessment of the potential climate change impact associated with the current operations and proposed expansion of DCM West, comprised the following terms of reference:

- A review of the relevant framework, protocol, legislation, regulations and strategies.
- A process description and GHG inventory.
- A global, national and regional climate change synopsis.
- Assessments of the contribution and outcome of the current mining operations' and the expansion project's effects on climate change.
- Benchmarking of the climate change impact of the GHG emissions against South Africa's national emissions inventory and the global GHG inventory.
- A climate change vulnerability assessment, assessing the potential impact of climate change on DCM West's current mining operations and the expansion project.
- A climate baseline was provided and future climate change scenarios were identified.
- Potential climate related risks were identified, scored and prioritised.
- Management and mitigation measures were proposed for the identified risks.

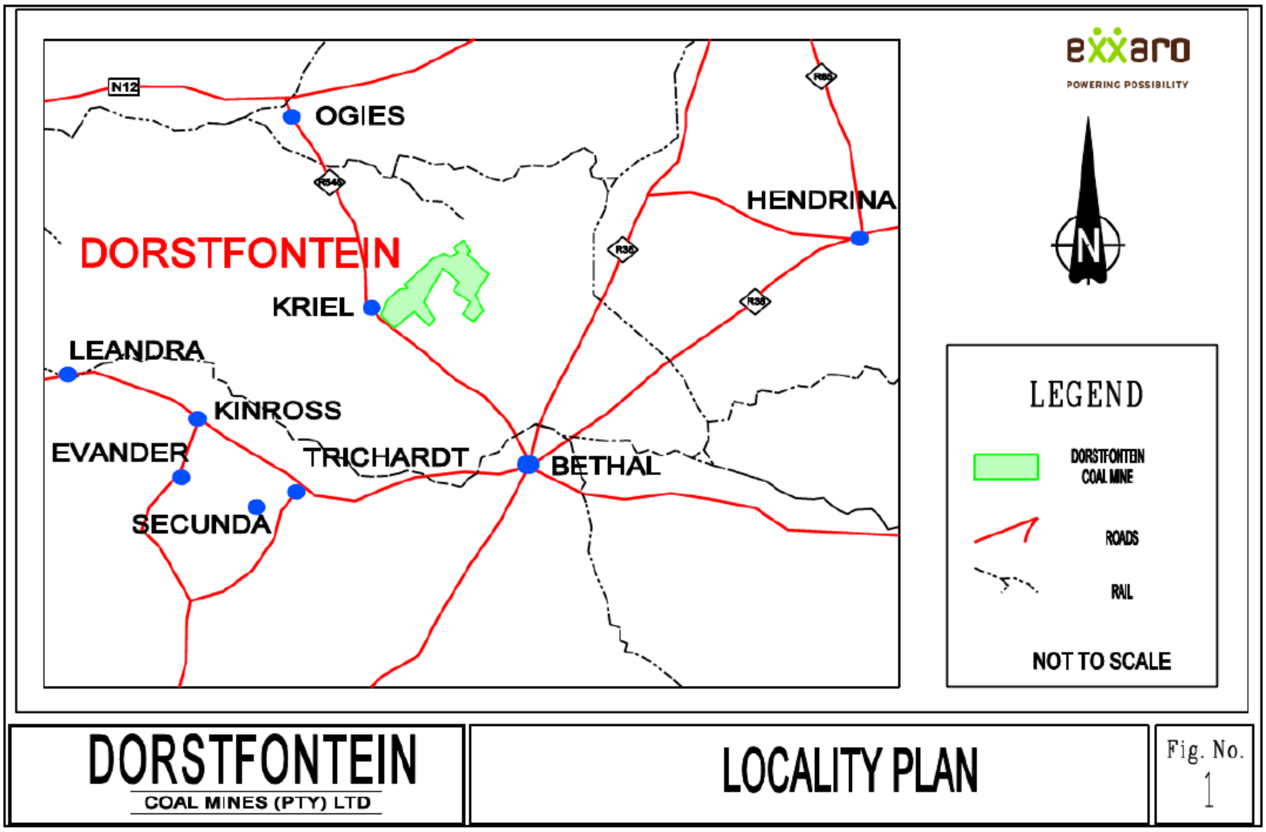

Figure 1: Dorstfontein Coal Mine West Locality Plan

1.3 METHODOLOGICAL OVERVIEW

The compilation of the GHG emission inventory for DCM West was based on *ISO/SANS 14064 Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals* (2006) and The Greenhouse Gas Protocol's *A Corporate Accounting and Reporting Standard (Revised Edition)* (2015).

The reporting boundary was set, GHG sources identified, quantification method established and the GHG emissions inventory was calculated.

Default emission factors, as set out in the Intergovernmental Panel on Climate Change (IPCC) *Guidelines for National Greenhouse Gas Inventories* (2006) and the Department of Environmental Affairs' *Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry* (2017) were used for the purpose of calculating the GHG emissions inventory. Relevant South African emission factors were source for related Scope 2 and Scope 3 emissions.

The climate change impact of the GHG emissions was benchmarked against South Africa's national emissions inventory and the global greenhouse gas inventory.

A climate change vulnerability assessment assessed the potential impact of climate change on DCM West's current mining operations and the expansion project. A climate baseline was provided and future climate change scenarios were identified. Potential climate-related risks were identified, scored and prioritised. Management and mitigation measures were proposed for Medium and High risks identified in the risk assessment.

1.4. ASSUMPTIONS, EXCLUSIONS AND LIMITATIONS

Data limitations and assumptions associated with the climate change impact assessment in support of mining operations at DCM West are listed below:

- The inventory included all sources that were practically and economically feasible to assess.
- The GHG inventory for the project includes the current operations and the proposed expansion.
- The construction and rehabilitation phases have been excluded due to a lack of available data.
- Limitations exist with the use of climate change projections to inform future climate scenarios.

2. FRAMEWORK, PROTOCOL LEGISLATION AND REGULATIONS

2.1 UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

The United Nations Framework Convention on Climate Change (UNFCCC), formed in 1992, is an international treaty put in place by the United Nations. The objective of the treaty is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

2.2 KYOTO PROTOCOL

The Kyoto Protocol is an international treaty among industrialised nations that sets mandatory limits on GHG emissions. The purpose of the Kyoto Protocol is to even out human-generated emissions at a level that will not inflict further harm on the atmosphere. There are currently 192 Parties to the Protocol. The Protocol is overseen by UNFCCC.

The Convention divides countries into three main groups. Annex 1 countries include industrialised countries. Annex 2 countries are developed countries that provide financial support for developing countries to undertake emission reduction projects. Non-Annex 1 countries are developing countries and do not have specific emission restraints.

2.3 COP 21 PARIS AGREEMENT

An historic agreement to combat climate change towards a low carbon, resilient and sustainable future was agreed by 165 nation in Paris in December 2015. The Paris Agreement confirms the irreversible transition to a low carbon, safer and healthier world.

The COP 21 Paris Agreement's main aim is to keep the global temperature rise this century well below 2 degrees Celsius and to drive efforts to limit the temperature increase even further to 1.5 degrees Celsius above pre-industrial levels.

2.4 SOUTH AFRICAN NATIONAL CLIMATE CHANGE RESPONSE WHITE PAPER

The South African National Climate Change Response White Paper (White Paper), published by the Department of Environmental Affairs (DEA, 2011), prioritises both climate change mitigation and adaptation in moving towards a climate-resilient and lower-carbon economy and society.

The climate change response objectives are to:

- Make a fair contribution to the global effort to achieve the stabilisation of greenhouse gas concentrations in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate system.
- Effectively adapt to and manage unavoidable and potential damaging climate change impacts through interventions that build and sustain South Africa's social, economic and environmental resilience and emergency response capacity.

2.5 CLIMATE CHANGE BILL

On 8 June 2018 the Climate Change Bill (GG No. 41689, Notice 580) was published for public comment.

The purpose of the Bill is to communicate and implement an effective nationally determined climate change response, including mitigation and adaptation actions, that represents South Africa's fair contribution to the global climate change response.

The objectives of the Bill are to:

- Provide for a coordinated and integrated response to climate change and its impacts by all spheres of government in accordance with the principles of cooperative governance.
- Provide for the effective management of inevitable climate change impacts through enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to building social, economic, and environmental resilience and an adequate national adaptation response in the context of the global climate change response.
- Make a fair contribution to the global effort to stabilise greenhouse gas concentrations in the atmosphere at a level that avoids dangerous anthropogenic interference with the climate system within a timeframe and in a manner that enables economic, employment, social and environmental development to proceed in a sustainable manner.

2.6 GREENHOUSE GAS REGULATIONS

On 3 April 2017 the National Greenhouse Gas Emission Reporting Regulations (GG No. 40762, Notice 275) in terms of NEMAQA were published.

The purpose of the regulations is to introduce a single national greenhouse gas (GHG) reporting system, which will be used to inform policy formulation and help South Africa to meet its international obligations such as targets set under the United Nations Framework Convention on Climate Change. In addition, the regulations are intended to facilitate the establishment and maintenance of a National Greenhouse Gas Inventory.

In terms of the regulations, organisations engaging in the following activities are considered to be data providers and will be legally required to report on their GHG emissions:

- Energy – fuel combustion activities, fugitive emission from fuels and carbon dioxide transport and storage.
- Industrial processes and product use – mineral industry, chemical industry, metal industry, non-energy products from fuels and solvents use, electronics industry, product uses as substitutes for ozone depleting substances, other product manufacture and use and other.
- Agriculture, forestry and other land use – livestock, land, aggregate source and non-CO_2 emission sources on land and other.
- Waste sector – solid waste disposal, biological treatment of solid waste, incineration and open burning of waste and wastewater treatment and discharge.

The regulations state that data providers are required to submit the greenhouse gas emissions and activity data as set out in the Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry, for each of the relevant greenhouse gases and emission sources, for all of its facilities for the preceding calendar year, to the competent authority by 31 March of each year.

On 21 July 2017, the Minister of Environmental Affairs, published the Declaration of Greenhouse Gases as Priority Air Pollutants (GG 40996, Notice 710) and the National Pollution Prevention Plans Regulations (GG 40996, Notice 712).

The regulations declares the following six greenhouse gases as priority air pollutants:

- Carbon dioxide (CO2)
- Methane (CH4)
- Nitrous oxide (N2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF6)

The regulations further stipulate that the following entities will be required to submit Pollution Prevention Plans:

- An entity that emit more than 0.1 Megatonnes annually of the declared greenhouse gases, measured in carbon dioxide equivalent (CO_2e)
- An entity undertaking a production process, as a primary activity, as set out in Annexure A of the Declaration of Greenhouse Gases as Priority Air Pollutants

Companies that are liable to submit Pollution Prevention Plans, will need to submit the plans within five months after the promulgation of the regulations. Companies are further required to submit an annual progress report by the 31 March, for the preceding calendar year.

The list of production processes as set out in Annexure A, include:

- Coal mining
- Production and/or refining of crude oil
- Production and/or processing of natural gas
- Production of liquid fuels from coal or gas
- Cement production

- Glass production
- Ammonia production
- Nitric acid production
- Carbon black production
- Iron and steel production
- Ferro-alloys production
- Aluminium production
- Polymers production
- Pulp and paper production
- Electricity production (combustion of fossil fuels, excluding the use of back-up generators)

2.7 CLIMATE CHANGE MITIGATION AND ADAPTATION

2.7.1 Draft National Climate Change Adaptation Strategies

On 6 May 2019 the Draft National Climate Change Adaptation Strategy (GG No. 42446, Notice 644) (NCCAS) was published. The NCCAS serves as South Africa's National Adaptation Plan and fulfils South Africa's commitment to its international obligations as outlined in the Paris Agreement under the UNFCCC. The NCCAS will be used as the basis for meeting South Africa's obligations in terms of the adaptation commitments outlined in the National Determined Contributions.

The NCCAS provides a common vision of climate change adaptation and climate resilience for the country and outlines priority areas for achieving this vision.

2.7.2 Mpumalanga Province Climate Change Adaptation Strategies

The Department of Environmental Affairs (DEA), in partnership with Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) developed the Mpumalanga Climate Change Adaptation Strategy Report (2015). The report investigated climate change vulnerabilities within the Province, identified priority sectors and recommended adaptation measures that can build adaptive capacity in the relevant sectors.

2.7.3 Nkangala District Municipality Climate Change Vulnerability Assessment and Response Plan

Nkangala District Municipality's Climate Change Vulnerability Assessment and Response Plan (2018) was developed in partnership with DEA and GIZ, through the Local Government Climate Change Support Program. The plan identified key climate change vulnerabilities, as well as climate change responses to address the vulnerabilities.

3. BACKGROUND ASSESSMENT

3.1 PROCESS DESCRIPTION

DCM West is currently mining 2 and 4 Seam via bord and pillar underground mining method on the western portion of their mining right area.

In bord and pillar mining parallel roads are developed in the mining direction. Perpendicular roads, called splits, are developed at predetermined intervals to the parallel roads. These roads interlink, creating pillars. The roads mined concurrently are determined by the size of the pillars required to support the overburden above, the coal seam and the length of the production equipment trailing cables.

Pillar size is determined by the safety factor formula, which is the pillar strength divided by the pillar load (mass of the overburden carried by the pillar). Panel design is based on either the Probability of Failure (PoF) or the Safety Factor (SF) design criterion.

Run off Mine (ROM) material is transported by means of shuttle cars to feeder breakers, where ROM is sized to-100mm. Sectional conveyors direct ROM material to a man line conveyer, which transports coal to a ROM stockpile on surface.

ROM is fed into the Bivitech screen, which separates to the sizes of -6mm, (-80+6mm) and +80mm. The -6mm material is bypassed as Bivitech duff product. The +80mm fraction is then fed to a roller crusher which crushes down to -50mm.

Crusher product combines with the -80+6mm fraction feed to plant. Feed to plant is further classified by a sizing screen, where the -50+25mm material is fed to the Dense Media Separation (DMS) plant. The -25mm material is then deslimed at 0.63mm, where the -25+0.63mm is beneficiated with the DMC and fines with the spirals. Final plant product is screened and classified into large nuts, small nuts, jumbo peas, peas and duff. DCM West's current market include the South African ferrochrome and charring industries.

DCM West proposes to further mine 4 Seam, which will extend the LOM to 23 years. The proposed expansion will result in ROM increasing to approximately 150 000 tonnes per month over the subsequent 15 years. The target market for the supplementary 4 Seam coal is the export market, including foreign power generation companies and international coal traders.

An additional discard dump facility is required to accommodate the disposal of the discard and slurry for the LOM. The construction of a conveyor belt and associated service road are required to transport beneficiated coal from DCM West to DCM East. The construction phase of the proposed project is estimated at approximately 18 months.

The development of the discard dump will entail the removal of topsoil and stockpiling for use during the rehabilitation phase. Following the removal of the topsoil, the barrier system will be constructed. The discar dump extension will cater for both slurry and discard and will be viable for the LOM. The conveyor belt will entail the construction, installation and commissioning of a 7.5km overland conveyor to link mining operations from DCM West to DCM East. A service road of approximately 3.9km long and 2.5m wide will be constructed along the conveyor route.

On completion of construction work, the site will be rehabilitated. The rehabilitation activities will include:

- Removal of excess building material and waste.
- Repairing any damage caused by construction activities.
- Rehabilitating the area affected by temporary access roads.
- Reinstating existing roads.
- Replacing topsoil and planting indigenous vegetation where necessary.

Figure 2 and **Figure 3** contains the proposed expansion's site layout plans for DCM West, while **Figure 4** illustrates the process flow diagram of the DMS plant.

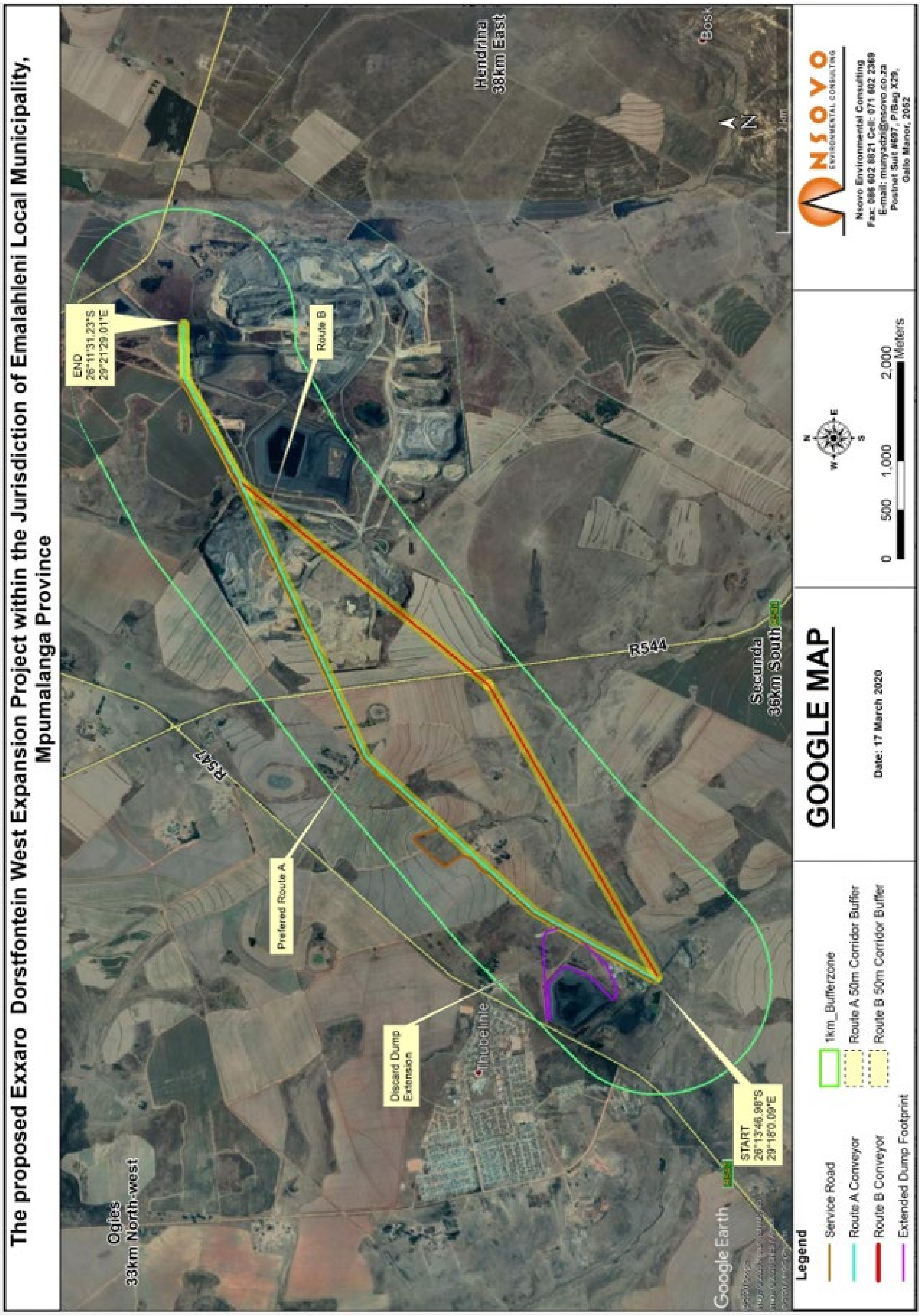

Figure 2: Dorstfontein Coal Mine West Expansion Project Site Plan

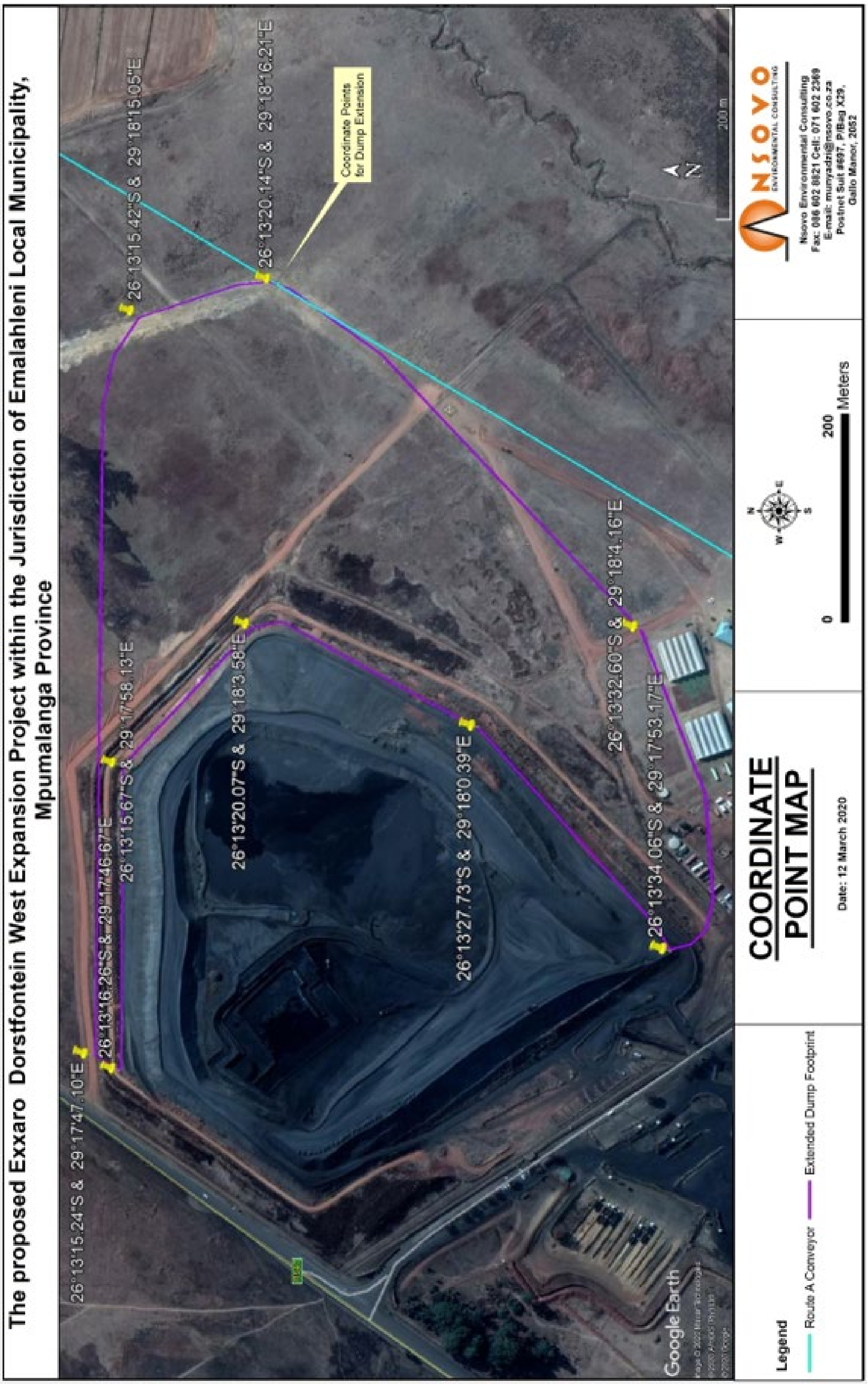

Figure 3: Dorstfontein Coal Mine West Expansion Project Discard Dump Site Plan

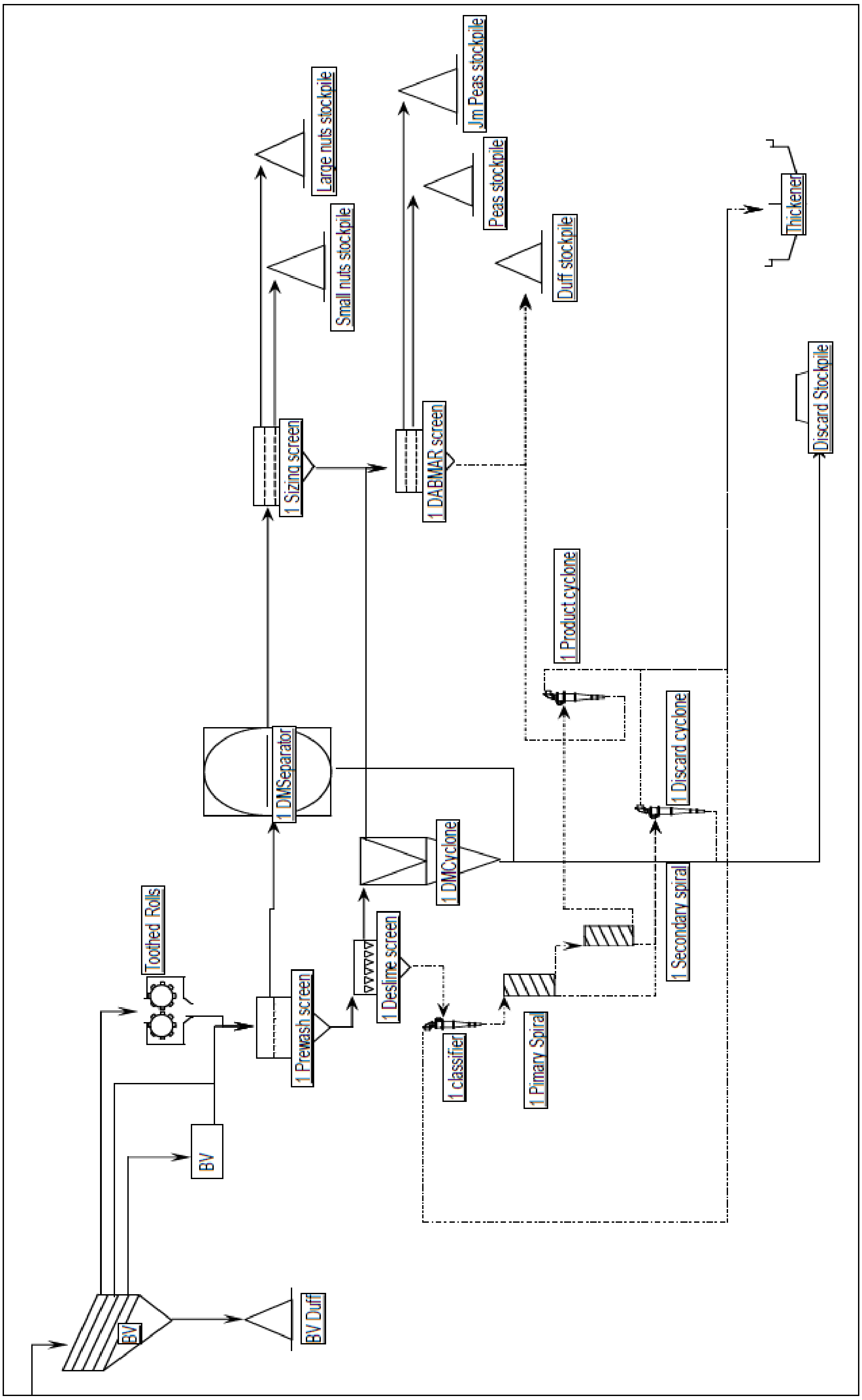

Figure 4: Dorstfontein Coal Mine West DMS Plant Process Flow Diagram

3.2 EMISSION INVENTORY

The boundary for the DCM West climate change impact assessment was set according to *ISO/SANS 14064 Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals* (2006). The GHG inventory for the project includes the current operations and the proposed expansion and is based on the operational control approach. The construction and rehabilitation phases have been excluded due to a lack of available data.

Setting of the operational boundary includes the identification of emissions associated with the operations and the classification of the emissions into categories. *ISO/SANS 14064 Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals* (2006) defines the categories as Direct GHG Emissions, Electricity Indirect GHG Emissions and Other Indirect GHG Emissions. The Greenhouse Gas Protocol's *A Corporate Accounting and Reporting Standard (Revised Edition)* (2015) refers to the categories as Scope1, Scope 2 and Scope 3 emissions (see **Figure 5**).

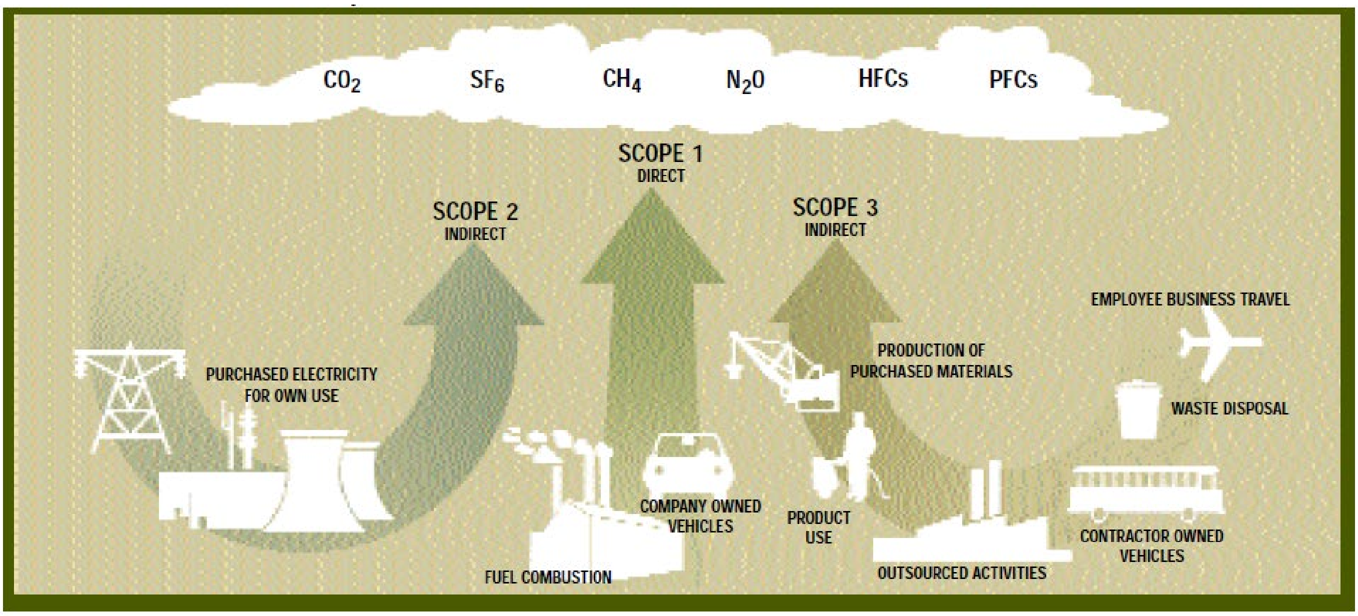

Figure 5: Overview of GHG Scopes and Emissions

Direct GHG Emissions are emissions from sources that are owned or controlled by DCM West. Electricity Indirect GHG Emissions are emissions from purchased electricity consumed by the mine. Other Indirect GHG Emissions are the consequence of activities within the operational boundary, which occur from sources not owned or controlled by the mine.

DCM West's GHG inventory included all sources that were practically and economically feasible to assess. GHG emission sources are summarised in **Table 1**:

Table 1: Dorstfontein Coal Mine West GHG Emission Sources

Scope 1 – Direct Emissions	Scope 2 – Energy Indirect Emissions	Scope 3 – Other Indirect Emissions
▪ Emissions from the combustion of diesel – mobile and stationary	▪ Emissions from purchased electricity	▪ None
▪ Fugitive emissions – coal mining		
▪ Fugitive emissions – post-mining		

3.3 EMISSION FACTORS

Default emission factors, as set out in the Intergovernmental Panel on Climate Change (IPCC) *Guidelines for National Greenhouse Gas Inventories* (2006) and the Department of Environmental Affairs' *Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry* (2017) were used for the purpose of calculating GHG emissions inventory. The electricity emission factor was sourced from Eskom's *Integrated Report* (2018).

Emissions were reported in carbon dioxide equivalent (CO_2e) and measured in tonnes (tCO_2e). The global warming potential (GWP) of all GHGs were considered and the South African equivalent calorific value for all materials and fuels were determined.

The GHG inventory for the current operations are summarised in **Table 2** and **Table 3**. The proposed expansion project's GHG inventory is included in **Table 4** and **Table 5**.

Table 2: Dorstfontein Coal Mine West Current Operations – Scope 1 GHG Emission Factors and Rates

Emission Source	**Emission Factors**	**Emission Rates (tCO_2e)**
		Annual Operations
Diesel – Stationary[1]	2.8326 tCO_2e/tonne	78.42
Diesel – Mobile[2]	3.1494 tCO_2e/tonne	535.98
Fugitive CH_4 Emissions – Coal Mining[3]	0.77 m^3 CH_4/tonne	658.25
Fugitive CH_4 Emissions – Post-mining[3]	0.18 m^3 CH_4/tonne	153.88
Fugitive CO_2 Emissions – Coal Mining[4]	0.077 m^3 CO_2/tonne	180.01
Fugitive CO_2 Emissions – Post-mining[4]	0.018 m^3 CO_2/tonne	42.08
Total	-	**1 648.61**

Notes:

tCO_2e	:	Tonne carbon dioxide equivalent (tCO_2e).
1	:	27.69 tonnes of stationary diesel combusted during 2019. CO_2 emission factor: 74 100kg/TJ, CH_4 emission factor: 3kg/TJ and N_2O emission factor: 0.6kg/TJ. GWP CO_2: 1 tCO_2e/tCO_2, CH_4: 23 tCO_2e/tCH_4 and N_2O: 296 tCO_2e/tN_2O Calorific value of diesel: 0.0381 TJ/t. Density of diesel: 0.845 kg/l Default Emission Factors for Diesel, Stationary Combustion in the Energy Industry as set out in the IPCC Guidelines (2006).
2	:	170.19 tonnes of mobile diesel utilised during 2019. CO_2 emission factor: 74 100kg/TJ, CH_4 emission factor: 4.15kg/TJ and N_2O emission factor: 28.6kg/TJ. GWP CO_2: 1 tCO_2e/tCO_2, CH_4: 23 tCO_2e/tCH_4 and N_2O: 296 tCO_2e/tN_2O Calorific value of diesel: 0.0381 TJ/t. Density of diesel: 0.845 kg/l Default Emission Factors for Diesel, Mobile Combustion as set out in the IPCC Guidelines (2006).
3	:	1 275 919 tonnes of coal produced during 2019. Emission factor in m^3/tonne Methane conversion factor 0.67E-06 Gg/m^3. Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry. TG-2016.1, April 2017. Table B.1.
4	:	1 275 919 tonnes of coal produced during 2019. Emission factor in m^3/tonne Carbon Dioxide conversion factor 1.83 kg m-3. Gg/m^3. Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry. TG-2016.1, April 2017. Table B.1.

Table 3: Dorstfontein Coal Mine West Current Operations - Scope 2 GHG Emission Factor and Rate

Emission Source	Emission Factor	Emission Rate (tCO_2e)
		Annual Operations
Purchased Electricity[1]	0.97 tCO_2e/MWh	14 538.27

Notes:

tCO_2e	:	Tonne carbon dioxide equivalent (tCO_2e).
1	:	Electricity Emission Factor 1 for Eskom as per the Eskom Integrated Report 2018. 14 987.91 MWh electricity consumed during 2019.

Table 4: Dorstfontein Coal Mine West Expansion Project – Scope 1 GHG Emission Factors and Rates

Emission Source	Emission Factors	Emission Rates (tCO_2e)	
		Expansion Project LOM	Expansion Project Annual Average
Diesel – Stationary[1]	2.8326 tCO_2e/tonne	0.00	0.00
Diesel – Mobile[2]	3.1494 tCO_2e/tonne	34 859.36	1 515.62
Fugitive CH_4 Emissions – Coal Mining[3]	0.77 m^3 CH_4/tonne	22 446.81	975.95
Fugitive CH_4 Emissions – Post-mining[3]	0.18 m^3 CH_4/tonne	5 247.31	228.14
Fugitive CO_2 Emissions – Coal Mining[4]	0.077 m^3 CO_2/tonne	6 138.44	266.89
Fugitive CO_2 Emissions – Post-mining[4]	0.018 m^3 CO_2/tonne	1 434.96	62.39
Total	-	**70 126.87**	**3 048.99**

Notes:

tCO_2e : Tonne carbon dioxide equivalent (tCO_2e).

1 : 0 tonnes of stationary diesel combusted during LOM.
CO_2 emission factor: 74 100kg/TJ, CH_4 emission factor: 3kg/TJ and N_2O emission factor: 0.6kg/TJ.
GWP CO_2: 1 tCO_2e/tCO_2, CH_4: 23 tCO_2e/tCH_4 and N_2O: 296 tCO_2e/tN_2O
Calorific value of diesel: 0.0381 TJ/t.
Density of diesel: 0.845 kg/l
Default Emission Factors for Diesel, Stationary Combustion in the Energy Industry as set out in the IPCC Guidelines (2006).

2 : 11 068.62 tonnes of mobile diesel utilized during LOM.
CO_2 emission factor: 74 100kg/TJ, CH_4 emission factor: 4.15kg/TJ and N_2O emission factor: 28.6kg/TJ.
GWP CO_2: 1 tCO_2e/tCO_2, CH_4: 23 tCO_2e/tCH_4 and N_2O: 296 tCO_2e/tN_2O
Calorific value of diesel: 0.0381 TJ/t.
Density of diesel: 0.845 kg/l
Default Emission Factors for Diesel, Mobile Combustion as set out in the IPCC Guidelines (2006).

3 : 43 510 000 tonnes of coal produced during LOM.
Emission factor in m^3/tonne
Methane conversion factor 0.67E-06 Gg/m^3.
Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry. TG-2016.1, April 2017. Table B.1.

4 : 43 510 000 tonnes of coal produced during LOM.
Emission factor in m^3/tonne
Carbon Dioxide conversion factor 1.83 kg m-3. Gg/m^3.
Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry. TG-2016.1, April 2017. Table B.1.

Table 5: Dorstfontein Coal Mine West Expansion Project - Scope 2 GHG Emission Factor and Rate

Emission Source	Emission Factor	Emission Rates (tCO_2e)	
		Expansion Project LOM	Expansion Project Annual Average
Purchased Electricity[1]	0.97 tCO_2e/MWh	**169 000.93**	**7 347.87**

Notes:

tCO_2e : Tonne carbon dioxide equivalent (tCO_2e).

1 : Electricity Emission Factor 1 for Eskom as per the Eskom Integrated Report 2018.
174 227.76 MWh electricity consumed during LOM.

3.4 CLIMATE CHANGE FRAMEWORK

3.4.1 Global Overview

Human influence has become a principal agent of change on the planet, often termed the Anthropocene. Global-level rates of human-driven change far exceed the rates of change driven by geophysical or biosphere forces that have altered the earth system trajectory in the past.

According to the UN Environment *Global Environmental Outlook – GEO6* (2019) climate change is a priority issue affecting both human systems and natural systems, including air, biological diversity, freshwater, oceans and land. Historical and ongoing GHG emissions have committed the world to an extended period of climate change, which is leading to global warming of air and ocean; rising sea-levels; melting glaciers, permafrost and Arctic sea ice; changes in carbon, biogeochemical and global water cycles; food security crises; fresh water scarcity and more frequent and extreme weather events. Higher atmospheric concentrations of carbon dioxide also lead to ocean acidification and affect the composition, structure and functionality of ecosystems. This makes climate change a global driver of environmental, social, health and economic impact and heightened society-wide risks.

A carbon budget can be defined as a tolerable quantity of GHG emissions that can be emitted in total over a specified time (Worldwide Fund South Africa, 2014). It therefore constitutes a limited resource.

The Intergovernmental Panel on Climate Change (IPCC) *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report* (2014) noted a global CO_2 emissions limit of 2 900 Gt CO_2 at a probability of 66%. By 2011 approximately 1 900 Gt CO_2 had already been emitted, leaving a remaining budget of 1 000 Gt CO_2.

The IPCC *Special Report on Global Warming of 1.5°C* (2018) suggests a remaining carbon budget of about 420 Gt CO_2 for a 66% change of limiting warming to 1.5°C and a budget of 580 Gt CO_2 for a 50% change. The remaining budget is defined as cumulative CO_2 emission from the start of 2018 to the time of reaching net zero global emission. It implies that CO_2 emission reach carbon neutrality in about 30 years for a budget of 580 Gt CO_2 and 20 years for 420 Gt CO_2.

3.4.2 South African Context

According to the Department of Environmental Affairs' *South Africa's Third National Communication Under the United Nations Framework Convention on Climate Change* (2018), climate change is projected to impact drastically on the African continent during the 21st century under low mitigation futures. Temperatures are projected to rise rapidly, at 1.5 to 2 times the global rate of temperature increase. The Southern African region is likely to become generally drier under enhanced anthropogenic forcing.

The changing African climate is likely to have a range of impacts across the continent, including impacts on energy demand (in terms of achieving human comfort within buildings and factories), agriculture (e.g. reductions of yield in the maize crop under higher temperatures and reduced soil moisture), livestock production (e.g. higher cattle mortality as a result of oppressive temperatures), water security (through reduced rainfall and enhanced evapotranspiration) and infrastructure (mostly through the occurrence of more large-scale floods in particular regions).

Climate change is not to take place only through changes in average temperatures and rainfall patterns, but also through changes in the attributes of extreme weather events. Over the southern African region, the more frequent occurrence of dry spells and droughts are likely to occur over most of the interior under low mitigation futures. Cut-off low related flood events are projected to occur less frequently over South Africa in response to a poleward displacement of the westerly wind regime. Some uncertainty surrounds the landfall of tropical cyclone tracks over southern Africa under climate change, but at least one study is indicative of more frequent landfall. Intense thunderstorms are plausible to occur more frequently over tropical and subtropical Africa in a generally warmer climate.

The Department of Environmental Affairs' *South Africa's Third Biennial Update Report to the United Nations Framework Convention on Climate Change* (2018), notes that South Africa's GHG emissions, excluding Forest and Other Land Use (FOLU), were 439 238 Gg CO_2e in 2000 and these increased by 101 616 Gg CO_2e (23.1%) by 2015. Net emissions (including FOLU) in 2015 were estimated at 512 383 Gg CO_2e. Emissions increased slowly over the 15-year period with a few small peaks in 2007, 2010 and 2013. Between 2000 and 2015 the average annual growth in net emissions was 1.27%.

The Energy sector was the largest contributor to South Africa's gross emissions in 2015, comprising 79.5% of total emissions. This was followed by the Agriculture, Forest and Other Land Use (AFOLU) sector (excl. FOLU) (9.2%), the Industrial Process and Product Use (IPPU) sector (7.7%) and the Waste sector (3.6%).

Figure 6 provides an overview of the National GHG Inventory for the period 2000 to 2015. **Figure 7** gives a sectoral contribution summary of the South African GHG emissions.

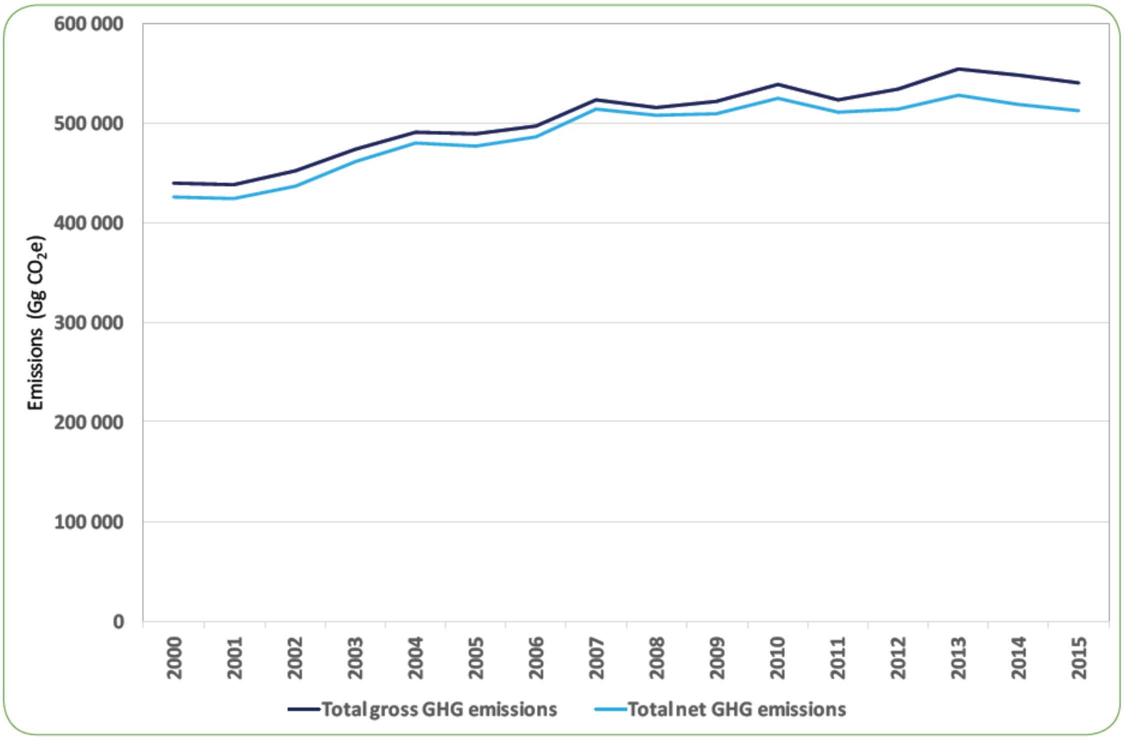

Figure 6: National GHG Inventory 2000 – 2015.

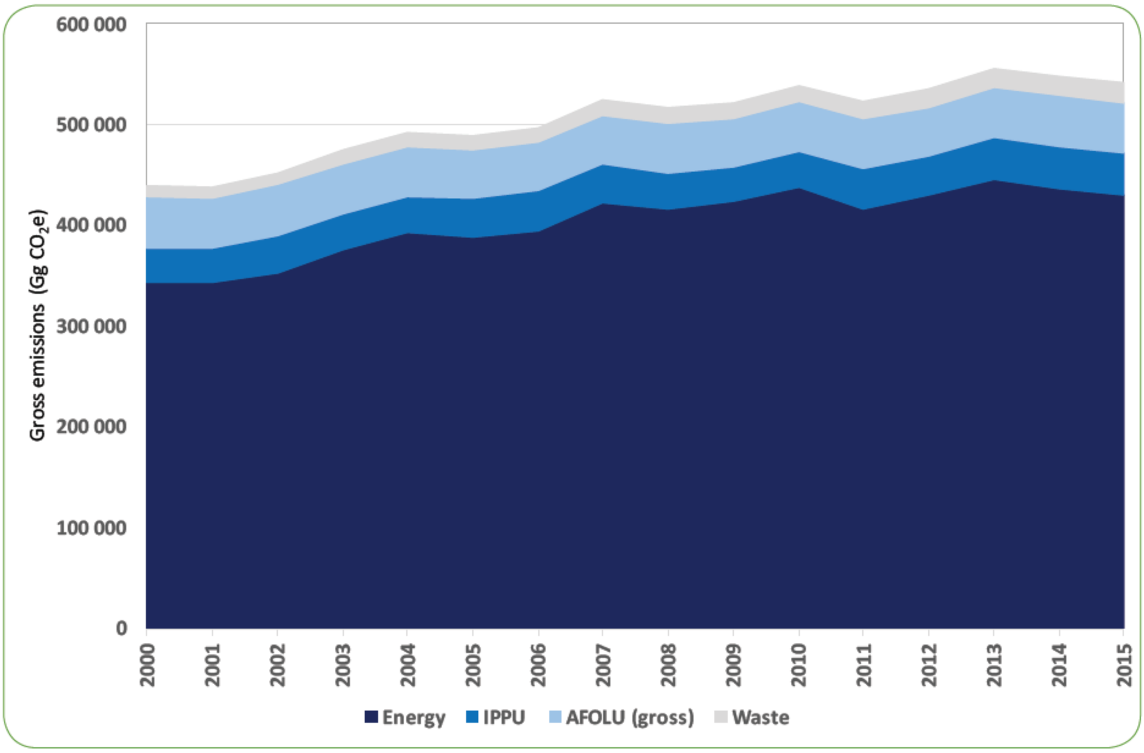

Figure 7: Sectoral Contribution Summary of the South African GHG emissions 2000 - 2015.

CO_2 gas is the largest contributor (85,0% - 84.2%) to South Africa's gross and net emissions. This is followed by CH_4 (9.4% in 2015) and then N_2O (4.5% in 2015). The contribution from CH_4 and N_2O declined between 2000 and 2015, while CO_2 and F-gases increased over the same period.

South Africa's emissions per capita increased from 9.93 t CO_2e per person in 2000 to 10.8 t CO_2e per person in 2007. Emissions then decline after 2010 from 10.7 t CO_2e per person to 9.8 t CO_2e per person.

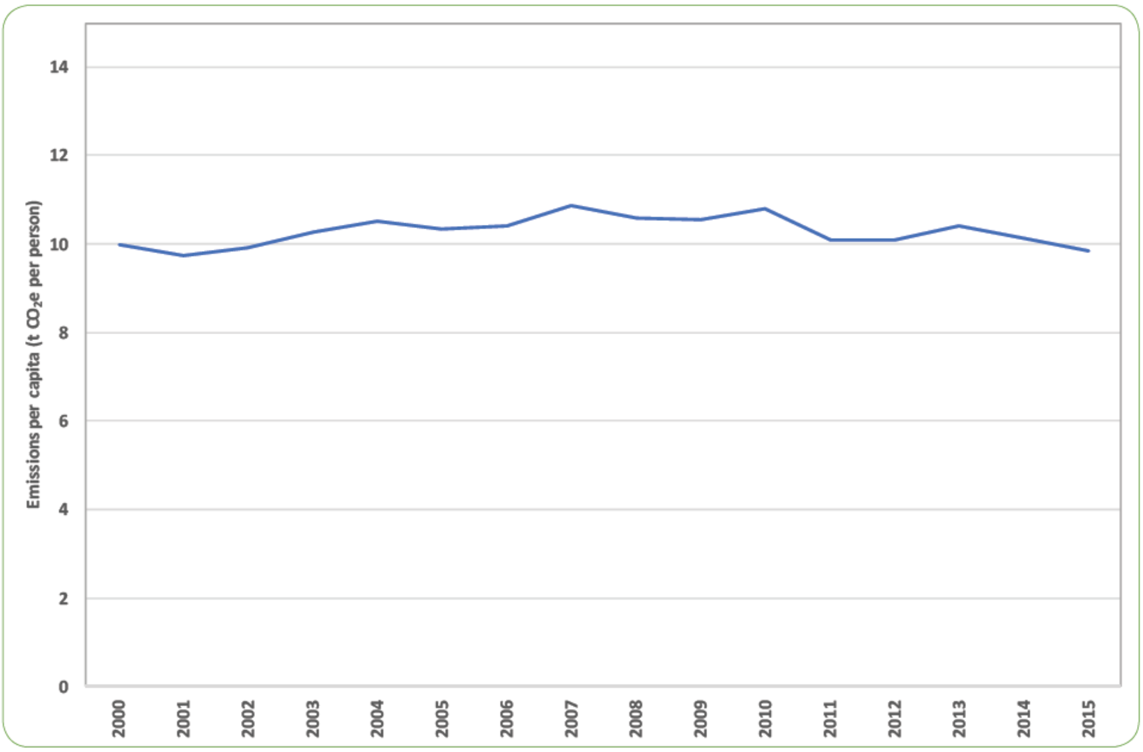

Figure 8: South Africa's GHG Emissions Per Capita 2000 – 2015.

The global carbon budget is a scares resource that needs to be divided fairly between countries. There is still no agreed method to allocate the global carbon budget between countries. The global carbon budget can be divided in many ways and include responsibility for historical emissions, state of economic development and the right to be able to develop to a certain level, size of population and per capita emissions, financial, technological and other capacity to reduce emissions.

In the absence of an international agreement on dividing up the global carbon budget, South Africa has derived its own total carbon allowance for the period 2010 to 2050. This has been done by adding up bottom up approaches to see how much emissions could be reduced, setting reduction targets against a baseline and deriving a "benchmark national emissions trajectory range." This is what is being referred to as the country's "carbon budget" – the overall quantity of emissions that should not be exceeded.

The Department of Environmental Affairs' *Long-Term Mitigation Scenarios* (LTMS) study (DEA, 2007) modelled "required by science", "current development path" and "growth without constraints" trajectories for South Africa's emissions. "Growth without constraints" projects South Africa's emissions as much as 42 GtCO_2e. The study indicated that South Africa's annual emission levels would still rise, before the country would be able to level off and then reduce them – a "peak, plateau and decline" trajectory. The rise in emissions before peaking is due to some effects which could not be reversed and which would increase emissions in the shorter term, the time lag needed to put low-carbon initiatives in place, the need for South Africa to extend the benefits of development to all (including access to water and energy, housing and job creation).

In early 2010 South Africa made a voluntary, conditional commitment to the United Nation Framework Convention on Climate Change (UNFCCC) to cut emissions, informally referred to as our "Copenhagen commitment." It undertook emission reduction targets of 34% by 2020 and 42% by 2025 below an unspecified "business as usual" trajectory. It said this would allow emissions to "peak between 2020 and 2025, plateau for about a decade and decline in absolute terms thereafter." Holding to the assumptions made at the time of the Copenhagen commitment, the targets translate to total emissions of around 17 GtCO_2e.

We have seen the absolute amount of South Africa's carbon allowance creep up. After Copenhagen, LTMS calculations were to be revised to cater for higher emissions from coal-fired electricity supply plans which had not been factored in before. While the "growth without constraints" trajectory was modelled as a worst-case scenario, it was increasingly seen as the baseline against which the Copenhagen commitment cuts were to be made. One of the papers which informed the White Paper indicated that the "current proposed allowance (for 2010 – 2050) is in the region of 19 Gt CO2e." Some now argue that even "growth without constraints" is too low to be used as the "business as usual" trajectory, because reality has already diverged from its starting points.

This is the risk with a "carbon budget" derived from cuts below a baseline – the absolute budget expands or shrinks as the baseline is moved up or down.

Adopted in November 2011, the White Paper defines a "benchmark national GHG emissions trajectory range" with upper and lower limits. This translates into total emissions over the 40 years from 2010 to 2050 of between 15 and 23 Gt CO_2e. The upper limit of the "trajectory range" allows for a national emissions peak of 614 Mt CO_2e, plateauing from 2025 and declining from 2035. The upper limit holds the risk that some interests will take the upper limit as the target, rather than aiming as close as possible to the original LTMS-aligned line.

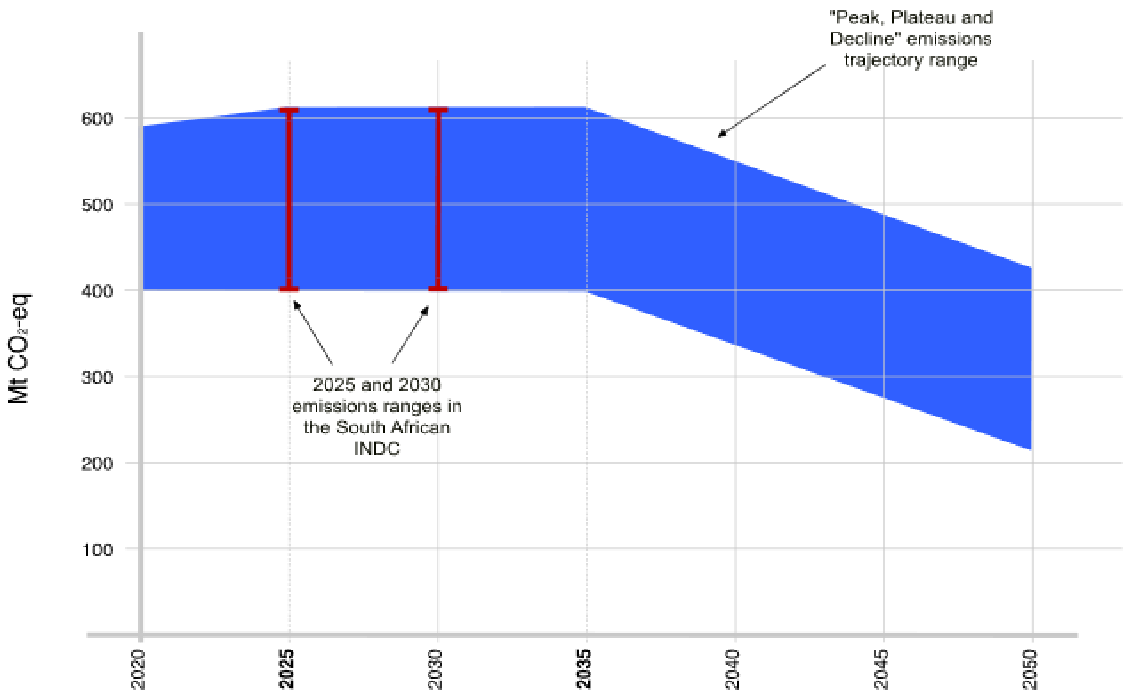

Figure 9: South Africa's GHG Emissions Trajectory Range.

WWF supports the White Paper for initiating real action to cut South Africa's emissions and recognising the overall framework of a carbon budget approach. However, WWF has some concerns regarding the "carbon budget" implied by the White Paper's emissions trajectory range:

- Emissions should not be allowed to exceed 550 Mt CO_2e at any time, which would happen if the upper range of the emissions trajectory is followed.
- Reduction in emissions in absolute terms should start from about 2025, rather than after 2035 as implied in the White Paper.

Delays in the date from which emissions begin to decline, makes later reductions both harder and more expensive to achieve. Furthermore, it will be more expensive to adapt to the ultimate impacts of climate change if these are more severe due to a low reduction effort. Work needs to be done to tighten up the very wide "benchmark range" into an indicative carbon budget the country is going to plan to remain within.

For the purpose of the climate change impact assessment South Africa's carbon budget was calculated based on a per capita basis. South Africa's current population is 59,0 million (Worldometers, 2020). The global populations according to Worldometers is 7,7 billion people. Based on a per capita basis, South Africa's carbon budget is calculated at approximately 4,410 Mt CO_2e, based on limiting warming to 1.5°C and a budget of 580 Gt CO_2 for a 50% change.

3.8.3 Regional and Local Synopsis

Climate Baseline

The NDM experiences a variable climate. Winters are generally cold and dry. Summers are mild to hot. The annual average maximum temperature varies between 22ºC and 34ºC at Middelburg and eMalahleni. Minimum temperatures fluctuate between -3ºC and 15ºC.

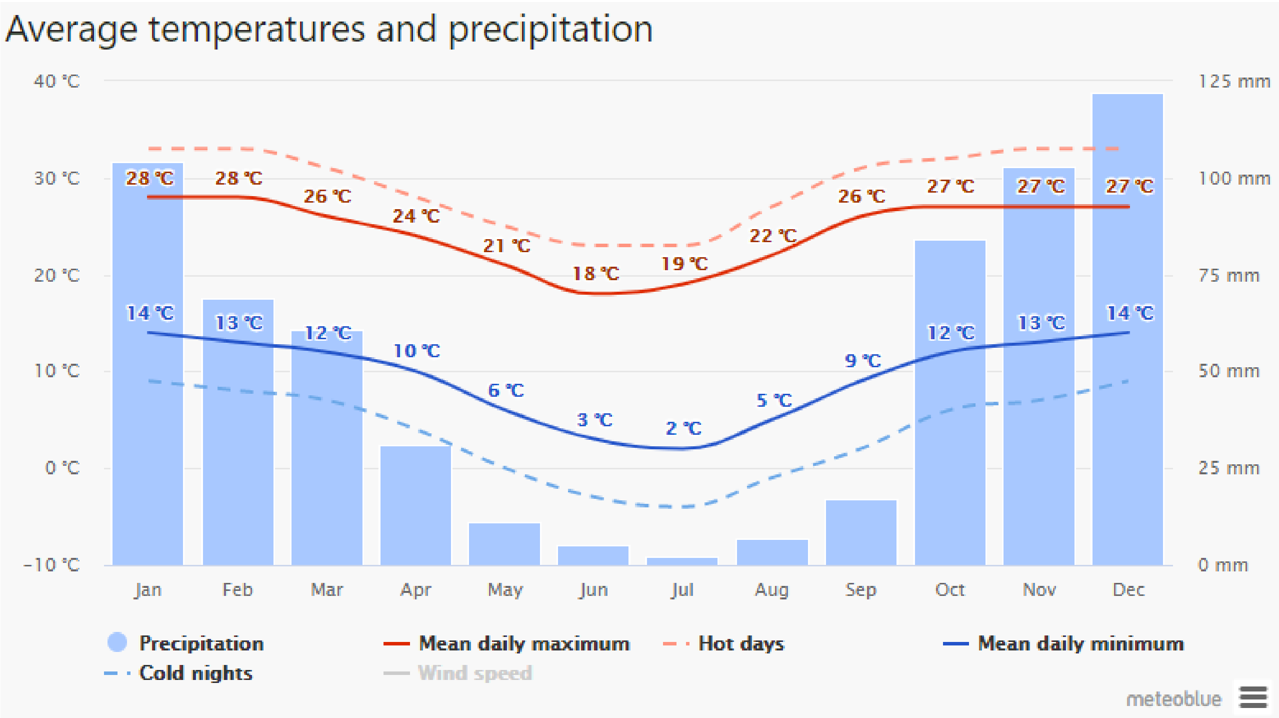

Figure 10: Ga-Nala (Kriel) Average Temperature and Precipitation for the Period 1989 – 2019

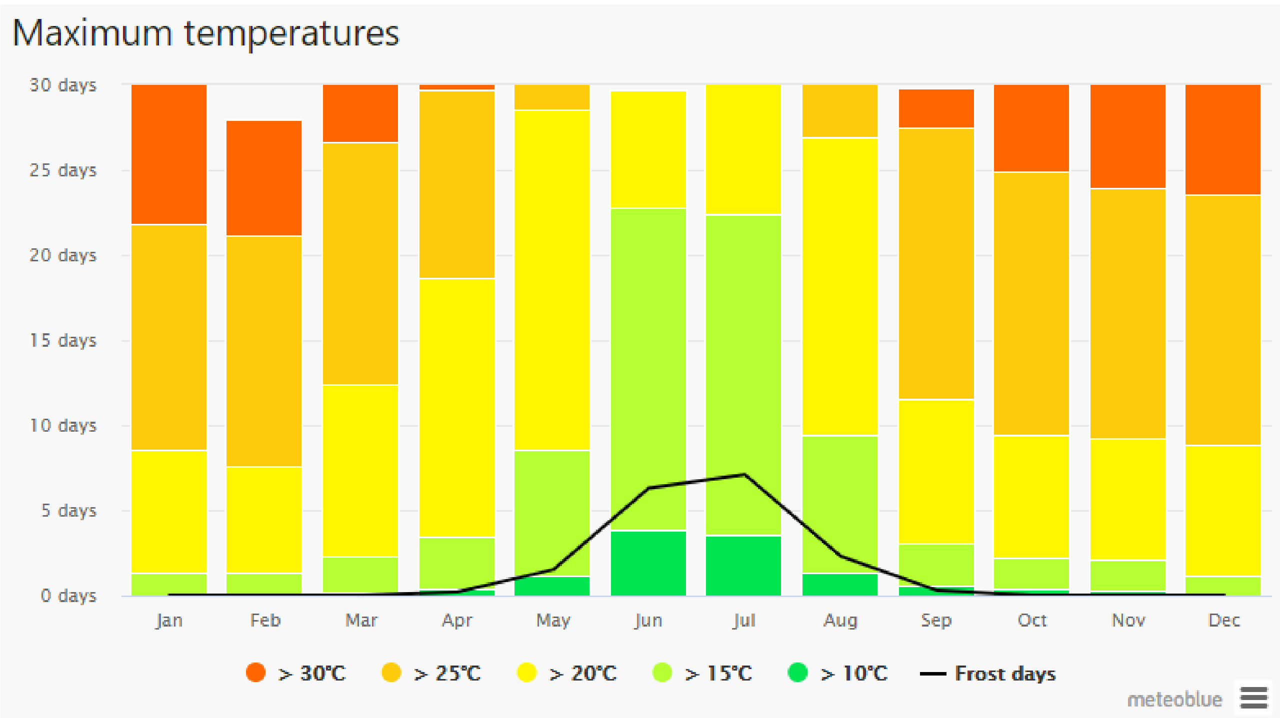

Figure 11: Ga-Nala (Kriel) Maximum Temperatures 1989 – 2019

Rainfall occurs predominantly in summer and autumn while the least amount of rain falls in the months of winter and spring. Summer temperatures are typically warmer, resulting in convection, with water vapour evaporation, and condensation completing the atmospheric water cycle processes. Precipitation in the form of showers and thundershowers are the products of condensation of atmospheric water vapour. Annual average rainfall varies from 680 mm at Middelburg to 378 mm at eMalahleni.

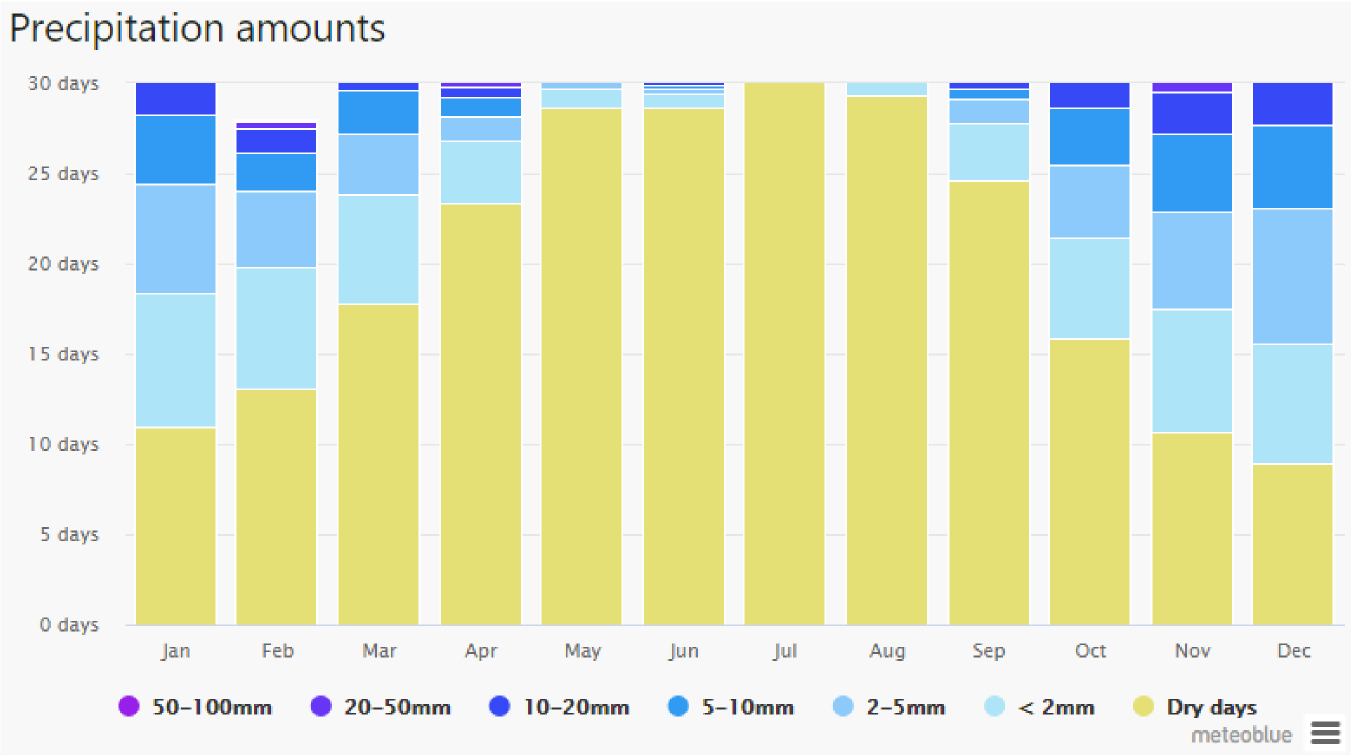

Figure 12: Ga-Nala (Kriel) Average Monthly Rainfall for the Period 1989 – 2019

Annual surface wind speeds vary between 2 m/s and 4 m/s, reaching highs of up to 10 m/s. Wind patterns vary across the District. Middelburg and eMalahleni reports predominantly south-easterly winds, followed by north-westerly winds. Ga-Nala (Kriel) records north-east and easterly winds followed by north-westerly winds.

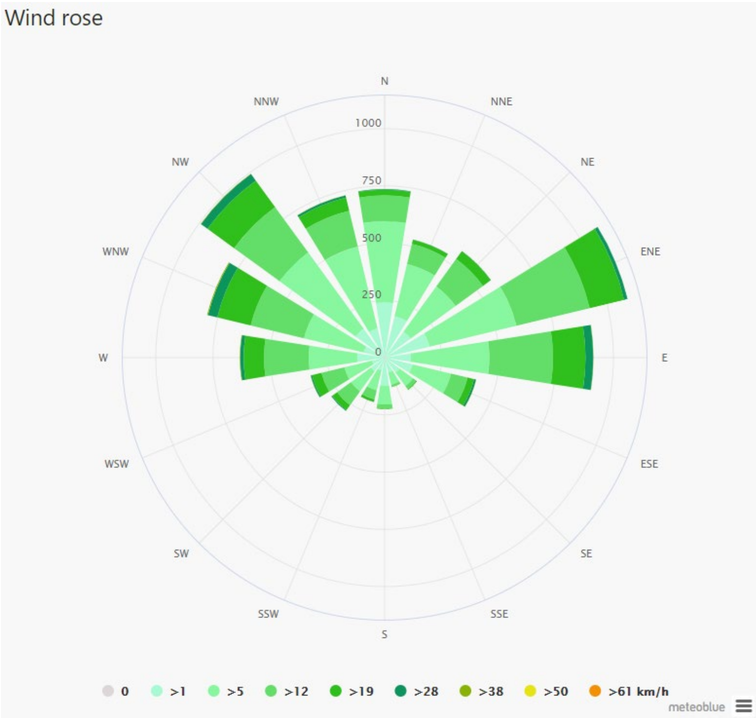

Figure 13: Ga-Nala (Kriel) Wind Rose for the Period 1989 – 2019

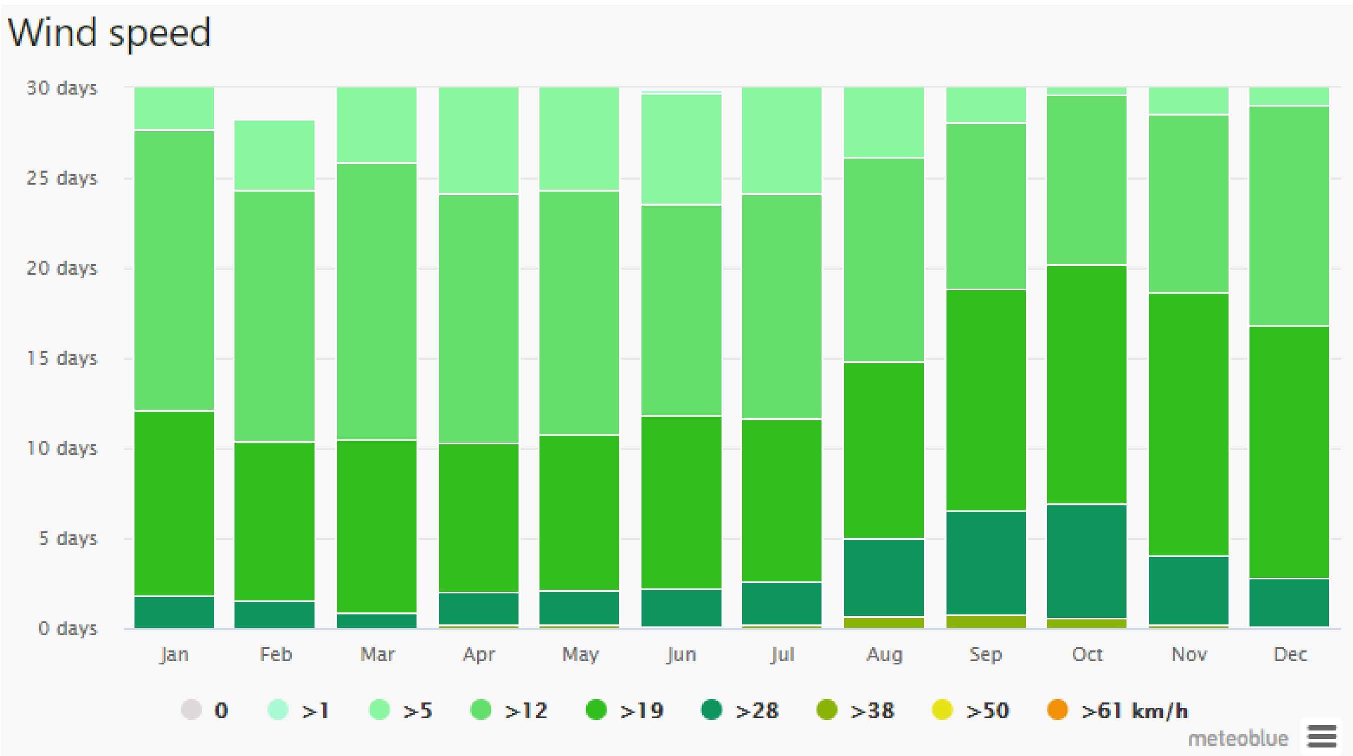

Figure 14: Ga-Nala (Kriel) Average Wind Speed for the Period 1989 – 2019

Future Climate Scenarios

A lack of stations with sufficiently long homogeneous temperature records complicate the identification of temperature trends over Mpumalanga. It is plausible though that the trends are strong, given the drastic temperature increases recorded over Gauteng to the west, Limpopo to the north and KwaZulu-Natal to the south. There is no evidence of statistically significant trends in annual rainfall or extreme daily precipitation events, but there are indications of spatially coherent increases in rainfall over the Highveld areas in the west and decreases over the Lowveld areas in the east.

The Department of Environmental Affairs' *South Africa's Third National Communication Under the United Nations Framework Convention on Climate Change* (2018), identified the following narratives for Mpumalanga:

Narrative 1: A Hot and Dry Future

Mpumalanga may plausibly experience a climate future that is significantly hotter and drier compared to the present-day climate. Under low mitigation, temperature increases as large as 2 °C by 2035 may occur, with associated drastic decreases in rainfall. Such a climate regime will also be associated with an increase in the frequency of occurrence of heat-wave days and high fire-danger days.

Narrative 2: A Warmer Future with Increased Rainfall

The main alternative narrative for Mpumalanga still implies significant increases in temperature, consistent with narrative 1. The main difference in this scenario is that rainfall totals increase under climate change, rather than to decrease. Such an increase may imply the more frequent occurrence of land-falling tropical lows over the Lowveld regions, with potentially significant impacts on tourism and infrastructure. Under such a scenario drought will not be such a major problem, but the increased occurrence of pests and pathogens may well pose an alternative set of challenges.

The Nkangala District Municipality drafted a *Climate Change Mitigation and Response Strategy* (CCMRS) in 2013. The CCMRS noted the key potential climatic changes within the NDM as set out in **Table 6** below:

Table 6: Key Potential Climate Changes for the Nkangala District Municipality.

Variable	Projected Change
Temperature	Average temperatures are expected to increase by 1°C to 3°C for the NDM region. Both maximum and minimum temperatures expected to increase.
Rainfall	Average rainfall is projected to decrease by 10-30% over the NDM regional, particularly during the summer rainfall season.
Extreme Events	Increases in the frequency and intensity of extreme events are projected. This includes more severe storms and flooding, as well as more severe droughts. Temperature-related extremes such as increases in the number and intensity of very hot days (maximum temperatures > 35°C) and extended very hot spells to increase.
Water Resources	As temperatures and evaporation increase, and rainfall decreases, already-scarce water resources will become further depleted. Existing problems of water quality will be further exacerbated by climate change.

It was found that the foreseen impacts of climate change on the NDM are generally negative and are likely to impact on, amongst others, the mining and energy, agriculture, and tourism sectors within the District.

The CCMRS proposed five key objectives to address the impacts of climate change and reduce carbon emissions:

- Mitigation
- Adaptation
- Education and Capacity-Building
- Climate Finance, Incentives and Taxation
- Monitoring, Reporting and Verification

3.5 CLIMATE CHANGE VULNERABILITY ASSESSMENT

3.5.1 Climate Risks

Mining is particularly vulnerable to climate change. It is inherently dependent on the natural environment and the industry's long-term viability. Strategic decision-making with regard to mining operations is directly tied to the location of the resource to be mined.

According to the Business for Social Responsibility's *Adapting to Climate Change: A Guide for the Mining Industry* (2011) changing climatic conditions will have both direct and indirect impacts on the mining sector:

Disturbance to Mine Infrastructure and Operations

Natural disasters and changes to precipitation patterns may damage infrastructure, requiring additional measures to ensure its stability. Existing assets may no longer be able to meet original design parameters and resource scarcity may constrain operations or increase costs.

Changing Access to Supply Chains and Distribution Routes

Increasing temperatures, greater precipitation and shifting storm patterns may inhibit transportation services that supply goods and services, carry personnel and move ore to facilities for processing and to ports for export.

Challenges to Worker Health and Safety Conditions

Natural disasters pose immediate health and safety risks, while warmer temperatures may affect worker recruitment, retention, safety and productivity by increasing risks of accidents, creating or exacerbating food and water shortages and causing greater prevalence of disease.

Challenges to Environmental Management and Mitigation

Changing temperature and rainfall patterns may affect assumptions about closure design and may increase financial liability and monitoring requirements. Companies may also be blamed for perceived impacts of subtle and cumulative climactic change.

Pressure Points with Community Relations

Mining companies often operate in areas with marginal physical environments, high poverty and significant social, political and economic challenges. Already vulnerable communities stand to suffer from environmental stressors such as drought, flood, rising temperatures and natural disasters. Resulting loss of livelihood and property, plus increased famine and disease, may worsen social conditions and contribute to civil unrest and political instability. Companies may face direct risks to operation over competition for resources such as water or energy and loss of legal license, or indirect risks such as loss of social license to operate and reputational damage from perceived human rights violations.

Exploration and Future Growth

Climate change may significantly shape opportunities for growth in the mining industry. Availability of key inputs such as water and energy will physically and financially constrain the establishment of new operations or make existing operations uneconomical. Investors and insurers will take into consideration climate risks and company performance (both in terms of mitigation and adaptation).

Table 7 summarises the potential climate risks identified based on the climate threats outlined in the **3.8.3 Regional and Local Synopsis – Future Climate Scenarios**.

Table 7: Dorstfontein Coal Mine West Potential Climate Risks

Variable	Potential Climate Risk
1. Increased temperature	1.1 Increased temperature, heatwaves and wildfires can pose a health risk to employees. 1.2 Increased temperature and heatwaves can influence productivity. 1.3 Increased temperature and heatwaves may present a risk of spontaneous combustion of stockpiles. 1.4 Wildfires may damage infrastructure and facilities.
2. Reduced rainfall	2.1 Water scarcity and drought can constrain exploration, processing and site rehabilitation. 2.2 Water scarcity and drought can lead to water conflicts with communities. 2.3 Water scarcity and draught may further exacerbate water quality. 2.4 Drought may result in increased dust generation and increased water requirements for dust suppression.
3. Extreme events	3.1 Floods, cyclones and storms may cause damage to infrastructure and facilities. 3.2 Floods, cyclones and storms may cause discharge of contaminated water into surrounding areas. 3.3 Floods, cyclones and storms may cause reduced accessibility due to flooding of roads.
4. Wind impacts	4.1 High wind speeds and gusts may damage infrastructure. 4.2 High wind speed and gusts may result in increased dust generation.

4. IMPACT ASSESSMENT

4.1 SIGNIFICANSE ANALYIS

4.1.1 Significance Analysis Approach

The assessment of impacts was largely based on the Department of Environmental Affairs and Tourism's *Sector Guidelines for Environmental Impact Assessment Regulations* (2010). The assessment consider impacts arising from the proposed project activities, both before and after the implementation of applicable mitigation measures.

For each predicted impact, criteria were applied to establish the significance of the impact based on the extent, duration, magnitude (intensity or severity) and probability of occurrence. Professional judgement was applied to ascribe a numerical rating for each criterion (see **Table 8**).

Table 8: Methodology for Determining the Significance of Potential Climate Change and Vulnerability Impacts

Status of Impact
The impacts are assessed as either having a: ▪ Negative effect (i.e. at a "cost" to the environment) ▪ Positive effect (i.e. a "benefit" to the environment) ▪ Neutral effect on the environment.
Extend of the Impact
(**1**) Site (site only) (**2**) Local (site boundary and immediate surrounds) (**3**) Regional (within the province or region) (**4**) National (**5**) International
Duration of the Impact
The length that the impact will last for: (**1**) Immediate (<1 year) (**2**) Short term (1-5 years) (**3**) Medium term (5-15 years) (**4**) Long term (ceases after the operational life span of the project) (**5**) Permanent
Magnitude of the Impact
The intensity or severity of the impact: (**0**) None (**2**) Minor (**4**) Low (**6**) Moderate (functions altered but continue) (**8**) High (functions temporarily cease) (**10**) Very high / Unsure (functions permanently cease)

Probability of Occurrence
The likelihood of the impact occurring: (**0**) None (the impact will not occur) (**1**) Improbable (probability very low due to design or experience) (**2**) Low probability (unlikely to occur) (**3**) Medium probability (distinct probability that the impact will occur) (**4**) High probability (most likely to occur) (**5**) Definite.

To determine the significance of an impact the sum of the extent (**E**), duration (**D**) and magnitude (**M**) is determined and multiplied by the probability (**P**) of the impact.

S = (E+D+M) x P

Depending on the numerical result, the impact's significance would be defined as either low, medium or high. These categories are provided in **Table 9**.

Table 9: Application of Significance Ratings.

Range	Significance	Criteria
< 30	Low	Where the impact will not have a direct influence on the decision to develop in the area.
30 – 60	Medium	Where the impact could influence the decision to develop in the area unless it is effectively mitigated.
> 60	High	Where the impact will have an influence on the decision process to develop in the area.

4.1.2 Significance Analysis Assessment

Table 10: Climate Change Significance Analysis – Current Operations and Expansion Project

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
Calculated GHG emissions inventory for current operations amounts to 0.0004% of South Africa's carbon budget (4,410 Mt CO_2e). The impact of GHG emissions from current coal mining and beneficiation operations was rated medium with or without mitigation measures.							
Current Operations – GHG Emissions							
Current coal mining and beneficiation operations.	No	Negative	5	5	2	5	Medium 60
	Yes	Negative	5	5	2	5	Medium 60
Mitigation Measures							

Mitigation will not alter the impacts of GHG emissions in terms of the extent, duration or probability of the project impact. The magnitude of the impact can however be reduced, notably by reducing the quantity of GHG emissions.

Mitigation strategies include (see **5.1 Recommendations** for detailed discussion):

- Optimisation of operational activities and logistics.
- Implementation of a fuel management strategy.
- Reduction in the amount of waste disposed to landfill and reuse of waste.
- Procurement of generators, which use biodiesel.
- Exploring alternative energy possibilities.
- Regular monitoring of fuel and energy.
- Identification of significant energy consuming equipment and opportunities where technical efficiencies can be applied.
- Annual GHGs emissions inventory review.
- Implementation of technology for the oxidation of ventilation air methane.

<table>
<tr><th rowspan="2">Issue</th><th rowspan="2">Corrective Measures</th><th colspan="5">Impact Rating Criteria</th><th rowspan="2">Significance</th></tr>
<tr><th>Nature</th><th>Extent</th><th>Duration</th><th>Magnitude</th><th>Probability</th></tr>
<tr><td colspan="8">The expansion project’s calculated GHG emissions inventory amounts to 0.0054% of South Africa’s carbon budget (4,410 Mt CO2e). The impact of GHG emissions from the expansion project was rated medium with or without mitigation measures.</td></tr>
<tr><td colspan="8">Expansion Project – GHG Emissions</td></tr>
<tr><td rowspan="2">Expansion project coal mining and beneficiation operations.</td><td>No</td><td>Negative</td><td>5</td><td>5</td><td>2</td><td>5</td><td>Medium 60</td></tr>
<tr><td>Yes</td><td>Negative</td><td>5</td><td>5</td><td>2</td><td>5</td><td>Medium 60</td></tr>
<tr><td colspan="8">Mitigation Measures</td></tr>
<tr><td colspan="8">Mitigation will not alter the impacts of GHG emissions in terms of the extent, duration or probability of the project impact. The magnitude of the impact can however be reduced, notably by reducing the quantity of GHG emissions.

Mitigation strategies include (see 5.1 Recommendations for detailed discussion):
Optimisation of operational activities and logistics.
Implementation of a fuel management strategy, which encourages more efficient use of plant and vehicles, planning, logistics, driver education and maintenance.
Reduction in the amount of waste disposed to landfill and reuse of waste, which will subsequently reduce the amount of vehicle movements and fuel usage.
Procurement of generators, which use biodiesel.
Exploring alternative energy possibilities.
Regular monitoring of fuel and energy.
Identification of significant energy consuming equipment and recognising opportunities where technical efficiencies in plant and equipment can be applied.
Annual GHGs emissions inventory review.
Implementation of a technology for the oxidation of ventilation air methane.
</td></tr>
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</table>

From the emissions inventory for the DCM West's current operations and expansion project the following observations can be made:

- A total GHG emission rate of 16 186.89 tCO_2e was calculated for the current operations. Scope 1 GHG emissions amounted to 1 648.61 tCO_2e (10.18%) and Scope 2 GHG emissions totalled 14 538.27 tCO_2e (89.82%).
- The expansion project's total GHG emission rate was calculated at 239 127.80 tCO_2e for the LOM. Scope 1 GHG emissions amounted to 70 126.87 tCO_2e (29.33%). Scope 2 GHG emissions totalled 169 000.93 tCO_2e (70.67%).

From the climate change significance analysis for DCM West's current operations and expansion project the following observations can be made:

- DCM West's calculated GHG emissions inventory for current operations amounts to 0.0004% of South Africa's carbon budget (4,410 Mt CO_2e). The magnitude of GHG emissions from the current operations is considered minor, as GHG emissions are less than 0.02% of the South Africa's carbon budget.
- The expansion project's calculated GHG emissions inventory amounts to 0.0054% of South Africa's carbon budget (4,410 Mt CO_2e). The magnitude of GHG emissions from the expansion project is considered minor, as GHG emissions are less than 0.02% of the South Africa's carbon budget.
- The impact of GHG emissions from current coal mining and beneficiation operations was rated medium with or without mitigation measures.
- The impact of GHG emissions from the expansion project was rated medium with or without mitigation measures.
- Mitigation will not alter the impacts of GHG emissions in terms of the extent, duration or probability of the project impact. The magnitude of the impact can however be reduced, notably by reducing the quantity of GHG emissions.

Table 11: Climate Vulnerability Significance Analysis – Current Operations and Expansion Project

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
The impacts of increased temperature on current operations and the expansion project were rated medium without and with mitigation measures.							
Current Operations and Expansion Project – Increased Temperature							
Increased temperature, heatwaves and wildfires can pose a health risk to employees.	No	Negative	3	4	4	4	Medium 44
	Yes	Negative	3	4	4	4	Medium 44
Mitigation Measures							
▪ The risk and management of heat related illnesses should be integrated in the Occupational Health and Safety Plans. ▪ Educating staff to recognise early symptoms of heat stress.							
Increased temperature and heatwaves can influence productivity.	No	Negative	5	4	4	4	Medium 52
	Yes	Negative	5	4	2	4	Medium 44
Mitigation Measures							
▪ Monitoring of temperature and humidity levels. ▪ Providing of adequate cooling and ventilation. ▪ Introducing systems to limit exposure to heat.							

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
Increased temperature and heatwaves may present a risk of spontaneous combustion of stockpiles.	No	Negative	2	4	4	4	Medium 40
	Yes	Negative	2	4	4	3	Medium 30
Mitigation Measures							
▪ Adequate monitoring, fire detection and suppression systems for the spontaneous combustion of coal stockpiles should be implemented.							
Wildfires may damage infrastructure and facilities.	No	Negative	2	4	4	4	Medium 40
	Yes	Negative	2	4	4	3	Medium 30
Mitigation Measures							
▪ The risk of wildfires in relation to infrastructure and facilities should be assessed. ▪ Adequate monitoring, fire detection and suppression systems for the spontaneous combustion of coal stockpiles should be implemented.							

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
The impact of water scarcity and draught on exploration, processing and site rehabilitation was rated high without mitigation and medium with mitigation. All other impacts related to reduced rainfall were rated medium without and with mitigation measures.							
Current Operations and Expansion Project – Reduced Rainfall							
Water scarcity and draught can constrain exploration, processing and site rehabilitation.	No	Negative	5	4	8	4	High 68
	Yes	Negative	5	4	6	4	Medium 60
Mitigation Measures							
▪ Regular monitoring of operational water requirements and available resources should be conducted. ▪ A contingency response plan should be developed in the event of short, medium or long-term water shortages. ▪ A water policy should be developed as to manage and minimise water usage, setting clear objectives and targets to improve efficiency.							
Water scarcity and draught can lead to water conflicts with communities.	No	Negative	2	4	4	4	Medium 40
	Yes	Negative	2	4	4	3	Medium 30
Mitigation Measures							
▪ Regular monitoring of operational water requirements and available resources should be conducted. ▪ A contingency response plan should be developed in the event of short, medium or long-term water shortages. ▪ A water policy should be developed as to manage and minimise water usage, setting clear objectives and targets to improve efficiency. ▪ Community participation should be considered with regards to water infrastructure and management.							

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
Water scarcity and draught may further exacerbate water quality.	No	Negative	2	4	4	4	Medium 40
	Yes	Negative	2	4	4	3	Medium 30
Mitigation Measures							
▪ Regular monitoring of water quality should be implemented. ▪ A contingency response plan should be developed in the event that water quality deteriorates.							
Draught may result in increased dust generation and increased water requirements for dust suppression.	No	Negative	2	4	4	4	Medium 40
	Yes	Negative	2	4	4	3	Medium 30
Mitigation Measures							
▪ Dust deposition monitoring should be performed. ▪ A contingency response plan should be developed for dust suppression in the event of dry spells and periods of elevated dust generation.							

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
The impacts of floods, cyclones and storms on infrastructure, facilities and reduced accessibility were rated high without mitigation and medium with mitigation. All other impacts related to extreme events were rated medium without and with mitigation measures.							
Current Operations and Expansion Project – Extreme Events							
Floods, cyclones and storms may cause damage to infrastructure and facilities.	No	Negative	5	4	8	4	High 68
	Yes	Negative	5	4	6	4	Medium 60
Mitigation Measures							
▪ A site-specific flood risk assessment should be conducted to identify areas vulnerable to flooding.							
Floods, cyclones and storms may cause discharge of contaminated water into surrounding areas.	No	Negative	2	4	6	4	Medium 48
	Yes	Negative	2	4	4	4	Medium 40
Mitigation Measures							
▪ A site-specific flood risk assessment should be conducted to identify areas vulnerable to flooding.							
Floods, cyclones and storms may cause reduced accessibility due to flooding of roads.	No	Negative	5	4	8	4	High 68
	Yes	Negative	5	4	6	4	Medium 60
Mitigation Measures							
▪ A risk assessment should be conducted to assess the flood risk in relation to key access roads. ▪ A contingency response plan should be developed should operations become inaccessibility due to floods.							

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
All impacts related to wind impacts were rated medium without and with mitigation measures.							
Current Operations and Expansion Project – Wind Impacts							
High wind speeds and gusts may damage infrastructure.	No	Negative	1	4	4	4	Medium 36
	Yes	Negative	1	4	4	4	Medium 36
Mitigation Measures							
▪ A continuous monitoring station should be installed to obtain site specific wind data. ▪ Regular maintenance checks for wind-related damage should be performed.							
High wind speeds and gusts may result in increased dust generation.	No	Negative	2	4	4	4	Medium 40
	Yes	Negative	2	4	4	4	Medium 40
Mitigation Measures							
▪ A continuous monitoring station should be installed to obtain site specific wind data. ▪ Regular maintenance checks for wind-related damage should be performed.							

From the climate vulnerability assessment for DCM West's current operations and expansion project the following observations can be made:

- Potential climate risks identified, based on the climate threat outline, include increased temperature, reduced rainfall, extreme events and wind impacts.
- The identified climate risks will have a direct and indirect impact on DCM West's current operations and expansion project.

From the climate vulnerability significance analysis for DCM West's current operations and expansion project the following observations can be made:

- Water scarcity and drought can constrain exploration, processing and site rehabilitation and has been assessed as highly significant without mitigation measures.
- Floods, cyclones and storms may cause damage to infrastructure and facilities and have been assessed as highly significant without mitigation measures.
- Floods, cyclones and storms may cause reduced accessibility due to flooding of roads and have been assessed as highly significant without mitigation measures.
- All other potential climate risks have been assessed as medium without and with mitigation measures

4.2 DISCUSSION

DCM West's markets include the South African ferrochrome and charring industries, as well as foreign power generation companies and international coal traders.

The Industrial Process and Product Use Sector contributed 41 882 Gg CO2e (7.7%) to the gross South African emissions in 2015. The main drivers are the Iron and steel industry and Ferroalloy Production emissions. DCM West's calculated GHG emissions inventory for current operations amounts to 0.0004% and the expansion project's inventory amounts to 0.0054% of South Africa's carbon budget (4,410 Mt CO_2e). The current operations and the expansion project are considered to have negligible impacts, as its GHG emissions inventory intensity ratings are less than 0.02%.

The global GHG inventory, according to the Global Carbon Budget 2018, is currently projected at 37.1 Gt CO_2e. Global energy-related CO_2 emissions grew 1.7% in 2018 to reach a historic high of 33.1 Gt CO_2e. While emissions from all fossil fuels increased, the power sector accounted for nearly two-thirds of emissions growth. Coal use in power alone surpassed 10 Gt CO_2e. The increase in emissions was driven by higher energy consumption resulting from a robust global economy, as well as from weather conditions in some parts of the world that led to increased energy demand for heating and cooling (*Global Energy & CO_2 Status Report*, The International Energy Agency 2019).

DCM West's GHG emissions although minor within the global context, will still contribute to global energy related GHG emissions. Due to the global scope and prolonged time frames of GHG emissions, DCM West's GHG emissions will contribute to anthropogenic climate change. Climate change is likely to be accelerated and extended as GHG emissions accumulate in the atmosphere.

Climate change, including temperature and precipitation shifts as well as more frequent and severe extreme weather events, could impact the mining operations. Climactic conditions could affect the stability and effectiveness of infrastructure and equipment, environmental protection, site rehabilitation practices and the availability of transportation routes. Climate change could also impact the stability and cost of water and energy supplies.

Warming temperatures could increase water scarcity, inhibiting water-dependent operations, complicating site rehabilitation and could bring the mine into direct conflict with communities for water resources. The extent to which DCM West avoids undermining communities, resilience to climate change, and even fortifies that resilience, will directly impact the reputation, social license to operate, and access to project financing.

DCM West should take a proactive approach to climate adaptation for the following reasons:

- The supply of critical inputs to mining processes, such as water and energy, is likely to face greater constraints.
- Employee health and safety will be put at risk by increases in communicable diseases, exposure to heat-related illnesses and the likelihood of accidents related to rising temperatures.
- Obtaining and maintaining a social license to operate will become more difficult in communities in which climate change exacerbates existing vulnerabilities and increased direct competition between the company and the community for resources.
- Increased physical and nonphysical risks will make project financing more difficult to secure.

5. EPILOGUE

5.1 RECOMMENDATIONS

Although mitigation will not alter the impacts of GHG emissions in terms of the extent, duration or probability of the project impact, the intensity of the impact can be reduced, notably by reducing the quantity of GHG emissions.

There are many ways to reduce GHG emissions from coal mining, which include basic mitigation strategies to specific tactics and actions.

Basic mitigation strategies include:

- Optimisation of operational activities and logistics.
- Implementation of a fuel management strategy, which encourages more efficient use of plant and vehicles, planning, logistics, driver education and maintenance.
- Reduction in the amount of waste disposed to landfill and reuse of waste, which will subsequently reduce the amount of vehicle movements and fuel usage.
- Procurement of generators, which use biodiesel.
- Exploring alternative energy possibilities.
- Regular monitoring of fuel and energy.
- Identification of significant energy consuming equipment and recognising opportunities where technical efficiencies in plant and equipment can be applied.
- Annual GHGs emissions inventory review.

According to a study conducted by the United States Environmental Protection Agency (USEPA), *Technical Options and Market Potential for Harnessing Ventilation Air Methane: An Optimisation Analysis* (2003), there are a number of technologies that may be applied for the oxidation of ventilation air methane (VAM). These can be divided into two broad categories: those that use VAM as the primary (or exclusive) source of fuel, and those that use another fuel source but also use VAM as an ancillary source. Primary VAM oxidation technologies include flow reversal reactors. Power projects that use VAM as feed air, but natural gas or coal as the primary fuel, are the purest examples of ancillary VAM oxidation technologies. In between these extremes are a number of lean fuel gas turbine technologies which may employ VAM as a primary fuel but depending on the VAM concentration, may require between 20 and 80% supplemental fuel. Methane concentrators, as the name indicates, offer a means for increasing VAM concentrations, and may play a role in enhancing the technical and economic potential for use of VAM in a number of technologies. In addition to these options, it may be possible for VAM to be used as a feedstock in the production of single celled proteins for animal feed supplements.

Flow Reversal Reactors

Flow reversal reactors may use up to 100% of all the methane from ventilation shafts, and the by-product, heat, may be used for the production of power or to satisfy local heating needs. These technologies employ the principle of regenerative heat exchange between a gas and a solid bed of heat exchange medium. Ventilation air flows into and through the reactor in one direction, its temperature increases until the methane is oxidized. Then the hot products of oxidation lose heat as they continue towards the far side of the bed, until the flow is automatically reversed. There are two flow reversal variants: thermal and catalytic reactors. Thermal reactors operate above the autoignition temperature of methane (1000 °C). Catalytic reactors reduce the autoignition temperature significantly. Both types of reactors produce heat which, through use of heat exchange technologies, may be transferred for local heating needs, or for the production of power in steam or gas turbines.

Ancillary Fuel Technologies

Ventilation air methane may be used as combustion air for power projects. This approach is technically straightforward and commercially proven, but the GHG reduction potential is limited since it requires the siting of large, capital intensive power projects close to ventilation shafts.

Lean Fuel Gas Turbines and Hybrid VAM/Coal Turbines

Several companies have or are developing technologies to employ VAM in gas turbines as a significant or even the primary fuel source. These technologies vary in size and in the mechanism used to combust the VAM. The smallest units are micro-turbines that have the capacity to produce 30 kW, while technology developers are planning to design turbines capable of producing several megawatts of power. Some of the technologies employ catalysts for the VAM combustion, while others take place in an external combustor without catalysts but at a lower temperature than with normal turbines. To date, the technology vendors claim that they can use VAM (or a mixture of VAM and higher concentration gas) down to concentrations of between 1% and 1.6%, but several are researching means of lowering the required concentration to .8% or lower. Depending on the VAM concentration, these turbines may use VAM for over 80% of all fuel if methane concentrations are high, or less than 20% with low VAM concentrations.

One novel approach that has been developed and will be demonstrated soon is a plant that co-fires waste coal and VAM in a rotary kiln. For the demonstration, the captured heat is used to power a 1.2 MW gas turbine. Depending on the quantities of coal versus VAM used, this plant is either a VAM ancillary or a VAM primary technology. Unlike the lean fuel turbine approaches, it doesn't require supplemental gas to increase the methane concentration of VAM to sustain operations.

Concentrators and Gasifiers

For those applications such as lean fuel turbines requiring concentrations at or above 1%, there are relatively few ventilation shafts with a sufficient percentage of methane to sustain turbine operation. Either a source of drained coal mine methane, propane, natural gas or some other source must be blended with the VAM to the minimum required concentration, or the VAM must be concentrated. Concentrators are traditionally used to control volatile organic compounds and may be another possible economical option for supporting VAM use technologies. Conceivably, a concentrator might increase the methane concentration of VAM twenty-fold. Depending on the output concentration, this might be useful in blending with lower concentration VAM for use in lean fuel turbines, or it might even increase concentrations for use in rich gas applications.

Coal gasification is another technically viable means of increasing the energy concentration of VAM for use in a number of applications.

Biological Removal of VAM

Ventilation air methane might be a good feedstock for the production of single celled, methane consuming proteins, called methanotrophs. Single celled proteins are used as a supplement to animal feed.

In the context of climate change, mitigation of risks associated with climate related impacts is referred to as "adaptation". Climate adaptation can be described as the implementation of actions to increase resilience towards climate related changes and impacts. Adaptation measures can include "hard" and "soft" measures.

Hard adaptation measures are measures incorporated into the design, including engineering measures. These measures are often more capital-intensive that soft adaptation measures. Soft adaptation measures are measures incorporated into operational processes. Soft adaptation measures often offer more flexibility in terms of responding to climate change impacts that hard adaptation measures.

A key concept to climate change adaptation is "adaptive management", the process whereby climate related risks are continually monitored, measurements implemented, tailored and revised in relation to climate change.

Risk mitigation measures for the identified climate risks are summerised in **Table 12** below.

Table 12: Dorstfontein Coal Mine West – Climate Change Risk Mitigation Measures

Potential Climate Risk	Risk Mitigation / Adaptation Measures
1. Increased temperature, heatwaves and wildfires	The risk and management of heat related illnesses should be integrated in the Occupational Health and Safety Plans. Measures may include monitoring of temperature and humidity levels, providing of adequate cooling and ventilation, introducing systems to limit exposure to heat and educating staff to recognise early symptoms of heat stress. Adequate monitoring, fire detection and suppression systems for the spontaneous combustion of coal stockpiles should be implemented. The risk of wildfires in relation to infrastructure and facilities should be assessed. Adequate monitoring, fire detection and suppression systems should be implemented.
2. Water scarcity and drought	Regular monitoring of operational water requirements and available resources should be conducted. A contingency response plan should be developed in the event of short, medium or long-term water shortages. A water policy should be developed as to manage and minimise water usage, setting clear objectives and targets to improve efficiency. Regular monitoring of water quality should be implemented. A contingency response plan should be developed in the event that water quality deteriorates. Measure may include additional water treatment infrastructure development. Dust deposition monitoring should be performed. A contingency response plan should be developed for dust suppression in the event of dry spells and periods of elevated dust generation. Community participation should be considered with regards to water infrastructure and management.

Potential Climate Risk	Risk Mitigation / Adaptation Measures
3. Floods, cyclones and storms	A site-specific flood risk assessment should be conducted to identify areas vulnerable to flooding. A risk assessment should be conducted to assess the flood risk in relation to key access roads. A contingency response plan should be developed should operations become inaccessibility due to floods.
4. High wind speeds and gusts	A continuous monitoring station should be installed to obtain site specific wind data. Regular maintenance checks for wind-related damage should be performed.

5.2 KEY FINDINGS

The climate change impact assessment conclude the following:

- The project falls within the Nkangala District Municipality of the Mpumalanga Province. The Mpumalanga Climate Change Adaptation Strategy Report and the Nkangala District Municipality's Climate Change Vulnerability Assessment and Response Plan have been developed.
- A total GHG emission rate of 16 186.89 tCO_2e was calculated for the current operations. Scope 1 GHG emissions amounted to 1 648.61 tCO_2e (10.18%) and Scope 2 GHG emissions totalled 14 538.27 tCO_2e (89.82%).
- The expansion project's total GHG emission rate was calculated at 239 127.80 tCO_2e for the LOM. Scope 1 GHG emissions amounted to 70 126.87 tCO_2e (29.33%). Scope 2 GHG emissions totalled 169 000.93 tCO_2e (70.67%).
- DCM West's calculated GHG emissions inventory for current operations amounts to 0.0004% of South Africa's carbon budget (4,410 Mt CO_2e).
- The expansion project's calculated GHG emissions inventory amounts to 0.0054% of South Africa's carbon budget (4,410 Mt CO_2e).

- The magnitude of GHG emissions from the current operations and the expansion project is considered minor, as GHG emissions are less than 0.02% of the South Africa's carbon budget.
- The impact of GHG emissions from current coal mining and beneficiation operations was rated medium with or without mitigation measures.
- The impact of GHG emissions from the expansion project was rated medium with or without mitigation measures.
- DCM West's GHG emissions although minor, will still contribute to local Industrial Process and Product Use Sector and global energy related GHG emissions.
- The project's GHG emissions will contribute to anthropogenic climate change. Climate change is likely to be accelerated and extended as GHG emissions accumulate in the atmosphere.
- Potential climate risks identified, based on the climate threat outlined, include increased temperature, reduced rainfall, extreme events and wind impacts.
- The identified climate risks will have a direct and indirect impact on DCM West's current operations and expansion project.
- Potential climate risks that have been assessed as highly significant include water scarcity and drought that can constrain exploration, processing and site rehabilitation; floods, cyclones and storms that may cause damage to infrastructure and facilities and floods, cyclones and storms that may cause reduced accessibility due to flooding of roads.
- All other potential climate risks have been assessed as medium without and with mitigation measures.
- Although mitigation will not alter the impacts of GHG emissions in terms of the extent, duration or probability of the impact, the intensity of the impact can be reduced, notably by reducing the quantity of GHG emissions.
- Basic mitigation strategies and specific tactics and actions have been outlined to reduce GHG emissions from the coal mining activities.
- Risk mitigation / adaptation measures have been proposed for the identified climate risks.

5.3 ABBREVIATIONS

AFOLU	:	Agriculture, Forestry and Other Land Use
AQIS	:	Air quality impact study
AQMP	:	Air quality management plan
ºC	:	Degree Celsius
CH_4	:	Methane
CO	:	Carbon monoxide
CO_2	:	Carbon dioxide
CO_2e	:	Carbon Dioxide Equivalent
DEA	:	Department of Environmental Affairs
EIA	:	Environmental Impact Assessment
EMP	:	Environmental Management Plan
GHG	:	Greenhouse Gas
GIZ	:	Deutsche Gesellschaft für Internationale Zusammenarbeit
HAPs	:	Hazardous air pollutants
IDP	:	Integrated Development Plan
IPCC	:	Intergovernmental Panel on Climate Change
kg	:	Kilogram
kg/l	:	Kilogram per litre
km	:	Kilometre
km/h	:	Kilometre per hour
LPG	:	Liquid Petroleum Gas
LTAD	:	Long Term Adaptation Scenarios

m^3	:	Cubic metre
mg	:	Milligrams
$mg/m^2/day$	:	Milligrams per square metre per day
mm	:	Millimetres
MW(th)	:	Megawatt (thermal)
Nm^3/h	:	Normal cubic metres per hour
m/s	:	Meters per second
NAAQS	:	National Ambient Air Quality Standards
NCCAS	:	National Climate Change Adaptation Strategy
NCCRP	:	National Climate Change Response Policy
NEMAQA	:	National Environmental Management: Air Quality Act (Act no. 39 of 2004)
NO	:	Nitrogen oxide
NO_2	:	Nitrogen dioxide
N_2O	:	Nitrous oxide
NO_x	:	Oxides of nitrogen
NPI	:	National Pollutant Inventory
O_3	:	Ozone
Pb	:	Lead
$PM_{2.5}$	:	Inhalable particulate matter with a mean aerodynamic diameter less than 2.5 micrometre
PM_{10}	:	Inhalable particulate matter with a mean aerodynamic diameter less than 10 micrometre
SANS	:	South African National Standards
SAWS	:	South African Weather Service
SO_2	:	Sulphur dioxide

SF_6	:	Sulphur hexafluoride
tCO_2e	:	Tonnes of Carbon Dioxide Equivalent
t/h	:	Tonnes per hour
TJ/tonne	:	Terajoule per tonne
TSP	:	Total Suspended Particulates
UNFCCC	:	The United Nations Framework Convention on Climate Change
USEPA	:	United States Environmental Protection Agency
VOCs	:	Volatile organic compounds
WHO	:	World Health Organisation

5.4 GLOSSARY

Act means the National Environmental Management: Air Quality Act, 2004 (Act No.39 of 2004).

Adaptation is the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.

Atmospheric emission or **emission** means any emission or entrainment process emanating from a point, non-point or mobile source that results in air pollution.

Biomass means non fossilised and biodegradable organic material originating from plants, animals and micro-organisms excluding (a) sewage; and (b) treated or coated wood waste which may contain halogenated organic compounds or heavy metals.

Boundaries the inventory boundaries determine which emissions are accounted for and reported. Boundaries include organisational and operational.

Climate change refers to a change in the state of the climate that can be identified (i.e. by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use.

CO_2e carbon dioxide equivalent – standardisation of all measured greenhouse gases to reflect their warming equivalent to carbon dioxide (CO_2). This is used to report different greenhouse gases against a common basis.

Direct emissions greenhouse gas emissions from facilities or sources owned or controlled by the reporting company.

Design capacity means capacity as installed.

Dust means solid materials suspended in the atmosphere in the form of small irregular particles, many of which are microscopic in size.

Emission means pollution discharged into the atmosphere from a range of stationary and mobile sources. These include smokestacks, vents and surface areas of commercial or industrial facilities; residential sources; motor vehicles and other transport related sources.

Emission control technology means technology that aims to reduce emissions into the atmosphere.

Emission inventory means a listing or register of the amount of pollution entering the atmosphere from all sources within a given time and geographic boundaries.

Emission factor means a representative value, relating the quantity of a pollutant to a specific activity resulting in the release of the pollutant to atmosphere.

Emission rate means the rate at which a pollutant is emitted from a source of pollution.

Emission reduction strategy means an intervention designed to reduce emissions into the atmosphere.

Environment means the surroundings within which humans exist and that are made up of the land, water and atmosphere of the earth; micro-organisms, plant and animal life and the interrelationships among and between them; and the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being.

Environmental management systems means a part of the management system of an organisation in which specific competencies, behaviours, procedures and demands for the implementation of an environment policy are defined.

Fugitive emissions means emissions that are released into the atmosphere by any other means than through an intentional release through stack or vent including extraction, processing, delivery and burning for energy production of fossil fuels, including leaks from industrial plant and pipelines.

Greenhouse gas means gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation, and includes carbon dioxide, methane and nitrous oxide.

GHG inventory a listing of the greenhouse gas emission sources that are attributable to a company.

Mitigation is a human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Mobile source means a single identifiable source of atmospheric emission which does not emanate from a fixed location.

Monitoring means periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.

Operational boundary the boundary to establish the operations and sources of emissions included in the greenhouse gas inventory.

Ozone-depleting substance means a substance having chemical or physical properties which, by its release into the atmosphere, can cause a depletion of the stratospheric ozone layer.

Oxides of nitrogen (NO_X) means the sum of nitrogen oxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide (NO_2)

Particulate matter (PM) means total particulate matter, that is the solid matter contained in the gas stream in the solid state as well as the insoluble and soluble solid matter contained in entrained droplets in the gas stream. The collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface and includes dust, smoke, soot, pollen and soil particles.

Precipitation means ice particles or water droplets large enough to fall at least 100 m below the cloud base before evaporating.

Resilience is the ability of a social, economic or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self- organisation and the capacity to adapt to stress and change.

Scope 1 emission is direct emission from company-owned or controlled assets.

Scope 2 emission is indirect emission from the consumption of purchased electricity.

Vulnerability is the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

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