Eskom Holdings SOC Ltd

ESKOM MINIMUM EMISSION STANDARDS EXEMPTION

Eskom Fleet Report

41107109
DECEMBER 2024

PUBLIC

Eskom Holdings SOC Ltd

ESKOM MINIMUM EMISSION STANDARDS EXEMPTION

Eskom Fleet Report

TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. 41107109

OUR REF. NO. 41107109

DATE: DECEMBER 2024

Eskom Holdings SOC Ltd

ESKOM MINIMUM EMISSION STANDARDS EXEMPTION

Eskom Fleet Report

WSP

Building 1, Maxwell Office Park
Magwa Crescent West, Waterfall City
Midrand, 1685
South Africa

Phone: +27 11 361 1300

WSP.com

PUBLIC

QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
Remarks	Draft Report for Stakeholder Review	Final Report – Ministerial Submission		
Date	5 November 2024	10 December 2024		
Prepared by	B. Keiser	B. Keiser		
Signature				
Checked by	A. Scheepers	A. Scheepers		
Signature		Digitally signed by Scheepers, Anri (ZAAS02690) DN: cn=Scheepers, Anri (ZAAS02690), ou=Active, email=Anri.Scheepers@wsp.com Date: 2024.12.10 22:14:49 +02'00'		
Authorised by	B. Keiser	B. Keiser		
Signature		Bradley.Keiser@wsp.com 2024.12.10 22:08:49 +02'00'		
Project number	41101709	41101709		
Report number	1 of 9	1 of 9		
File reference	\\corp.pbwan.net\za\Central_Data\Projects\41100xxx\41107109 - ESKOM MES EXEMPTION APPLICATIONS\41 EPA\01-Reports\02-Final\Exemption Reports			

INDEX AND REPORT STRUCTURE

Ch. 9: Stakeholder Engagement	All	69 – 73	Presents the stakeholder engagement process followed, including methods of notification and meeting dates and venues.
Appendix A	N/A	N/A	Cumulative Atmospheric Impact Reports: 1) Highveld and Vaal Triangle; 2) Waterberg
Appendix B	N/A	N/A	Cumulative dispersion modelling results for stack only particulate matter emissions.
Appendix C	N/A	N/A	Airshed specific Health Cost Benefit Analysis: 1) Highveld and Vaal Triangle; 2) Waterberg

ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Definition
AEL	Atmospheric Emissions Licence
AOA	Annual Operational Analyses
AP-HRA	Air pollution health risk assessments
APHR-BCA	Air Pollution Health Risk Benefit Cost Analysis
AQMP	Air Quality Management Plan
AQO	Air Quality Offsets
ARM	Air Resource Management
BAT	Best Available Technology
BCA	Benefit-cost analysis
BPFS	Biodiversity Plan Free State Province
BU	Business Units
CAPEX	Capital Expenditure
CRA	Concept Release Approval
CV	Calorific value
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
DHP	Dust Handling Plant
DSI	Dry Sorbent Injection
DWS	Department of Water and Sanitation
EAF	Energy Availability Factors
EIA	Environmental Impact Assessment
ERF	Exposure-response functions
ERI	Eskom Rotek Industries
ERP	Emission Reduction Plan
ESA	Ecological Support Area
EWE	Extreme Weather Events
FDDM	Fezile Dabi District Municipality
FEPA	Freshwater Ecosystem Priority Areas
FGD	Flue Gas Desulphurisation
GBV	Gender-Based Violence
GCD	Group Capital Department
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GHGP	Greenhouse Gas Protocol

Acronym/Abbreviation	Definition
GVA	Gross Value Added
HFPS	High Frequency Power Supplies
I&AP	Interested and Affected Parties
IDP	Integrated Development Plan
IPCC	Intergovernmental Panel on Climate Change
IPPs	Independent Power Producers
IRP	Integrated Resource Plan
IVRSv	Integrated Vaal River System
LCOE	Levelised cost of electricity
JET	Just Energy Transition
LNB	Low NO_X burner
LPG	Liquid Petroleum Gas
MES	Minimum Emission Standards
MLM	Metsimaholo Local Municipality
Mt	Megatonnes
NAAQS	National Ambient Air Quality Standards
NAQO	National Air Quality Officer
NCCAS	National Climate Change Adaptation Strategy
NCCRP	National Policies such as the Climate Change Response
NDC	Nationally Determined Contribution
NDP	National Development Plan
NECA	National Environmental Consultative and Advisory
NECOM	National Energy Crisis Committee of Ministers
NEMAQUA	National Environmental Management: Air Quality Act
NERSA	National Energy Regulator of South Africa
NGER	National Greenhouse Gas Emission Reporting
NO_X	Nitrogen Oxides
NPV	Net Present Value
NWA	National Water Act (No. 36 of 1998)
OEMs	Original Equipment Manufacturers
OFA	Over-fire Air
OIP	Offset Intervention Plan
Opex	Operating Expenditure
PCD	Pollution Control Dam
PF	Pulverised fuel
PJFF	Pulse Jet Fabric Filter

Acronym/Abbreviation	Definition
PM	Particulate Matter
PMV	Planning, Monitoring and Verification
PPE	Personal Protective Equipment
PV	Photovoltaic
RR	Relative Risk
R&R	Repowering and Repurposing
ROI	Return on investment
SAPS	South African Police Service
SAWS	South African Weather Services
SCR	Selective Catalytic Reduction
SO_2	Sulphur dioxide
SPF	Spray Polyurethane Foam
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile Organic Compounds
VRESS	Vaal River Eastern Sub-system
VSL	Value of a statistical life
VTAPA	Vaal Triangle Airshed Priority Area
WBCSD	World Business Council for Sustainable Development
WCWDM	Water Conservation and Water Demand Measures
WHO	World Health Organisation
WMO	World Meteorological Organisation
WRI	World Resources Institute
WTP	Willingness to Pay

CONTENTS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

Eskom Holdings SOC Ltd (Eskom) is South Africa's public electricity utility, supplying about 95% of the country's electricity with a generation capacity exceeding 35,000 MW. Around 90% of its power comes from coal-fired stations, primarily located in the Mpumalanga Highveld, with others in the Free State and Limpopo provinces.

Coal-fired power stations must comply with strict environmental regulations under the National Environmental Management: Air Quality Act (NEM:AQA). Eskom sought postponements and alternative limits to the Minimum Emission Standards (MES) for oxides of nitrogen (NO_X), sulphur dioxide (SO_2) and particulate matter (PM) between 2018 and 2020. These applications were necessary due to several factors, such as the restrictive legal framework, the advanced age of Eskom's power plant fleet, and the technical challenges of reducing emissions. The high costs of emission reduction technologies, which could significantly impact electricity tariffs and the financial stability of the utility, further underscored the need for a phased approach to compliance.

In October 2021, the Department of Forestry, Fisheries, and the Environment (DFFE) granted conditional postponements for some power stations (Grootvlei, Arnot, Komati, Camden, Hendrina, Acacia, and Port Rex Power Stations), provided partial refusals for others (Majuba, Tutuka, Kendal, and Kriel), and rejected the applications for Lethabo, Matla, Medupi, Matimba, and Duvha.

In December 2021 Eskom initiated an appeal process, engaging with the DFFE, and other governmental departments, on the basis that immediate compliance would lead to the shutdown of about 16,000 MW of coal-fired capacity. Eskom emphasised that this would negatively impact the national grid and delay South Africa's energy transition, that flu gas desulphurisation (FGD) retrofit on "six-pack" power stations was not proven to be technically feasible and would be a world first, and that if funding was available to execute the required compliance projects in time to meet the MES, this would result in an approximate increase of 10% on existing electricity tariffs (Eskom, 2020).

In May 2024, the Minister approved the MES suspensions for the power stations set to shut down by 31 March 2030 (Hendrina, Grootvlei, Arnot, Camden, and Kriel) and, under Section 59 of the NEM:AQA, instructed Eskom to apply for MES exemptions for the remaining stations (Lethabo, Kendal, Tutuka, Matla, Duvha, Majuba, Matimba, and Medupi). The Minister would then assess each application based on its merits and supporting information.

This report presents the Eskom Fleet exemption application, comprising Lethabo, Tutuka, Matla, Duvha, Majuba, Kendal, Medupi, and Matimba, highlighting the specific environmental and operational challenges each face. While the primary focus is on the Eskom Fleet, aspects of the Highveld and Vaal Triangle Fleet and Waterberg Fleet are discussed separately. This holistic approach is necessary as a particular station's circumstances cannot be considered in isolation of the entire Eskom Fleet as station performance, emissions impacts, and financial impacts need to be considered cumulatively. By considering the entire Eskom fleet, the report aims to provide a cohesive strategy for reducing emissions and achieving compliance while addressing the unique challenges of each power station.

To address emission reductions in the Eskom Fleet, Eskom developed an Emission Reduction Plan (ERP) in 2015, with this being updated in 2019 (EERP 2019), 2020 and 2022. In May 2024, as part of the Minister's decision, Eskom were required to review the 2022 ERP, with this having been revised by Eskom in 2024.

Eskom currently has abatement technologies to mitigate PM at all power stations since this is historically the pollutant of most concern considering health impacts, and boilers with low NO_X design at Medupi, Kendal, Kusile, and Camden, with SO_2 abatement technology in the form of flue-gas desulphurisation (FGD) installed at Kusile. Further, Eskom is currently taking steps to further reduce PM emissions at the stations, with several abatement equipment upgrades and refurbishments completed, and currently being undertaken, focusing on projects such as electrostatic precipitator (ESP) refurbishments, high frequency power supply (HFPS) installations, sulphur trioxide (SO_3) plant upgrades, and Dust Handling Plant (DHP) upgrades. In addition to these projects, and ensuring Eskom's commitment to emission reductions, as part of the 2024 ERP, Eskom are also planning and/or evaluating the following to reduce emissions:

- Wet FGD at Medupi (included in previous ERPs)
- Kendal (semi-dry FGD) and Majuba (Duct Sorbent Injection (DSI FGD)) SO_2 reduction projects have been identified as potential alternatives, although are being evaluated as part of this process.
- Low NO_X Burner (LNB) technology at Majuba, Tutuka and Lethabo to mitigate NO_X emissions.
- Despatch Prioritisation Strategy at specific power stations, initiated to reduce SO_2 emissions, however also positively impacting PM and NO_X emissions.
- Efficiency improvement projects under the Generation Recovery Programme to optimise the air-to-fuel ratio which should abate some SO_2 emissions and maximise combustion efficiency.
- The progressive shutdown of coal-fired stations will reduce overall Eskom Fleet emissions.
- Although not a method of reducing emissions at source (i.e. the power stations), the cumulative impact on neighbouring communities is reduced through the air quality offset (addressing emission sources within the community) projects already implemented by Eskom, therefore Eskom are looking to expand this beyond the 35,000 households originally planned.

Key emissions of concern, and regulated by the NEM:AQA, are PM, SO_2, and NO_X. The following discussions provide key highlights for each pollutant, considering details such as current performance, planned projects, Eskom Fleet emission reductions and trajectories, and Eskom's exemption request, where applicable. The Eskom Fleet emission reduction trajectories consider four scenario projections:

- ERP 2024 A (PM and NO_X reduction, Despatch Prioritisation strategy, efficiency improvements, and SO_2 abatement at Medupi and Kusile), representing Eskom's planned projection.
- ERP 2024 B (As per ERP 2024 A plus SO_2 reduction technology installed at Majuba and Kendal), representing a projection, that with additional guarantees and strategic decisions, could be achieved.
- ERP 2024 C (As per ERP 2024 A and B, plus SO_2 reduction technology at Matimba, Lethabo and Tutuka), representing a projection that would require substantial guarantees and considerations of the significant financial impacts, such as on electricity tariffs.
- Eskom's Security of Supply Projection developed using conservative assumptions such as higher electricity demands due to a growing economy, a delay in IPP projects, and a delay in Kusile U6 generating unit coming online.

The following sections focus on the key aspects assessed in this report, namely ambient concentrations, dispersion modelling, Eskom's Fleet emissions trajectory, financial considerations, and conclusions from the health benefit cost analysis. While not specifically discussed in the executive summary, other aspects considered in this report include water, waste, climate change, and socioeconomic impacts. Further, a comprehensive stakeholder engagement process was followed, aligned with the NEMA regulations, detailed in this report.

PARTICULATE MATTER

Presently ambient air quality monitoring shows PM to be non-compliant in the Highveld, Vaal Triangle and Waterberg, with this impacted by multiple sources, such as Eskom power stations, mining, industrial activities, uncontrolled waste burning, veld fires, and domestic fuel burning; importantly, the non-compliant ambient concentrations are not only due to Eskom emissions. Cumulatively the Eskom Fleet shows a significant reduction in PM stack emissions in the coming years due to the various abatement projects being implemented. Eskom's emission trajectories for the options of ERP 2024 A, ERP 2024 B, and ERP 2024 C, show identical trajectories as the same PM abatement projects are planned for each. By FY2030, these show a 65-kilo tonne (kt) reduction from FY2025, representing a 74% decrease, due to PM abatement projects implemented in the fleet and stations entering shutdown phase.

Despite the significant PM emission reduction, and the dispersion modelling indicating compliant PM_{10} annual average concentrations, non-compliant 24-hour PM_{10} concentrations are predicted, as well as non-compliant annual and 24-hour average $PM_{2.5}$ concentrations; although, the conservative approach to the PM simulations providing an absolute worst-case scenario must be considered. The predicted ambient PM concentrations are predominantly due to the low-level fugitive sources (windblown ash from the ashing facilities), rather than the stack emissions themselves; the benefit of the stack emissions reductions, as evident in the trajectories, is over-shadowed by the impacts associated with fugitive emissions. This conclusion is supported by the additional dispersion modelling undertaken to assess particulate matter emissions only from the stacks, which showed full compliance with the annual and 24-hour average PM_{10} and $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS), with no exceedances predicted. This was evident for the Highveld and Vaal Triangle Fleet, as well as the Waterberg Fleet, indicating ground-level impacts associated with stack emissions are well below the NAAQS.

While the abovementioned emission trajectories show significant improvements in the next few years, to offset Eskom PM emissions further, Eskom has introduced an air quality offset (AQO) program, a key component of Eskom's ERP. This program aims to offset PM emissions by implementing interventions that deliver net ambient air quality benefits within communities impacted by Eskom's stations, focusing on PM_{10} and $PM_{2.5}$. In the Highveld and Vaal Triangle, key interventions include the distribution of hybrid stoves, ceilings, electrical rewiring, and LPG heaters to households, as well as clean-up campaigns to remove illegally dumped waste. The program has been implemented in phases, with Phase 1 targeting Kwazamokuhle, Ezamokuhle, and Sharpeville. Preliminary results show significant reductions in PM_{10} and $PM_{2.5}$ concentrations and improvements in indoor air quality in participating households. Eskom plans to expand its AQO program to additional communities and explore new interventions, such as dust suppression on unpaved roads and veld fire management.

In the Waterberg area interventions to date have focussed on educational initiatives, with further options being considered including introducing cleaner household energy sources, managing waste burning, reforestation, and surfacing bare public grounds. Research into Eskom's potential AQO initiatives is ongoing, focusing on interventions that reduce emissions to create the greatest positive impact in specific communities.

Considering each power stations performance, Duvha Unit (U)1 and U2, Majuba, Medupi, and Matimba currently comply with the new plant PM MES. The remaining stations are unable to comply with the new plant MES until completion of their respective PM abatement projects, detailed in this report. While Eskom recognises the currently non-compliant PM ambient concentrations in the Waterberg, Highveld, and Vaal Triangle, to which Eskom is not the sole contributor, Eskom's PM emission trajectory shows substantial reductions in the next few years, driven by the commissioning of the PM abatement projects, as well as the assumed shutdowns of Arnot, Kriel, Hendrina, Grootvlei, and Camden. Further reductions will be achieved by the plant efficiency improvements and the Despatch Prioritisation strategy.

In light of the above, Eskom is requesting exemption from the new plant PM MES at Duvha (U4 and U6), Lethabo (U1, U2, U3, U4, and U5), Matla (U4, U5, and U6), Kendal, and Tutuka until completion of the abatement projects, after which these stations will comply with the new plant MES, as presented in Table 0-1. The total nominal Capex to complete the PM abatement projects is estimated at R9.4 billion.

Table 0-1 – Particulate matter requested emission limits and timeframes

STATION	GENERATING UNIT	MAXIMUM RELEASE RATE*			DURATION OF EMISSIONS
		mg/Nm^3	Average	Date To Be Achieved	
LETHABO	U6	100 mg/Nm^3	Daily	Immediate	Continuous
		50 mg/Nm^3	Daily	1 April 2025	Continuous
	U2, U3	100 mg/Nm^3	Daily	Immediate	Continuous
		50 mg/Nm^3	Daily	1 April 2026	Continuous
	U5	100 mg/Nm^3	Daily	Immediate	Continuous
		50 mg/Nm^3	Daily	1 October 2026	Continuous
	U4	100 mg/Nm^3	Daily	Immediate	Continuous
		50 mg/Nm^3	Daily	1 April 2027	Continuous
	U1	100 mg/Nm^3	Daily	Immediate	Continuous
		50 mg/Nm^3	Daily	1 October 2027	Continuous
DUVHA	U1, U2, U5	50 mg/Nm^3	Daily	Immediate	Continuous
	U4, U6	100 mg/Nm^3	Daily	Immediate	Continuous
		50 mg/Nm^3	Daily	1 October 2026	Continuous
MATLA	U1, U2, U3	100 mg/Nm^3	Daily	Immediate	Continuous
		50 mg/Nm^3	Daily	1 April 2025	Continuous
	U4, U5, U6	100 mg/Nm^3	Daily	Immediate	Continuous
		50 mg/Nm^3	Daily	1 April 2026	Continuous
TUTUKA	All Units	300 mg/Nm^3	Daily	Immediate	Continuous
		50 mg/Nm^3	Daily	1 April 2027	Continuous
KENDAL	U3, U4, U6	100 mg/Nm^3	Daily	Immediate	Continuous
		50 mg/Nm^3	Daily	1 October 2025	Continuous
	U1, U2, U5	100 mg/Nm^3	Daily	Immediate	Continuous
		50 mg/Nm^3	Daily	1 April 2026	Continuous
MAJUBA	All Units	50 mg/Nm^3	Daily	Immediate	Continuous
MEDUPI	All Units	50 mg/Nm^3	Daily	Immediate	Continuous
MATIMBA	All Units	50 mg/Nm^3	Daily	Immediate	Continuous

*Emission limits requested are for normal operations, so excludes upset, startup, shutdown, or maintenance conditions.

OXIDES OF NITROGEN

For the period 2021 – 2023, measured ambient NO_2 concentrations in the Highveld and Vaal Triangle are compliant with the National Ambient Air Quality Standards (NAAQS). While Eskom is not the sole contributor to these concentrations, Eskom emissions still do contribute, recognising these contributions are made at Eskom's current emission rates i.e. without NO_X abatement at Matla, Duvha, Tutuka, Majuba, and Lethabo. Despite these stations not having NO_X abatement, ambient concentrations are compliant with the NAAQS. Considering the cumulative Eskom Fleet NO_X emissions trajectory, by FY2030 (compared to 2025), NO_X emissions are estimated to reduce by 292kt (40%) due to assumed shutdowns of Arnot, Kriel, Hendrina, Camden, and Grootvlei. Between FY2025 and FY2050, total NO_X emissions are estimated to reduce by 78%.

Considering the cumulative Highveld and Vaal Triangle dispersion model and maximum sensitive receptor predictions, all modelling scenarios predicted compliant NO_2 concentrations, with annual averages well below the NAAQS, and no hourly exceedances predicted. This included the current scenarios (modelling Scenario 1 and Scenario A), which assumed no NO_X abatement at Matla, Duvha, Tutuka, Majuba, and Lethabo.

Although ambient concentrations and the dispersion modelling indicate compliance with the NAAQS, Eskom is still planning to install LNB at Majuba, Lethabo, and Tutuka, after which all three stations will comply with the new plant NO_X MES. Currently, Kendal, Matimba, and Medupi comply with the new plant NO_X MES. LNB installation at Tutuka is planned to commence in 2025 on the first generating unit, with installation complete by 2029; Majuba's installation commences 2026, with the last unit in 2030; and Lethabo's LNB installation commences in 2027, with the last unit complete by 2031. As noted, once LNB installations are complete, the stations will comply with the new plant MES.

Considering Duvha and Matla, with assumed shutdown due to commence in 2030, and optimistic LNB commencement dates of 2028, with LNB installations only complete well into the station's shutdown phases, it is not economically feasible to install LNB at Matla and Duvha. Consideration also needs to be given to the National Environmental Consultative and Advisory (NECA) Panel, which commented that it would not be economically feasible to install LNB at Matla due to its assumed shutdown; this same consideration can be given to the Duvha station. Currently, both stations comply with the existing plant MES, and with the initiation of Despatch Prioritisation to address SO_2 emissions, NO_X emissions will reduce further, although not to compliance with the new plant MES.

In light of the above, and the currently compliant ambient NO_X concentrations in the Highveld and Vaal Triangle, the dispersion modelling predictions indicating NAAQS compliance, the NO_X emission reductions anticipated in the Eskom Fleet over the next few years, and that once LNB installations are complete all Eskom stations operating post 2035 will comply with the new plant MES, Eskom is requesting exemption from the new plant MES. This exemption request is for Tutuka, Majuba, and Lethabo until completion of the LNB installations, and for Matla and Duvha until their assumed shutdowns (Table 0-2). The total nominal Capex to install LNB at Lethabo, Tutuka, and Majuba is estimated at R7 billion (-15% to +20%).

Table 0-2 – Oxides of nitrogen requested emission limits and timeframes

STATION	GENERATING UNIT	MAXIMUM RELEASE RATE*			DURATION OF EMISSIONS
		mg/Nm^3	Average	Date To Be Achieved	
DUVHA	All Units	1,100 mg/Nm^3	Daily	Immediate - Shutdown	Continuous
MATLA	All Units	1,100 mg/Nm^3	Daily	Immediate - Shutdown	Continuous
LETHABO	All Units	1,100 mg/Nm^3	Daily	Immediate	Continuous
		750 mg/Nm^3	Daily	1 April 2031	Continuous
TUTUKA	All Units	1,100 mg/Nm^3	Daily	Immediate	Continuous
		750 mg/Nm^3	Daily	1 April 2029	Continuous
MAJUBA	All Units	1,100 mg/Nm^3	Daily	Immediate	Continuous
		750 mg/Nm^3	Daily	1 April 2030	Continuous
KENDAL	All Units	1,100 mg/Nm^3	Daily	Immediate	Continuous
		750 mg/Nm^3	Daily	1 April 2025	Continuous
MEDUPI	All Units	750 mg/Nm^3	Daily	Immediate	Continuous
MATIMBA	All Units	750 mg/Nm^3	Daily	Immediate	Continuous
*Emission limits requested are for normal operations, so excludes upset, startup, shutdown, or maintenance conditions.					

SULPHUR DIOXIDE

Measured ambient SO_2 concentrations in the Highveld, Vaal Triangle and Waterberg for the period 2021 – 2023 show compliance with the NAAQS. While Eskom is not the sole contributor to these concentrations, Eskom emissions are a key contributor, recognising these contributions are made at Eskom's current emission rates i.e. without SO_2 abatement at Duvha, Matla, Lethabo, Tutuka, Medupi, Matimba, Kendal and Majuba, with ambient concentrations remaining compliant with the NAAQS. Considering the cumulative Eskom Fleet SO_2 reductions under ERP 2024 A (which excludes SO_2 abatement at Lethabo, Tutuka, Matimba, Majuba and Kendal), by FY2030 a reduction of 555kt (32%) is anticipated, with a further 165kt (14%) by FY2035 due to completion of the wet FGD at Medupi, Despatch Prioritisation, efficiency improvement projects, and assumed shutdown of Arnot, Kriel, Camden, Hendrina, Grootvlei, Duvha, and Matla.

The cumulative Highveld and Vaal dispersion modelling indicated compliance with the NAAQS under all modelling scenarios, including those where Lethabo, Majuba, Kendal, and Tutuka were simulated at current emission rates, without SO_2 abatement. The cumulative Waterberg dispersion model showed compliance with the hourly and annual average NAAQS, however predicted non-compliance with the 24-hour NAAQS until completion of the wet FGD at Medupi. Following Medupi's FGD completion, modelling predictions showed compliance with the NAAQS, despite Matimba not having FGD technology installed i.e. emitting at current rates.

While all stations comply with their respective current emission limits, the stations cannot comply with the new plant MES without SO_2 abatement technology. Following the completion of the wet FGD at Medupi, Medupi will comply with the new plant MES. The Medupi installations are due to commence in FY2028, taking five-years to complete on all generating units, with a completion date of FY2032.

Considering Matla and Duvha, no SO_2 abatement technologies were assessed in the ERP scenarios due to the costs associated with the technology, time to install the technology, and that Matla and

Duvha commence their assumed shutdowns in 2030. Further, based on the commentary provided by the NECA Panel regarding the LNB installation at Matla not being economically feasible due to its shutdown schedule, the same consideration can be given to the SO_2 abatement technologies at Matla and Duvha.

SO_2 abatement technologies at Majuba and Kendal were evaluated as part of this application, assessed under ERP 2024 B (a scenario, that with additional guarantees and considerations, could be achieved), with semi-dry FGD identified as the most appropriate at Kendal, while DSI FGD was identified for Majuba. The semi-dry FGD would bring Kendal into compliance with the new plant MES, while the Majuba DSI FGD would reduce SO_2 emissions, however not to compliance with the new plant MES.

Regarding Kendal, should the new plant MES be enforced, an optimistic installation start date of FY2031 could be achieved as concept and design has not commenced, with full installation complete by FY2035. This installation has an estimated nominal Capex of R44.4 billion (-15% to +20%), with an annual real Opex of approximately R1 billion. Considering the full FGD impact would only be realised approximately four-years before the assumed Kendal shutdown, and the cost of installation, it is not deemed economically feasible to install.

At Majuba, installation of the DSI would commence in FY2029 due to the pilot project being commissioned, and concept and design not yet commenced, with full completion by FY2033. This installation has an estimated nominal Capex of R13.1 billion (-15% to +20%), with an annual real Opex of approximately R1 billion. Assumed Majuba shutdown is due to commence in FY2047, with complete shutdown by FY2052. While Majuba has a longer remaining life, and DSI FGD is lower in cost compared to alternatives, Majuba's high operating cost, in addition to the DSI FGD Capex and high annual Opex, challenges the economic and financial viability of installing DSI at Majuba. Further to this, the DSI FGD will not achieve compliance with the new plant MES, with alternatives (wet or semi-dry FGD) not being technically feasible at Majuba.

Considering ERP 2024 C, which represents a scenario that would require substantial guarantees, with significant financial implications, SO_2 technologies were evaluated for Tutuka, Lethabo, and Matimba. In previous applications, Eskom's position has been that installation of SO_2 technologies at Lethabo, Tutuka, and Matimba are not economically feasible and are at high risk of not even being technically feasible for implementation; this position is maintained in this application.

Should new plant SO_2 MES compliance be enforced at Tutuka, Lethabo, and Matimba, and since concept and design have not commenced, followed by procurement and construction, an optimistic start date of FY2031 is estimated. Since installation is five years for all generating units, estimated completion dates would be optimistically FY2035. Tutuka starts shutdown in FY2036, one year after completion of the FGD, Lethabo starts shutdown FY2037, two years of completion of FGD, and Matimba starts shutdown FY2039, four years of completion of the FGD. Considering the nominal Capex (-15% to +20%) to install FGD at Tutuka (R38.4 billion), Lethabo (R40 billion), and Matimba (R42 billion), as well as the approximate annual real Opex of R1 billion for each station, return on investment would not be realised and is therefore not economically feasible to install this equipment.

The total nominal Capex to implement ERP 2024 C, inclusive of ERP 2024 A (planned) and ERP 2024 B (with additional guarantees and considerations) is R256.9 billion, with an estimated real Opex of R6.3 billion per year. No detailed energy system modelling has been completed for this study due to timing constraints but previous work has shown that attempts to install FGD at multiple stations simultaneously to bring about rapid MES compliance will result in significant capacity shortages and unprecedented levels of load shedding which will have catastrophic impacts on the economy and the country broadly.

In light of the above, and the currently compliant ambient SO_2 concentrations in the Waterberg, Highveld and Vaal Triangle, the dispersion modelling predictions indicating NAAQS compliance, and the SO_2 emission reductions anticipated in the Eskom Fleet over the next few years, Eskom is requesting exemption from the new plant SO_2 MES. This exemption request is for Medupi until completion of the FGD installations, and Lethabo, Matimba, Majuba, Tutuka, Kendal, Matla and Duvha until their assumed shutdowns (Table 0-3). To reduce SO_2 emissions, the Despatch Prioritisation Strategy will be initiated, while efficiency improvement projects, addressing combustion efficiencies, will be implemented.

While extension of a station's life may provide improved economic viability for SO_2 reduction at certain stations, this would mean an extension of South Africa's reliance on coal generation, potentially impacting South Africa's greenhouse gas (GHG) commitments. A possible alternative to consider, would be that if funding is made available Eskom increases its investments in renewables and grid connection by the same amounts that would have been invested in such SO_2 retrofits; this would result in larger economic value add than FGD retrofits, and would progress South Africa's transition to renewables quicker.

Table 0-3 – Sulphur dioxide requested emission limits and timeframes

STATION	GENERATING UNIT	MAXIMUM RELEASE RATE*			DURATION OF EMISSIONS
		mg/Nm^3	Average	Date To Be Achieved	
DUVHA	All Units	2,600 mg/Nm^3	Daily	Immediate - Shutdown	Continuous
MATLA	All Units	2,600 mg/Nm^3	Daily	Immediate - Shutdown	Continuous
LETHABO	All Units	2,600 mg/Nm^3	Daily	Immediate - Shutdown	Continuous
TUTUKA	All Units	3,000 mg/Nm^3	Daily	Immediate - Shutdown	Continuous
MATIMBA	All Units	3,500 mg/Nm^3	Monthly	Immediate - Shutdown	Continuous
KENDAL	All Units	3,000 mg/Nm^3	Daily	Immediate	Continuous
		1,000 mg/Nm^3	Daily	1 April 2036**	Continuous
MAJUBA	All Units	3,000 mg/Nm^3	Daily	Immediate	Continuous
		2,100 mg/Nm^3	Daily	1 April 2034**	Continuous
MEDUPI	All Units	3,500 mg/Nm^3	Monthly	Immediate	Continuous
		800 mg/Nm^3	Monthly	1 April 2032	Continuous

*Emission limits requested are for normal operations, so excludes upset, startup, shutdown, or maintenance conditions.
**Should semi-dry FGD be installed at Kendal, and DSI FGD at Majuba.

SUMMARY

In addition to the above motivations, is consideration of the Health Cost Benefit Analysis (CBA) undertaken for the Highveld and Vaal Triangle, and Waterberg regions. This analysis evaluated the health benefits and costs associated with ERP 2024 A, ERP 2024 B, and ERP 2024 C. The benefit:cost ratios (BCR) need to be interpreted with care. They are meant only to provide a perspective on and inform the decision-making process underlying the scenarios. They are not meant to be interpreted as a definitive answer to making abatement decisions. Decisions involving human health have to be informed by non-economic criteria as well. In addition, with uncertainty inherent in the analysis, the cost benefit ratio should thus not be viewed as absolute, but rather as a relative value from which to compare scenarios (Prime Africa Consult, 2024).

In the Highveld and Vaal, the CBA concludes that greatest health benefits relative to costs would be realised in ERP 2024 A, with a BCR above 1. While ERP 2024 B approaches 1 in the most optimistic scenarios, it generally shows that costs of installations outweigh the health benefits that will be realised. Implementation of ERP 2024 C is shown that costs of installations far outweigh the health benefits that will be realised, with the BCR well below one. Considering the Waterberg CBA, the BCR's for all scenarios are significantly low, well below 1, concluding that under all scenarios the costs of installation far outweigh the health benefits that will be realised.

Over the past decade, South Africa's electricity system has struggled to meet demand due to frequent breakdowns and reduced capacity, leading to recurrent loadshedding. This crisis has severely impacted the economy, particularly the mining and industrial sectors, causing reduced outputs and a loss of investor confidence and government revenue. Power outages have also affected medical care, food storage, sanitation, water, and sewerage facilities, while citizens faced daily challenges such as extended commutes, increased crime, and difficulties in food preparation. The exemptions applied for aim to ensure that security of supply is maintained and the impacts described above are avoided while minimising the environmental impact of the stations operations.

Eskom is mindful that any exemption application should be limited in extent and believes that the alternative emission limits requested above, and this application in general, complies with this approach. Specifically, Eskom has:

- In respect of PM limits only requested exemption where it is necessary for the time to complete the emission reduction projects to bring the stations into new plant MES compliance. Further, the exemption requested alternate limits is no worse than the MES existing plant limits which the stations have operated at historically.
- In respect of NO_X limits for Lethabo, Tutuka and Majuba, exemptions are requested where it is necessary for the time to complete the emission reduction projects to bring the stations into compliance with the new plant MES. Further, there is compliance to NAAQS ambient air quality limits for NO_2 and the exemption requested alternate limits is no worse than the MES existing plant limits which the stations have operated at historically.
  - In the case of NO_X limits for Duvha and Matla the exemption request is supported by a clear motivation, there is compliance to NAAQS ambient air quality limits for NO_2, and the requested alternate limits are no worse than the MES existing plant limits which the stations have operated at historically.
- In terms of SO_2 the exemption request has provided clear motivation above of the appropriateness of the alternate limits specifically illustrating that there is compliance to NAAQS ambient air quality limits for SO_2. In addition, Eskom is not seeking a blanket exemption as it intends to operate at alternate SO_2 limits generally below the existing plant limits and it will obtain MES compliance for two out of the three priority pollutants at all stations operating post 2035.

In conclusion, Eskom believes that based on the analysis completed for this application the exemptions requested are appropriate and balance the environmental and health impact of its emissions with the national requirement for security of supply and sustainable growth and development.

The public participation phase is complete, which commenced on 6 November 2024 and ended 6 December 2024. The comments received during this process have been responded to, as contained within the Stakeholder Engagement Report. The final Exemption Application reports will be submitted to the Minister of the DFFE to consider the applications. Any further comments can be directed to the Minister.

1 INTRODUCTION

Eskom Holdings SOC Ltd (Eskom) is South Africa's public electricity utility, supplying about 95% of the country's electricity with a generation capacity exceeding 35,000 MW. Around 90% of its power comes from coal-fired stations, primarily located in the Mpumalanga Highveld, with others in the Free State and Limpopo provinces.

Coal-fired power stations must comply with strict environmental regulations under the National Environmental Management: Air Quality Act (NEM:AQA). Eskom sought postponements and alternative limits to the Minimum Emission Standards (MES) for oxides of nitrogen (NO_X), sulphur dioxide (SO_2) and particulate matter (PM) between 2018 and 2020. These applications were necessary due to several factors, such as the restrictive legal framework, the advanced age of Eskom's power plant fleet, and the technical challenges of reducing emissions. The high costs of emission reduction technologies, which could significantly impact electricity tariffs and the financial stability of the utility, further underscored the need for a phased approach to compliance.

In October 2021, the Department of Forestry, Fisheries, and the Environment (DFFE) granted conditional postponements for some power stations (Grootvlei, Arnot, Komati, Camden, Hendrina, Acacia, and Port Rex Power Stations), provided partial refusals for others (Majuba, Tutuka, Kendal, and Kriel), and rejected the applications for Lethabo, Matla, Medupi, Matimba, and Duvha.

In December 2021 Eskom initiated an appeal process, engaging with the DFFE, and other governmental departments, on the basis that immediate compliance would lead to the shutdown of about 16,000 MW of coal-fired capacity. Eskom emphasised that this would negatively impact the national grid and delay South Africa's energy transition, that flu gas desulphurisation (FGD) retrofit on "six-pack" power stations was not proven to be technically feasible and would be a world first, and that if funding was available to execute the required compliance projects in time to meet the MES, this would result in an approximate increase of 10% on existing electricity tariffs (Eskom, 2020).

In May 2024, the Minister approved the MES suspensions for the power stations set to shut down by 31 March 2030 (Hendrina, Grootvlei, Arnot, Camden, and Kriel) and, under Section 59 of NEM:AQA, instructed Eskom to apply for MES exemptions for the remaining stations (Lethabo, Kendal, Tutuka, Matla, Duvha, Majuba, Matimba, and Medupi). The Minister would then assess each application based on its merits and supporting information.

This report presents a summary for the Eskom Fleet exemption application, highlighting the specific environmental and operational challenges it faces. While the primary focus is on the Eskom Fleet, aspects of the Highveld and Vaal Triangle Fleet and Waterberg Fleet are discussed separately. This holistic approach is necessary as a particular station's circumstances cannot be considered in isolation of the entire Eskom Fleet as station performance, emissions impacts, and financial impacts need to be considered cumulatively. By considering the entire Eskom fleet, the report aims to provide a cohesive strategy for reducing emissions and achieving compliance while addressing the unique challenges of each power station. Station specific and cumulative reports are contained in Annexures of this report, as follows:

- Annexure A: Cumulative airshed Atmospheric Impact Report
- Annexure B: Cumulative stack emissions only dispersion modelling
- Annexure C: Airshed specific Health Cost Benefit Analysis

2 LEGAL OVERVIEW

In terms of Section 21 of the NEM:AQA a list of activities which result in atmospheric emissions and which the Minister or Member of the Executive Council (MEC) reasonably believes, have or may have a significant detrimental effect on the environment, must be promulgated. Sections 22, 36 to 49, 61 and 62 provide additional information regarding the Atmospheric Emissions Licence (AEL) requirements and processes to be followed. GNR 893 (22 November 2013), as amended, promulgated in terms of the NEM:AQA, contains a list of activities that would require licensing

2.1 THE MINIMUM EMISSION STANDARDS

In March 2010, the MES was published in terms of the NEM:AQA. The intent is that by setting these emission limits (known as point source limits), overall air quality at the local or ambient level, as defined by the National Ambient Air Quality Standards (NAAQS), will be maintained. In terms of the NEM:AQA, all of Eskom's coal- and liquid fuel-fired power stations are required to meet the MES contained in GNR 893, and as amended in GNR 1207. The MES also provides transitional arrangements in respect of the requirement for existing plants to meet the MES and provided that less stringent limits had to be achieved by existing plants by 1 April 2015, and more stringent “new plant” limits had to be achieved by existing plants by 1 April 2020.

2.1.1 POSTPONEMENT OR SUSPENSION OF COMPLIANCE TIMEFRAMES

Section 12 of GNR 893 (as amended by GNR 1207) provides for the postponement or suspension of compliance timeframes with the MES under specific conditions. This means that facilities may apply to the NAQO for a postponement or suspension, for a maximum of 5 years, if they are unable to comply with the set standards by the required date.

The applicant must demonstrate current or future projects aimed at ensuring eventual compliance. They should also include an air quality impact assessment detailing the implications of continued emissions on the environment and health and evidence of consultation with I&APs.

2.1.2 EXEMPTION FROM MINIMUM EMISSION STANDARDS

Section 59 of the NEM:AQA grants any person, or organ of state, the right to apply for exemption from a provision of the NEM:AQA. These exemptions are typically made where compliance with a provision is economically or technically unfeasible and are generally time-bound and subject to review.

Section 59 of the NEM:AQA provides Eskom the opportunity to apply for exemption from certain provisions of the NEM:AQA. In terms of Section 59, Eskom is required to advertise the application in at least two newspapers circulating nationally and give reasons for the application. The approval of an MES exemption application could potentially limit the constitutional rights of South Africans by leading to environmental degradation, posing health risks, and creating economic and social challenges. As such, an approval would likely be issued subject to a range of conditions to limit potential negative impacts.

2.2 NATIONAL AMBIENT AIR QUALITY STANDARDS

In terms of Section 9 of the NEM:AQA the Minister identified substances in the ambient air that are believed to present a threat to the health, well-being or the environment and has in respect of those substances, established national standards for ambient air quality. These standards provide the permissible amount or concentration of each of the substances in ambient air. The standards contain the averaging periods, concentrations, frequencies of exceedance, compliance dates and reference methods for select substances.

In 2004, the National Ambient Air Quality Standards (NAAQS) were promulgated to better regulate local air quality. The NAAQS define the acceptable levels of environmental risk associated with human exposure to air pollutants. If an area meets the NAAQS, it is considered to have an air quality that poses a legally acceptable level of risk to the environment and human health in South Africa.

The NAAQS relevant to the Eskom Power Stations and this exemption application are sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and particulate matter (PM_{10} and $PM_{2.5}$). The NEM:AQA defines ambient air to exclude air regulated by the Occupational Health and Safety Act (No. 85 of 1993).

2.3 ENFORCEMENT OF PRIORITY AREA MANAGEMENT PLANS

The Regulation for Implementing and Enforcing Priority Air Quality Management Plans of 26 August 2024 (GNR 5153) is a framework established by the South African government to provide for the implementation and enforcement of a priority area's air quality management plans, in terms of sections 19(1)(b) and 19(5) of the NEM:AQA, to strengthen air quality management in identified priority areas with high levels of air pollution. It was published for public comment, allowing stakeholders and the public to provide input before it is finalised.

GNR 5153 is aimed at ensuring that designated priority areas meet national ambient air quality standards. The regulations also establish the mandatory steps for implementing emission reduction and management measures, with the government empowered to monitor their effectiveness and enforce compliance where necessary. They apply to various proponents, including those involved in activities like mining, reclamation, or operating controlled emitters such as power stations. These proponents are required to submit emission reduction and management plans, in terms of the Regulations, within six months of the publication of a priority area AQMP. Once these emission reduction and management plans are approved, they must be implemented within specified timeframes. Additionally, any existing priority area AQMPs, published prior to the commencement of these regulations, must be reviewed by the DFFE within two years to include updated emission reduction targets. These measures ensure that compliance is regularly evaluated and enforced across sectors.

The priority areas defined in South Africa, and applicable to Eskom's exemption application, are the Vaal Triangle Airshed Priority Area (VTAPA), Highveld Priority Area (HPA) and the Waterberg Priority Area (WPA). The Eskom power stations that fall within each of these are:

- Vaal Triangle PA: Lethabo
- Highveld PA: Kusile, Tutuka, Matla, Duvha, Kendal, Majuba, Arnot, Kriel, Grootvlei, Hendrina, and Camden
- Waterberg PA: Medupi and Matimba

Each priority area includes industrial activities, such as power stations, refineries, and other significant emission sources that contribute to poor air quality in the region, such as mining, domestic fuel burning and uncontrolled waste burning. The priority area AQMP's seek to reduce emissions from industries such as power stations and petrochemical plants, with specific focus on reducing SO_2, NO_x, and PM. Specific emission limits, including those tied to MES for industries, are a cornerstone of each AQMP, although the implementation of regulations relevant to priority areas by authorities must also be done under the consideration and indulgence of any MES postponements, suspensions and exemptions granted to emitters. The AQMP's require industries to meet strict MES values and incorporate Best Available Technology (BAT) for emission reduction. These measures include continuous monitoring and improvements, such as reducing fugitive emissions (unintended releases of pollutants, such as dust or gases from industrial activities). The AQMP's also calls for offsets to reduce pollution in other areas as compensation when targets are not immediately achievable. In addition, industries are encouraged to regularly review and update their emission reduction strategies to align with evolving environmental policies.

Adherence to the priority area AQMP's, as it currently stands, is not a legal requirement. The AQMP's outline guidelines and recommended actions for stakeholders in the region to help meet air quality standards. However, while it sets MES and encourages BAT use, its enforcement has been somewhat limited. Non-compliance primarily results in reputational risks or administrative sanctions but is not uniformly enforced across sectors. In terms of the recently published Priority Area Regulations (GNR 5153) the AQMP's must be reviewed within two years of publication of the regulations to include emission reduction targets. Once reviewed, stakeholders (such as industries, municipalities, and other entities operating within a priority area) will be required to develop emission reduction and management plans indicating how they will comply with the agreed emission reduction targets. The regulation also provides enforcement mechanisms, including fines or penalties for non-compliance, making adherence to such air quality management plans legally enforceable. Thus, with the new regulation, failure to comply would result in legal consequences, strengthening the overall governance and impact of air quality management in priority areas.

2.4 ESKOM POWER STATION LEGAL STATUS

Table 2-1 presents the status of Eskom's Atmospheric Emission Licenses (AELs) and which stations are requesting exemption for which pollutant, as part of this application. Considering the stations due for complete shutdown by 2030 (Arnot, Hendrina, Camden, Grootvlei, and Kriel), their suspension applications have been approved by the Minister, and therefore no exemption applications are made in this submission.

Currently, with the exception of Matimba, all Eskom AELs have expired at those stations requesting exemption in this submission. Eskom has submitted AEL renewal applications for all its applicable power stations but the renewal process is on hold until the exemption applications are finalised and decisions made. AELs will be renewed once the exemption process is complete.

Table 2-1 – Eskom Fleet AEL, Suspension, and Exemptions Status

<table>
<tr><th rowspan="2"></th><th rowspan="2">AEL REFERENCE</th><th rowspan="2">EXPIRY</th><th colspan="3">EXEMPTION APPLICATIONS (THIS APPLICATION)</th></tr>
<tr><th>PM</th><th>NO_X</th><th>SO_2</th></tr>
<tr><td>Arnot</td><td>17/4/AEL/MP312/11/15</td><td>10 June 2029</td><td colspan="3" rowspan="5">Suspension applications approved; therefore, no exemption request being made in this application</td></tr>
<tr><td>Camden</td><td>Msukaligwa/Eskom H SOC Ltd/CPS/0012/2024/F04</td><td>31 March 2030</td></tr>
<tr><td>Kriel</td><td>17/AEL/MP312/11/09</td><td>05 August 2029</td></tr>
<tr><td>Grootvlei</td><td>Dipaleseng/Eskom H SOC Ltd/GPS/0015/2024/F04</td><td>31 March 2030</td></tr>
<tr><td>Hendrina</td><td>17/4/AEL/MP312/11/16</td><td>10 June 2029</td></tr>
<tr><td>Duvha</td><td>17/04/AEL/MP312/11/07</td><td>30 June 2022</td><td>Y[1]</td><td>Y</td><td>Y</td></tr>
<tr><td>Matla</td><td>17/4/AEL/MP312/11/14</td><td>30 June 2022</td><td>Y[1]</td><td>Y</td><td>Y</td></tr>
<tr><td>Kendal</td><td>17/4/AEL/MP312/11/15</td><td>30 September 2024</td><td>Y</td><td>N</td><td>Y</td></tr>
<tr><td>Lethabo</td><td>FDDM-MET-2011-08-P1</td><td>31 March 2020</td><td>Y[1]</td><td>Y</td><td>Y</td></tr>
<tr><td>Majuba</td><td>R PKI Seme/Eskom H SOC Ltd MPS/0014/2021/F04</td><td>25 April 2024</td><td>N</td><td>Y</td><td>Y</td></tr>
<tr><td>Tutuka</td><td>Lekwa/Eskom H SOC Ltd TPS/0013/2019/F03</td><td>25 April 2024</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>Matimba</td><td>H16/1/13-WDM05</td><td>27 September 2027</td><td>N</td><td>N</td><td>Y</td></tr>
<tr><td>Medupi</td><td>H16/1/13-AEL/M1/R1</td><td>01 December 2025</td><td>N</td><td>N</td><td>Y</td></tr>
<tr><td colspan="6">Y: Exemption application being made as part of this submission.
N: No exemption application being made as part of this submission i.e. parameter compliant with new plant MES
Y[1]: Limited exemption from MES requested for parameter i.e. certain generating units will comply from 1 April 2025.</td></tr>
</table>

3 CURRENT PERFORMANCE SUMMARY

3.1 CURRENTLY INSTALLED ABATEMENT EQUIPMENT

Currently installed emission abatement equipment at each station within the Eskom Fleet are presented in Table 3-1.

Table 3-1 – Current installed abatement on Eskom Fleet

STATION	CURRENT INSTALLED ABATEMENT
Lethabo	Electrostatic precipitators (ESPs), sulphur trioxide (SO_3) plant, and high frequency power supplies (HFPS) to mitigate PM emissions.
Medupi	Pulse Jet Fabric Filter (PJFF) to mitigate PM emissions Low NO_X Burner (LNB) to mitigate NO_X emissions
Matla	ESPs, HFPS (Unit (U) 1, U2, U4 and U6), and SO_3 plant to mitigate PM emissions
Duvha	ESPs and SO_3 Plants (U4, U5, U6), fabric filters (U1, U2), HFPS (U5) to mitigate PM emissions
Tutuka	ESPs, HFPS (U4, U5, U6) to mitigate PM emissions
Kendal	ESPs, HFPS and SO_3 plant to mitigate PM emissions. Low NO_X boilers designed to mitigate NO_X emissions
Majuba	PJFF to mitigate PM emissions
Matimba	ESPs and SO_3 plant to mitigate PM emissions Low NO_X boilers designed to mitigate NO_X emissions
Kusile	Wet FGD, PJFFP to mitigate PM emissions Low NO_X Burner (LNB) to mitigate NO_X emissions
Arnot	PJFFP to mitigate PM emissions
Kriel	ESP Upgrade, HFPS installation (in progress) and SO_3 plant to mitigate PM emissions
Camden	PJFFP to mitigate PM emissions, LNB to mitigate NO_X emissions
Hendrina	PJFFP to mitigate PM emissions
Grootvlei	PJFFP to mitigate PM emissions, 4-units offline

3.2 CURRENT AND NEW PLANT EMISSION LIMITS

As per each station AEL and/or aligned to each station's 2015 and 2021 postponement applications in which extensions of the current limits were provided until 31 March 2025 for SO_2 and NO_X at some stations, Table 3-2 presents the current and new plant emission limits applicable to those stations applying for exemptions. New plant limits are due to come into effect on 1 April 2025, if not already in effect at a particular station. The exemption requests, as presented in Chapter 7 of this report, are being made in terms of the new plant MES, due to come into effect 1 April 2025.

Table 3-2 – Current and future emission limits applicable to the Eskom Fleet

	PM (mg/Nm^3)		NO_X (mg/Nm^3)		SO_2 (mg/Nm^3)	
	Current	1 April 2025	Current	1 April 2025	Current	1 April 2025
Duvha	100	50	1,100	750	2,300	1,000
Matla – U5, U6	100	50	750	750	2,600	1,000
Matla – South Stack, U4	200	50				
Kendal	100	50	1,100	750	3,500	1,000
Lethabo	100	50	1,100	750	2,600	1,000
Majuba	100	50	1,500	750	3,200	1,000
Tutuka	300	50	1,100	750	3,400	1,000
Matimba	50	50	750	750	3,500*	1,000
Medupi	50	50	750	750	3,500*	1,000
*Approval received for monthly average						

3.3 STATION EMISSIONS PERFORMANCE

Table 3-3 presents average emissions for each station for the period April 2019 – October 2024; importantly, these averages include upset conditions which are not regulated by the emission limits, and therefore the averages presented should be considered as worst-case. As evident, all stations complied with their applicable (current) emission limits for SO_2, with no exceedances of the limit during FY2023/24 (during normal operations). However, as is evident from the averages, no stations will comply with the new plant SO_2 MES (1,000mg/Nm^3) without abatement technology.

Regarding NO_X emissions between April 2019 – October 2024, emission averages have complied with current emission limits at all stations, except for Lethabo, where although the average remains compliant, exceedances of the limit did occur in FY2023/24. While Medupi, Kusile, Matimba, and Kendal will comply with the new plant NO_X MES (750 mg/Nm^3), the remaining stations will not be able to comply without NO_X abatement technology.

During April 2019 – October 2019, and as presented, PM emissions remain the greatest challenge at most stations, except for Duvha Unit (U)1 and U2, Majuba, and Medupi, all of which have pulse jet fabric filters (PJFF). Although the average emission at Matimba complies with the new plant MES, exceedances of this have recently occurred. While Medupi, Matimba, Majuba, and Duvha U1 and U2 will comply with the new plant PM MES (50 mg/Nm^3) by 1 April 2025, the remaining stations cannot comply until the necessary PM abatement projects are complete.

Table 3-3 – Average station emissions between 2019 – 2024 (mg/Nm^3)

	PM (mg/Nm^3)*	NO_X (mg/Nm^3)*	SO^2 (mg/Nm^3)*
Duvha U1, U2	28	796	1,663
Duvha U4, U5, U6	100		
Matla	184	765	1,936
Kendal	341	785	2,055
Lethabo	101	837	1,856
Majuba	20	1,004	1,934
Tutuka	239	818	2,141
Matimba	36	441	2,522
Medupi	27	379	2,689

Red text indicates the average is non-compliant with the current limit.
Orange text indicates that although the average complied with the current limit, exceedances of this limit occurred.
*Emission averages include upset conditions, which are not regulated by the emission limits, and therefore averages presented are worst-case, and not representative of normal operations as regulated by the emission limits.

4 EMISSION REDUCTION PLAN

Coal-fired power stations are subject to strict environmental regulations and monitoring due to their emissions. All coal-fired power stations are required to meet the MES contained in GNR 893 that was issued on 22 November 2013 (as updated by GNR 1207 on 31 October 2018) and promulgated in terms of Section 21 of the NEM: AQA.

Between 2018 and 2020, Eskom submitted applications for postponement, suspension and/or alternative limits to the MES for several of its power stations to the DFFE as the power utility sought more time to implement necessary pollution control technologies for NO_X, SO_2 and PM emissions.

To address emission reductions, Eskom developed an Emission Reduction Plan (ERP) in 2015, with this being updated in 2019 (EERP 2019), 2020 and 2022. In May 2024, as part of the Minister's decision, Eskom were required to review the 2022 ERP, with this having been revised by Eskom in 2024.

Eskom's focus has been on PM emission reductions, which is aligned with the ambient monitoring data from the various stations located through the Waterberg, Highveld and Vaal; importantly these stations represent cumulative ambient concentrations with Eskom not being the sole contributor to measured concentrations. Of the Highveld and Vaal monitoring stations reviewed for this exemption application, for the period 2021 – 2023, all monitoring stations indicated non-compliance with the PM_{10} and $PM_{2.5}$ annual average NAAQS at some point, with numerous exceedances of the NAAQS 24-hour standards also recorded. The Waterberg monitoring stations indicate non-compliance with the PM_{10} and $PM_{2.5}$ NAAQS, with annual exceedances at Marapong, while 24-hr exceedances also occurred more than the permitted frequency of exceedances at Marapong and Medupi.

While PM has been the critical focus, NO_X and SO_2 emission reduction projects have also been considered. However, unlike PM, ambient NO_2 and SO_2 concentrations in the Highveld, Waterberg, and Vaal Triangle for 2021 – 2023 remain below the annual SO_2 and NO_2 NAAQS; although exceedances of the short-term averaging periods (10-minute, hourly, 24-hour, as applicable) of the NAAQS were measured at certain monitoring stations, their frequency of occurrence remained below the permitted frequency of exceedance, remaining compliant with relevant standards.

Following Eskom's review of the 2022 ERP, and to ensure continued focus on emission reductions, Eskom developed the 2024 ERP. In addition to the various abatement equipment upgrades and refurbishments currently being undertaken at each station, predominantly addressing PM emissions through electrostatic precipitator (ESP) refurbishments, high frequency power supply (HFPS) upgrades, SO_3 plant upgrades, and Dust Handling Plant (DHP) upgrades, many of which are already complete, Eskom are also planning and/or evaluating the following to reduce emissions:

- Wet flue gas desulphurisation (FGD) at Medupi (included in previous ERPs)
- Kendal (semi-dry FGD) and Majuba (Duct Sorbent Injection (DSI FGD)) SO_2 reduction projects have been identified as potential alternatives, although are being evaluated as part of this process.
- Low NO_X Burner (LNB) technology at Majuba, Tutuka and Lethabo to mitigate NO_X emissions.
- Despatch Prioritisation Strategy at specific power stations, initiated to reduce SO_2 emissions, however also positively impacting PM and NO_X emissions.
- Efficiency improvement projects under the Generation Recovery Programme to optimise the air-to-fuel ratio which should abate some SO_2 emissions and maximise combustion efficiency.
- The progressive shutdown of coal-fired stations will reduce overall Eskom Fleet emissions.

- Although not a method of reducing emissions at source (i.e. the power stations), the cumulative impact on neighbouring communities is reduced through the air quality offset (addressing emission sources within the community) projects already implemented by Eskom, therefore Eskom are looking to expand this beyond the 35,000 households originally planned.

Figure 4-1 illustrates Eskom's planned or estimated installation dates, linked to the 2024 ERP, for abatement equipment upgrades, retrofits, and new installations. This installation schedule considers:

- Time required to secure funding for each project.
- Lead time required to procure, design, manufacture, and begin installations.
- The outage schedule to allow generating units to be taken offline for upgrades / retrofitting while maintaining security of supply i.e. ensuring sufficient generating capacity remains across the stations to avoid loadshedding.
- To ensure security of supply, generally only a single generating unit at a station can be taken offline at a time, particularly with regards to the long installation timelines of the equipment.

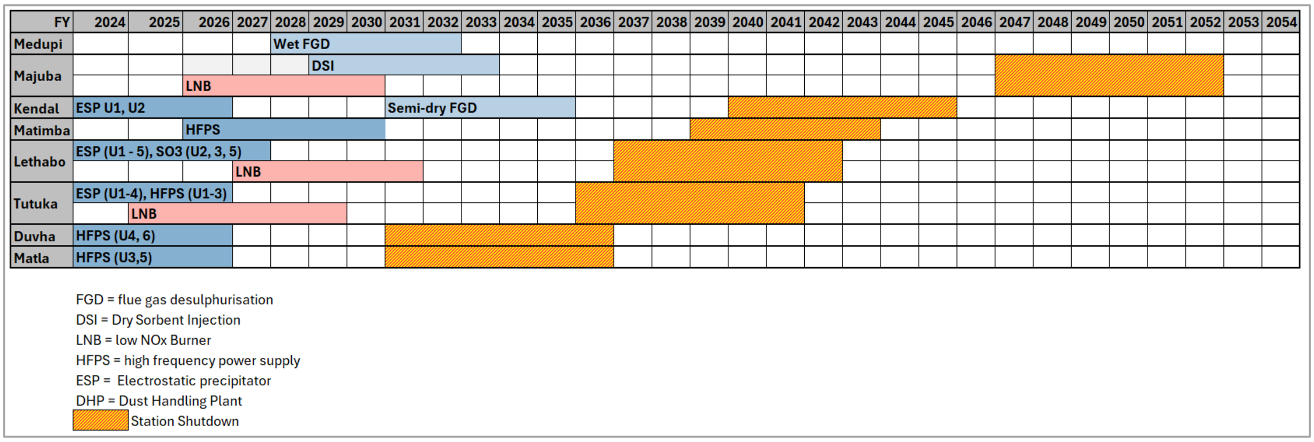


Figure 4-1 - Eskom's abatement equipment installation schedule

Coal beneficiation as a method of reducing SO_2 emissions has been investigated by Eskom and research continues. Investigations to date illustrate the potential for sulphur reduction but various complexities in terms of implementation need to be confirmed and managed such as the energy intensive nature of the process, increased coal mined, and the generation of additional wastewater and coal discards/solid waste. The financial and contractual implications of beneficiation also need to be assessed and shown to be positive for Eskom. Given these uncertainties Eskom has not included any benefit associated with coal beneficiation in the ERP and emission reduction calculations. Any emission reduction identified in this area in future will be considered additional to the 5% improvement in emissions associated with efficiency improvement projects.

Similarly, investigations completed to assess emission reductions using coal with a lower sulphur content confirm that for Eskom to obtain coal with low(er) sulphur content will, in most cases, require sourcing a washed product. This will result in Eskom acquiring coal from the same source pool that services the export market. Purchasing export market coal will result in a significant cost increase for Eskom and this filter though as an increase in electricity prices.

4.1 DESPATCH PRIORITISATION STRATEGY

With the addition of alternate energy sources (wind and solar) on to the national grid planned in the draft IRP, the existing coal fired power stations are expected to provide additional flexibility to the system through increased variability in a load following mode of operation, as well as providing back-up to the variable intermittent non-dispatchable renewable technologies, as well as providing ancillary services, inertia etc. which are not provided by the inverter-based renewable technologies. This essentially results in lower running load factors for these stations as the renewable energy sources will be given priority dispatch over the fossil fuelled stations. Furthermore, South Africa's commitments under the Paris Agreement (with the upcoming revision of the NDC) is expected to result in a new GHG emissions target for 2035. Considering an indicative limit of 125-140 Mt CO_2 per annum from fossil fuel generation from 2031, this equates to average load factors of 40-45% for stations operating in 2031 and between 48% to 55% for stations operating beyond 2035, i.e. after Matla and Duvha shutdown. While the MES and climate change regulatory process are legally separate it is useful to note both ERP 2024 A and the security of supply projection are aligned with Eskom's current pollution prevention plan running to December 2025. Future CO_2 trajectories will be based on the updated pollution prevention plan and IRP, NDC, and Sectorial Emission Targets (SET).

Despatch Prioritisation of renewables reduces SO_2 emissions given the costs associated with SO_2 abatement equipment, complexities of installation, and the age of most stations within the Eskom fleet where return on investment may not be realised. The recent improvement in the reliability of the fleet, allowing Eskom to adopt increased use of Despatch Prioritisation to reduce emissions, is due to a variety of reasons, although most critically the successful implementation of the Generation Recovery Programme. This programme was initiated in March 2023 focusing on specific projects targeting major and minor breakdowns and has improved the generating capacity at stations, allowing improved load management.

To limit emission loads Eskom will not run coal stations at maximum loads but will rather aim to limit the loads to only what is required for system adequacy making maximum use of other available energy sources for generation, resulting in less coal burnt. This reduction in load will result in a reduction in the levels of total emissions from Eskom into the atmosphere. Although the objective is to reduce SO_2 emissions, given the reduced coal burnt, NO_X and PM emissions will also be positively impacted.

Although Despatch Prioritisation will lead to reduced emissions, it is noted this is based on other power generation sources being added to the grid, allowing Eskom to reduce loads overtime. The addition of these alternative generation sources is outside of Eskom's control, and therefore should these not materialise within anticipated timeframes or there is an increase in economic growth, to avoid constraining the economy and ensure continued grid stability and security of supply, in terms of national energy planning Eskom may be required to operate stations at higher loads with increased emissions.

4.2 FLEET EMISSIONS TRAJECTORY AND ABATEMENT PROJECTS

Eskom considered various emission reduction scenarios (ERP alternatives) based on present planning assumptions considering the various abatement initiatives undertaken, planned or being evaluated, energy demand, station shutdowns, and the positive impact of Despatch Prioritisation. No detailed stochastic energy systems analysis, such as is done for the Integrated Resource Plan (IRP), was completed for this exemption application process given time constraints. The energy projections used for the ERP alternatives were based on presently available planning assumptions and Eskom internal projections. Considering security of supply, a fourth emission projection was included, representing an upper emission limit projection based on more conservative assumptions than the original ERP alternatives with the aim to ensure security of electricity supply in the absence of any stochastic energy system analysis is provided. The trajectories considered comprised:

- ERP 2024 A (PM and NO_X reduction, Despatch Prioritisation strategy, and SO_2 abatement at Medupi and Kusile), representing Eskom's planned projection.
- ERP 2024 B (As per ERP 2024 A plus SO_2 reduction technology installed at Majuba and Kendal), representing a projection, that with additional guarantees and strategic decisions, could be achieved.
- ERP 2024 C (As per ERP 2024 A and B, plus SO_2 reduction technology at Lethabo and Tutuka), representing a projection that would require substantial guarantees and considerations of the significant financial impacts, such as on electricity tariffs.
- Eskom's Security of Supply Projection developed using conservative assumptions such as higher electricity demands due to a growing economy, a delay in IPP projects, and a delay in Kusile U6 generating unit coming online.

Each ERP alternative emission trajectory considered, as well as the Security of Supply trajectory, and abatement projects linked to each are illustrated and discussed in the following sections. These sections consider a 2025 baseline for comparative purposes which better represents Eskom's current performance in meeting national demand as opposed to 2019, when loadshedding was in place, constraining the economy and reducing demand. While the below sections refer to requested exemptions, the motivations for these exemptions are provided in Chapter 7 of this report. For the following sections, it is assumed that the proposed FGD retrofit type (where applicable) on a 'six-pack' power station has proven to be technically feasible, notwithstanding that it would be a world-first.

4.2.1 PARTICULATE MATTER

PM emissions at most power stations remain a challenge, and without the necessary abatement projects will not achieve MES compliance, except for those already in compliance. Table 4-1 presents complete and planned PM related projects, and the date of when the last abatement project will be complete. Given the ambient levels of PM it is important for the Eskom Fleet to comply with the new plant PM MES, and therefore all projects presented below are included in ERP 2024 A, ERP 2024 B, ERP 2024 C, and the Security of Supply trajectory. Eskom is committed to and will be commissioning these projects, if not already commissioned. The following highlights are noted:

- Duvha U1 and U2, Medupi, and Majuba have no PM projects planned as these stations have PJFF and comply with the new plant MES.
- Although Matimba has recently experienced elevated PM emissions, these are being addressed which will ensure compliance with the new plant MES from 1 April 2025; despite this compliance, HFPS installations are planned for Matimba to reduce emissions further. Since emissions will comply by 1 April 2025 with the new plant MES, priority has been given to other station's abatement projects to bring them into compliance, after which Matimba projects will commence.
- Regarding Duvha U4, U5, and U6, Matla, Kendal, Lethabo, and Tutuka, compliance with the new plant MES can only be achieved once these abatement projects are complete.

Considering the timeframes to complete these projects, some of which will not be complete by 1 April 2025, exemptions from the new plant PM MES are being requested, specifically for Duvha (U4, U5, U6), Kendal, Lethabo (U1, U2, U3, U4, U5), Matla (U4, U5, U6), and Tutuka. Critically, once these projects are complete, the Eskom Fleet will comply with the new plant MES.

Table 4-1 – Status of particulate matter abatement projects

	ERP Alternative	Complete	Planned	Timeframe to Full Completion
Duvha U1, U2	ERP 2024 A; ERP 2024 B; ERP 2024 C	Not required	None	N/A
Duvha U4, U5, U6		U5 HFPS	U4 and U6 HFPS	1 April 2026 (U4, U6)
Matla		All Unit ESP upgrades; HFPS on U1, U2, U4, U6	HFPS on U3, U5	1 April 2026 (U4, U5, U6)
Kendal		HFPS on all units; ESP upgrades on U3, U4, U5, U6; SO_3 plant refurbishment on all units; DHP overhauls on U2, U3, U4, U5, U6	ESP upgrade U2; DHP overhaul U1	1 October 2025 (U1, U4, U6); 1 April 2026 (U1, U2, U5)
Lethabo		ESP upgrade U6; HFPS on all units; SO_3 plant upgrades on U1, U4, U6	ESP upgrade U1, U2, U3, U4, U5; SO_3 plant upgrades U2, U3, U5	1 April 2026 (U2, U3) 1 October 2026 (U5) 1 April 2027 (U4) 1 October 2027 (U1)
Majuba		Not required	None	N/A
Tutuka		ESP upgrades U6, U5; HFPS U4, U6	ESP upgrades U1, U2, U3, U4; DHP refurb U1, U2, U3, U4; HFPS U1, U2, U3, U5; SO_3 flue gas conditioning	1 January 2027
Kusile		Not required	None	N/A
Matimba		Not required	HFPS on U1, U2, U3, U4, U5, U6	31 March 2030
Medupi		Not required	None	N/A
*Includes required optimisation periods of new equipment				

PM emission trajectories associated with ERP 2024 A, ERP 2024 B, ERP 2024 C and the Security of Supply are illustrated in Figure 4-2. As noted, all alternatives considered the same PM abatement installed at Tutuka, Matla, Duvha, Kendal, Lethabo, and Matimba, so have the same trajectories, while the Security of Supply trajectory includes these projects as well as increased generation to meet demand assumptions.

From FY2025, emissions are anticipated to reduce sharply until FY2028 due to the PM abatement projects at Tutuka, Matla, Duvha, Kendal and Lethabo, as well as the progression of the assumed shutdown phases at Grootvlei, Hendrina, Arnot, Kriel, and Camden. From FY2030, PM emissions remain consistently low, showing further reductions from FY2040 due to stations assumed to be entering shutdown phases. By FY2030, compared to FY2025 (actuals), Eskom Fleet PM emissions are anticipated to have reduced by 65kt, representing a 74% reduction, after which emissions will gradually reduce as stations enter shutdown. Between FY2025 and FY2050, a total PM emissions reduction of 94% (82kt) is estimated.

Considering Eskom's Security of Supply projection, representing an upper emissions limit, emissions show a similar trend to the ERP projections, although are marginally higher between FY2026 to FY2030 due to the conservativeness of this projection. By FY2030, a PM reduction of 64kt (71%) is estimated, with a further reduction by FY2035 of 6.5kt (25%). As noted, this is an upper emissions projection, the same trend of emission reductions year on year is evident from FY2026.

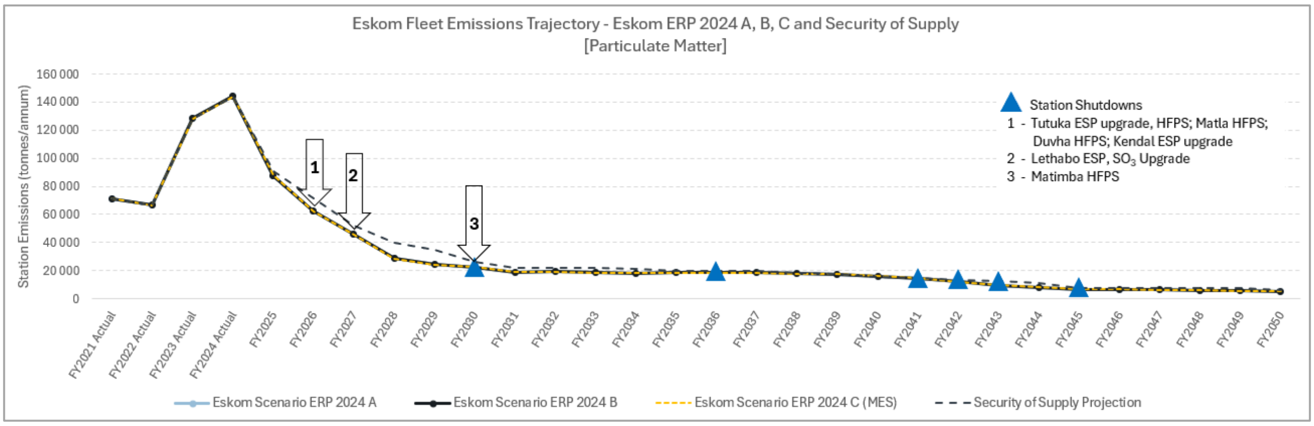


Figure 4-2 - Eskom Fleet particulate matter trajectories

While the abovementioned emission trajectories show significant improvements in the next few years due to the planned projects and station shutdowns, to offset Eskom PM emissions further, Eskom has introduced an air quality offset (AQO) program, a key component of Eskom's ERP. This program aims to offset PM emissions by implementing interventions that deliver net ambient air quality benefits, focusing on PM_{10} and $PM_{2.5}$. While the focus is on PM emitting activities in the communities, addressing low-level and indoor pollution, through these initiatives other pollutants are also impacted positively, as illustrated below. These improvements have direct impacts on concentrations communities are exposed to.

In the Highveld and Vaal Triangle, key interventions include the distribution of hybrid stoves, ceilings, electrical rewiring, and LPG heaters to households, as well as cleanup campaigns to remove illegally dumped waste. The program has been implemented in phases, with Phase 1 targeting Kwazamokuhle, Ezamokuhle, and Sharpeville. Preliminary results show significant reductions in PM_{10} and $PM_{2.5}$ concentrations and improvements in indoor air quality in participating households. Eskom plans to expand its AQO program to additional communities and explore new interventions, such as dust suppression on unpaved roads, and veld fire management. Air Resource Management (Pty) Ltd (ARM) have been appointed by Eskom to undertake planning, monitoring, and verification of Phase 1 of Eskom's AQO Plan at Kwazamokuhle, Ezamokuhle, and Sharpeville. In Kwazamokuhle and Ezamokuhle ARM have calculated a net reduction in emissions, with reductions in PM_{10} (132t), $PM_{2.5}$ (123t), as well as carbon monoxide (CO), SO_2, NO_2, and volatile organic compounds (VOCs). These emission reductions occur at ground-level and within households, so have real improvements on public health.

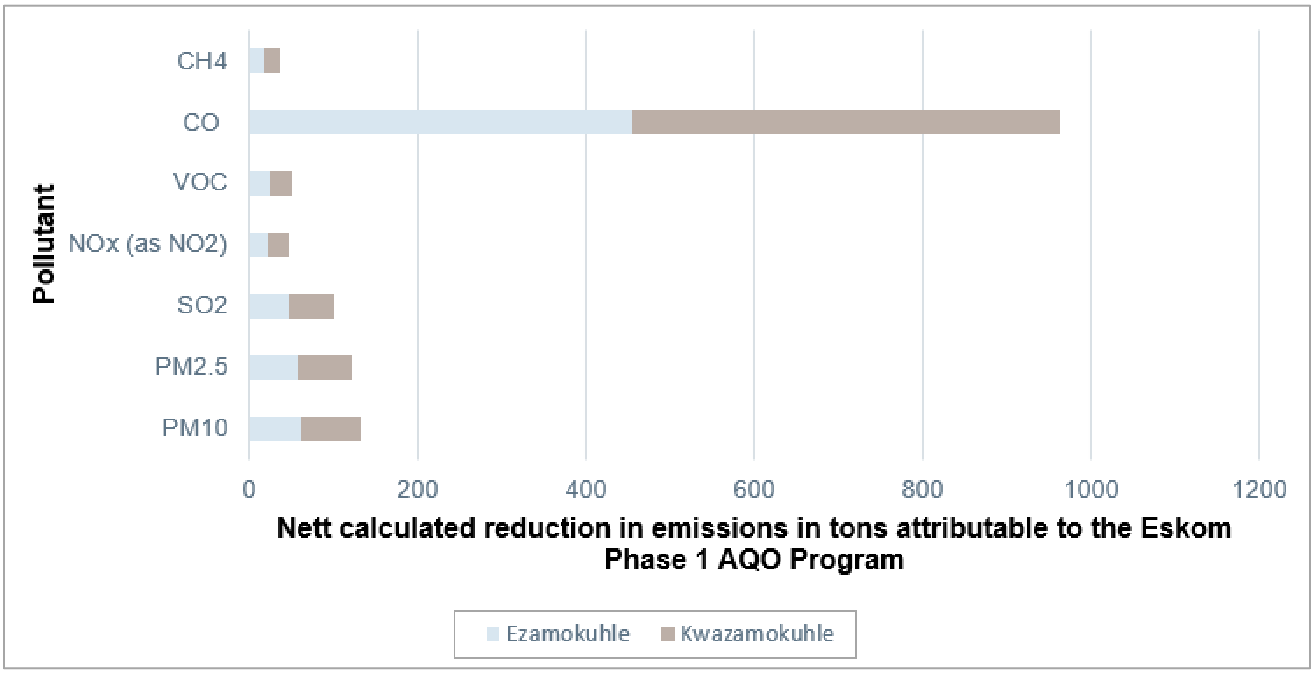


Figure 4-3 - Total net reduction in emissions attributable to Eskom's Phase 1 AQO Project (tonnes) for Ezamokuhle and Kwazamokuhle (Air Resource Management, 2024)

In the Waterberg area key interventions include introducing cleaner household energy sources, managing waste burning, reforestation, and surfacing bare public grounds. Research into Eskom's potential AQO initiatives is ongoing, focusing on interventions that reduce PM and SO_2 emissions to create the greatest positive impact in specific communities. Biomass fuel burning in Marapong has been identified as a significant contributor to emissions. While no direct offset solution for SO_2 emissions has been identified, the focus remains on PM reduction, with AQO initiatives running concurrently with onsite emissions reduction projects.

4.2.2 OXIDES OF NITROGEN

As noted previously, NO_X emissions at Kendal, Matimba, and Medupi will comply with the new plant MES from 1 April 2025, and therefore no NO_X abatement projects are planned at these stations. The remaining stations will require NO_X abatement technologies to achieve compliance with the new plant MES. Of these, LNB installations are planned for Majuba, Tutuka and Lethabo, although given the timeframes to complete, will not comply with the new plant MES by 1 April 2025. Given the assumed shutdown phases of Matla and Duvha (both assumed to be commencing in 2030), NO_X abatement technologies at these stations are not planned as the stations would be shutting down at the same time as the NO_X upgrades was underway.

Considering the timeframes of the LNB installations, and that abatement is not planned at Matla and Duvha, exemptions from the new plant NO_X MES are being requested for Majuba, Tutuka, and Lethabo until completion of the LNB installations, and at Duvha and Matla until shutdown.

Table 4-2 – Status of NO_X abatement projects

	ERP Alternative	Complete	Planned	Timeframe to Full Completion
Duvha	ERP 2024 A; ERP 2024 B; ERP 2024 C	None	None	N/A
Matla		None	None	N/A
Kendal		Not Required	None	N/A
Lethabo		None	LNB	1 April 2031
Majuba		None	LNB	1 April 2030
Tutuka		None	LNB	1 January 2028
Kusile		LNB	None	N/A
Matimba		Not Required	None	N/A
Medupi		LNB	None	N/A
*Includes required optimisation periods of new equipment				

NO_X emission trajectories associated with ERP 2024 A, ERP 2024 B, ERP 2024 C and the Security of Supply are illustrated in Figure 4-4. All Scenario's ERP 2024 A, ERP 2024 B, and ERP 2024 C assume the same NO_X abatement installed; that is LNBs at Tutuka, Majuba, and Lethabo, therefore the emission trajectory for each is the same, while the Security of Supply includes this abatement this is based on an increased electricity demand.

From FY2025, emissions are anticipated to reduce in the coming years due to the burner efficiency improvement projects, Despatch Prioritisation initiated to address SO_2 emissions, station shutdowns assumed to be complete by FY2030 (Grootvlei, Camden, Hendrina, Arnot, and Kriel), Duvha and Matla assumed to be entering shutdown phase in FY2031, and the completion of the LNB abatement on Tutuka (FY2029), Majuba (FY2030), and Lethabo (FY2031). By FY2030, compared to FY2025 (actuals), Eskom Fleet NO_X emissions are anticipated to have reduced by 292kt, representing a 40% reduction. Emissions remain stable until FY2041, after which further reductions will occur due to stations entering shutdown. Between FY2025 and FY2050, a total NO_X emissions reduction of 78% (574kt) is estimated.

Considering Eskom's Security of Supply projection, representing an upper emissions limit, emissions increase to FY2026, remaining above the ERP 2024 A, B, and C projections, given the conservativeness of the Security of Supply projection, although by FY2030 shows a 256kt (33%) reduction and is more closely aligned with the ERP projections. By FY2035, a further 151kt (29%) reduction is estimated and aligns more closely with the ERP projections and shows closer alignment until FY2041. As noted, although this is an upper emissions projection, the same trend of emission reductions year on year is evident from FY2026.

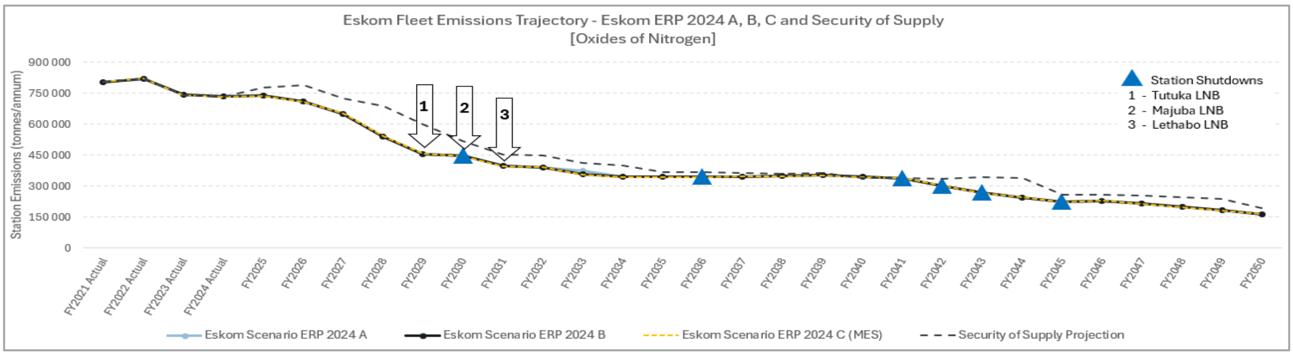


Figure 4-4 - Eskom Fleet oxides of nitrogen emission trajectories

4.2.3 SULPHUR DIOXIDE

The Eskom Fleet complies with each stations current plant SO_2 MES, with the Highveld and Vaal Fleet measuring an average emission between 2019 – 2024 of 1,930mg/Nm^3, and the Waterberg an average emission of 2,606mg/Nm^3, although without abatement technologies will not comply with the new plant MES (1,000mg/Nm^3). Table 4-3 presents planned and/or evaluated SO_2 abatement projects. To achieve SO_2 MES new plant limits, Medupi will install a wet FGD, due to commence in FY2028, with completion in FY2032, while Kusile has FGD installed, both are included as part of ERP 2024 A. The Majuba DSI FGD and Kendal semi-dry FGD are assessed in the ERP 2024 B alternative and presented in Table 4-3, although their commissioning requires various considerations and is not the recommended option ,as presented in Chapter 7 of this report. Should the semi-dry FGD be commissioned at Kendal, new plant MES compliance will be achieved. Regarding the DSI FGD being evaluated for Majuba, although this would reduce SO_2 emissions, this would not achieve MES compliance.

Considering the commissioning timeframes of the SO_2 abatement technologies, exemptions from the new plant MES are requested for Medupi until completion of the installations. Should installations proceed at Majuba and Kendal, despite the recommendations of this report, and assuming it is technically feasible, exemptions are requested until completion of these installations. For Matla, Duvha, Lethabo, Tutuka, and Matimba, since SO_2 abatement is not being evaluated for these stations, exemption from the new plant SO_2 MES is requested until shutdown; motivations for each are provided in Chapter 7 of this report. Alternate SO_2 emission limits below the existing plant limits are being requested for all stations (except Matimba).

Table 4-3 – Status of SO_2 abatement projects

	ERP Alternative	Complete	Planned	Evaluation[1]	Exemption Request[2]	Timeframe to Full Completion
Duvha	-	-	-	-	-	N/A
Matla	-	-	-	-	-	N/A
Kusile	ERP 2024 A	Wet FGD	-	-	-	N/A
Medupi	ERP 2024 A	-	Wet FGD	-	-	1 April 2032
Kendal	ERP 2024 B	-	-	Semi-Dry FGD[2]	-	1 April 2036
Majuba	ERP 2024 B	-	-	DSI FGD[2]	-	1 April 2034
Lethabo	ERP 2024 C	-	-	-	Semi-Dry FGD	N/A
Tutuka	ERP 2024 C	-	-	-	Semi-Dry FGD	N/A
Matimba	ERP 2024 C	-	-	-	Semi-Dry FGD	N/A

[1]Considered an alternative and is being evaluated as part of this application
[2]While technologies are included in this table, exemption for these is being requested, with this position maintained by Eskom from previous applications, and therefore no completion dates are provided as concept and design has not commenced.

As noted previously, scenario ERP 2024 A assumed only the FGD installation at Kusile and Medupi (completion in 2032), with no other stations receiving SO_2 abatement technology. Scenario ERP 2024 B assumed SO_2 abatement installations at Kusile, Medupi, Kendal, and Majuba, representing a potentially practical option with certain considerations, if proven to be technically feasible. Scenario ERP 2024 C assumed SO_2 abatement installed at Kusile, Matimba, Medupi, Kendal, Majuba, Lethabo, and Tutuka (Matla and Duvha were not given FGD as it cannot be practically installed given their shutdown before 2035).

As illustrated in Figure 4-5, all three scenarios remain similar until FY2032, when the Majuba DSI FGD takes effect, followed by the Kendal FGD, resulting in ERP 2024 B and ERP 2024 C having lower emissions than ERP 2024 A. In FY2036, ERP 2024 C reduces further due to a combination of SO_2 abatement technology at Matimba, Lethabo and Tutuka, and completion of the Duvha and Matla shutdowns. While actual emissions show a reduction from ERP 2024 A to ERP 2024 B and C, considering the cumulative Highveld and Vaal dispersion modelling predictions at receptors, ERP 2024 A, which only assumes SO_2 abatement at Kusile, still shows full MES compliance, without abatement at Kendal and Majuba. The modelling predictions show ERP 2024 B, which assumes Kendal and Majuba abatement, have slightly lower ambient concentrations than ERP 2024 A, while these reduce further for ERP 2024 C, although crucially all modelling scenarios predict full MES compliance (discussed further in Chapter 5).

Considering ERP 2024 A, by FY2030, compared to FY2025 (actuals), Eskom Fleet SO_2 emissions are anticipated to have reduced by 555kt, representing a 32% reduction in emissions. In FY2035, compared to FY2030, a further reduction of 165kt (14%) is anticipated, and by FY2040 a further 6% reduction is anticipated. Between FY2025 and FY2050, a total SO_2 emissions reduction of 85% (1.45Mt) is estimated.

Regarding Eskom's Security of Supply projection, representing an upper emissions limit, emissions increase to FY2026, remaining above the ERP 2024 A, B, and C projections, although by FY2030 shows a 482kt (27%) reduction and is more closely aligned with the ERP projections. By FY2035, the Security of Supply projection shows a further reduction of 294kt (23%) and aligns more closely with the ERP projections, and from FY2036 shows closer alignment until FY2050. Crucially, although this is an upper emissions projection, the same trend of emission reductions year on year is evident from FY2026.

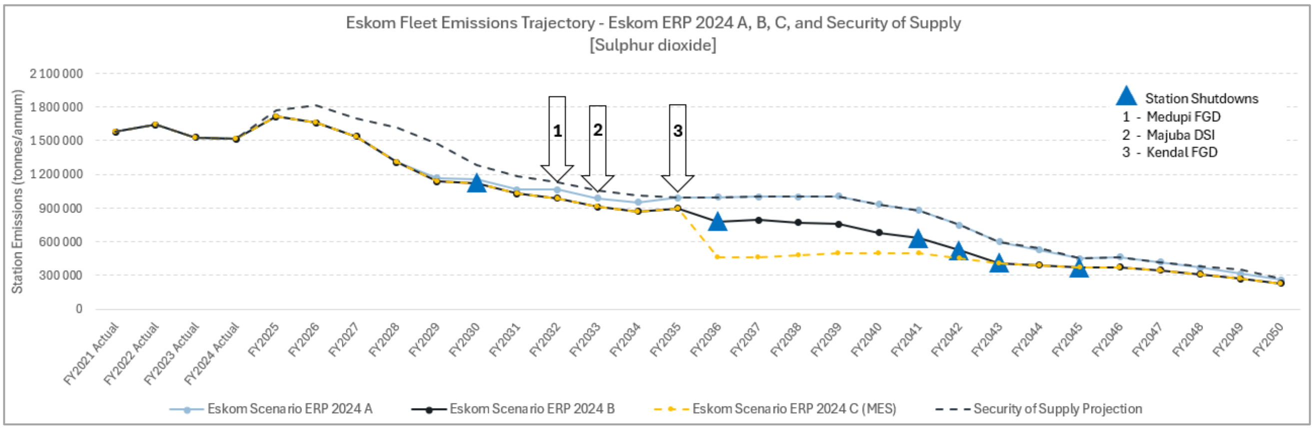


Figure 4-5 - Eskom Fleet sulphur dioxide emission trajectories

4.2.3.1 Abatement Technology Impacts

While SO_2 abatement technologies will lead to reduced SO_2 emissions, the impacts of this technology also need to be considered, predominantly impacting water, waste, and carbon dioxide (CO_2) emissions.

Impacts on Water

Wet FGD, while having higher efficiency in SO_2 removal (up to 98%), has higher operational complexity and environmental impact due to its high-water usage. Semi-dry FGD's have a lower water requirement than wet FGD and a smaller footprint, with no wastewater production, simplifying water management, however there will still be an increase in water usage from current operations.

Power generation is identified as a strategic water use in terms of the National Water Act (Act No. 36 of 1998) and is provided with the highest assurance of supply (99.5 %) in the operation of all water resource systems in the country (National Water Resources Strategy -3 (NWRS-3), DWS 2023). However, a key goal of the NWRS-3 is reducing water demand, and while water supply for electricity generation is afforded priority it is not unlimited and has to be balanced with other strategic objectives of the NWRS-3. The NWRS-3 does refer to the disadvantage of the proposed FGD technology with its high-water usage, and due to water scarcity in the country, recommends further research on alternative technologies and options to meet the future Eskom water demand (DWS, NWRS-3, 2023). Future allocations to meet the increased water supply, should FGD's be installed, to Eskom can thus not be guaranteed if it's not aligned with the strategic goals of the NWRS-3 and imperatives to reduce water demand, increase water conservation and improve water use efficiency.

Table 4-4 presents increased water requirements should SO_2 abatement technologies be installed. Largest increases occur at Medupi due to wet FGD being installed and should the semi-dry FGD at Matimba be installed, a total of 15.3 million m^3/annum would be required, in addition to the current water requirements, with both Medupi and Matimba extracting from the Mokolo River Catchment. While the water balance of the Mokolo system has allocated for this, authorised until 2051, this is allocated from both the Mokolo Dam and MCWAP-2A, with Phase 2A only being available from 2028. Further, based on the 2023/2024 DWS Annual Operating Analyses (AOA) conducted for the Mokolo River System, deficit in the water supply in the Mokolo catchment is expected in 2025, with water security predicted to be low between 2025 to 2028. All scenarios analysed for the AOA indicated that a shortage of water and the risk of violating the assurance of supply to Eskom could happen as early as 2025 (prior to FGD technology). Severe water restrictions will be required from 2025 to 2028 for all users (including Matimba and Medupi power stations for its current water requirement).

Water for Kendal, Majuba, Lethabo, and Tutuka is suppled from the Integrated Vaal River System (IVRS) via various subsystems. Should SO_2 MES compliance be enforced (i.e. semi-dry FGD at Kendal, Lethabo and Tutuka), an additional 16.1 million m^3/annum of water will be required to operate the FGDs. Each station could meet this additional requirement due to their low current water use due to low load factors. However, should loads increase, stations may require additional allocations from the IVRS. This additional supply is not necessarily available over the short-term, with limited water supply development potential existing in the IVRS, with water security remaining a risk. The water security risk from IVRS will be alleviated with the LHWP-Phase 2, expected to be online post 2030.

Table 4-4 – Increase in water use due to SO_2 abatement

	ERP Alternative	Technology	Water Increase (m^3/a)	Water Increase (%)	Water Catchment
Medupi	ERP 2024 A	Wet FGD	9.7 million	146%	Mokolo River
Kendal	ERP 2024 B	Semi-Dry FGD	5.8 million	67%	Upper Olifants
Majuba	ERP 2024 B	DSI[1]	negligible	0%	Upper Vaal
Lethabo	ERP 2024 C	Semi-Dry FGD	5.2 million	13%	Upper Vaal

	ERP Alternative	Technology	Water Increase (m^3/a)	Water Increase (%)	Water Catchment
Tutuka	ERP 2024 C	Semi-Dry FGD	5.1 million	23%	Upper Vaal
Matimba	ERP 2024 C	Semi-Dry FGD	5.6 million	180%	Mokolo River
[1]DSI technology is a dry FGD process, and therefore negligible increase in water is anticipated.					

Impacts on Waste

FGD technology will impact waste production at each station, introducing new waste management challenges. The FGD process typically produces a byproduct known as calcium sulphates (gypsum in the case of wet FGDs), which, based on DFFE waste management requirements, must be managed and stored separately from existing waste streams like ash. Implementing FGD increases both the volume of waste generated and the complexity of waste handling infrastructure. Since co-disposal is not permitted by DFFE, stations will be required to design and construct new facilities to accommodate the gypsum, which requires additional approvals, water management, operational adjustments, and new handling infrastructure. This added waste stream, combined with the increased water use needed for the FGD process, can substantially impact the overall environmental footprint of the facility, making waste management a critical aspect of FGD implementation. Table 4-5 presents estimated waste increases due to SO_2 abatement technologies.

Table 4-5 – Increase in waste production due to SO_2 abatement

	ERP Alternative	Technology	Average Increase (t/a)[1]	Waste Increase (%)
Medupi	ERP 2024 A	Wet FGD	2.7 million	54%
Kendal	ERP 2024 B	Semi-Dry FGD	932kt	31%
Majuba	ERP 2024 B	DSI FGD	931kt	22%
Lethabo	ERP 2024 C	Semi-Dry FGD	840kt	11%
Tutuka	ERP 2024 C	Semi-Dry FGD	827kt	24%
Matimba	ERP 2024 C	Semi-Dry FGD	904kt	18%
[1]Once installation are complete on all generating units.				

Impacts on Carbon Dioxide Emissions

South Africa's revised Nationally Determined Contribution (NDC) will significantly impact Eskom, as most mitigation in the updated NDC target needs to come from the electricity sector which now accounts for approximately 41% of South Africa's greenhouse gas (GHG) emissions. Eskom will need to decommission multiple coal-fired power stations over the next decade for South Africa to align to the objectives of international climate agreements. This means that coal-fired power stations would need to be supplemented with generation capacity from renewable and lower carbon technologies to meet South Africa's climate change commitments while maintaining security of supply. Preliminary analysis by the department shows that greenhouse gases from fossil fuel power generation will need to be limited to 125 – 140Mt CO_2 per annum in 2030 for South Africa to remain within the upper end of the NDC for 2030. While a new NDC is still being developed for 2035, the range (125 – 140 Mt CO_2 per annum) is maintained in the modelling from 2031.

Table 4-6 presents estimated CO_2 increases due to FGD installations, while Figure 4-6 illustrates the addition of CO_2 from the FGD's to Eskom's current estimated CO_2 emissions for the fleet. While the

MES and climate change regulatory process are legally separate it is useful to note both ERP 2024 A and the security of supply projection are aligned with Eskom's current pollution prevention plan running to December 2025. Future CO_2 trajectories will be based on the updated pollution prevention plan and IRP, NDC, and Sectorial Emission Targets (SET).

Due to the FGD installations, should these occur at all stations (ERP 2024 C), an estimated total of 25Mt CO_2 would be added to the Eskom Fleet. Considering each scenario, ERP 2024 A (Medupi only, excluding Kusile), would add 453kt CO_2 per annum; ERP 2024 B would add a further 436kt CO_2, while ERP 2024 C would increase this by a further 481kt. In total, should ERP 2024 C be enforced, a total of 1.5Mt CO_2 per annum would be added to Eskom's GHG emissions. While the focus on reducing CO_2 emissions from coal generation is noted, considering the annual increase in CO_2 emissions due to the FGDs, and Eskom's 2030 CO_2 targets, these annual increases are unlikely to significantly impact Eskom emissions in 2030.

More significantly, if a large investment is required to improve MES compliance at a coal-fired power station, this will drive longer lifetimes and/or higher load factors to achieve a reasonable cost-benefit, which will result in additional CO_2 emissions, and extending South Africa's reliance on coal power generation.

Table 4-6 – Increase in CO_2 emissions due to SO_2 abatement

	ERP Alternative	Technology	Total Increase (t)	Average Increase (t/a)[1]	Contribution to Eskom 2031 target (pa)[2]
Medupi	ERP 2024 A	Wet FGD	10.4 million	453kt	0.32%
Kendal	ERP 2024 B	Semi-Dry FGD	3.8 million	263kt	0.19%
Majuba	ERP 2024 B	DSI FGD	3.8 million	173kt	0.12%
Lethabo	ERP 2024 C	Semi-Dry FGD	2.3 million	211kt	0.15%
Tutuka	ERP 2024 C	Semi-Dry FGD	1.9 million	193kt	0.14%
Matimba	ERP 2024 C	Semi-Dry FGD	3.3 million	251kt	0.18%
		TOTAL	25.5 million	1.5 million	1.1%

[1]Once installation are complete on all generating units.
[2]Contribution to the 2031 target for Eskom based on South Africa's commitment to limit fossil fuel generation to 125 – 140Mt CO_2 per annum.

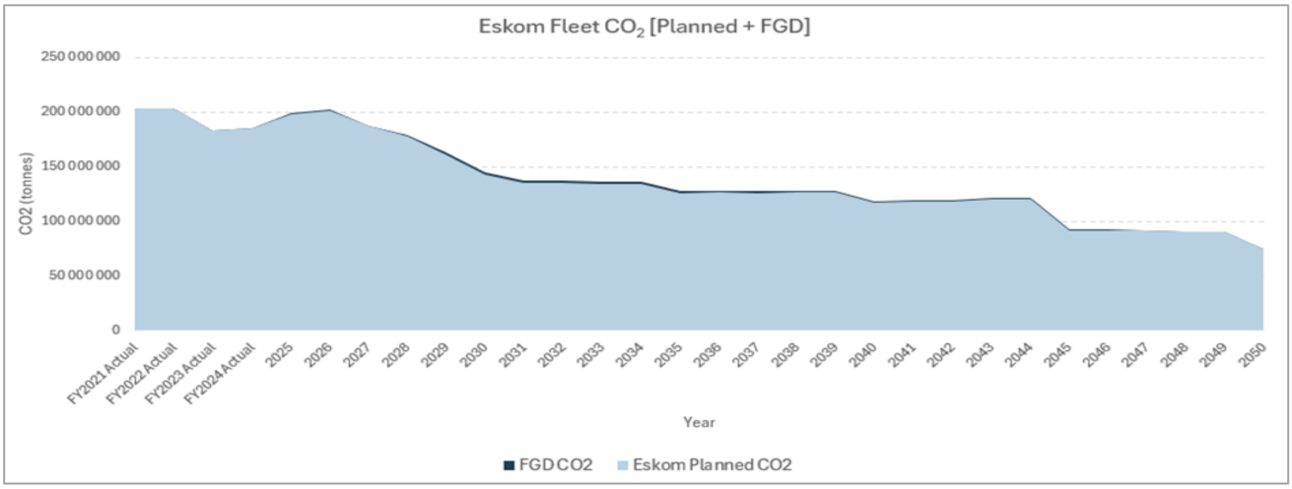


Figure 4-6 – Eskom coal-fired fleet CO_2 emission trajectory and contribution from FGDs

5 ESKOM FLEET AIR QUALITY IMPACTS

5.1 HEALTH IMPACTS

A coal-fired power station releases impurities into the air during coal combustion in the boiler. These pollutants are released through stacks, where they are diluted and endure chemical transformations before ultimately reaching the surface. Here, they may be inhaled or impact the physical environment. The pollutants include SO_2, NO_X, polycyclic aromatic hydrocarbons, and trace substances such as mercury.

The effects of coal combustion-associated air pollution on health are recognised worldwide. The sensitive receptors mainly consist of schools, hospitals, and other locations where children, the elderly, and the infirm might reside. While many factors impact air quality, air pollution exposure in communities near coal-fired power stations is significantly higher than areas without these facilities.

Air emissions are responsible for a variety of detrimental health effects. Examples of these effects include respiratory diseases, lung cancer, cardiovascular diseases, and neurodevelopmental disorders. Potential health impacts associated with power station emissions are outlined below:

- SO_2 that potentially contributes to respiratory illnesses (chronic bronchitis, nasal, throat and lung irritations, asthma attacks) and cardiovascular disease.
- $PM_{2.5}$ is the air pollutant responsible for the most significant health issues and premature mortality. $PM_{2.5}$ is more likely to penetrate and accumulate on the surface of the deeper lung regions. Furthermore:
  - Short-term exposure to $PM_{2.5}$ is linked to premature mortality, acute and chronic bronchitis, asthma attacks, and other respiratory symptoms, as well as heart or lung distress. Infants, children, and older individuals who have preexisting cardiac or lung diseases are more likely to experience these adverse health effects.
  - Long-term exposure to $PM_{2.5}$ (months to years) has been associated with reduced lung function growth in children and premature death, particularly in those with chronic heart or lung diseases.
- PM_{10} contributes to adverse health effects as it is more likely to deposit on the surfaces of the larger airways of the upper lung region, inducing tissue damage and lung inflammation.
  - There is evidence of the adverse effects of short-term exposure on respiratory health.
  - The consequences of prolonged exposure to PM_{10} are less certain, although studies indicate a correlation between respiratory mortality and long-term PM_{10} exposure.
- Nitrogen oxides contribute to respiratory illnesses (e.g., respiratory infection, asthma, chronic bronchitis) and smog.
- Mercury and other heavy metals have been associated with neurological and developmental impairment in humans.

Noting the above issues, the NAAQS described in section 3.2 above were established to protect air quality and public health. Compliance with the standard in an area implies that the area is exposed to an acceptable level of risk from air quality impacts and air quality related health issues. This does not imply that there is no risk associated with lower levels of pollutants in the atmosphere but there is arguably no acceptable risk to some pollutants and the NAAQS thus represent what is considered acceptable in the South African context. The benefit-cost analysis discussed below attempts to put a financial cost on these health impacts.

Considering the existing activities in each airshed impacting air quality, ensuring improvement in air quality in the area and public health requires a targeted, practical and integrated approach to emissions management in the area.

It can also be noted that unplanned electricity outages through load shedding can also result in health impacts due to challenges with the availability of medical facilities, water provision and food storage challenges for example.

5.2 HIGHVELD AND VAAL TRIANGLE FLEET – AIR QUALITY

5.2.1 BASELINE AMBIENT AIR QUALITY MONITORING DATA

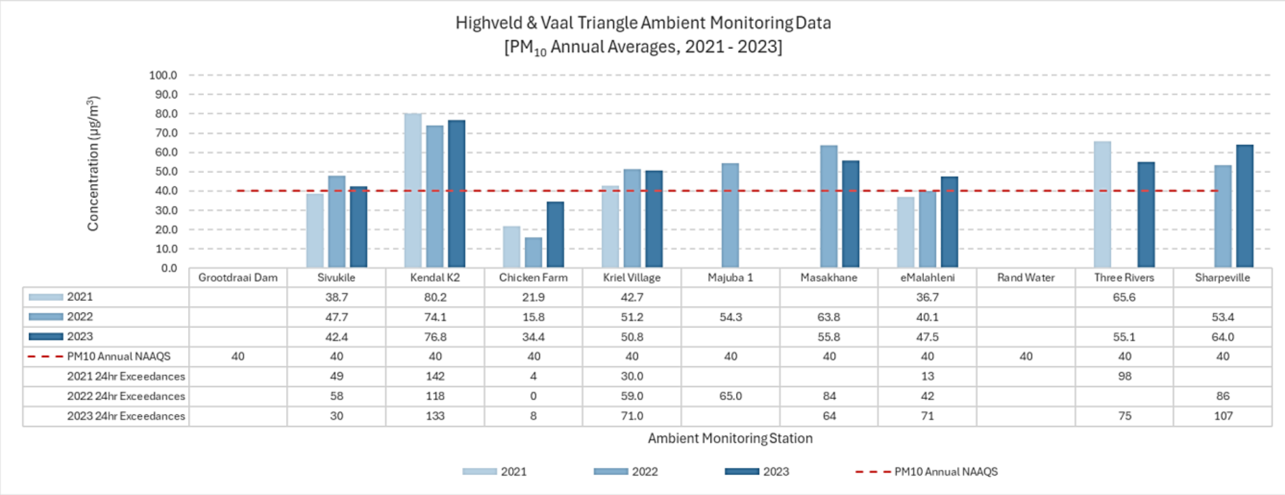
Ambient air quality monitoring stations in the Highveld and Vaal areas considered in this exemption application comprised Eskom owned stations and South African Weather Services (SAWS) stations, for the period 2021 - 2023. Although a minimum data recovery of 90% is required, as stipulated by the SANAS TR 07-03 (SANAS, 2012), for the purposes of this report, data recovery of 50% and greater were considered. Station selection was based on proximity to each power station, as follows:

- Duvha – Masakhane (Eskom) and eMalahleni (SAWS)
- Kendal – Kendal K2 (research station located at the point of maximum impact from Kendal power station) and Chicken Farm (both Eskom)
- Lethabo – Rand Water (Eskom), Sharpeville and Three Rivers (SAWS)
- Matla – Kriel Village (Eskom)
- Majuba – Majuba 1 (Eskom)
- Tutuka – Sivukile and Grootdraai Dam (both Eskom)

Figure 5-1 illustrates annual average PM_{10} concentrations and exceedances of the 24-hour average NAAQS measured in 2021 – 2023; no data was recovered at the Grootdraai Dam and Rand Water monitoring stations. As is evident, except for the annual average at Chicken Farm which remained compliant, ambient PM_{10} concentrations are non-compliant at all stations with both the annual and 24-hour NAAQS, with the frequency of 24-hour exceedances exceeding the permitted frequency of exceedances per calendar year (four exceedances are permitted per calendar year).

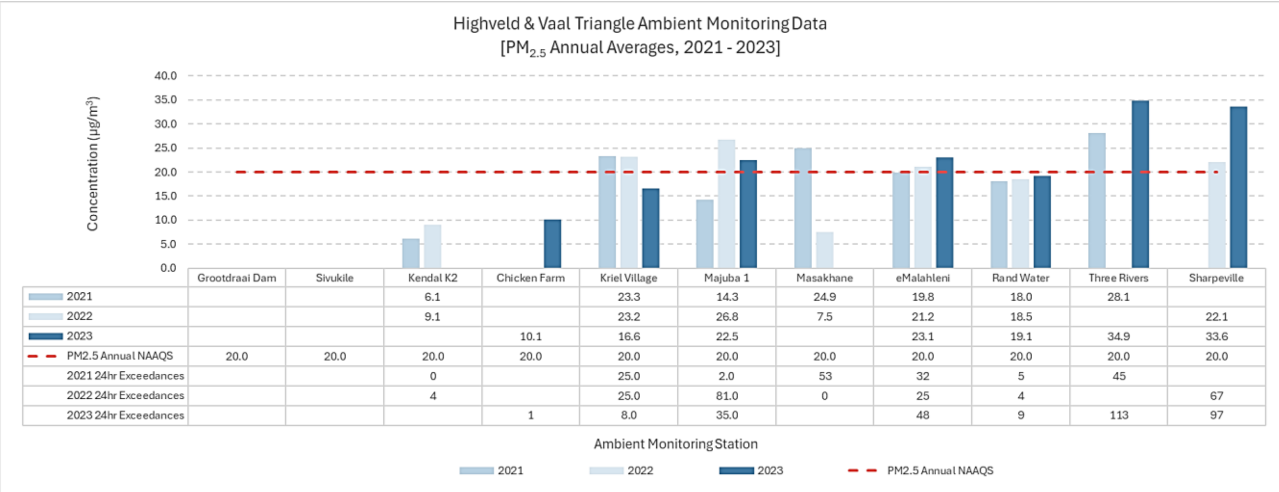
Considering $PM_{2.5}$ concentrations, as illustrated in Figure 5-2, similar to PM_{10}, non-compliance with the annual NAAQS is evident at the Kriel Village, Majuba 1, Masakhane, eMalahleni, Sharpeville and Three Rivers stations, with Kendal K2 (research station at maximum point of impact location), Chicken Farm, and Rand Water showing compliance with the annual $PM_{2.5}$ NAAQS. All stations measured frequent exceedances of the 24-hour NAAQS, while Rand Water, which was compliant with the annual NAAQS, showed non-compliance with the 24-hour NAAQS given the frequency of exceedances.

Given the elevated PM_{10} and $PM_{2.5}$ concentrations throughout the Highveld and Vaal Triangle areas, the PM_{10} and $PM_{2.5}$ NAAQS should be considered saturated, with these contributing emission sources requiring focus. Key sources of emissions in the area comprise mining, industrial activities, the Eskom power stations, vehicle emissions, uncontrolled waste burning, and domestic fuel burning.



	Grootdraai Dam	Sivukile	Kendal K2	Chicken Farm	Kriel Village	Majuba 1	Masakhane	eMalahleni	Rand Water	Three Rivers	Sharpeville
2021		38.7	80.2	21.9	42.7			36.7		65.6	
2022		47.7	74.1	15.8	51.2	54.3	63.8	40.1			53.4
2023		42.4	76.8	34.4	50.8		55.8	47.5		55.1	64.0
PM10 Annual NAAQS	40	40	40	40	40	40	40	40	40	40	40
2021 24hr Exceedances		49	142	4	30.0			13		98	
2022 24hr Exceedances		58	118	0	59.0	65.0	84	42			86
2023 24hr Exceedances		30	133	8	71.0		64	71		75	107

Figure 5-1 - Highveld and Vaal Triangle ambient PM_{10} concentrations, 2021 – 2023



	Grootdraai Dam	Sivukile	Kendal K2	Chicken Farm	Kriel Village	Majuba 1	Masakhane	eMalahleni	Rand Water	Three Rivers	Sharpeville
2021			6.1		23.3	14.3	24.9	19.8	18.0	28.1	
2022			9.1		23.2	26.8	7.5	21.2	18.5		22.1
2023				10.1	16.6	22.5		23.1	19.1	34.9	33.6
PM2.5 Annual NAAQS	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
2021 24hr Exceedances			0		25.0	2.0	53	32	5	45	
2022 24hr Exceedances			4		25.0	81.0	0	25	4		67
2023 24hr Exceedances				1	8.0	35.0		48	9	113	97

Figure 5-2 - Highveld and Vaal Triangle ambient $PM_{2.5}$ concentrations, 2021 – 2023

SO_2 measured concentrations in the Highveld and Vaal Triangle for the period 2021 – 2023 are presented in Figure 5-3. Annual average concentrations across the ambient monitoring network indicate compliance with the annual NAAQS, with no stations exceeding the NAAQS in any year. Although not presented in Figure 5-3, exceedances of the short-term NAAQS (10-minute, hourly and 24-hour) were recorded at most stations, although importantly these remained below the permitted frequency of exceedances.

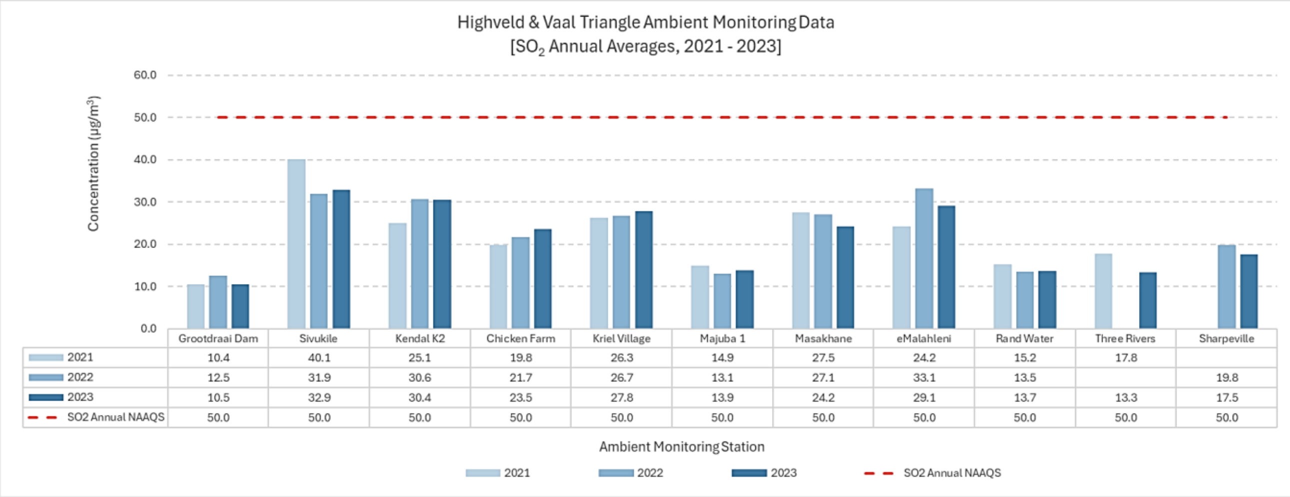


Figure 5-3 - Highveld and Vaal Triangle ambient SO_2 concentrations, 2021 – 2023

Nitrogen dioxide (NO_2) measured concentrations in the Highveld and Vaal Triangle for the period 2021 – 2023 are presented in Figure 5-4. Annual average concentrations across the ambient monitoring network indicate compliance with the annual NAAQS, with no stations exceeding the NAAQS in any year. Although not presented in Figure 5-4, exceedances of the hourly NAAQS were recorded at Chicken Farm, importantly these remained well below the permitted frequency of exceedances, with 15 exceedances recorded and 88 permitted.

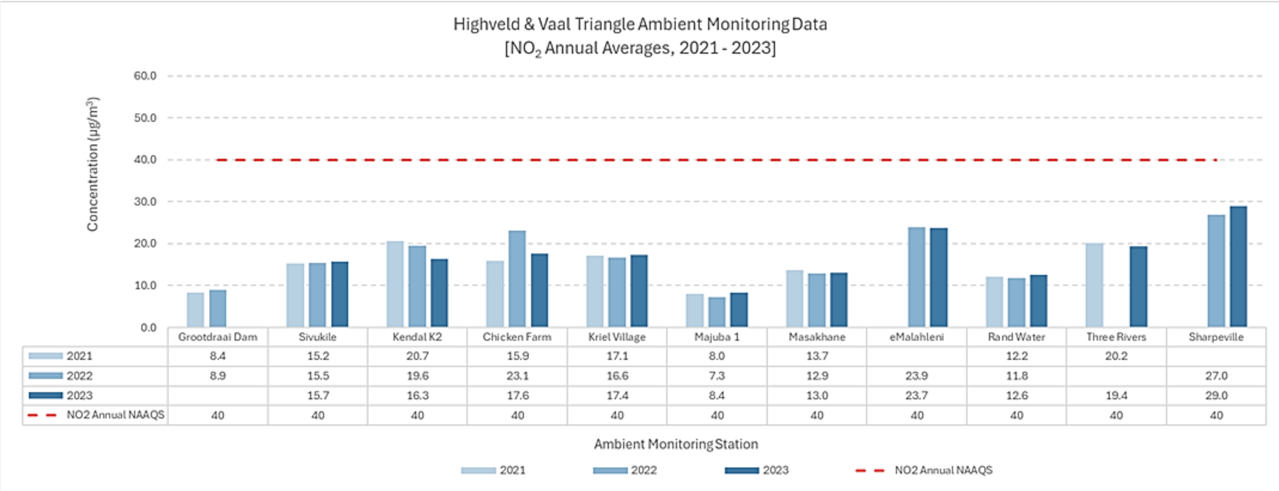


Figure 5-4 - Highveld and Vaal Triangle ambient NO_2 concentrations, 2021 – 2023

5.2.2 DISPERSION MODELLING - CUMULATIVE AIR QUALITY IMPACTS

CALPUFF dispersion modelling was undertaken by uMoya-NILU Consulting (Pty) Ltd, as contained within the Cumulative Highveld and Vaal AIR (report uMN220-24, 2024) to assess various operational scenarios anticipated by Eskom for the Highveld and Vaal Fleet, comprising Komati, Arnot, Camden, Kriel, Grootvlei, Hendrina, Duvha, Matla, Kendal, Lethabo, Tutuka, Majuba, and Kusile in the coming years for SO_2, NO_X, and PM (PM_{10} and $PM_{2.5}$), namely:

- **Scenario 1 (Current)**: The baseline scenario using actual monthly stack emissions for 2021-2023 and fugitive emissions from the ash dump.

- **Scenario A (2025)**: Eskom's planned 2025 stack emissions, representing anticipated station performance between 2025 – 2030, including fugitive emissions from the ash dumps and stockpiles. This includes the shutdown of Komati; the completion of PM abatement projects at Kendal, Lethabo, Tutuka, Duvha, and Matla; and the FGD at Kusile.
- **Scenario B (2031) / ERP 2024 A**: Eskom's planned 2031 stack emissions, representing anticipated station performance between 2031 – 2035, including fugitive emissions from the ash dumps and stockpiles. This includes completion of shutdowns at Arnot, Kriel, Hendrina, Camden, and Grootvlei, including their fugitive sources, with Matla and Duvha also entering shutdown phase; FGD at Kusile and reduced SO_2 emissions achieved through Despatch Prioritisation and efficiency improvement projects; and NO_X abatement (LNB) at Majuba, Lethabo, and Tutuka.
- **Scenario C (2036) / ERP 2024 B**: Representing an alternative scenario for anticipated station performance from 2036 onwards, including fugitive emissions from the ash dumps and stockpiles. This includes the complete shutdown of Matla and Duvha; shutdowns of Tutuka, Lethabo, and Kendal, including their fugitive sources, with Majuba entering shutdown phase in FY2047; SO_2 abatement installed at Kusile (Wet FGD), Majuba (DSI FGD), and Kendal (Semi-dry FGD); as well as reduced SO_2 emissions achieved through Despatch Prioritisation and efficiency improvement projects.
- **Scenario D (MES) / ERP 2024 C**: MES compliance, inclusive of the ash dumps and stockpiles, where relevant (i.e. not for the stations shutdown), and in addition to the abatement included in above scenarios, FGD installations at Tutuka and Lethabo. (Additional NO_X and FGD technology not installed at Duvha and Matla given the shutdown of these stations by 2035).

Table 5-1 presents maximum ground level concentrations predicted at sensitive receptors and monitoring stations (only the highest concentration and predicted exceedances presented) associated with each operational scenario. While the focus of the assessment is on stack emissions, and SO_2 particularly, the inclusion of fugitive PM emissions provides a holistic understanding of the Highveld/ Vaal Fleet contributions to ambient PM_{10} and $PM_{2.5}$ concentrations. Key findings from this AIR comprised:

- For SO_2:
  - Maximum predicted annual concentrations at all receptors remain below the annual NAAQS in all scenarios.
  - No exceedances of the short-term NAAQS (24-hour and hourly) are predicted at receptors in all scenarios.
  - Considering Scenario D (ERP 2024 C) and Scenario C (ERP 2024 B), concentration predictions show an improvement in Scenario D. However, critically, Scenario C and B, inclusive of the abatement planned by Eskom, does not show any exceedances of the NAAQS. This is also evident in Eskom's current operational scenarios (Scenario 1 and A) where abatement has not yet taken effect, although improvements in emissions due to Despatch Prioritisation and efficiency improvements are considered.
- For NO_2:
  - Maximum predicted concentrations remain well below all averaging periods of the NAAQS at all receptors for the five scenarios.
  - No short-term exceedances (hourly) are predicted to occur.
- For PM_{10} and $PM_{2.5}$:
  - Predicted concentrations are attributed to stack emissions and low-level fugitive sources (ash dumps and stockpiles).

- The inclusion of the fugitive sources was done assuming most the area is exposed and available for entrainment, while in reality only a small portion of the modelled area would be exposed to entrainment due to the vegetated sides and wet areas of the dumps. This approach should be considered an over-estimate.

- The PM emissions from stacks and fugitive sources are not speciated into PM_{10} and $PM_{2.5}$, rather all PM emitted is assumed to be PM_{10}, and all PM emitted is assumed to be $PM_{2.5}$, considered environmentally conservative.
- Maximum PM_{10} annual concentrations predicted at sensitive receptors, inclusive of the ambient monitoring stations, are predicted to remain below the annual NAAQS in all scenarios, with a maximum annual average concentration of 28.1µg/m^3 predicted to occur at a receptor.
  - Exceedances of the 24-hour PM_{10} NAAQS are predicted in Scenarios 1, A, and B, exceeding the permitted frequency of exceedance in a three-year period (12 in a three-year period, as modelled). Predicted concentrations decrease in Scenario's C and D, with no 24-hour exceedances predicted, predominantly due to station shutdowns, inclusive of their fugitive sources which are assumed to be rehabilitated, which are the main contributing sources.
- Maximum annual average $PM_{2.5}$ concentrations are predicted to exceed the annual NAAQS in Scenario's 1, A, and B, while 24-hour exceedances are also predicted, exceeding the permitted frequency of exceedance. While the annual averages in Scenario C and D are below the more stringent $PM_{2.5}$ standard coming into effect in 2030, 24-hour exceedances are still predicted, above the permitted frequency.
  - $PM_{2.5}$ predictions must be viewed in light of the conservative assumptions (over-estimate) applied in the dispersion models, as discussed previously.
- Further, considering the areas of predicted non-compliances and their proximity to each power station, as noted in the uMoya-Nilu AIR (report uMN220-24, 2024), the elevated PM can mostly be attributed to the low-level fugitive sources, which have poor buoyancy and disperse poorly, as opposed to the stack emissions which are released at a much higher height above ground-level, with considerable buoyancy, and so disperse well.
- In comparison to measured ambient annual average SO_2, NO_X, PM_{10} and $PM_{2.5}$ concentrations, the modelling scenario representing Eskom current emissions (Scenario 1) predicted lower annual averages compared to the measured data, to be expected as Eskom is not the sole contributor to measured ambient concentrations.
- Given the conservative approach to the fugitive emission source simulations, and that this provided an absolute worst-case emission scenario, and based on recommendations received from uMoya-Nilu, Eskom undertook an additional cumulative modelling scenario, assessing only PM, SO_2, and NO_X stack emissions from the Highveld and Vaal Triangle Fleet. NO_X and SO_2 emissions were included to ensure secondary particulate formation is accounted for. Key findings from this include:

  - Predicted PM_{10} and $PM_{2.5}$ concentrations, including secondary particulate formation, indicated full compliance with the NAAQS, with no 24-hour exceedances predicted within the modelling domain.
  - The maximum PM_{10} annual and 24-hour average predicted was 4.7µg/m^3 and 36.5µg/m^3, respectively, predicted in Scenario A, remaining well below the NAAQS.
  - The maximum $PM_{2.5}$ annual and 24-hour average predicted was 4.2µg/m^3 and 31.3µg/m^3, respectively, predicted in Scenario A, remaining well below the NAAQS.

– This additional modelling confirms ground-level concentrations due to Eskom stack emissions remain well below the NAAQS, with the elevated concentrations originally predicted being influenced by the low-level fugitive sources, rather than the stack emissions.

Table 5-1 - Predicted maximum annual and short-term ground level concentrations occurring at selected receptors and ambient monitoring stations for each operational scenario (uMoya-NILU, report uMN220-24, 2024)

Pollutant			
Predicted maximum SO_2	**Annual**	**24-hour (P99)**	**1-hour (P99)**
Scenario 1 (Current)	11.4	81.3 (0)	150.8 (0)
Scenario A (2025)	23.0	121.1 (0)	344.0 (0)
Scenario B (2031)	17.2	95.8 (0)	289.2 (0)
Scenario C (2036)	13.3	79.7 (0)	241.0 (0)
Scenario D (MES)	5.4	31.8 (0)	105.2 (0)
NAAQS limit value	**50**	**125 (12)***	**350 (264)***
Predicted maximum NO_2	**Annual**	**-**	**1-hour (P99)**
Scenario 1 (Current)	5.1	-	89.4 (0)
Scenario A (2025)	6.7	-	107.8 (0)
Scenario B (2031)	3.9	-	75.3 (0)
Scenario C (2036)	3.9	-	79.0 (0)
Scenario D (MES)	3.9	-	79 (0)
NAAQS limit value	**40**	**-**	**200 (264)***
Predicted maximum PM_{10}	**Annual**	**24-hour (P99)**	**-**
Scenario 1 (Current)	27.7	205.8 (96)	-
Scenario A (2025)	28.1	209.4 (95)	-
Scenario B (2031)	18.7	135.3 (27)	-
Scenario C (2036)	10.4	62.3 (0)	-
Scenario D (MES)	10.2	59.9 (0)	-
NAAQS limit value	**40**	**75 (12)***	**-**
Predicted maximum $PM_{2.5}$	**Annual**	**24-hour (P99)**	**-**
Scenario 1 (Current)	27.7	205.8 (222)	-
Scenario A (2025)	28.1	209.4 (218)	-
Scenario B (2031)	18.7	135.3 (278)	-
Scenario C (2036)	10.4	62.3 (98)	-
Scenario D (MES)	10.2	59.9 (98)	-
NAAQS limit value	**20**	**40 (12)***	Up to 31 Dec 2029
	15	**25 (12)***	From 01 Jan 2030
Note: Red represent non-compliances, with exceedance counts in brackets *Regulations provide for permitted frequency of exceedance per calendar year; 4 exceedances per year of a 24-hour standard, and 88 exceedances per year of an hourly standard. Since the model simulated three years, these permissible exceedance counts represent a three-year period.			

5.3 WATERBERG FLEET – AIR QUALITY

5.3.1 BASELINE AMBIENT AIR QUALITY

Ambient air quality monitoring stations in the Waterberg considered in this exemption application comprised Eskom owned stations and South African Weather Services (SAWS) stations, for the period 2021 - 2023. Although a minimum data recovery of 90% is required, as stipulated by the SANAS TR 07-03 (SANAS, 2012), for the purposes of this report, data recovery of 50% and greater were considered. The stations considered for both Medupi and Matimba were Marapong, Medupi (both Eskom owned) and Lephalale (SAWS).

Figure 5-5 illustrates annual average PM_{10} concentrations and exceedances of the 24-hour average NAAQS measured in 2021 – 2023; no data was recovered from the Marapong station in 2022 and 2023, nor Lephalale in 2022. Except for Marapong, which exceeded the annual NAAQS, all other annual averages remained compliant with the NAAQS, although Medupi does show elevated concentrations. Considering 24-hour averages, both Marapong and Medupi indicate non-compliance with the 24-hour NAAQS given the number of exceedances measured each year, which exceeded the permitted frequency of exceedances (four exceedances are permitted per calendar year).

Considering $PM_{2.5}$ concentrations, as illustrated in Figure 5-2, non-compliance with the annual NAAQS is evident at Marapong, with Medupi and Lephalale showing compliance with the annual $PM_{2.5}$ NAAQS, although this should be viewed with caution given the missing data. While Medupi showed compliance with the annual NAAQS in 2021, the number of 24-hour exceedances recorded exceeded the permitted frequency of exceedances. 24-Hour exceedances at Marapong also exceeded the permitted frequency of exceedances, with four exceedances permitted per calendar year.

While PM concentrations show general compliance with the NAAQS, the standards should be considered as becoming saturated, and therefore the contributing emission sources in the area should receive focus. Key sources of emissions in the area comprise mining, Medupi and Matimba, exposed areas and domestic fuel burning.

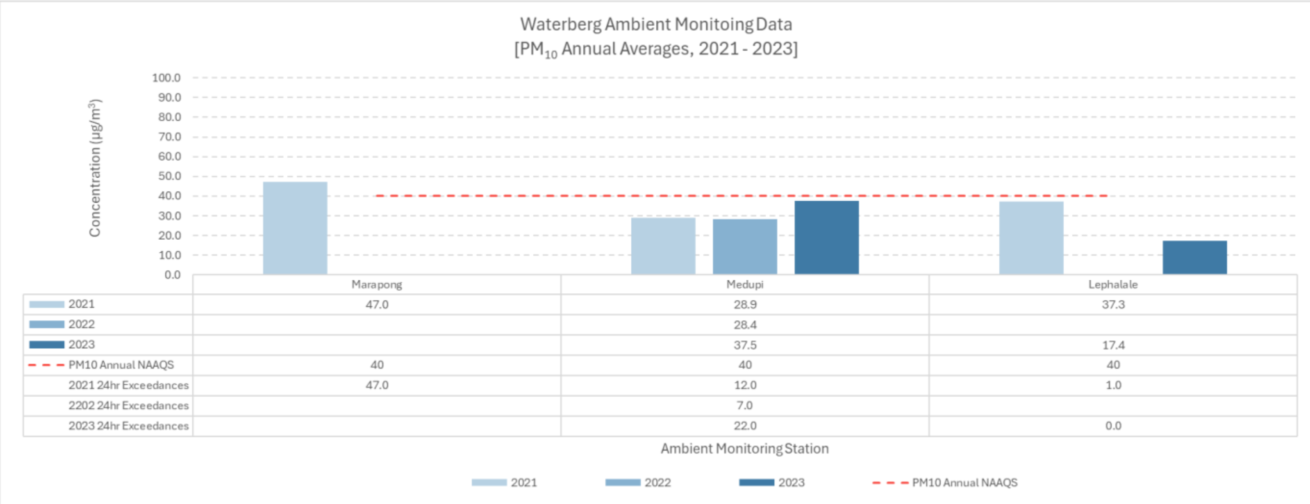


Figure 5-5 - Waterberg ambient PM_{10} concentrations, 2021 – 2023

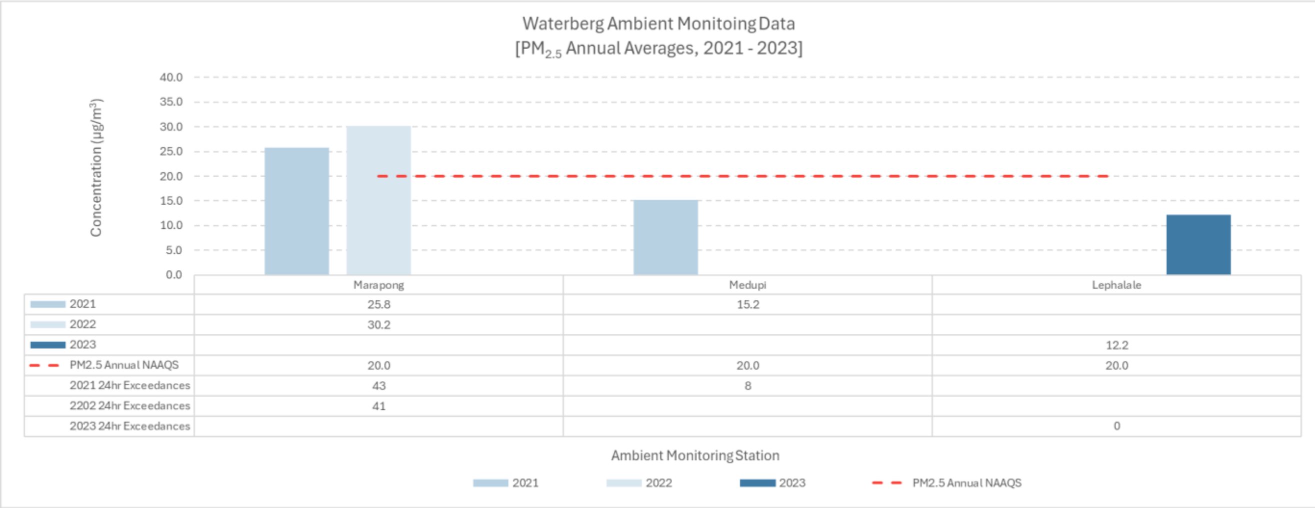


Figure 5-6 - Waterberg ambient $PM_{2.5}$ concentrations, 2021 – 2023

SO_2 measured concentrations in the Waterberg for the period 2021 – 2023 are presented in Figure 5-7. Annual average concentrations across the ambient monitoring network indicate compliance with the annual NAAQS, with no stations exceeding the NAAQS in any year. Highest concentrations were measured at Medupi, which exhibits an increasing trend in SO_2 concentrations year on year, although remaining below the annual NAAQS. Although not presented in Figure 5-7, exceedances of the short-term NAAQS (10-minute, hourly and 24-hour) were recorded at all stations, although importantly these remained below the permitted frequency of exceedance.

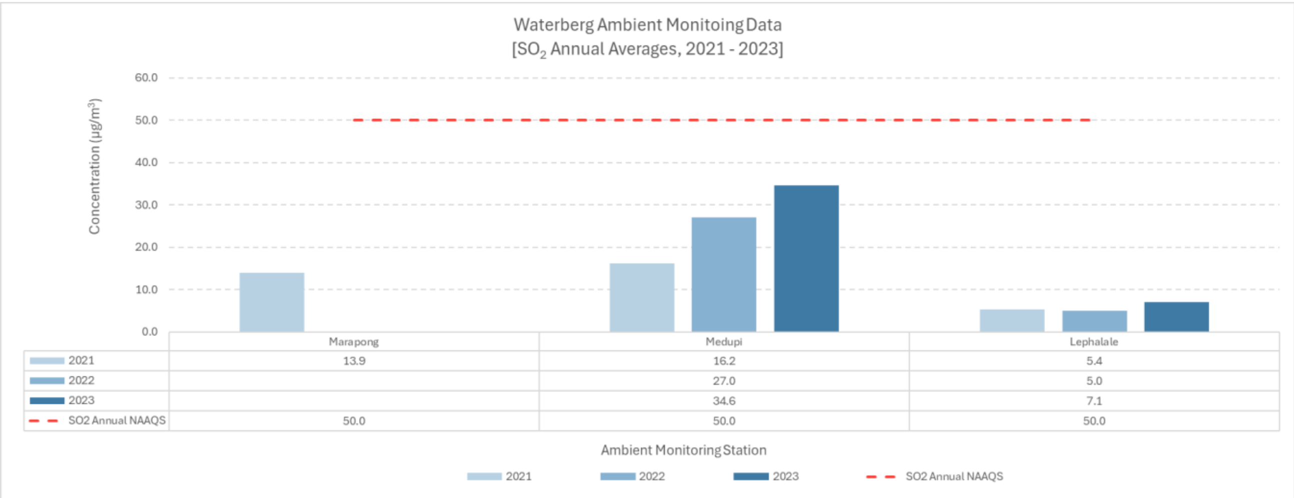


Figure 5-7 - Waterberg ambient SO_2 concentrations, 2021 – 2023

NO_2 measured concentrations in the Waterberg for the period 2021 – 2023 are presented in Figure 5-8. Annual average concentrations across the network indicate compliance with the annual NAAQS, with no stations exceeding the NAAQS in any year. Highest concentrations were typically measured at Marapong. Further, no hourly exceedances of the NAAQS were recorded at any of the stations, illustrating the generally low NO_2 concentrations in the area.

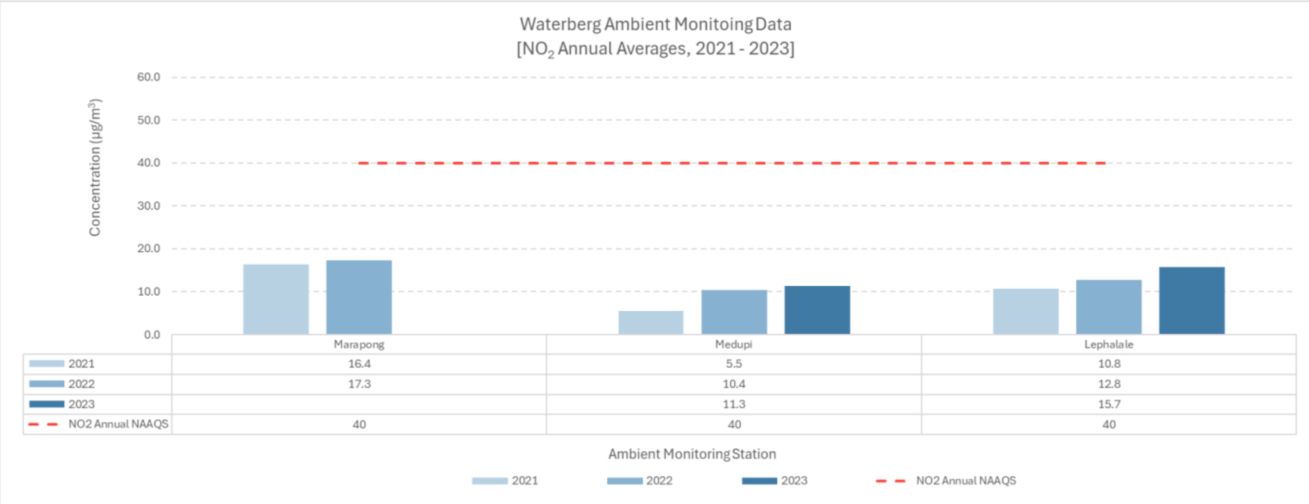


Figure 5-8 - Waterberg ambient NO_2 concentrations, 2021 – 2023

5.3.2 DISPERSION MODELLING – CUMULATIVE AIR QUALITY IMPACTS

CALPUFF dispersion modelling was undertaken by uMoya-NILU Consulting (Pty) Ltd, as contained within the Cumulative Waterberg AIR (report uMN219-24, 2024) to assess various operational scenarios anticipated by Eskom at Medupi and Matimba in the coming years for SO_2, NO_X, and PM (PM_{10} and $PM_{2.5}$), namely:

- **Scenario 1 (Current):** The baseline scenario using actual monthly stack emissions for 2021-2023 and fugitive emissions from the ash dump.
- **Scenario A (2025):** Eskom's planned 2025 stack emissions, representing anticipated station performance between 2025 – 2030, including fugitive emissions from the ash dump.
- **Scenario B (2031) / ERP 2024 A:** Eskom's planned 2031 stack emissions, representing anticipated station performance between 2031 – 2035, including fugitive emissions from the ash dump and the Medupi wet FGD.
- **Scenario C (2036) / ERP 2024 B:** Eskom's planned 2036 stack emissions, representing anticipated station performance from 2036 onwards, including fugitive emissions from the ash dump, and including the Medupi wet FGD.
- **Scenario D (MES) / ERP 2024 C:** Full compliance with the MES from 2036, including wet FGD at Medupi and semi-dry FGD at Matimba.

Table 5-2 presents maximum ground level concentrations predicted at sensitive receptors and monitoring stations (only the highest concentration and predicted exceedances presented) associated with each operational scenario. While the focus of the assessment is on stack emissions, and SO_2 in particular, the inclusion of fugitive PM emissions provides a holistic understanding of the Medupi and Matimba power stations contribution to ambient PM_{10} and $PM_{2.5}$ concentrations. Key findings from this AIR comprise:

- For SO_2:
  - Maximum predicted annual concentrations at all receptors remain well below the annual NAAQS in all scenarios.
  - Exceedances of the 24-hour NAAQS are predicted, exceeding the permitted number of exceedances (12 in a three-year period) in Scenario A and B, while exceedances remain below

the permitted frequency in Scenario C following completion of the Medupi wet FGD, with no exceedances predicted in Scenario 1 and D.
  - No exceedances of the hourly NAAQS are predicted at receptors in all scenarios.
- For NO_2:
  - Maximum predicted concentrations remain well below all averaging periods of the NAAQS at all receptors for the five scenarios.
  - No short-term exceedances due to the cumulative Medupi and Matimba emissions are predicted to occur.
- For PM_{10} and $PM_{2.5}$:
  - Predicted concentrations are attributed to stack emissions and low-level fugitive sources (ash dumps and stockpiles).
    - The inclusion of the fugitive sources was done assuming most the area is exposed and available for entrainment, while in reality only a small portion of the modelled area would be exposed to entrainment due to the vegetated sides and wet areas of the dump. This approach can be considered as an over-estimate.
  - The PM emissions from stacks and fugitive sources are not speciated into PM_{10} and $PM_{2.5}$, rather all PM emitted is assumed to be PM_{10}, and all PM emitted is assumed to be $PM_{2.5}$, considered environmentally conservative.
  - Maximum PM_{10} annual concentrations predicted at sensitive receptors, inclusive of the ambient monitoring stations, are predicted to remain below the annual NAAQS, with a maximum concentration of 17.7µg/m^3 predicted to occur at a receptor.
    - Exceedances of the 24-hour PM_{10} NAAQS are predicted in Scenarios 1, A, and B, although these remain well below the permitted frequency of exceedance (12 in a three-year period). No 24-hour exceedances are predicted in Scenarios C and D.
  - Despite the conservative assumption that $PM_{2.5}$ is equivalent to PM in the modelling simulations, predicted annual average $PM_{2.5}$ concentrations still remain below the annual $PM_{2.5}$ NAAQS at all receptors in Scenarios 1 and A (prior to 2030). Exceedances of the more stringent $PM_{2.5}$ annual NAAQS, coming into effect in 2030, are predicted in Scenarios B, C, and D.
    - Numerous 24-hour exceedances are predicted in all scenarios, well above the permitted frequency of exceedance, although this must be viewed conservatively given the assumption that PM is $PM_{2.5}$. This frequency of exceedance increases from Scenario B due to the more stringent $PM_{2.5}$ NAAQS coming into effect in 2030.
  - Further, considering the proximity of the exceedances to Medupi and Matimba, as noted in the uMoya-Nilu AIR (report uMN219-24, 2024), the elevated PM can mostly be attributed to the low-level fugitive sources, which have poor buoyancy and disperse poorly, as opposed to the stack emissions which are released at a height of 200m above ground-level, with considerable buoyancy, and so disperse well.
  - Comparing measured annual average NO_X and SO_2 concentrations to model predictions, predicted annual averages are lower than measured, which is expected as Eskom activities are not the only source contributing to ambient concentrations.
  - While predicted annual average PM_{10} and $PM_{2.5}$ concentrations at the Marapong and Lephalale monitoring stations are lower than measured concentrations, at Medupi predicted concentrations are higher than measured. As highlighted in the uMoya-Nilu AIR (Report uMN219-24,2024), this is contrary to expectations as the monitoring station measures all sources, and this is likely due to the low data recovery at the Medupi station. Further to this, and

although not specifically highlighted in the uMoya-Nilu AIR, this could also be a result of the worst-case assumptions applied to the simulation of the fugitive sources (ash dumps), which likely provided an over-estimate of emissions.

- Given the conservative approach to the fugitive emission source simulations, and that this provided an absolute worst-case emission scenario, and based on recommendations received from uMoya-Nilu, Eskom undertook an additional cumulative modelling scenario, assessing only PM, SO_2, and NO_X stack emissions from the Waterberg Fleet. NO_X and SO_2 emissions were included to ensure secondary particulate formation is accounted for. Key findings from this include:
  - Predicted PM_{10} and $PM_{2.5}$ concentrations, including secondary particulate formation, indicated full compliance with the NAAQS, with no 24-hour exceedances predicted within the modelling domain.
  - The maximum PM_{10} annual and 24-hour average predicted was 1.7µg/m^3 and 17.9µg/m^3, respectively, predicted in Scenario A, remaining well below the NAAQS.
  - The maximum $PM_{2.5}$ annual and 24-hour average predicted was 1.5µg/m^3 and 16.8µg/m^3, respectively, predicted in Scenario A, remaining well below the NAAQS.
  - This additional modelling confirms ground-level concentrations due to Eskom stack emissions remain well below the NAAQS, with the elevated concentrations originally predicted being influenced by the low-level fugitive sources, rather than the stack emissions.

Table 5-2 - Predicted maximum annual and short-term ground level concentrations occurring at selected receptors and ambient monitoring stations for each operational scenario (uMoya-NILU, report uMN219-24, 2024)

Pollutant			
Predicted maximum SO_2	**Annual**	**24-hour (P99)**	**1-hour (P99)**
Scenario 1 (Current)	9.4	120.3 (0)	226.2 (0)
Scenario A (2025)	14	195.5 (24)*	332.4 (0)
Scenario B (2031)	11.7	186.9 (18)*	315.1 (0)
Scenario C (2036)	8.5	152.4 (7)*	202.4 (0)
Scenario D (MES)	3.5	52.4 (0)	90.1 (0)
NAAQS limit value	**50**	**125 (12)***	**350 (264)***
Predicted maximum NO_2	**Annual**	**-**	**1-hour (P99)**
Scenario 1 (Current)	1.1	-	31.3 (0)
Scenario A (2025)	2.0	-	50.9 (0)
Scenario B (2031)	1.6	-	47.7 (0)
Scenario C (2036)	1.5	-	40.9 (0)
Scenario D (MES)	1.5	-	40.9 (0)
NAAQS limit value	**40**	**-**	**200 (264)***
Predicted maximum PM_{10}	**Annual**	**24-hour (P99)**	**-**
Scenario 1 (Current)	17.4	78.3 (1)	-
Scenario A (2025)	17.7	79.7 (1)	-
Scenario B (2031)	17.6	75.8 (1)	-

Pollutant			
Scenario C (2036)	17.3	74.0 (0)	-
Scenario D (MES)	17.1	70.4 (0)	-
NAAQS limit value	**40**	**75 (12)***	**-**
Predicted maximum $PM_{2.5}$	**Annual**	**24-hour (P99)**	**-**
Scenario 1 (Current)	17.4	78.3 (92)	-
Scenario A (2025)	17.7	79.7 (92)	-
Scenario B (2031)	17.6	75.8 (270)*	-
Scenario C (2036)	17.3	74.0 (269)*	-
Scenario D (MES)	17.1	70.4 (269)	-
NAAQS limit value	**20**	**40 (12)***	**Up to 31 Dec 2029**
	15	**25 (12)***	**From 01 Jan 2030**
Note: Red text represent non-compliances, with exceedance counts in brackets. *Regulations provide for permitted frequency of exceedance per calendar year; 4 exceedances per year of a 24-hour standard, and 88 exceedances per year of an hourly standard. Since the model simulated three years, these permissible exceedance counts represent a three-year period.			

6 FINANCIAL CONSIDERATIONS

6.1 FINANCIAL COSTS

Previous assessments completed as part of the MES and NECA process have shown that attempting to install the technology required to meet new plant SO_2 limits (wet-FGD) at stations by 2025 was unfeasible from a technical, economic and project-implementation perspective, apart from Medupi that was designed for a FGD retrofit, the other plants were not (Eskom 2021). Given the previous analysis and the time and other constraints influencing the present exemption applications only the two most potentially viable SO_2 reduction implementations (Majuba and Kendal) were assessed as part of this exemption application.

The assessments completed previously, included an analysis of the Levelised Cost of Electricity (LCOE) to compare the viability of FGD investments at stations with other options like gas or renewables. They also used stochastic electricity systems modelling to understand the full impact of FGD implementations. The studies indicated that retrofitting the plants with FGD would increase the cost of electricity produced due to the high capital and operating cost of FGD and the limited remaining life of the plants. (Eskom, 2020). Full implementation might have resulted in an increase in the average electricity tariff of around 10%, whereas the partial implementation scenarios would have a lesser impact – depending on the scenario. Studies also showed that the shutdown of multiple stations to enable the rapid implementation of FGD would result in significant security of supply issues which would result in massive levels of load shedding and a resultant destruction of the economy.

With an average age of the coal fleet being almost 40 years old, the long lead time to implement retrofits results in a limited economic life remaining post retrofit of the FGD. Assuming it was technically feasible to retrofit (which is a significant risk), and ignoring the unserved energy and load shedding, even with the increased cost, in the short term the plants would be cost competitive, relative to the comparable alternatives which could be deployed in the same time frames. These alternatives included that of running the OCGTs at 20% p.a. load factor and load shedding of the remaining demand in the earlier years. In the latter years with the increased cost due to the FGD, the plants would need to run at guaranteed higher load factors i.e. have a higher output, to remain competitive with comparable alternatives.

Two years have passed since the last detailed analysis, which now further limits the remaining useful life over which to recover any financial investment.

Eskom has maintained in all previous applications, that the costs associated with retrofitting FGD to any of its plant outweighs the benefits. This has been rejected by the NAQO, and partially by the NECA panel advising the Minister and in the Ministers Appeal decision. Although, in the case of Medupi, the report by the NECA indicated that FGD was very costly and would require Medupi to be offline for 80 additional days per year for six years, increasing load shedding risks. (DFFE, 2024).

From a national strategic and risk perspective, if it is considered necessary for Eskom to implement a SO_2 abatement project at an Eskom station beyond Kusile and Medupi, and if it is proven to be technically feasible, it would be necessary to source funding against the background of guaranteed cost -reflective tariffs. From an economic/financial perspective a defined minimum load factor/take or pay agreement would ensure that the units costs are acceptable compared to known alternatives however if consideration could be given to the extension of the station life the economic/financial viability could improve. Given the quantum of the requirement investment, it is probable that Eskom would require fiscal support in order to raise funding for additional abatement projects beyond Kusile and Medupi. There might also be implications regarding possible carbon tax and carbon budget allocation target adjustments with the increase in load factor and extended plant life.

With the current uncertainties in the context of the pre-concept phase of planning and not yet having performed the thorough stochastic systems modelling process (based on any updated IRP), factoring in the range of possible outcomes on all the key input variables, it would be reckless for Eskom to make unconditional commitments to any SO_2 reduction implementation. Any commitments must be subject to completion of the mentioned systems modelling process as well as the completion of a detailed technical implementation feasibility study/ pilot. If retrofit proves technically unfeasible, a relief from obligations and commitments should be obtained. This might include SO_2 exemption for relevant stations, depending on the system's alternatives and the potential requirement for the stations to continue operating, as established through the stochastic systems modelling process.

Any Eskom commitments or authority decision should also incorporate an economic viability threshold. The market tendering processes should indicate that if costs exceed the estimates made for purposes of these commitments by a defined degree (which could be linked to budgets, operational cost caps etc), the decision will need to be revisited. Such thresholds should not just be defined in terms of project costs but rather in terms of economic/financial viability, factoring in the likely system alternatives in the event of these power plants not continuing to be operated.

The decision on any SO_2 reduction implementation must consider the benefit of SO_2 reduction from the power stations, against the opportunity cost of such SO_2 reduction. A possible alternative solution is that if funding is available Eskom increases its investments in renewables and grid connection by the same amounts that would have been invested in such SO_2 retrofits, this would result in larger economic value add than FGD retrofits.

6.1.1 COST ANALYSIS FOR MES COMPLIANCE AT KENDAL

Kendal has a lower operating cost and higher load factor than most stations, however it has a relatively short useful life post retrofit to recover the high FGD retrofit cost, resulting in marginal financial and economic viability. Kendal will need to sustain higher load factors than presently planned, to remain competitive with alternative options in an unconstrained power system context, where these alternatives would potentially be the lowest-cost Risk Mitigation Independent Power Producer Program (RMIPPPP) type of projects (The RMIPPP program called for dispatchable technologies including a combination of wind, solar, gas, diesel etc). Like Majuba, if the power system continues to be highly constrained, where the alternatives include OCGTs and the cost of inadequate supply (load shedding/ unserved energy etc) then Kendal could be much cheaper thus economically and financially very viable even at very low load factors, and with the cost of the retrofit included and assuming technical feasibility is proven

It should however be noted that 9.5 years post retrofit for a significant investment is very short. Kendal will be approximately 40 years old by the time the retrofit is complete and will only operate for a full 5 years with all 6 units running with the retrofit, assuming it is delivered on time. In the context of such a short remaining life, consistently higher load factors of a minimum 40% are required to sustain viability within the future market competing with alternative options of potentially the lowest-cost RMIPPPP type of projects. The assumption of a longer remaining life could improve Kendal's competitiveness and make it viable at lower load factors, from a purely economic/financial perspective.

The capital expenditure (Capex) required to ensure SO_2 compliance at Kendal is estimated at R44,4 billion, while the annual Opex is estimated at R1,04 billion. Additionally, the costs associated with Kendal achieving its proposed maximum daily limits for PM is R1,43 billion.

6.1.2 COST ANALYSIS FOR MES COMPLIANCE AT MAJUBA

Despite Majuba having a longer remaining life than Kendal (17 Years post retrofit) and DSI FGD being lower in cost (and technically less efficient relative to the Wet and Semi-dry FGDs), Majuba's high operating cost, even before considering the additional capex, makes the economic and financial viability of the DSI FGD investment challenging.

At low load factors e.g., below 50%, the LCOE for Majuba will probably not be competitive with alternative options in an unconstrained power system, where these alternatives would potentially be the lowest-cost RMIPPP program type of projects Under a constrained power system scenario, where the alternatives include OCGTs and the cost of load shedding/unserved energy, then Majuba with DSI FGD could have a lower cost and be economically and financially viable even at low load factors (assuming it is technically feasible).

With the identified implementation risks, a sensitivity was performed assuming the implementation of DSI FGD is delayed by three years. The LCOE increased i.e. the option became more expensive. For it to remain competitive with alternative options, a minimum load factor of approximately 60% is required.

Which technology to deploy and Majuba's likely range of load factors results in uncertainty, which could only be established and quantified trough the stochastic systems modelling process. Depending on the outcome of such modelling process it might also be appropriate to justify the continued operation of Majuba (with or without the retrofit) based on strategic risk considerations.

The Capex required to ensure SO_2 compliance at Majuba is estimated at R13,1 billion, while the annual Opex is estimated at R1,04 billion. Additionally, the costs associated with Majuba achieving its proposed maximum daily limits for NO_X is R1,1 billion.

6.1.3 ERP NOMINAL COSTS AND TARIFF IMPACTS

Table 6-1 presents estimated nominal costs associated with each ERP option. The total nominal cost of all Eskom ERP scenarios has been estimated by Eskom at a Class 2 accuracy, implying a variance between -15% and +20%. Increases in Eskom capital costs impact on the electricity tariff paid by consumers. The extent of any tariff increases is influenced by multiple factors including the extent and timing of funding and projected energy sales. Implementation of the ERP scenarios with additional SO_2 reduction requirements could increase the electricity tariff by between 3 and 10% from current levels. Work to confirm the extent of increases utilising Eskom NERSA applicable methodologies will be undertaken.

Table 6-1 – Eskom Fleet ERP financial summary

	ERP 2024 A	ERP 2024 B	ERP 2024 C
	Eskom Fleet (cumulative)		
SO_2 Abatement	Kusile, Medupi FGD	Kusile, Medupi, Kendal (FGD), Majuba (DSI)	Kusile, Matimba, Medupi, Kendal, Tutuka, Lethabo (FGD), and Majuba (DSI)
NO_X Abatement	Majuba, Lethabo, Tutuka LNB	Majuba, Lethabo, Tutuka LNB	Majuba, Lethabo, Tutuka LNB
PM Abatement	Kendal, Matimba, Lethabo, Tutuka, Duvha, Matla PM Projects	Kendal, Matimba, Lethabo, Tutuka, Duvha, Matla PM Projects	Kendal, Matimba, Lethabo, Tutuka, Duvha, Matla PM Projects
Capex (nominal)	R77.2 billion	R134.6 billion	R256.9 billion
Opex (real, pa)	R2.1 billion	R4.2 billion	R6.3 billion

6.2 HEALTH COST BENEFIT ANALYSIS

As part of the Eskom exemption applications, a health cost benefit analysis (CBA) was undertaken for the Highveld and Vaal Triangle, and Waterberg regions, evaluating the health benefits and costs associated with ERP 2024 A, ERP 2024 B, ERP 2024 C. These assessments considered a combination of all abatement technologies under each ERP. The CBA uses exposure-response functions (ERFs) to estimate the health benefits in terms of reduced mortality rates due to lower pollutant levels. The value of a statistical life (VSL) is applied to monetize these health benefits (Prime Africa Consult, 2024).

The benefit:cost ratios (BCR) need to be interpreted with care. They are meant only to provide a perspective on and inform the decision-making process underlying the scenarios. They are not meant to be interpreted as a definitive answer to making abatement decisions. Decisions involving human health have to be informed by non-economic criteria as well. In addition, with uncertainty inherent in the analysis, the cost benefit ratio should thus not be viewed as absolute, but rather as a relative value from which to compare scenarios (Prime Africa Consult, 2024).

6.2.1 HIGHVELD AND VAAL TRIANGLE COST BENEFIT ANALYSIS

Table 6-2 summarises the BCR ratio findings (Prime Africa Consult, 2024). The analysis reveals that ERP 2024 A, which includes PM and NO_X reduction and Despatch Prioritisation addressing SO_2 emissions, has a BCR greater than 1, indicating that health benefits exceed costs. ERP 2024 B, which adds SO_2 reduction at Majuba and Kendal, approaches a BCR of 1 in optimistic scenarios but generally shows lower benefits relative to costs. ERP 2024 C, which includes full compliance with MES for SO_2 at Lethabo and Tutuka, has a BCR significantly less than 1, suggesting that the costs far outweigh the health benefits, especially given the short operational period before shutdown of Lethabo and Tutuka.

In summary, greatest benefits relative to costs are evident in ERP 2024 A, which assumes all PM and NO_X reduction projects as planned, with SO_2 abatement only installed at Kusile. The analysis underscores the importance of considering both economic and health impacts in decision-making for emission reduction strategies.

Table 6-2 – Benefit:Cost ratios (lower and upper ranges) for each scenario (Prime Africa Consult, 2024)

	ERP 2024 A		ERP 2024 B		ERP 2024 C	
	Lower	Upper	Lower	Upper	Lower	Upper
Benefit:Cost Ratio (range)	0.34	3.14	0.11	0.99	0.07	0.60
Benefit:Cost Ratio (central)	1.74		0.55		0.33	

6.2.2 WATERBERG COST BENEFIT ANALYSIS

Table 6-3 summarises the BCR findings (Prime Africa Consult, 2024). The results show that for all three scenarios (ERP 2024 A, B, and C), the costs of abatement exceed the health benefits, with benefit-cost ratios significantly less than 1. This remains true even under the most optimistic conditions. Even when evaluated at a social discount rate of 2%, all scenarios still show ratios less than 1, indicating that the financial costs are disproportionately high compared to the health benefits. As highlighted in the Prime Africa Consult (2024) assessment, a key reason for the low BCR is the small population in the Waterberg area that will benefit from reduced pollution levels due to abatement technology installations.

Table 6-3 – Benefit:Cost ratios (lower and upper ranges) for each scenario (Prime Africa Consult, 2024)

	ERP 2024 A		ERP 2024 B		ERP 2024 C	
	Lower	Upper	Lower	Upper	Lower	Upper
Benefit:Cost Ratio (range)	0.0002	0.0012	0.0004	0.0029	0.0006	0.0042
Benefit:Cost Ratio (central)	0.0007		0.0017		0.0024	

7 FLEET EXEMPTION REQUESTS

7.1 EXEMPTION REQUEST MOTIVATIONS

The following section presents each of the projects associated with ERP 2024 A, ERP 2024 B, and ERP 2024 C, summarising timeframes associated with the projects (detailed in section 4.2), and MES exemption requests, where applicable. Emission limits requested, and timeframes attached to each, are presented in section 7.2.

7.1.1 ERP 2024 A SCENARIO

As noted previously, ERP 2024 A includes all PM and NO_X abatement equipment projects, and SO_2 abatement at Medupi, in summary (detailed in section 4.2):

- Duvha:
  - HFPS installations on U4 and U6, complete by 1 April 2026.
- Matla:
  - HFPS installations on U3 and U5, complete by 1 April 2026.
- Kendal:
  - ESP upgrade on U1, and DHP overhaul on U1, complete by 1 April 2026.
- Lethabo:
  - ESP upgrades on U1, U2, U3, U4, and U5, and SO_3 Plant upgrades on U2, U3, U5, complete by 1 October 2027.
  - LNB installations on all units, complete by 1 April 2031
- Tutuka:
  - ESP upgrades on U1, U2, U3, and U4; DHP refurbishments on U1, U2, U3, and U4; and HFPS installations on U1, U2, U3, and U5, all to be complete by 1 January 2027.
  - LNB installations on all units, complete by 1 January 2028.
- Majuba:
  - LNB installations on all units, complete by 1 April 2031.
- Medupi:
  - Wet FGD installation on all units, complete by 1 April 2032.

In addition to the technology implementation scenario A includes:

- Efficiency improvement projects to optimise the air-to-fuel ratio which would reduce SO_2 emissions and maximise combustion efficiency.
- Despatch Prioritisation.
- An extension of the air quality offset programme.

The above installation timeframes consider:

- Time required to secure funding for each project (where applicable).
- Lead time required to procure, design, manufacture, and begin installations.
- The outage schedule to allow generating units to be taken offline for upgrades / retrofitting while maintaining security of supply i.e. ensuring sufficient generating capacity remains across the stations to avoid loadshedding.
- To ensure sufficient capacity remains in the grid, generally only a single generating unit at a station can be taken offline at a time, particularly with regards to the long installation timelines of the equipment.

7.1.1.1 Particulate Matter

Although Matimba has HFPS installations scheduled, Matimba will comply with the new plant PM MES by 1 April 2025 and is therefore not included in the above abatement project list, with no PM exemption requested for Matimba. Medupi and Majuba currently comply with the new plant MES, with no PM abatement projects required, and therefore no PM exemption request is made for Medupi and Majuba.

Following completion of the above PM abatement projects, Duvha, Matla, Kendal, Tutuka, and Lethabo PM emissions will comply with the new plant MES. However, this cannot be achieved prior to the completion of these projects, and given the project lead times, which include equipment optimisations, these will not be complete by 1 April 2025, and therefore these stations will not comply with the new plant MES by 1 April 2025. Importantly, Duvha U1 and U2; Matla U1, U2, and U3; and Lethabo U6 will comply with the new plant MES from 1 April 2025.

While the non-compliant ambient PM_{10} and $PM_{2.5}$ concentrations in the Highveld, Vaal Triangle, and Waterberg are noted (detailed in chapter 5 of this report), and recognising Eskom are not the sole contributor to these, the Eskom Fleet PM emissions show significant improvements from 2025 to 2028 due to the planned abatement projects and shutdown phases of Kriel, Arnot, Camden, Hendrina, and Grootvlei in effect. By FY2030, a PM emission reduction of 65kt (74%) is estimated, and by 2050, compared to 2025, a total reduction of 94% is estimated.

Despite the significant PM emission reductions described above, the cumulative Highveld and Vaal dispersion modelling assessment predicted non-compliant PM_{10} 24-hour, $PM_{2.5}$ annual, and $PM_{2.5}$ 24-hour average concentrations; predicted annual average PM_{10} concentrations remained compliant with the NAAQS in all scenarios. Critically, when considering these predictions, the conservative approach to the PM simulations must be noted, such as assuming all PM was PM_{10}, and all PM was $PM_{2.5}$, as well as the worst-case assumption that most of the ash dumps are exposed and available for entrainment, while in reality much of these surfaces are vegetated and wet, reducing actual exposed areas. Further to this, and as noted in the uMoya-Nilu AIRs (report uMN220-24, 2024 and uMN219-24, 2024), predicted ambient PM concentrations are predominantly due to the low-level fugitive sources, rather than the stack emissions themselves; the benefit of the stack emissions reductions, as evident in the trajectories, is over-shadowed by the impacts associated with fugitive emissions given the conservative assumptions applied to these.

Eskom recognises the importance of reducing PM emissions, and is committed to the planned abatement projects, and in conjunction with these has also implemented its air quality offsets programme. As noted in section 4.2.1, significant indoor PM_{10} and $PM_{2.5}$ concentration reductions have been achieved in participating households of the Highveld and Vaal Triangle communities, with Eskom planning to expand this program to additional communities and explore new interventions to reduce ambient PM_{10} and $PM_{2.5}$ concentrations in surrounding communities further.

In light of the above, Eskom is requesting exemption from the new plant PM MES at Duvha (U4 and U6), Lethabo (U1, U2, U3, U4, and U5), Matla (U4, U5, and U6), Kendal, and Tutuka until completion of the abatement projects, after which these stations will comply with the new plant MES. Emission limits requested, and timeframes attached to each, are presented in section 7.2.

7.1.1.2 Oxides of Nitrogen

Medupi currently has LNBs installed, complying with the new plant MES (750mg/Nm^3), while Kendal and Matimba have low NO_X boilers (corner-fired), with emissions also compliant with the new plant

MES. Given this, no NO_X abatement projects are planned at these stations, and therefore no exemption from the new plant MES are requested for these stations.

NO_X abatement technology, in the form of LNBs, is planned for installation at Lethabo, Tutuka, and Majuba, which, once installation and optimisations are complete, will result in these stations complying with the new plant NO_X MES. LNBs are long-term installations, and once procurement, concept and design, and manufacturing are complete, installations take five years to complete on all generating units, recognising that only one generating unit can be taken offline at a time to ensure maintained security of electricity supply.

The Tutuka LNB manufacturing contract was awarded in February 2024, while the installation contract will be awarded early 2025, depending on market response. Installation on the first generating unit is planned for 2025, after which LNBs will be installed sequentially according to available outages, with the last LNB to be complete by 2029.

Majuba have initiated the LNB project, currently at tender evaluation stage. Installation on the first generating unit is due to commence in 2026, after which LNBs will be installed sequentially according to available outages, with the last LNB to be complete by 2030.

The Lethabo LNB project is currently in Concept Release Approval (CRA) phase. Installation on the first generating unit is due to commence in 2027, after which LNBs will be installed sequentially according to available outages, with the last LNB to be complete by 2031.

Following completion of the above projects, Tutuka, Majuba, and Lethabo will comply with the new plant NO_X MES, however, as shown above, these projects will not be complete by 1 April 2025. Given this, Eskom is requesting exemption from the new plant MES for these stations until completion of the LNB installations. Currently, NO_X emissions at Majuba and Tutuka comply with the existing plant MES (1,100mg/Nm^3) limit, and while two exceedances of the existing limit occurred at Lethabo, the average NO_X emission complies with the existing limit. These emissions will reduce further with the initiation of Despatch Prioritisation to address SO_2 emissions, ensuring compliance with the existing plant MES is maintained. Emission limits requested, and timeframes attached to each, are presented section 7.2.

Regarding Matla and Duvha, installations of NO_X abatement technologies are not being considered. Should the new plant MES be enforced at Matla and Duvha, an LNB installation start date of 2028 is estimated, considering concept and design, market response, and procurement, following which manufacturing can commence. The first LNB installation would be complete in 2029, one year before Matla and Duvha commence shutdown. Considering that both Matla and Duvha commence shutdown in 2030, and the costs associated with an LNB, it is not economically feasible to install this technology. Further, regarding Matla, the National Environmental Consultative and Advisory (NECA) Panel had provided commentary that it was not economically feasible to install LNB at Matla, although if security of supply could be maintained, Matla was to be considered for early shutdown. The same consideration can be given to Duvha as both stations have the same shutdown schedule.

Although NO_X abatement technology is not being considered at Matla and Duvha, both stations currently comply with the exiting plant limit (1,100mg/Nm^3), and with the initiation of Despatch Prioritisation to address SO_2 emissions, will reduce further.

For the period 2021 – 2023, as discussed in chapter 5, measured ambient NO_2 concentrations in the Highveld and Vaal Triangle are compliant with the NAAQS, and although hourly exceedances occurred, these remained well below the permitted frequency of exceedance. While Eskom is not the sole contributor to these concentrations, Eskom emissions still do contribute, recognising these contributions are made at Eskom's current emission rates i.e. without NO_X abatement at Matla, Duvha, Tutuka, Majuba, and Lethabo. Despite these stations not having NO_X abatement, ambient concentrations are compliant with the NAAQS. Considering the cumulative Eskom Fleet NO_X emissions trajectory, by FY2030 (compared to 2025), NO_X emissions are estimated to reduce by 292kt (40%) due to shutdowns of Arnot, Kriel, Hendrina, Camden, and Grootvlei. Between FY2025 and FY2050, total NO_X emissions are estimated to decrease by 78%.

Considering the cumulative Highveld and Vaal Triangle dispersion model and maximum sensitive receptors predictions, discussed in chapter 5, all modelling scenarios predicted compliant NO_2 concentrations, with annual averages well below the NAAQS, and no hourly exceedances predicted. This included the current scenarios (modelling Scenario 1 and Scenario A), which assumed no NO_X abatement at Matla, Duvha, Tutuka, Majuba, and Lethabo.

In light of the above, Eskom is requesting exemption from the new plant NO_X MES at Matla and Duvha until shutdown is complete, and at Tutuka, Majuba, and Lethabo until LNB installations are complete. Emission limits requested, and timeframes attached to each, are presented section 7.2.

7.1.1.3 Sulphur Dioxide

ERP 2024 A includes the installation of a wet FGD at Medupi, which, after various abatement technology evaluations, was found to be the most suitable for Medupi. The wet FGD has now been conceptualised with Medupi going to market in August 2024 to acquire an EPC contractor to execute the FGD project, anticipated to be concluded by the first quarter of 2025, although this is wholly dependent on market response. Planned commencement of the FGD installations is FY2028, taking five years to complete on all generating units, with the last unit completed in FY2032.

Following completion of these installations, Medupi will comply with the new plant MES (1,000mg/Nm^3), and anticipates improving on this MES and achieving an emission of 800mg/Nm^3 to offset SO_2 emissions from Matimba (discussed further in section 7.1.2). While Medupi will achieve MES compliance after installation of the FGD, it cannot achieve the new plant MES until these are completed. Given this, SO_2 emissions at Medupi will be managed through Despatch Prioritisation (discussed in section 4.1) and efficiency improvement projects optimising the air-to-fuel ratio which will maximise combustion efficiency and reduce SO_2 emissions further.

Measured ambient SO_2 concentrations in the Waterberg for the period 2021 – 2023 show compliance with the NAAQS, and although short-term exceedances were recorded, these did not exceed the permitted frequency of exceedance (discussed in section 5.3). While Eskom is not the sole contributor to these concentrations, Eskom emissions comprise one of the key SO_2 sources in the region, recognising these contributions are made at Eskom's current emission rates i.e. without SO_2 abatement at Medupi, with ambient concentrations remaining compliant with the NAAQS. Considering the cumulative Eskom Fleet SO_2 reductions under ERP 2024 A, by FY2030 a decrease of 555kt (32%) is anticipated, with a further 165kt (14%) by FY2035 due to completion of the wet FGD at Medupi, Despatch Prioritisation, efficiency improvement projects, and shutdown of Arnot, Kriel, Camden, Hendrina, Grootvlei, Duvha, and Matla. Eskom's Security of Supply projection, representing an upper emissions limit, still shows emission reductions, and by FY2030 a 482kt (27%) reduction is anticipated, with a further decrease of 294kt (23%) by FY2035.

The cumulative Waterberg dispersion modelling (discussed in section 5.3) predicts maximum sensitive receptor annual average SO_2 concentrations will remain well below the NAAQS, as well as no exceedances of the hourly NAAQS, in all modelling scenarios, including those where current

Medupi emissions are simulated without wet FGD. Despite this compliance, 24-hour non-compliances are predicted in scenarios where FGD is not yet installed at Medupi, however following FGD completion, 24-hour concentration predictions are compliant with the NAAQS, with no exceedances predicted.

Considering the above, Eskom is requesting exemption from the new plant MES at Medupi until completion of the FGD. For Matla, Duvha, Lethabo, Tutuka, and Matimba, since SO_2 abatement is not being evaluated for these stations in ERP 2024 A, exemption from the new plant SO_2 MES is requested until shutdown; emission limits requested, and timeframes attached to each, are presented in section 7.2. Alternate SO_2 emission limits below the existing plant limits are being requested for all stations (except Matimba).

7.1.1.4 Health Cost Benefit Analysis

As discussed in section 6.2, the health cost benefit analysis (CBA) undertaken considered the costs and health benefits of all projects under ERP 2024 A, although separately for the Highveld and Vaal, and Waterberg.

Considering the Highveld and Vaal CBA, health benefits for ERP 2024 A outweighed the costs to implement the projects, indicating these projects should be considered. As noted previously, Eskom is committed to implementing the ERP 2024 A projects, although given the timeframes associated with completion of these projects, exemption from the new plant MES is being requested for certain stations and pollutants.

Considering the Waterberg CBA, the central BCR was extremely low, well below 1, predominantly due to the small population in the Waterberg area, indicating that the costs to install the FGD at Medupi, outweigh the health benefits that will be recognised from the FGD. Despite this, and as noted previously, a wet FGD will be installed at Medupi to achieve MES compliance, although given the timeframes of installation, exemption from the new plant MES is being requested for Medupi until the FGD is complete.

7.1.1.5 Summary

The total cost (Highveld, Vaal Triangle, and Waterberg) associated with implementation of ERP 2024 A is estimated to be R77 billion, inclusive of the PM, NO_X, and SO_2 projects presented above. Based on the summary above and the multiple other issues and impacts raised in the exemption reports ERP 2024 A is considered the most appropriate scenario for implementation. This is further supported by the high BCR ratio obtained for the Highveld and Vaal areas, implying health benefits realised from ERP 2024 A outweigh the costs associated with ERP 2024 A. While the BCR is low for the Waterberg, Eskom will be installing a wet FGD at Medupi.

7.1.2 ERP 2024 B SCENARIO

As noted previously, in addition to the already discussed projects in ERP 2024 A, ERP 2024 B assessed DSI FGD at Majuba and a semi-dry FGD at Kendal (detailed in section 4.2). This represents a scenario, that based on nationally lead strategic decisions and additional guarantees, could be achieved. This ERP requires careful evaluation of financial consequences, shutdown timeframes, Eskom Fleet emissions reduction, existing ambient concentrations, and dispersion modelling predictions.

While SO_2 emissions at Kendal and Majuba comply with their respective existing plant MES, neither station can comply with the new plant MES (1,000mg/Nm^3) without SO_2 abatement. The semi-dry FGD at Kendal, being evaluated as part of this application, would bring Kendal SO_2 emissions to compliance with the new plant MES. DSI FGD at Majuba, also being evaluated as part of this application, would not result in compliance with the new plant MES, although would approximately reduce emissions by 25%.

Measured ambient SO_2 concentrations in the Highveld and Vaal Triangle for the period 2021 – 2023 show compliance with the NAAQS, and although short-term exceedances were recorded, these did not exceed the permitted frequency of exceedance (discussed in section 5.2). While Eskom is not the sole contributor to these concentrations, Eskom emissions are a key contributor, recognising these contributions are made at Eskom's current emission rates i.e. without SO_2 abatement at Kendal and Majuba, with ambient concentrations remaining compliant with the NAAQS. Considering the cumulative Eskom Fleet SO_2 reductions under ERP 2024 A (excluding SO_2 abatement at Majuba and Kendal), by FY2030 a decrease of 555kt (32%) is anticipated, with a further 165kt (14%) by FY2035 due to completion of the wet FGD at Medupi, Despatch Prioritisation, efficiency improvement projects, and shutdown of Arnot, Kriel, Camden, Hendrina, Grootvlei, Duvha, and Matla. Eskom's Security of Supply projection, representing an upper emissions limit, still shows emission reductions, and by FY2030 a 482kt (27%) reduction is anticipated, with a further decrease of 294kt (23%) by FY2035.

The cumulative Highveld and Vaal Triangle Eskom Fleet dispersion modelling (discussed in section 5.2) predicts maximum sensitive receptor annual average SO_2 concentrations will remain well below the NAAQS, as well as no exceedances of the 24-hour or hourly NAAQS being predicted, in all modelling scenarios, including those where current Majuba and Kendal emissions are simulated without abatement technologies. While annual average ambient concentration predictions do improve when comparing ERP 2024 B (13.3µg/m^3) to ERP 2024 A (17.2µg/m^3), an improvement of 3.9µg/m^3 is realised, but is attributable to a combination of the SO_2 abatement at Majuba and Kendal, but more so from the shutdown of Duvha and Matla, with greatest SO_2 reductions achieved through station shutdowns, rather than SO_2 abatement.

Regarding Kendal, following evaluation of various SO_2 abatement technologies, the semi-dry FGD was identified as the most suitable. Due to the lead times associated with concept and design, procurement, construction, and installation, the semi-dry FGD installation would commence FY2031, with completion of the last unit in FY2035, although this is dependent on market response and timeframe commitments from contractors. Kendal is scheduled to enter shutdown phase in FY2040, with shutdown complete by FY2045, with the full impact of FGD only realised for approximately four years before Kendal enters shutdown. An estimated nominal Capex of R44.4 billion (-15% to +20%) is required for the semi-dry FGD at Kendal, with an annual real Opex of approximately R1 billion.

At Majuba, key technologies considered to abate SO_2 were FGD (either wet or semi-dry) and variations of DSI Dry FGD, such as a combination of DSI (hydrated lime into duct) and/or furnace sorbent injection (limestone into furnace). A semi-dry FGD would require breaking into the existing plant to install the FGD between the boiler and before the PJFFP, which is a very intrusive process with a long timeframe. A wet FGD is installed after the PJFFP but requires a dedicated absorber tower and much more water than both semi-dry and DSI, while space on the existing terrace is limited for an absorber tower. Given this, DSI has been identified as the most appropriate technology at Majuba to reduce emissions, although not to MES compliance. Pilot projects are currently planned to test the effectiveness of the DSI technology. Due to the lead times associated with the pilot project, concept and design, procurement, construction, and installation, DSI installation would commence FY2029, with completion of the last unit in FY2033. Majuba shutdown is due to commence in FY2047, with complete shutdown by FY2052. An estimated nominal Capex of R13.1 billion (-15% to +20%) is required for the DSI at Majuba, with an annual real Opex of approximately R1 billion.

To reduce SO_2 emissions at Kendal and Majuba, either as an interim measure until abatement is installed, or permanently if the decision is made not to install abatement, is the implementation of Despatch Prioritisation and completion of efficiency improvement projects, both of which will have a positive impact on SO_2 emissions, although would not bring emissions into compliance with the new plant MES.

Considering the health cost benefit analysis for ERP 2024 B, the central BCR suggests costs to implement ERP 2024 B outweigh the health benefits that will be achieved with implementation. Implementation of ERP 2024 B, in addition to ERP 2024 A, would have a combined nominal Capex of R134.6 billion.

The installation of SO_2 abatement at Majuba and Kendal needs to be considered carefully, particularly at Kendal where the project will only be complete approximately four years before shutdown starts, and therefore return on investment will not be realised. For ERP 2024 B, it would be necessary to source funding against the background of guaranteed cost-reflective tariffs. From an economic/financial perspective a defined minimum load factor/take or pay agreement would ensure that the unit costs are acceptable compared to known alternatives, however if consideration could be given to the extension of the station life the economic/financial viability could improve.

While extension of a station's life may provide improved viability, this would mean an extension of South Africa's reliance on coal generation, potentially impacting South Africa's GHG commitments. A possible alternative to consider, would be that if funding is made available Eskom increases its investments in renewables and grid connection by the same amounts that would have been invested in such SO_2 retrofits; this would result in larger economic value add than FGD retrofits, and would progress South Africa's transition to renewables quicker.

Based on the summary above, considering the costs of technology installations, the benefits realised from this, and the multiple other issues and impacts raised in the exemption reports ERP 2024 B is not considered an appropriate scenario for implementation.

7.1.3 ERP 2024 C SCENARIO

As noted previously, in addition to the already discussed projects in ERP 2024 A and ERP 2024 B, ERP 2024 C assessed semi-dry FGD at Lethabo, Tutuka, and Matimba (detailed in section 4.2). This represents a scenario that would require substantial guarantees and considerations of financial impacts, such as on electricity tariffs, and return on investments.

While SO_2 emissions at Lethabo, Tutuka, and Matimba comply with their respective existing plant MES, these stations cannot comply with the new plant MES (1,000mg/Nm^3) without SO_2 abatement. Eskom has consistently motivated in previous applications that an FGD, or similar technology, at Lethabo, Tutuka and Matimba is not feasible and has therefore not commenced with concept and design. Eskom maintains this position in this application, as presented below.

Should new plant MES compliance be enforced at Tutuka, Lethabo, and Matimba, and since concept and design have not commenced, followed by procurement and construction, a start date of FY2031 is estimated. Since installation is five years for all generating units, estimated completion dates would be optimistically FY2035. Tutuka starts shutdown in FY2036, one year after completion of the FGD, Lethabo starts shutdown FY2037, two years of completion of FGD, and Matimba starts shutdown FY2039, four years of completion of the FGD. Considering the nominal Capex to install FGD at Tutuka (R38.4 billion), Lethabo (R40 billion), and Matimba (R42 billion), return on investment would not be realised and is therefore not economically feasible to install this equipment.

Further to the above, is the consideration of the existing compliant ambient SO_2 concentrations in the Highveld, Vaal Triangle, and Waterberg regions, with Tutuka, Lethabo, and Matimba currently contributing to these measurements in their respective regions, without SO_2 abatement. Further to this, the cumulative dispersion modelling for the Highveld and Vaal predicts compliant ambient SO_2 concentrations due to the Eskom Fleet, inclusive of the scenarios which simulated Tutuka, Lethabo, and Matimba without abatement. These predictions correlate with the existing compliant ambient concentrations in the area. While the Waterberg cumulative dispersion model predicted non-compliant 24-hour concentrations, it predicted fully compliant annual and hourly concentrations in all scenarios. Further, once the Medupi FGD is complete, model predictions showed full compliance, even with Matimba simulated without abatement. Regarding Matimba, is consideration of the low emissions that will be achieved on completion of the Medupi FGD, which can be considered as offsetting Matimba SO_2 emissions. Further, the NECA Panel questioned the feasibility of installing wet FGD at Medupi, and while Eskom will be installing wet FGD at Medupi, the same consideration can be provided to installing FGD at Matimba.

Comparing predicted air quality improvements between ERP 2024 A and ERP 2024 C, in the Highveld and Vaal region, a maximum sensitive receptor annual average reduction of 11.8µg/m^3 will be realised. Importantly, this reduction is not only due to the FGDs at Lethabo and Tutuka, but more so from the shutdown of Arnot, Kriel, Hendrina, Camden, Grootvlei, Duvha and Matla, with a station shutdown having a much greater impact on SO_2 emission reduction than abatement technology. In the Waterberg, once the Medupi FGD is installed, and should Matimba also receive an FGD, a maximum sensitive receptor annual average reduction of 5µg/m^3 would be realised.

In addition, the health cost benefit analysis, in all regions, suggests the costs to implement ERP 2024 C far outweigh the health benefits that will be realised, and particularly so in the Waterberg due to the small population.

Implementation of ERP 2024 C, in combination with ERP 2024 A and ERP 2024 B, would result in a nominal Capex of R256.9 billion. This would place additional strain on the South African economy, without return on investment, both from a financial perspective, and ambient air quality benefits. While extension of the operational life of the stations would provide economic return on investment, this approach would extend South Africa's reliance on coal power generation.

Based on the summary above, considering the costs of technology installations, the benefits realised from this, and the multiple other issues and impacts raised in the exemption reports ERP 2024 C is not considered an appropriate scenario for implementation.

7.2 REQUESTED EMISSION LIMITS FOR THE EXEMPTION STATIONS

As presented in section 3.2, Eskom are required to comply with the new plant MES by 1 April 2025. As discussed, and motivated in section 7.1, this is not achievable for certain pollutants at certain stations. Given this, Eskom is requesting exemption from the new plant MES until shutdown for certain stations, and until completion of abatement equipment installations at others. Table 7-1 to Table 7-8 present the requested emission limits for each station contained in this exemption application.

Table 7-1 – Emission limits requested for Duvha

POINT SOURCE CODE	POLLUTANT	MAXIMUM RELEASE RATE			DURATION OF EMISSIONS
		mg/Nm³	Average Period	Date To Be Achieved	
U1, U2, U4, U5, U6	SO_2	2,600 mg/Nm³	Daily	Immediate - shutdown	Continuous
	NO_X	1,100 mg/Nm³	Daily	Immediate - shutdown	Continuous
U1, U2, U5	PM	50 mg/Nm³	Daily	Immediate	Continuous
U4, U6	PM	100 mg/Nm³	Daily	Immediate	Continuous
		50 mg/Nm³	Daily	1 October 2026	Continuous
*Emission limits requested are for normal operations, so exclude upset, startup, shutdown, or maintenance conditions					

Table 7-2 - Emission limits requested for Matla

POINT SOURCE CODE	POLLUTANT	MAXIMUM RELEASE RATE*			DURATION OF EMISSIONS
		mg/Nm³	Average Period	Date To Be Achieved	
U1, U2, U3, U4, U5, U6	SO_2	2,600 mg/Nm³	Daily	Immediate - shutdown	Continuous
	NO_X	1,100 mg/Nm³	Daily	Immediate - shutdown	Continuous
U1, U2, U3	PM	100 mg/Nm³	Daily	Immediate	Continuous
		50 mg/Nm³	Daily	1 April 2025	Continuous
U4, U5, U6	PM	100 mg/Nm³	Daily	Immediate	Continuous
		50 mg/Nm³	Daily	1 April 2026	Continuous
*Emission limits requested are for normal operations, so exclude upset, startup, shutdown, or maintenance conditions					

Table 7-3 - Emission limits requested for Tutuka

POINT SOURCE CODE	POLLUTANT	MAXIMUM RELEASE RATE*			DURATION OF EMISSIONS
		mg/Nm³	Average Period	Date To Be Achieved	
Stack 1 (U1-3) Stack 2 (U4 -6)	SO_2	3,000 mg/Nm³	Daily	Immediate - shutdown	Continuous
	NO_X	1,100 mg/Nm³	Daily	Immediate	Continuous
		750 mg/Nm³	Daily	1 April 2029	Continuous
	PM	300 mg/Nm³	Daily	Immediate	Continuous
		50 mg/Nm³	Daily	1 April 2027	Continuous
*Emission limits requested are for normal operations, so exclude upset, startup, shutdown, or maintenance conditions					

Table 7-4 - Emission limits requested for Lethabo

POINT SOURCE CODE	POLLUTANT	MAXIMUM RELEASE RATE*			DURATION OF EMISSIONS
		mg/Nm³	Average Period	Date To Be Achieved	
U1, U2, U3, U4, U5, U6	SO_2	2,600 mg/Nm³	Daily	Immediate - shutdown	Continuous
	NO_X	1,100 mg/Nm³	Daily	Immediate	Continuous
		750 mg/Nm³	Daily	1 April 2031	Continuous
U6	PM	100 mg/Nm³	Daily	Immediate	Continuous
		50 mg/Nm³	Daily	1 April 2025	Continuous
U2, U3	PM	100 mg/Nm³	Daily	Immediate	Continuous
		50 mg/Nm³	Daily	1 April 2026	Continuous
U5	PM	100 mg/Nm³	Daily	Immediate	Continuous
		50 mg/Nm³	Daily	1 October 2026	Continuous
U4	PM	100 mg/Nm³	Daily	Immediate	Continuous
		50 mg/Nm³	Daily	1 April 2027	Continuous
U1	PM	100 mg/Nm³	Daily	Immediate	Continuous
		50 mg/Nm³	Daily	1 October 2027	Continuous
*Emission limits requested are for normal operations, so excludes upset, startup, shutdown, or maintenance conditions.					

Table 7-5 - Emission limits requested for Matimba

POINT SOURCE CODE	POLLUTANT	MAXIMUM RELEASE RATE*			DURATION OF EMISSIONS
		mg/Nm³	Average Period	Date To Be Achieved	
SV0013, SV0014, SV0015, SV0002, SV0011, SV0012	SO_2	3,500 mg/Nm³	Monthly	1 April 2025 - shutdown	Continuous
	NO_X	750 mg/Nm³	Daily	1 April 2025	Continuous
	PM	50 mg/Nm³	Daily	1 April 2025	Continuous
*Emission limits requested are for normal operations, so exclude upset, startup, shutdown, or maintenance conditions					

Table 7-6 - Emission limits requested for Kendal

POINT SOURCE CODE	POLLUTANT	MAXIMUM RELEASE RATE*			DURATION OF EMISSIONS
		mg/Nm³	Average Period	Date To Be Achieved	
U1, U2, U3, U4, U5, U6	SO_2	3,000 mg/Nm³	Daily	Immediate	Continuous
		1,000 mg/Nm³	Daily	1 April 2036**	Continuous
	NO_X	1,100 mg/Nm³	Daily	Immediate	Continuous
		750 mg/Nm³	Daily	1 April 2025	Continuous
U3, U4, U6	PM	100 mg/Nm³	Daily	Immediate	Continuous
		50 mg/Nm³	Daily	1 October 2025	Continuous
U1, U2, U5	PM	100 mg/Nm³	Daily	Immediate	Continuous
		50 mg/Nm³	Daily	1 April 2026	Continuous

*Emission limits requested are for normal operations, so exclude upset, startup, shutdown, or maintenance conditions
**Should semi-dry FGD be installed

Table 7-7 - Emission limits requested for Majuba

POINT SOURCE CODE	POLLUTANT	MAXIMUM RELEASE RATE*			DURATION OF EMISSIONS
		mg/Nm³	Average Period	Date To Be Achieved	
SV0013, SV0014, SV0015, SV0002, SV0011, SV0012	SO_2	3,000 mg/Nm³	Daily	Immediate	Continuous
		2,100 mg/Nm³	Daily	1 April 2034**	Continuous
	NO_X	1,100 mg/Nm³	Daily	Immediate	Continuous
		750 mg/Nm³	Daily	1 April 2030	Continuous
	PM	50 mg/Nm³	Daily	Immediate	Continuous

*Emission limits requested are for normal operations, so exclude upset, startup, shutdown, or maintenance conditions.
**Should DSI be installed

Table 7-8 - Emission limits requested for Medupi

Point Source Code	Pollutant	Maximum release rate*			Duration of Emissions
		mg/Nm³	Average Period	Date To Be Achieved	
SV0013, SV0014, SV0015, SV0002, SV0011, SV0012	SO_2	3,500mg/Nm³	Monthly	Immediate	Continuous
		800mg/Nm³	Monthly	1 April 2032	Continuous
	NO_X	750 mg/Nm³	Daily	Immediate	Continuous
	PM	50 mg/Nm³	Daily	Immediate	Continuous

*Applicable to normal operations, so excludes upset, startup, shutdown, and maintenance periods.

7.3 EXEMPTION APPLICATION – OTHER CONSIDERATIONS

7.3.1 SOCIOECONOMIC CONSIDERATIONS

While various motivations have been provided in the previous sections supporting Eskom's requests for the various exemptions, consideration needs to be given to the potential impacts associated with the MES being strictly enforced.

Strict adherence to the legal framework and regulations (i.e. MES) will require generating units to be taken offline until abatement installations are complete, or for certain stations (e.g. Matla and Duvha) to enter shutdown early with NERSA approval, which will reduce available capacity in the grid, resulting in an increased degree of loadshedding. Should generating units be taken offline at the various stations, approximately 29,230MW will be at risk.

Over the past decade, South Africa's electricity system has struggled to meet demand due to frequent breakdowns and reduced capacity, leading to recurrent loadshedding. This crisis has severely impacted the economy, particularly the mining and industrial sectors, causing reduced outputs and a loss of investor confidence and government revenue. Power outages have also affected medical care, food storage, sanitation, water, and sewerage facilities, while citizens face daily challenges such as extended commutes, increased crime, and difficulties in food preparation.

As was shown through scenario modelling in 2021/22, full compliance (whether immediate or even over a period of several years) could potentially limit the constitutional rights of South Africans by leading to severe energy deficits, at minimum constraining GDP growth and economic recovery, at worst causing total economic collapse. While impacts of loadshedding on the economy is well understood, considerations also need to be given to local communities potentially impacted by the shutdown of generating units and/or certain stations starting shutdown early. Across the Eskom Fleet applying for exemption, approximately 5,450 people are directly employed, with thousands of contractors associated with the stations, as well as the various collieries supplying the stations. Shutdown of generating units would place a significant risk on these employees, and with extremely high unemployment rates throughout the country, would exacerbate the situation. Numerous impacts are associated with unemployment, such as increasing crime and Gender Based Violence (GBV), alienation in communities, reductions in standards of living, and inability to meet necessities.

A balanced approach to energy policy is required, aiming to reduce reliance on coal while expanding renewable and lower-emission energy sources, although the roll-out of these transitions has been slow. Aligning with the National Energy Crisis Committee (NECOM) Energy Action Plan, Eskom aims to address the energy gap with immediate solutions such as demand reduction, accelerating the construction of new generation and storage capacity, improving infrastructure, and enhancing Eskom's operational efficiency.

7.3.2 ESTABLISHMENT OF AN EMISSION REDUCTION TRAJECTORY

The scenarios described above have referred to emission reduction trajectory in terms of PM, NO_X and SO_2. With scenario ERP 2024 A showing emission reductions by FY2030 for PM (65kt), NO_X (292kt), and SO_2 (555kt), while the Eskom security of supply projection also shows reductions by FY2030 for PM (64kt), NO_X (256kt) and SO_2 (482kt). While the MES and climate change regulatory process are legally separate it is useful to note both ERP 2024 A and the security of supply projection are aligned with Eskom's current pollution prevention plan running to December 2025. Future CO_2

trajectories will be based on the updated pollution prevention plan and IRP, NDC, and Sectorial Emission Targets (SET).

The Priority Area regulations and priority area plans refer to emission reduction targets, with the draft HPA plan indicating that industry should obtain a 40% reduction in total emissions by 2030 from a 2019 base. The emission reduction projections described above are based on the best available assessment of what Eskom is required to generate from coal stations in terms of the nationally driven IRP process and Eskom planning. Neither of these processes are static and they are influenced by a range of factors including economic growth rates, IPP production and national climate change commitments. If economic growth increases and there are substantive delays in the provision of non-coal-based generation then the Eskom coal fleet may be asked to ensure security of supply which will result in an increase in emissions above the trajectories predicted in this application. As such Eskom believes it would be inappropriate for the setting of specific legally binding emission reduction targets at either a fleet or station level and request exemption from any such requirements where they are enforced through air quality related legal mechanisms.

7.3.3 THE LIMITED EXTENT OF THIS APPLICATION

Eskom is mindful that any exemption application should be limited in extent and believes that the alternative emission limits requested above and this application in general complies with that approach. Further, the exemptions requested will ensure security of supply will be maintained. Specifically, Eskom has:

- In respect of PM limits only requested exemption where it is necessary for the time to complete the emission reduction projects to bring the stations into new plant MES compliance. Further, the exemption requested alternate limits is no worse than the MES existing plant limits which the stations have operated at historically.
- In respect of NO_X limits for Lethabo, Tutuka and Majuba only requested exemption where it is necessary for the time to complete the emission reduction projects to bring the stations into compliance with the new plant MES. Further, there is compliance to NAAQS ambient air quality limits for NO_2 and the exemption requested alternate limits is no worse than the MES existing plant limits which the stations have operated at historically.
  - In the case of NO_X limits for Duvha and Matla the exemption request is supported by a clear motivation, there is compliance to NAAQS ambient air quality limits for NO_2 and the requested alternate limits are no worse than the MES existing plant limits which the stations have operated at historically.
- In terms of SO_2 the exemption request has provided clear motivation above of the appropriateness of the alternate limits specifically illustrating that there is compliance to NAAQS ambient air quality limits for SO_2. In addition, Eskom is not seeking a blanket exemption as it intends to operate at alternate SO_2 limits generally below the existing plant limits and it will obtain MES compliance for two out of the three priority pollutants at all stations operating post 2035.

8 ASSUMPTIONS AND LIMITATIONS

The following assumptions, limitations and exclusions are applicable to this application:

- A 50-year operational life for the power stations has been assumed for this application.
- It is assumed the emission trajectories for scenario options of ERP 2024 A, ERP 2024 B, and ERP 2024 C, as provided by Eskom, are accurate and representative of reality and future anticipated plans.
- It is assumed current emissions data, as provided by Eskom, used to assess compliance to emission limits, and used as input to the dispersion models, are accurate and representative of existing operations.
- It is assumed abatement projects, as proposed by Eskom, will be undertaken as presented within the timeframe commitments, to the best of Eskom's ability i.e. should outage schedules and grid capacity allow.
- Operational challenges identified at the stations, and confirmed by Eskom, are assumed to be accurate of current operational conditions at the stations.
- Results from the dispersion modelling, discussed herein, are assumed to accurately represent emissions data provided.
- Due to time constraints, the Security of Supply emission projection could not be assessed in the dispersion modelling.
- Ambient monitoring data, as contained herein, is assumed to accurately represent existing ambient air quality within the various airsheds.
- Qualitative technology evaluations, particularly relating to SO_2 abatement technologies, were undertaken by Eskom. This application assumes these evaluations, and the preferred technologies from these, accurately reflect the most appropriate technology for a particular station. WSP's involvement in this application, and high-level understanding of Eskom stations, does indicate the technologies selected are most suitable, considering all aspects, such as costs, timeframes to commission, water requirements, retrofitting complexities, waste management, and emission reduction efficiencies. Despite this, WSP cannot be held responsible should more appropriate technologies be identified in the future.
- Shutdown dates provided by Eskom are not within Eskom's legal mandate to decide, but require prior approval from NERSA, which may not necessarily be granted should security of supply be jeopardised.

9 STAKEHOLDER ENGAGEMENT

The Ministers Decision issued in May 2024 requires that: "Eskom must ensure that all relevant organs of state, I&APs are notified of its applications for exemption and provided with an opportunity to comment thereon."

Based on this requirement, a public participation process based on the requirements of the EIA Regulations have been undertaken. Public participation is understood to be a series of inclusive and culturally appropriate interactions aimed at providing stakeholders with opportunities to express their views, so that these can be considered and incorporated into the decision-making process.

9.1 PUBLIC PARTICIPATION

9.1.1 IDENTIFICATION OF KEY STAKEHOLDERS

The stakeholder engagement commenced with the compilation of a stakeholder database to include relevant stakeholders, such as Commenting Authorities, State Owned Enterprises, business landowners/users, and Ward Councillors, as well as any other I&APs who may be interested or affected by the project.

Relevant authorities (organs of state) have been automatically registered as I&APs. In accordance with the EIA Regulations, 2014 all other persons must request in writing to be placed on the register, submit written comments, or attend meetings to be registered as stakeholders and included in future communication regarding the application.

Section 41 of the EIA Regulations, 2014 states that written notices must be given to identified stakeholders as outlined in the table below.

Table 9-1 - I&AP Identification

NEMA REQUIREMENT	DISCUSSION
(i) the owner or person in control of that land if the applicant is not the owner or person in control of the land	The applicant is the landowner.
(ii) the occupiers of the site where the activity is or is to be undertaken or to any alternative site where the activity is to be undertaken	The applicant is the landowner and occupant.
(iii) owners and occupiers of land adjacent to the site where the activity is or is to be undertaken or to any alternative site where the activity is to be undertaken	The landowners and occupant of adjacent properties will be notified of the proposed application by newspaper advert, site notices placed around the proposed site and also emails and SMS for those already registered in the database.
(iv) the municipal councillor of the ward in which the site or alternative site is situated and any organisation of ratepayers that represent the community in the area	The Ward Councillor from Wards 18 of the MLM has been included in the stakeholder database and will be notified by newspaper, received personal email and SMS notifications.
(v) the municipality which has jurisdiction in the area	The Fezile Dabi District Municipality (FDDM) as well as the Metsimaholo Local Municipality have been included in

NEMA REQUIREMENT	DISCUSSION
	the stakeholder database and will be notified by newspaper, received email and SMS notifications.
(vi) any organ of state having jurisdiction in respect of any aspect of the activity	The FDDM will be notified by newspaper, email and SMS notifications.
(vii) any other party as required by the competent authority	All tiers of government, namely, national, provincial, local government and parastatals have been included on the stakeholder database and were notified by newspaper, received email and SMS notifications. Inclusive of: ▪ DESTEA ▪ DFFE ▪ Department of Energy ▪ Department of Water and Sanitation

9.1.2 MES EXEMPTION APPLICATIONS ANNOUNCEMENT

The exemption application process will be announced for public comment for a period of 30 days from **6 November 2024 – 6 December 2024**. Additionally, the technical report along with an electronic version of the comment sheet will be placed on the WSP Group Africa (Pty) Ltd (WSP) website as well as the WSP Datafree website to be accessed by the public at the following links: https://www.wsp.com/en-ZA/services/public-documents and https://wsp-engage.com/.

9.1.2.1 DIRECT NOTIFICATION

9.1.2.1.1 Email notifications

Notification of the exemption application will be issued to registered I&APs and stakeholders, via email on **06 November 2024**. The purpose of the notification was to offer registered I&APs and stakeholders the opportunity to comment on the application process. A total of 830 registered stakeholders were notified via email.

9.1.2.1.2 SMS

Notification of the exemption application will be issued to registered I&APs and stakeholders, via SMS on **06 November 2024**. The purpose of the notification was to offer registered I&APs and stakeholders the opportunity to comment on the application process. A total of 1,321 registered stakeholders were notified via sms.

9.1.2.1.3 Site notices

The EIA Regulations, 2014 require that site notices be fixed at places conspicuous to the public at the boundary or on the fence of the site where the activity (to which the application relates) is to be undertaken, as well as at any alternative sites. Posters (in English, Afrikaans and Sesotho), conforming to the size specifications as per the EIA Regulations, 2014 will be placed on **06 November 2024**. Six posters in each language (where relevant) were placed for each power station.

9.1.3 AVAILABILITY OF TECHNICAL REPORTS

The exemption reports were made available for public comment at the public places outlined in Table 9-2.

Table 9-2 - Public Availability of Exemption Report

LOCATION	ADDRESS	STATION REPORT AVAILABILITY
Lethabo Power Station	Klasie Havenga Street, Vanderbijlpark	Lethabo Power Station
Bophelong Library	Corner Ncuma and Matthews Street, Bophelong	Lethabo Power Station
Vereeniging Library	Lesley Street, Vereeniging	Lethabo Power Station
Sharpeville Library	Seeiso Street, Sharpeville	Lethabo Power Station
Matimba Power Station	Nelson Mandela Dr, Lephalale	Matimba Power Station
Medupi Power Station	Kuipersbuld Street, Marapong	Medupi Power Station
Lephalale Municipality Library	Corner Joe Slovo and Douwater Avenue, Lephalale	Waterberg Power Stations
Marapong Library	916 Phukubye Street, Marapong	Waterberg Power Stations
Kendal Power Station	Kendal Rd, Ogies	Kendal Power Station
Ogies Library	105 R555, Ogies	Kendal Power Station
Phola Public Library	Phola (25°59'44.88"S; 29° 2'21.30"E)	Kendal Power Station
Matla Power Station	Matla, Ga-Nala (26°16'55.63"S, 29° 8'26.34"E)	Matla Power Station
Ga Nala Public Library	c/o Quintin & Heinrich St, Ga-Nala	Matla Power Station
Duvha Power Station	Old Bethal Road, eMalahleni	Duvha Power Station
Majuba Power Station	Volksrust (27° 6'0.25"S; 29°46'9.99"E)	Majuba Power Station
Amersfoort Public Library	Amersfoort (27° 0'24.18"S; 29°52'11.10"E)	Majuba Power Station
Perdekop Public Library	Perdekop (27° 9'41.71"S; 29°37'36.37"E)	Majuba and Tutuka Power Stations
Tutuka Power Station	Thuthukani, Standerton 9 26°46'42.02"S; 29°20'49.16"E0	Tutuka Power Station
Standerton Public Library	Mbonani Mayisela St, Standerton	Tutuka Power Station
Stanwest Public Library	103 Sydney de Lange St, Standerton	Tutuka Power Station
EMalahleni Main Library	28 Hofmeyer St, eMalahleni	All Stations in the Highveld Priority Area
Thubelihle Public library	Thubelihle, Ga-Nala (26°13'1.68"S; 29°17'26.50"E)	All Stations in the Highveld Priority Area
Lynville Public Library	Vector Road, Lynville, eMalahleni	All Stations in the Highveld Priority Area
WSP Website	https://www.wsp.com/en-ZA/services/public-documents	All Power Stations
Data-free Website	https://wsp-engage.com/	All Power Stations

9.1.4 ADVERTISEMENT

Notification of the exemption application as well as opportunity to comment on the application process was issued to the general public via advertisements published in the newspapers outlined in Table 9-3, in **October 2024**, in English in all national newspapers and one other language in local newspapers. As mentioned above, the purpose of the advertisement was to notify the general public of the application, inform the public about the public meetings, and provide an opportunity to register on the project database and provide input into the process.

Table 9-3 - Placement of Adverts

NEWSPAPER NAME	DATE OF PUBLICATION
Vaal Weekblad	31 October 2024
Mogol Pos	1 November 2024
Mpumalanga News	6 November 2024
Standerton Advertiser	1 November 2024
Mpumalanga Lowvelder	1 November 2024
Ridge Times	1 November 2024
Witbank News	1 November 2024
Middelburg Observer	1 November 2024
City Press	3 November 2024
The Star	3 November 2024
Die Beeld	3 November 2024
Sunday Times	3 November 2024
Daily Sun	6 November 2024

9.1.5 PUBLIC MEETINGS

Public meetings will be convened for the project team to present the application to stakeholders as well as gather feedback from them. These meetings offer the stakeholders an opportunity to participate in the decision-making process and ensures that their voices are heard. Meetings will be convened at the locations outlined in Table 9-4 translation services will be available at the meetings and hard copy summaries of key documents will be made available at the physical meetings.

Table 9-4 - Date, venue and time of public meeting

VENUE	ADDRESS	DATE	TIME	MEETING AGENDA
Buitepos Saal	6 Carlyle Ct, Vanderbijlpark	13 November 2024	10:00	Lethabo
NG Kerk	Church St, Ogies	14 November 2024	10:00	Kendal
Secunda Community Hall	Walter Sisulu Road, Cnr Fisant Street - Lilian Ngoyi Centre Building	14 November 2024	18:00	All Stations in the Highveld Priority Area
eMalahleni Civic Centre	Mandela Street eMalahleni	19 November 2024	18:00	Duvha

VENUE	ADDRESS	DATE	TIME	MEETING AGENDA
Ga Nala (Kriel) Municipal Chambers	Quintin St, Ga-Nala	20 November 2024	10:00	Matla
Standerton Community Hall	81 Tamarisk St, Standerton	20 November 2024	18:00	Tutuka
Siyazenzela Community Hall	Durban Street - same street with Police Station & the Clinic Perdekop	21 November 2024	10:00	Majuba
Eskom Academy of Learning	Dale Road, Midrand	26 November 2024	10:00	All Power Stations
Mogol Golf Club	Cnr. George Wells Rd & Nelson Mandela Dr Lephalale	28 November 2024	10:00	Matimba / Medupi
Marapong Hall	458 Phukubje Street, Extension 2 Marapong	28 November 2024	18:00	Matimba / Medupi
Online Meeting	Microsoft Teams Meeting Meeting ID: 334 202 077 604 Passcode: 8PwGGQ	25 November 2024	13:00	All Power Stations
Middelburg Civic Centre	Eastdene Hall - Boncker Street (Verdoeran Street)	03 December	12:00	All Stations in the Highveld Priority Area

9.1.6 COMMENTS AND RESPONSES

Following the receipt of comments from I&APs, a Comments and Response Report ("CRR") will be prepared and submitted to the Minster.

Proof of stakeholder engagement undertaken will be included in the submission to the Minister.

10 REFERENCES

Air Resource Management (ARM). (2024). *Offsets Research: Proposal for the expansion of Eskom's AQO Programme in the Highveld and Vaal, Rev: 02[ESK-A16-AQOE-02].*

Air Resource Management. (2024). *Offsets Research: Proposal for the expansion of Eskom's AQO Program in the Highveld and Vaal, Rev: 00 [ESK-A16-AQOE-00].*

BizNews. (n.d.). *The devastating impact of power cuts on South Africa's economy*. Retrieved from BizNews: https://www.biznews.com/energy/2023/02/01/devastating-impacts-power-cuts-sa-economy

CarbonBrief. (2020). *Global coal power*. Retrieved from CarbonBrief: https://www.carbonbrief.org/mapped-worlds-coal-power-plants/

Department of Environmental Affairs. (2018, October 26). The 2017 National Framework for Air Quality Management in the Republic of South Africa, Government Gazette No. 41996. Pretoria, Gauteng Province, South Africa: Government Printing Works. Retrieved from www.gpwonline.co.za

Department of Forestry, Fisheries and the Environment. (2024). *Report of the NECA Forum to the Minister of Forestry Fisheries and the Environment on the Appeals Relating to Eskom's Power Stations.*

DFFE. (2024). *Report of the National Environmental Consultative and Advisory Forum pertaining to the Appeals relating to Eskom's Power Stations.*

Eskom. (2020). *APPLICATION AND MOTIVATION FOR EXEMPTION, POSTPONEMENT AND SUSPENSION FROM THE MINIMUM EMISSIONS STANDARDS COMPLIANCE TIMEFRAMES FOR ESKOM'S COAL-FIRED POWER STATIONS IN THE HIGHVELD.*

Eskom. (2020). *Application for alternative limits and postponement or exemption of the minimum emissions standards compliance timeframes for the Medupi power station.*

Eskom. (2021, MArch). *Air Quality Offset Implementation Plans for Lethabo Power Station: March 2021 Update [ENV21-R053].* Retrieved from Eskom: https://www.eskom.co.za/wp-content/uploads/2021/08/AQoffsetplanFezileDabiMarch2021update.pdf

Eskom. (2021). *ASH MANAGEMENT IN ESKOM*. Retrieved from https://www.eskom.co.za/wp-content/uploads/2021/08/CO-0004-Ash-Management-Rev-15.pdf

Eskom. (2021). *Initial Financial Analysis of MES policy option.*

Eskom. (2023). *Eskom*. Retrieved October 17 , 2024, from https://www.eskom.co.za/eskom-releases-its-results-for-the-2022-23-financial-year/

Eskom. (2024).

Eskom. (2024). *Comment made during the review of an exemption report by Eskom, 2024.*

Eskom. (2024). *Eskom Air Quality Offset Plans: Progress Report March 2024 [GEM24-DOC015].*

Eskom. (2024). *Generation Division Business Plan FY 2025.* Eskom Generation Division.

Eskom. (2024). *Quarterly Update on the Implementation of Eskom's Minimum Emission Standards Postponement Commitment: June 2024 [GEM24-L266].*

Eskom. (2024). *Quarterly update on the implementation of minimum emission standards postponement commitment.*

Eskom. (Air Quality Offset Project, 2024). *Air Quality Offset Project – Steering Committee.*

Eskom. (August 2024). *Eskom Licensing Authority – NAQO Meeting, Eskom Input (23 August 2024 rev 1.1).*

Eskom. (ENV21-R053, 2021). *Air Quality Offset Implementation Plans for Lethabo Power Station: March 2021 Update*. Retrieved from https://www.eskom.co.za/wp-content/uploads/2021/08/AQoffsetplanFezileDabiMarch2021update.pdf

Eskom Licensing Authority. (2024). *NAQO Meeting, Eskom Input .*

Eskom. (Progress Report, March 2024). *Eskom Air Quality Offset Plans: Progress Report March 2024 [GEM24-DOC015].*

Eskom. (Quarterly Update, June 2024). *Quarterly Update on the Implementation of Eskom's Minimum Emission Standards Postponement Commitment: June 2024 [GEM24-L266].*

Metsimaholo Local Municipality. (2024). *Draft 2024/2025 Reviewed Integrated Development Plan: Metsimaholo LM.* Retrieved from https://www.metsimaholo.gov.za/download/idp-5-year-plan-2022-23-2026-27/

Moolman, S. (2022). *Power Optimal*. Retrieved October 18, 2024, from https://poweroptimal.com/2021-update-eskom-tariff-increases-vs-inflation-since-1988/

Municipalities of South Africa. (2024). *Fezile Dabi District Municipality (DC20)*. Retrieved from Municipalities of South Africa: https://municipalities.co.za/overview/107/fezile-dabi-district-municipality

North-West University. (2024). *Pre-feasibility study for potential offset opportunities for Marapong Township.*

North-West University. (2024). *Pre-feasibility study for potential offset opportunities for Marapong Township.*

Prime Africa Consult. (2024). *Air Pollution Health Risk Benefit Cost Analysis for exemption power stations in the Highveld Priority Area.*

Quantec Easydata. (2024, September). *Quantec Standardised Regional*. Retrieved from https://www.easydata.co.za/

Republic of South Africa. (1996). Constitution of the Republic of South Africa (Act No. 108 of 1996). Cape Town, Western Cape Province, South Africa: Government Printing Works. Retrieved from www.gpwonline.co.za

Republic of South Africa. (2005, February 24). National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004). Government Gazette No. 27318, Notice No. 163. Cape Town, Western Cape Province, South Africa: Government Printing Works. Retrieved from www.gpwonline.co.za

Republic of South Africa. (Government Gazette 43418, 2020). *Government Notice 655 (2020) Government Gazette 43418: National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Draft Second Generation Air Quality .*

Republic of South Africa, G. N. (2016). *National Environmental Management: Air Quality Act, 2004 9Act No.39 of 2004), Air Quality Offsets Guideline.* Government Gazette 39833.

Republic of South Africa, G. N. (Air Quality Offsets Guideline, 2016). *National Environmental Management: Air Quality Act, 2004 9Act No.39 of 2004), Air Quality Offsets Guideline.* Government Gazette 39833.

Republic of South Africa, Government Notice 533 (2014) Government Gazette 37804. (2004). *National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Regulations Regarding Air Dispersion Modelling.*

Seriti. (2020). *New Vaal Social and Labour Plan 2020/21 - 2024/25.*

South African Police Service. (2024). *First Quarter Crime Statistics 2024/2025.* Retrieved from https://www.saps.gov.za/services/crimestats.php

Stats SA. (n.d.). *Dataset: Descriptive by Municipality*. Retrieved from SuperWEB2: https://superweb.statssa.gov.za/webapi/jsf/tableView/tableView.xhtml

Stats SA. (n.d.). *Govan Mbeki*. Retrieved from Stats SA: https://www.statssa.gov.za/?page_id=993&id=govan-mbeki-municipality

uMoya-NILU. (2024). *Atmospheric Impact Report in Support of the Application for Exemption from the Minimum Emission Standards for Lethabo Power Station, Report No.: uMN215-24.*

United States Environmental Protection Agency. (2024, August). *Clinical Outcomes Related to Particulate Matter Exposure and Cardiovascular Disease*. Retrieved from https://www.epa.gov/air-research/clinical-outcomes-related-particulate-matter-exposure-and-cardiovascular-disease

Van Horen, C. (1996): Counting the social costs: electricity and externalities in South Africa. University of Cape Town Press, 1996.

World Health Organisation (2009): Environmental Burden of Disease. South Africa. http://www.who.int/quantifying_ehimpacts/national/countryprofile/en/.

World Health Organisation. (2014): WHO Expert Meeting: Methods and tools for assessing the health risks of air pollution at local, national and international level. Meeting report Bonn, Germany, 12-13 May 2014. Available: http://www.euro.who.int/pubrequest.

World Health Organisation (2016a): Health risk assessment of air pollution – general principles. Copenhagen: WHO Regional Office for Europe; 2016.

World Health Organisation (2016b): International Statistical Classification of Diseases and Related Health Problems 10th Revision. http://apps.who.int/classifications/icd10/browse/2016/en.

World Health Organisation (2021): WHO global air quality guidelines. Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. Geneva: World Health Organization; 2021. License: CC BY-NC-SA 3.0 IGO.

Appendix A

CUMULATIVE AIRSHED ATMOSPHERIC IMPACT REPORTS

ATMOSPHERIC IMPACT REPORT IN SUPPORT OF THE APPLICATION FOR EXEMPTION FROM THE MINIMUM EMISSION STANDARDS FOR ESKOM's COAL-FIRED POWER STATIONS ON THE HIGHVELD AND IN THE VAAL TRIANGLE (A CUMULATIVE ASSESSMENT)

Final
4 November 2024

uMOYA-NILU

Report issued by:

uMoya-NILU Consulting (Pty) Ltd
P O Box 20622
Durban North, 4016
South Africa

Report issued to:

WSP Group Africa (Pty) Ltd
Building 1, Maxwell Office Park
Magwa Crescent West, Waterfall City
Midrand, 1685
South Africa

Report Details

Client:	WSP Group Africa (Pty) Ltd
Report title:	Atmospheric Impact Report in Support of the Application for Exemption from the Minimum Emission Standards for Eskom's Coal-Fired Power Stations on the Highveld and in the Vaal Triangle (A Cumulative Assessment)
Project:	uMN920-24
Report number:	uMN220-24
Version:	Final 4 November 2024
Prepared by:	uMoya-NILU Consulting (Pty) Ltd, P O Box 20622, Durban North 4016, South Africa
Authors:	Mark Zunckel, Atham Raghunandan and Nopasika Xulu

When used in a reference this document should be cited as follows:
uMoya-NILU (2024): Atmospheric Impact Report in Support of the Application for Exemption from the Minimum Emission Standards for Eskom's Coal-Fired Power Stations on the Highveld and in the Vaal Triangle (A Cumulative Assessment), Report No.: uMN220-24, November 2024.

Front page picture credit: https://www.eskom.co.za/eskom-divisions/gx/coal-fired-power-stations/

EXECUTIVE SUMMARY

Eskom operates a fleet of 14 coal-fired power stations, collectively generating more than 39 000 MW of electricity. Of these, 13 are on the Highveld and the Free State Province, and 2 are in the Waterberg District Municipality. The combustion of coal to generate steam for the generation of electricity is a Listed Activity in terms of the National Environmental Management: Air Quality Act (Act No. 39 of 2004). As such, Eskom holds Atmospheric Emission Licenses (AELs) for the respective power stations and is obligated to operate these power stations according to conditions specified in the respective AELs. Minimum Emission Standards (MES) for Listed Activities were published in 2010 (DEA, 2010) including compliance timeframes for existing and new plants. Existing plants had to comply with the MES for new plants by 30 April 2020 unless otherwise authorised.

Between 2018 and 2020, Eskom submitted applications to the Department of Forestry, Fisheries and the Environment (DFFE) based on an internally approved Emission Reduction Plan, which defined which power stations would have emission reduction technology installed and when. The National Air Quality Officer (NAQO) made decisions on these applications in 2019, which were not in favour of Eskom. Eskom appealed the NAQO's decision, and the Minister established the National Environmental Consultative and Advisory (NECA) Forum to advise her on the issue. The Minister ruled on the Eskom appeals on 22 May 2024 and granted the suspension of the Minimum Emission Standards (MES) at five (5) power stations on the Highveld up to 31 March 2030, namely Arnot, Camden, Grootvlei, Hendrina and Kriel. The Minister further directed Eskom to submit an application in terms of Section 59 of the National Environmental Management: Air Quality Act for the exemption of the MES for eight (8) power stations that will continue to operate post 2030. These are Duvha, Kendal, Majuba, Matla and Tutuka in the Highveld Priority Area; Lethabo in the Vaal Triangle Airshed Priority Area; and Medupi and Matimba in the Waterberg-Bojanala Priority Area.

In terms of the Minister's ruling, Eskom Holdings SOC Ltd appointed WSP Group Africa (Pty) Ltd to prepare the necessary applications. WSP Group Africa (Pty) Ltd sub-contracted uMoya-NILU Consulting (Pty) Ltd to prepare the associated Atmospheric Impact Reports (AIRs) to support these applications. In response, AIRs have been prepared to support the applications for the individual power stations. This AIR collectively assesses the 12 coal-fired power stations in the Highveld Priority Area and Lethabo in the Vaal Triangle Airshed Priority Area to provide further supporting information for the respective application.

Eskom intends to systematically reduce emissions resulting from the fleet of coal-burning power stations. Three emission reduction trajectories from Eskom's financial ERP models are described here and illustrated in Figure E-1 for NO_X, SO_2 and PM.

> **ERP 2024 A**: Eskom continue as planned, which includes all PM and NO_X abatement projects and FGD at Kusile – This is why ERP 2024 A = B = C for NO_X & PM (only security of supply differs) – by the time Grootvlei, Kriel, Arnot, Hendrina, Camden, Duvha and Matla are shutdown, Eskom will be fully compliant with NO_X and PM MES through the fleet.
>
> **ERP 2024 B**: 2024 A as above, but also FGD at Medupi, DSI at Majuba, and FGD at Kendal, hence the improvement from 2036 in SO_2 for ERP 2024 B. This

is Eskom's middle-ground scenario; doing more than 2024 A, but not doing 2024 C.

ERP 2024 C: All of 2024 A and 2024 B above, but also FGD at Lethabo and Tutuka. Although this shows big improvement in SO_2 vs ERP 2024 B, this is a combination of Lethabo & Tutuka FGD, and actually probably more from shutdown of Duvha & Matla – station shutdowns have bigger impact on SO_2 reduction than FGD. When you look at the modelling results, ERP 2024 B already well within NAAQS (this is our model Scenario C), so enforcing ERP 2024 C not really justifiable, especially considering all the other negative impacts of FGD (age of Tutuka & Lethabo, costs, waste, water etc.).

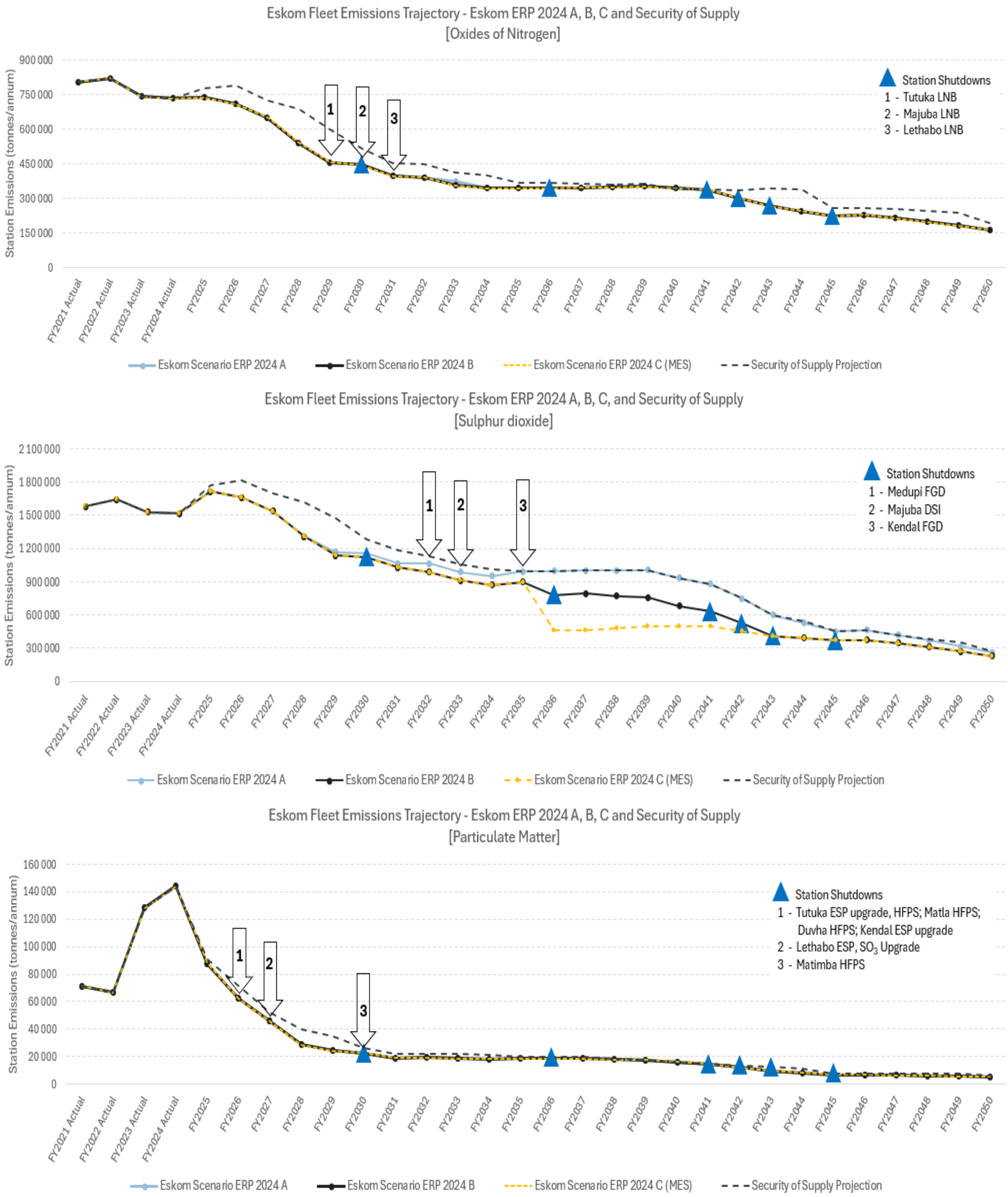
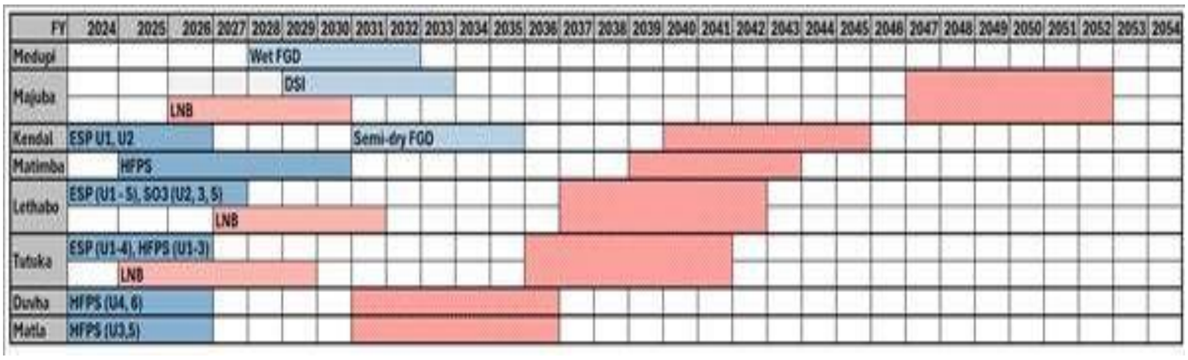


Figure E-1: Eskom's fleet emission trajectory for NO_x (top), SO_2 (middle) and PM (bottom)

The proposed schedule for the installation of NO_X, PM and SO_2 emission reduction technologies and the shutdown schedule for power stations is shown in Figure E-2.



FGD: flue gas desulphurisation
DSI: Dry Sorbent Injection
LNB: low NO_X Burner
HFPS: high frequency power supply
ESP: Electrostatic precipitator
DHP: Dust Handling Plant
Station Shutdown

Figure E-2: Emission reduction installation schedule and the planned shutdown of power stations

Ambient air quality is monitored at several monitoring stations in the area. The measured ambient SO_2 and NO_2 concentrations may be attributed to a number of sources such as industrial combustion of fossil fuels and the related stack emissions. They may also be attributed to domestic coal combustion and vehicle emissions. Annual average ambient SO_2 and NO_2 concentrations are below the respective NAAQS at all the monitoring stations. At these stations the predicted 10-minute, 1-hour and 24-hour concentrations comply with the respective NAAQS, although the limit value is sometimes exceeded.

The measured ambient PM_{10} and $PM_{2.5}$ concentrations may also be attributed to several sources, including industrial processes and the stack emissions as well as low-level sources that include, amongst others, mining activity, domestic coal combustion, agricultural processes, vehicle dust entrainment and wind-blown dust. The ambient 24-hour PM_{10} and $PM_{2.5}$ concentrations are generally high and exceed the NAAQS at several AQMS.

In this AIR five operational scenarios anticipated by Eskom for the Highveld and Vaal power station fleet are assessed, comprising Komati, Arnot, Camden, Kriel, Grootvlei, Hendrina, Duvha, Matla, Kendal, Lethabo, Tutuka, Majuba, and Kusile in the coming years for SO_2, NOx, and PM (PM_{10} and $PM_{2.5}$). The scenarios are:

Scenario 1 (Current): The baseline scenario using actual monthly stack emissions for 2021-2023 and fugitive emissions from the ash dumps and stockpiles.

Scenario A (2025): Eskom's planned 2025 stack emissions, representing anticipated station performance between 2025 – 2030, including fugitive emissions from the ash dumps and stockpiles. This includes the shutdown of Komati; the completion of PM abatement projects at Kendal, Lethabo, Tutuka, Duvha, and Matla; and the FGD at Kusile.

Scenario B (2031): Eskom's planned 2031 stack emissions, representing anticipated station performance between 2031 – 2035, including fugitive emissions from the ash dumps and stockpiles. This includes completion of shutdowns at Arnot, Kriel, Hendrina, Camden, and Grootvlei, including their fugitive sources, with Matla and Duvha also entering shutdown phase; FGD at Kusile and completion of the DSI at Majuba (SO_2 emissions); reduced SO_2 emissions achieved though load curtailment and efficiency improvement projects; and NO_X abatement (LNB) at Majuba, Lethabo, and Tutuka.

Scenario C (2036): Eskom's planned 2036 stack emissions, representing anticipated station performance from 2036 onwards, including fugitive emissions from the ash dumps and stockpiles. This includes the complete shutdown of Matla and Duvha; shutdowns of Tutuka, Lethabo, and Kendal, including their fugitive sources, with Majuba entering shutdown phase in FY2047; SO_2 abatement installed at Kusile (FGD), Majuba (DSI), Kendal (FGD); as well as reduced SO_2 emissions achieved though load curtailment and efficiency improvement projects.

Scenario D (MES): Full compliance with the MES, inclusive of the ash dumps and stockpiles, where relevant (i.e. not for the stations shutdown), and in addition to the abatement included in above scenarios, FGD installations at Tutuka and Lethabo.

The CALPUFF dispersion model is used to predict ambient concentrations of SO_2, NO_2, PM_{10} and $PM_{2.5}$ resulting from the suite of power stations operating together in each scenario. The dispersion modelling simulates the stack emissions (PM, SO_2, NO_X) and fugitive emissions (PM) from the coal yard and the ash dump for the five scenarios. While the focus of the assessment is on stack emissions, the inclusion of fugitive PM emissions provides a holistic understanding of the contribution of the power stations to ambient PM_{10} and $PM_{2.5}$ concentrations. Modelling is done according to the modelling regulations and 3-years of hourly surface and upper air meteorological data is used.

The PM emissions from the stacks and fugitive sources are not speciated into PM_{10} and $PM_{2.5}$. Rather, all PM emitted is assumed to be firstly PM_{10} in the modelling and is assessed against the NAAQS for PM_{10}. Secondly, all PM emitted is assumed to be $PM_{2.5}$ in the modelling and is assessed against the NAAQS for $PM_{2.5}$. The predicted PM_{10} and $PM_{2.5}$ concentrations also include the formation of secondary particulates from SO_2 and NO_2 stack emissions. Together, this represents a worse-case environmental scenario for PM_{10} and $PM_{2.5}$. The stack emissions generally have an effect some distance from the source as they are released well above ground level and are buoyant. Fugitive emissions are released close to ground level and without any buoyancy, and therefore have an effect close to the source.

In the body of the report, predicted ambient SO_2, NO_2, PM_{10} and $PM_{2.5}$ concentrations are presented as isopleth maps over the modelling domain. The predicted concentrations at 405 identified sensitive receptor points in the study area are included Appendix 2 of this report. In this executive summary the maximum predicted annual SO_2, NO_2, PM_{10} and $PM_{2.5}$ concentrations and the 99th percentile concentration of the 24-hour and 1-hour predicted concentrations in the modelling domain are discussed below.

For SO_2, the predicted concentrations are attributed only to stack emissions. The maximum predicted annual average concentrations for the 5 scenarios are low relative to the limit value of the respective NAAQS. The predicted 99th percentile of the 24-hour SO_2 concentrations are also relatively low compared to the limit value of the NAAQS, except for Scenario A (2025) when the limit value is exceeded. The 99th percentile of the predicted 1-hour concentrations are higher, but are below the limit value of the NAAQS for all five scenarios. The predicted maximum SO_2 concentration occurs on the central Highveld. Noteworthy is the systematic decrease in the predicted maximum and 99th percentile concentrations from 2025 to 2036 for all averaging periods.

For NO_2, the predicted concentrations are attributed only to the stack emissions. The predicted maximum and 99th percentile concentrations are low relative to the limit values of the respective NAAQS for the 5 scenarios. The predicted maximum NO_2 concentration occurs on the central Highveld.

For PM_{10} and $PM_{2.5}$, the predicted concentrations are attributed to stack emissions and the low-level fugitive sources (coal yard and ash dump) and the contribution from secondary particulate formation. It must be remembered that the total PM emissions are not speciated into PM_{10} or $PM_{2.5}$, rather all PM emitted is assumed to be firstly PM_{10}, and then all PM emitted is assumed to be $PM_{2.5}$. It must also be remembered that it was assumed that entire area of ash dumps are available for emissions compared with the actual exposed area. Included in the predicted $PM_{2.5}$ concentrations is the formation of secondary particulates from SO_2 and NO_2 stack emissions. Together, this represents a worse-case emission scenario for PM_{10} and $PM_{2.5}$.

For PM_{10} and $PM_{2.5}$, the maximum predicted annual average concentrations exceed the limit values of the respective NAAQS in all scenarios. Similarly, the 99th percentile of the 24-hour PM_{10} and $PM_{2.5}$ concentrations exceed the limit value of the NAAQS in all scenarios. The predicted maximum PM_{10} and $PM_{2.5}$ concentrations occur close to the individual power stations.

Occurring close to the power stations, the high predicted PM_{10} and $PM_{2.5}$ are mostly attributed to the low-level fugitive sources. It is noteworthy therefore that the maximum predicted concentrations decrease significantly from 2025 when 13 power stations are in operation to 2031 with the shutdown of 5 power stations and the completion of PM abatement projects at Kendal, Lethabo, Tutuka, Duvha, and Matla

The predicted ambient concentrations of SO_2 and NO_2 at all the AQMS are lower than those measured at the corresponding monitoring stations. This is to be expected since AQMS are exposed to all sources of SO_2 and NO_2 while the model includes only the power station stack emissions. Similarly, the predicted ambient concentrations of PM_{10} and $PM_{2.5}$ are considerably lower than those measured at the corresponding monitoring stations. This too is to be expected since AQMS are exposed to all sources of PM_{10} and $PM_{2.5}$ while the model includes power station stack emissions and the fugitive sources only for each power station. At all AQMS, the difference between the predicted model concentrations and the measured concentrations provides an indication of the contribution of the power station stack and fugitive emissions at the respective AQMS.

The predicted SO_2 and NO_2 concentrations are below the respective limit values of the NAAQS for all averaging periods in all 5 emission scenarios at all sensitive receptors. Similarly, the predicted annual average PM_{10} and $PM_{2.5}$ concentrations are below the limit values of the NAAQS at all sensitive receptor points in all five scenarios. Exceedances of the 24-hour limit value of the NAAQS for PM_{10} and $PM_{2.5}$ are predicted in all five scenarios at several sensitive receptor points (Table E-1). For Scenario A (2025) the exceedances of the limit value for PM_{10} occur at most sensitive receptor points. For $PM_{2.5}$, the limit value of the NAAQS drops from 40 μg/m^3 to 25 μg/m^3 in 2030, resulting in an increase in the number of receptor points where the limit value is exceeded. The number of receptor points where the limit value is exceeded decreases as power stations are shutdown and emissions from the associated fugitive sources cease.

Table E-1: Number of sensitive receptors where the limit value of the NAAQS is exceeded

Scenario	Number of sensitive receptors	
	PM_{10}	**$PM_{2.5}$**
Scenario 1 (Current)	26	129
Scenario A (2025)	29	149
Scenario B (2031)	9	157
Scenario C (2036)	0	53
Scenario D (MES)	0	45

Noteworthy findings from the modelling results may be summarised as follows:

i) Ambient SO_2 and NO_2 concentrations are attributed to the stack emissions only, while ambient PM_{10} and $PM_{2.5}$ concentrations are attributed to the stack emissions and the low-level fugitive sources. The stack emissions generally have an effect some distance from the source, while low-level fugitive emissions have an effect close to the source.

ii) The predicted ambient concentrations are lower than the monitored concentrations for all pollutants at all AQMS. This is to be expected since AQMS are exposed to all sources of the pollutants while the modelled concentrations result from power station emission only. The difference between the modelled concentrations and measured concentrations are indicative of the contribution of other sources at the respective AQMS.

iii) For Scenario 1 (Current):
   a. Predicted SO_2 and NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.
   b. Predicted PM_{10} and $PM_{2.5}$ concentrations generally comply with the NAAQS, except close to the power stations where the limit value of the 24-hour NAAQS are exceeded. Exceedances of the limit value for PM_{10} and $PM_{2.5}$ are predicted at 26 and 129 sensitive receptor points respectively.

iv) For Scenario A (2025):
   a. Predicted SO_2 and NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain, except for the 99th percentile of the 24-hour SO_2 concentrations which exceed the limit value of the NAAQS.
   b. Predicted PM_{10} and $PM_{2.5}$ concentrations generally comply with the NAAQS, except close to the power stations where the limit value of the 24-hour NAAQS are exceeded. Exceedances of the limit value for PM_{10} and $PM_{2.5}$ are predicted at 29 and 149 sensitive receptor points respectively.

v) For Scenario B (2031):
   a. Predicted SO_2 and NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain. Predicted NO_2 concentrations show a reduction with the completion of LNB projects at Kendal and Tutuka.

b. Predicted PM_{10} and $PM_{2.5}$ concentrations generally comply with the NAAQS, except close to the power stations where the limit value of the 24-hour NAAQS are exceeded. The number of predicted exceedances for PM_{10} decrease to 9, while the number of exceedances for $PM_{2.5}$ increase to 157 sensitive receptor points. The increase corresponds to the more stringent $PM_{2.5}$ limit value of 25 µg/m^3 which is implemented in 2030.

c. The effect of the shutdown of Arnot, Camden, Hendrina, Kendal and Kriel by 2031 and the associated reduction in emissions is clearly evident, with the modelling showing lower ambient concentrations, i.e. improved air quality.

vi) For Scenario C: (2036):

a. Predicted SO_2 and NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.

b. Predicted PM_{10} and $PM_{2.5}$ concentrations comply with the NAAQS, except close to the power stations where the limit value of the 24-hour $PM_{2.5}$ NAAQS is exceeded. Exceedances of the limit value for $PM_{2.5}$ is predicted at 53 sensitive receptor points.

c. Reductions in predicted ambient PM concentrations are due to Duvha and Matla entering shutdown phase, as well as abatement improvements from Scenario B for PM. Ambient SO_2 reductions are due to the Majuba DSI and Kendal semi-dry FGD projects. Ambient NO_2 improvements are due to the Lethabo LNB project.

vii) For Scenario D:

a. Predicted SO_2 and NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.

b. Predicted PM_{10} and $PM_{2.5}$ concentrations generally comply with the NAAQS, except close to the power stations where the limit value of the 24-hour $PM_{2.5}$ NAAQS is exceeded. Exceedances of the limit value for $PM_{2.5}$ is predicted at 45 sensitive receptor points.

Given the conservative approach to the fugitive emission source simulations, and that this has provided an absolute worst-case emission scenario, and based on recommendations received from uMoya-Nilu, Eskom will be undertaking an additional modelling scenario, assessing only PM, SO_2, and NO_X stack emissions. NO_X and SO_2 emissions will be included in this scenario to ensure secondary particulate formation is accounted for. This will provide improved insight to impacts directly related to stack emissions, which are the focus of this exemption application.

ACKNOWLEDGEMENT

Jared Lodder, Yakeen Kowlas and Lehlohonolo Sello from WSP Group Africa (Pty) Ltd are acknowledged for processing the ambient air quality and wind data for the baseline assessment.

GLOSSARY OF TERMS AND ACRONYMS

AEL	Atmospheric Emission Licence
AIR	Atmospheric Impact Report
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
DSI	Dry Sorbent Injection
EIA	Environmental Impact Assessment
FGD	Flue-gas desulfurisation
g/s	Grams per second
kPa	Kilo Pascal
LNB	Low NO_X burner
MES	Minimum Emission Standards
mg/Nm^3	Milligrams per normal cubic meter refers to emission concentration, i.e. mass per volume at normal temperature and pressure, defined as air at 20°C (293.15 K) and 1 atm (101.325 kPa)
NAAQS	National Ambient Air Quality Standards
NAQO	National Air Quality Officer
NECA	National Environmental Consultative and Advisory
NEM-AQA	National Environment Management: Air Quality Act, 2004 (Act No. 39 of 2004)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
USEPA	United States Environmental Protection Agency
µm	1 µm = Micro meter 1 µm = 10^{-6} m

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

Eskom operates a fleet of 14 coal-fired power stations, collectively generating more than 39 000 MW of electricity. Of these, 13 are on the Highveld and the Free State Province, and 2 are in the Waterberg District Municipality. The combustion of coal to generate steam for the generation of electricity is a Listed Activity in terms of the National Environmental Management: Air Quality Act (Act No. 39 of 2004). As such, Eskom holds Atmospheric Emission Licenses (AELs) for the respective power stations and is obligated to operate these power stations according to conditions specified in the respective AELs. Minimum Emission Standards (MES) for Listed Activities were published in 2010 (DEA, 2010) including compliance timeframes for existing and new plants. Existing plants had to comply with the MES for new plants by 30 April 2020 unless otherwise authorised.

Between 2018 and 2020, Eskom submitted applications to the Department of Forestry, Fisheries and the Environment (DFFE) based on an internally approved Emission Reduction Plan, which defined which power stations would have emission reduction technology installed and when. The National Air Quality Officer (NAQO) made decisions on these applications in 2019, which were not in favour of Eskom. Eskom appealed the NAQO's decision, and the Minister established the National Environmental Consultative and Advisory (NECA) Forum to advise her on the issue. The Minister ruled on the Eskom appeals on 22 May 2024 and granted the suspension of the Minimum Emission Standards (MES) at five (5) power stations on the Highveld up to 31 March 2030, namely Arnot, Camden, Grootvlei, Hendrina and Kriel. The Minister further directed Eskom to submit an application in terms of Section 59 of the National Environmental Management: Air Quality Act for the exemption of the MES for eight (8) power stations that will continue to operate post 2030. These are Duvha, Kendal, Majuba, Matla and Tutuka in the Highveld Priority Area; Lethabo in the Vaal Triangle Airshed Priority Area; and Medupi and Matimba in the Waterberg-Bojanala Priority Area.

In terms of the Minister's ruling, Eskom Holdings SOC Ltd appointed WSP Group Africa (Pty) Ltd to prepare the necessary applications. WSP Group Africa (Pty) Ltd sub-contracted uMoya-NILU Consulting (Pty) Ltd to prepare the associated Atmospheric Impact Reports (AIRs) to support these applications.

While AIRs have been prepared to support the respective applications for the individual power stations, this AIR collectively assesses 12 coal-fired power stations in the Highveld Priority Area and one power station in the Vaal Triangle Airshed Priority Area. The intention is to provide further supporting information for the respective applications. The power stations included in this cumulative assessment are listed in Table 1-1 with information regarding their respective AELs and proposed shutdown dates.

Table 1-1: Power stations and current AEL information

Power Station	District	Installed capacity	AEL No.	Date		Shutdown complete
				Issued	Expire	
Arnot	Nkangala	2 352	17/4/AEL/MP312/11/15	10-06-24	10-06-29	2029
Camden	Gert Sibande	1 561	Muskaligwa/Eskom H SOC Ltd/CPC/0012/2024/F04	28-06-24	31-03-30	2024
Duvha	Nkangala	3 600	17/04/AEL/MP312/11/07	30-06-17	31-05-22	2036
Grootvlei	Gert Sibande	1 180	Dipaleseng/Eskom H SOC Ltd/GPS/0015/2024/F04	28-06-24	31-03-30	2029
Hendrina	Nkangala	1 893	17/4/AEL/MP312/11/16	10-06-24	01-12-28	2029
Kendal	Nkangala	4 116	17/4/AEL/MP312/11/15	30-09-19	31-08-24	2045
Komati	Nkangala	990	NDM/AEL/MP313/12/12			shutdown
Kriel	Nkangala	3 000	17/AEL/MP312/11/19	05-08-24	31-03-30	2031
Kusile	Nkangala	4 800	17/04/AEL/MP311/12/01	09-04-24	09-04-29	2073
Lethabo	Fazile Dabi	3 708	FDDM-MET-2011-08-P1	01-04-15	31-03-20	2042
Majuba	Gert Sibande	4 110	Dr PKI Seme/Eskom H SOC Ltd MPS/0014/2021/F04	25-04-19	25-04-24	2052
Matla	Nkangala	3 600	17/AEL/MP313/11/14	28-06-17	30-06-22	2036
Tutuka	Gert Sibande	3 600	Lekwa/Eskom H SOC Ltd TPS/0013/2019/F03	25-04-19	25-04-24	2041

2. ENTERPRISE DETAILS

2.1 Enterprise Details

Eskom enterprise details are summarised in Table 2-1.

Table 2-1: Enterprise details

Entity Name:	Eskom Holdings SOC Limited
Type of Enterprise, e.g. Company/Close Corporation/Trust, etc.:	State Owned Company
Company Registration Number:	2002/015527/30
Registered Address:	Megawatt Park, Maxwell Drive, Sunninghill, Sandton
Postal Address:	P. O. Box 1091, Johannesburg, 2000
Telephone Number (General):	+27 11 800 3861
Fax Number (General):	
Company Website:	www.eskom.co.za
Industry Type/Nature of Trade:	Electricity Generation
Land Use Zoning as per Town Planning Scheme:	Agricultural/Heavy industry
Land Use Rights if outside Town Planning Scheme:	Not applicable

2.2 Location and extent of the power stations

Thirteen Eskom-owned and operated coal-fired power stations are included in the dispersion modelling assessment for Scenario 1 (Current) and Scenario A (2025). Of these, twelve are in the Mpumalanga Province and one is in the Free State Province. Their relative locations are shown in Figure 2-1. Specific site information for each of the power stations is included in the respective Atmospheric Impact Reports (AIRs). In the three later scenarios Komati is shutdown and is excluded.

2.3 Description of surrounding land use

The Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa (DEA, 2014a) recommends the Land Use Procedure as sufficient for determining the urban/rural status of a modelling domain. The classification of the study area as urban or rural is based on the Auer method (Auer, 1978), as specified in the USEPA guideline on air dispersion models (USEPA, 2005). From the Auer's method, areas typically defined as rural include residences with grass lawns and trees, large estates, metropolitan parks and golf courses, agricultural areas, undeveloped land and water surfaces. An area is defined as urban if it has less than 35% vegetation coverage or it falls into one of the use types in Table 2-2.

Table 2-2: Land types, use and structures and vegetation cover

Type	Use and Structures	Vegetation
I1	Heavy industrial	Less than 5 %
I2	Light/moderate industrial	Less than 5 %
C1	Commercial	Less than 15 %
R2	Dense single / multi-family	Less than 30 %
R3	Multi-family, two-story	Less than 35 %

Generally, the individual power stations are located in rural areas where the surrounding land use is primarily agriculture and includes coal mining. The surrounding land-use includes amongst others, urban areas with residential, commercial and recreational areas, industrial areas, agriculture, mining, forestry, undeveloped areas and conservation areas.

The US Environmental Protection Agency (USEPA, 2024) recognise Sensitive Receptors as areas which include, but are not limited to, hospitals, schools, daycare facilities, elderly housing and convalescent facilities or specialised healthcare facilities. These are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides and other pollutants. The California Air Resources Board (CARB, 2024) identify Sensitive Receptors as children, elderly, asthmatics and others who are at a heightened risk of negative health outcomes due to exposure to air pollution.

The locations where these sensitive receptors congregate are considered sensitive receptor locations and therefore include hospitals, schools and day care centres, and other such locations. Twenty-four ambient air quality monitoring stations (AQMS) and 405 sensitive receptor points were identified in the modelling domain. These are listed in Annexure 1 and shown in Figure 2-1.

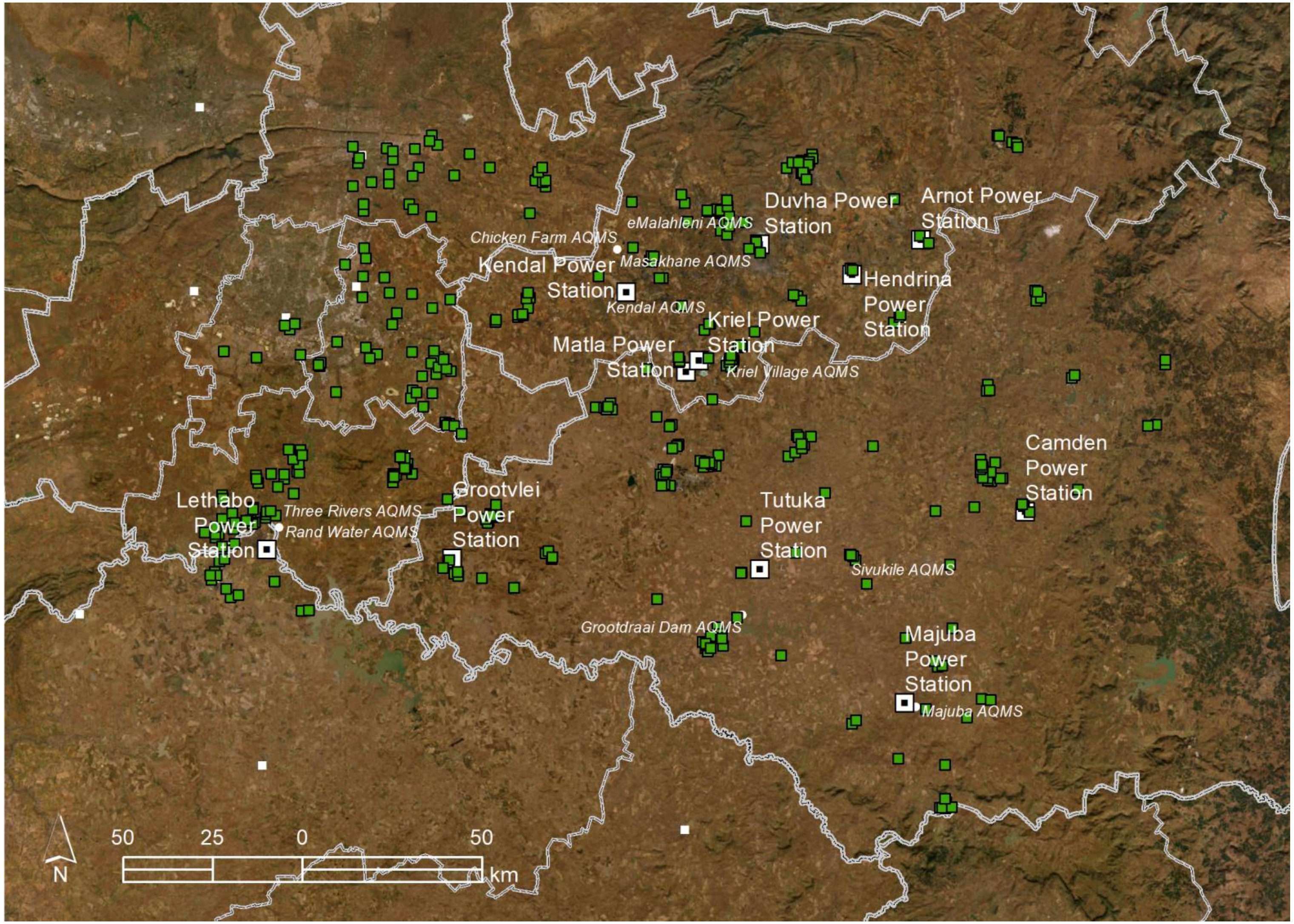


Figure 2-1: Relative location of the Eskom's coal-fired power stations in the modelling domain shown by white squares, with sensitive receptors shown by green squares

2.4 Atmospheric Emission License (AEL) and Other Authorisations

Atmospheric Emissions Licence (AEL) have been issued by the Nkangala, Gert Sibande and Fazile Dabi District Municipalities. The AEL numbers, expiry dates and the AEL status are listed in Table 2-3.

Table 2-3: Current authorisations related to air quality

<table>
<tr><th rowspan="2">Power Station</th><th rowspan="2">Atmospheric Emission License</th><th rowspan="2">Expiry Date</th><th colspan="2">Listed Activity</th><th rowspan="2">Listed Activity Process Description</th></tr>
<tr><th>Category</th><th>Sub-category</th></tr>
<tr><td>Arnot</td><td>17/4/AEL/MP312/11/15</td><td>10-06-29</td><td rowspan="13">1

2

5</td><td rowspan="13">1.1

2.4

5.1</td><td rowspan="13">Solid Fuel Combustion Installations

Storage and Handling of Petroleum Products

Storage and Handling of Ore and Coal</td></tr>
<tr><td>Camden</td><td>Muskaligwa/Eskom H SOC Ltd/CPC/0012/2024/F04</td><td>31-03-30</td></tr>
<tr><td>Duvha</td><td>17/04/AEL/MP312/11/07</td><td>31-05-22</td></tr>
<tr><td>Grootvlei</td><td>Dipaleseng/Eskom H SOC Ltd/GPS/0015/2024/F04</td><td>31-03-30</td></tr>
<tr><td>Hendrina</td><td>17/4/AEL/MP312/11/16</td><td>01-12-28</td></tr>
<tr><td>Kendal</td><td>17/4/AEL/MP312/11/15</td><td>31-08-24</td></tr>
<tr><td>Komati</td><td>NDM/AEL/MP313/12/12</td><td>N/A</td></tr>
<tr><td>Kriel</td><td>17/AEL/MP312/11/19</td><td>31-03-30</td></tr>
<tr><td>Kusile</td><td>17/04/AEL/MP311/12/01</td><td>09-04-29</td></tr>
<tr><td>Lethabo</td><td>FDDM-MET-2011-08-P1</td><td>31-03-20</td></tr>
<tr><td>Majuba</td><td>Dr PKI Seme/Eskom H SOC Ltd MPS/0014/2021/F04</td><td>25-04-24</td></tr>
<tr><td>Matla</td><td>17/AEL/MP313/11/14</td><td>30-06-22</td></tr>
<tr><td>Tutuka</td><td>Lekwa/Eskom H SOC Ltd TPS/0013/2019/F03</td><td>25-04-24</td></tr>
</table>

2.5 Modelling contractor

The dispersion modelling for this AIR is conducted by:

Company: uMoya-NILU Consulting (Pty) Ltd
Modellers: Dr Mark Zunckel, Atham Raghunandan, Nopasika Xulu
Contact details: Tel: 031 262 3265
Cell: 083 690 2728
email: mark@umoya-nilu.co.za
atham@umoya-nilu.co.za
nopasika@umoya-nilu.co.za

See Annexure 2 for abridged CV's

2.6 Terms of Reference

The terms of reference for this AIR are to assesses the cumulative effect of 13 coal-fired power stations to provide supporting information for the exemption applications for Duvha, Kendal, Matla, Majuba and Tutuka in the Highveld Priority area and Lethabo in the Vaal

Triangle Airshed Priority Area. Five operational scenarios anticipated by Eskom for the Highveld and Vaal power station fleet are assessed, comprising Komati, Arnot, Camden, Kriel, Grootvlei, Hendrina, Duvha, Matla, Kendal, Lethabo, Tutuka, Majuba, and Kusile in the coming years for SO_2, NO_X, and PM (PM_{10} and $PM_{2.5}$). The scenarios are:

Scenario 1 (Current): The baseline scenario using actual monthly stack emissions for 2021-2023 and fugitive emissions from the ash dumps and stockpiles.

Scenario A (2025): Eskom's planned 2025 stack emissions, representing anticipated station performance between 2025 – 2030, including fugitive emissions from the ash dumps and stockpiles. This includes the shutdown of Komati; the completion of PM abatement projects at Kendal, Lethabo, Tutuka, Duvha, and Matla; and the FGD at Kusile.

Scenario B (2031): Eskom's planned 2031 stack emissions, representing anticipated station performance between 2031 – 2035, including fugitive emissions from the ash dumps and stockpiles. This includes completion of shutdowns at Arnot, Kriel, Hendrina, Camden, and Grootvlei, including their fugitive sources, with Matla and Duvha also entering shutdown phase; FGD at Kusile and completion of the DSI at Majuba (SO_2 emissions); reduced SO_2 emissions achieved though load curtailment and efficiency improvement projects; and NO_X abatement (LNB) at Majuba, Lethabo, and Tutuka.

Scenario C (2036): Eskom's planned 2036 stack emissions, representing anticipated station performance from 2036 onwards, including fugitive emissions from the ash dumps and stockpiles. This includes the complete shutdown of Matla and Duvha; shutdowns of Tutuka, Lethabo, and Kendal, including their fugitive sources, with Majuba entering shutdown phase in FY2047; SO_2 abatement installed at Kusile (FGD), Majuba (DSI), Kendal (FGD); as well as reduced SO_2 emissions achieved though load curtailment and efficiency improvement projects.

Scenario D (MES): Full compliance with the MES, inclusive of the ash dumps and stockpiles, where relevant (i.e. not for the stations shutdown), and in addition to the abatement included in above scenarios, FGD installations at Tutuka and Lethabo.

2.7 Assumptions

The following assumptions are relevant to this AIR:

a) No ambient monitoring is done in this assessment, rather available ambient air quality data is used.
b) The assessment of potential human health impacts is based on predicted (modelled) ambient concentrations of SO_2, NO_2, PM_{10} and $PM_{2.5}$ and the health-based National Ambient Air Quality Standards (NAAQS).
c) Emissions data used in this AIR have been provided by Eskom and are deemed to be accurate and representative of operating conditions in the respective scenarios.
d) The PM emissions are not speciated into PM_{10} and $PM_{2.5}$, rather all PM emitted is assumed to be PM_{10}, and all PM emitted is assumed to be $PM_{2.5}$. This represents a worse-case emission scenario for PM_{10} and $PM_{2.5}$.
e) Assumptions regarding emissions from coal yards and ash dumps are included in Section 4.4.

3. NATURE OF THE PROCESS

3.1 Listed Activity or Activities

As a measure to reduce emissions from industrial sources and to improve ambient air quality, Listed Activities and associated Minimum Emission Standards (MES) were initially published in 2010 in Government Notice 248 (DEA, 2010) with the most recent revision applicable in 2020 (Government Notice 421, DEA, 2020).

The Listed Activities relevant to all coal-fired power stations are listed in Table 3-1.

Table 3-1: Details of the Listed Activity for coal-fired power stations according to GN 248 (DEA, 2010) and its revisions (DEA, 2013b, 2019, 2020)

Category of Listed Activities	Sub-category of Listed Activity	Description of Listed Activity	Description and Application of the Listed Activity
1: Combustion Installations	1.1: Solid Fuel Combustion Installations	Solid fuels combustion installations used primarily for steam raising or electricity generation.	All installations with design capacity equal to or greater than 50 MW heat input per unit, based on the lower calorific value of the fuel used.
2: Petroleum Industry, the production of gaseous and liquid fuels as well as petrochemicals from crude oil, coal, gas or biomass	2.4: Storage and handling of petroleum products	Petroleum products storage tanks and product transfer facilities.	All permanent immobile liquid storage facilities at a single site with a combined storage capacity of greater than 1 000 cubic metres.
5: Mineral Processing, Storage and Handling	5.1: Storage and Handling of Ore and Coal	Storage and handling of ore and coal not situated on the premises of a mine or works as defined in the Mines Health and Safety Act 29/1996.	Locations designed to hold more than 100 000 tons.

3.2 Process Description

Eskom Holdings SOC Limited is a South African utility that generates, transmits and distributes electricity. The bulk of that electricity is generated by large coal-fired power stations that are situated close to the sources of coal.

The generic process is that coal is received at the power station's coal yard from nearby mines, it is milled to pulverised fuel and fed to the boilers. Combustion of the coal in the boilers heats water to superheated steam, which drives the turbines. In turn, the turbines drive the generators which generate electricity.

Typical process units at a coal-fired power station are listed in Table 3-2.

Table 3-2: Unit processes at a coal-fired power station

Unit Process	Function of Unit Process	Batch or Continuous Process
Boiler Unit 1	Generation of electricity from coal	Continuous
Boiler Unit 2	Generation of electricity from coal	Continuous
Boiler Unit 3	Generation of electricity from coal	Continuous
Boiler Unit 4	Generation of electricity from coal	Continuous
Boiler Unit 5	Generation of electricity from coal	Continuous
Boiler Unit 6	Generation of electricity from coal	Continuous
Coal stockyard	Storage of coal	Continuous
Fuel oil storage tanks	Storage of fuel oil	Continuous
Ashing facility	Storage of ash	Continuous

3.3 Air pollutants resulting from the process

3.3.1 Air pollutants

Atmospheric emissions depend on the fuel composition and rate of consumption, boiler design and operation, and the efficacy of pollution control devices. Emissions from the boilers are emitted via two stacks and include sulphur dioxide (SO_2), oxides of nitrogen ($NO + NO_2 = NO_X$) and Particulate Matter (PM).

SO_2 is produced from the combustion of sulphur bound in coal. The stoichiometric ratio of SO_2 to sulphur dictates that 2 kg of SO_2 are produced from every kilogram of sulphur combusted. The coal has a sulphur content (wt %) of less than 1 %. NO_X is produced from thermal fixation of atmospheric nitrogen in the combustion flame and from oxidation of nitrogen bound in the coal. The quantity of NO_X produced is directly proportional to the temperature of the flame.

The non-combustible portion of the fuel remains as solid waste. The coarser, heavier waste is called 'bottom ash' and is extracted from the boiler, and the lighter, finer portion is 'fly ash' and is usually suspended in the flue gas, and in the absence of any emission control would be emitted as PM through the stack. The coal used at most power stations have an ash content of between 30 and 40%.

3.3.2 National Ambient Air Quality Standards

National Ambient Air Quality Standards (NAAQS) (DEA, 2009, 2012) apply to the pollutants emitted by the power stations. The NAAQS consists of a 'limit' value and a permitted frequency of exceedance. The limit value is the fixed concentration level aimed at reducing the harmful effects of a pollutant. The permitted frequency of exceedance represents the acceptable number of exceedances of the limit value expressed as the 99th percentile. Compliance with the ambient standard implies that the frequency of exceedance of the limit value does not exceed the permitted tolerance. The NAAQS for SO_2, NO_2, PM_{10} and $PM_{2.5}$ are presented in Table 3-3.

Table 3-3: NAAQS for pollutants emitted by power stations

Pollutant	Averaging period	Limit value (µg/m^3)	Tolerance
SO_2	1 hour	350	88
	24 hour	125	4
	1 year	50	0
NO_2	1 hour	200	88
	1 year	40	0
PM_{10}	24 hour	75	4
	1 year	40	0
$PM_{2.5}$	24 hour	40 (25[a])	4
	1 year	20 (15[a])	0

(a): Applicable from 01 January 2030

4. ATMOSPHERIC EMISSIONS

4.1 Point Source Emission Rates (Emission scenarios)

Eskom intends to systematically reduce emissions resulting from the fleet of coal-burning power stations. Three emission reduction trajectories from Eskom's financial ERP models are described here and illustrated in Figure 4-1 to Figure 4-3 for NO_X, SO_2 and PM.

ERP 2024 A: Eskom continue as planned, which includes all PM and NO_X abatement projects and FGD at Kusile – This is why ERP 2024 A = B = C for NO_X & PM (only security of supply differs) – by the time Grootvlei, Kriel, Arnot, Hendrina, Camden, Duvha and Matla are shutdown, Eskom will be fully compliant with NO_X and PM MES through the fleet.

ERP 2024 B: 2024 A as above, but also FGD at Medupi, DSI at Majuba, and FGD at Kendal, hence the improvement from 2036 in SO_2 for ERP 2024 B. This is Eskom's middle-ground scenario; doing more than 2024 A, but not doing 2024 C.

ERP 2024 C: All of 2024 A and 2024 B above, but also FGD at Lethabo and Tutuka. Although this shows big improvement in SO_2 vs ERP 2024 B, this is a combination of Lethabo & Tutuka FGD, and actually probably more from shutdown of Duvha & Matla – station shutdowns have bigger impact on SO_2 reduction than FGD. When you look at the modelling results, ERP 2024 B already well within NAAQS (this is our model Scenario C), so enforcing ERP 2024 C not really justifiable, especially considering all the other negative impacts of FGD (age of Tutuka & Lethabo, costs, waste, water etc.).

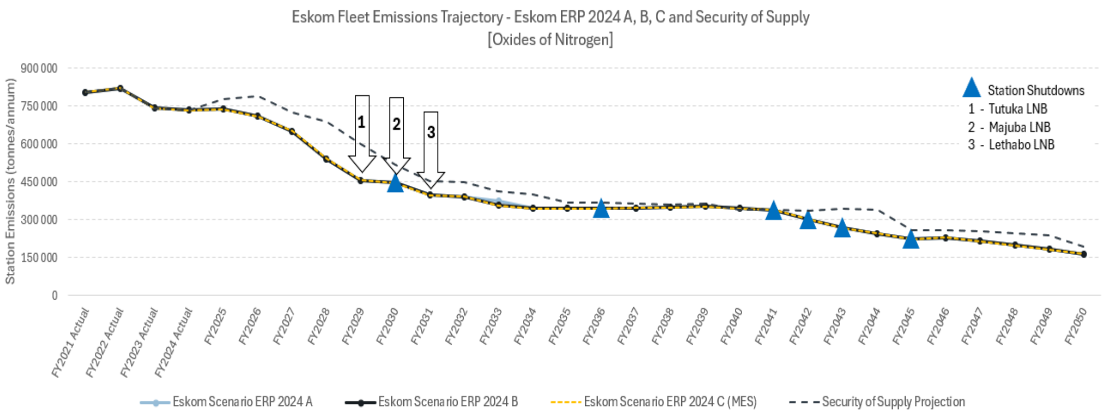


Figure 4-1: Eskom's fleet emission trajectory for NO_X

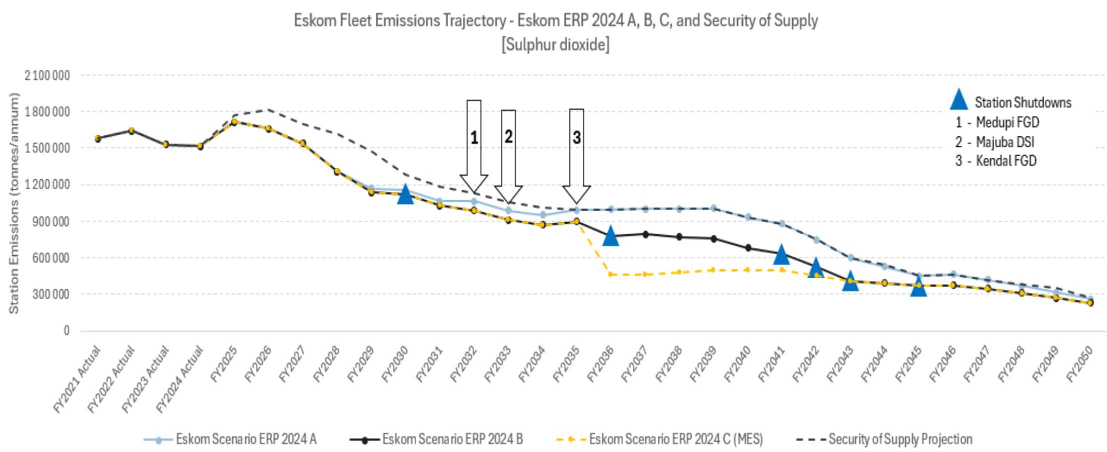


Figure 4-2: Eskom's fleet emission trajectory for SO_2

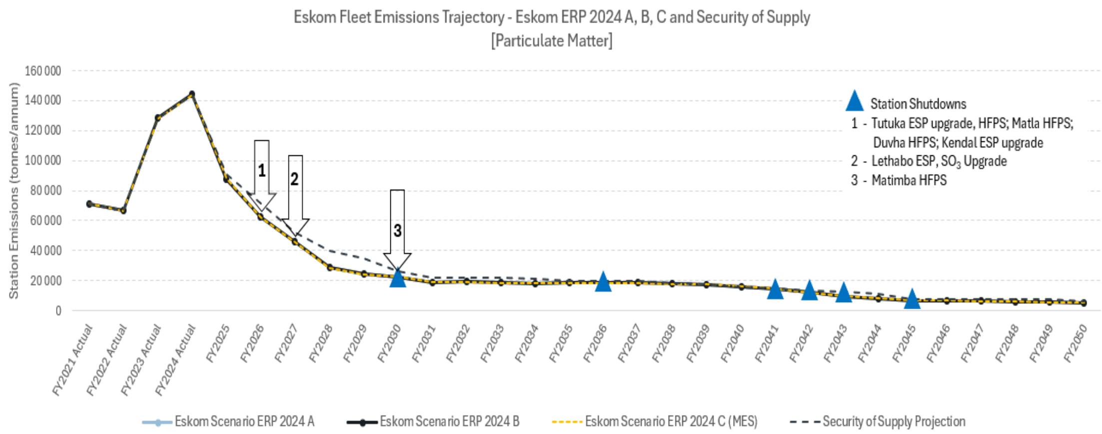
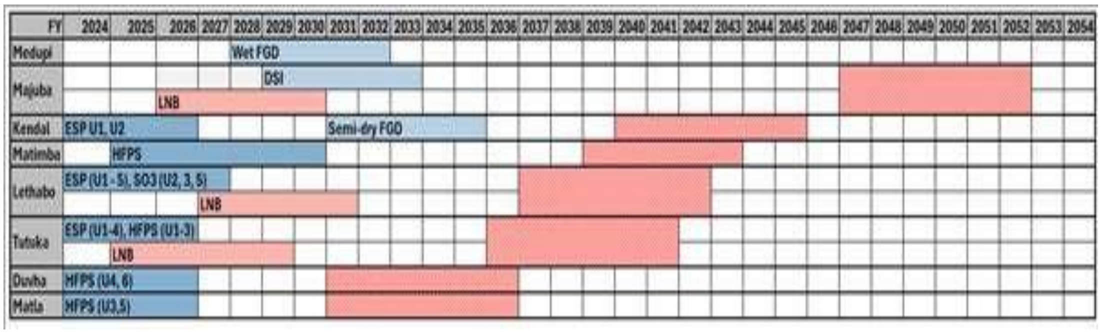


Figure 4-3: Eskom's fleet emission trajectory for PM

The proposed schedule for the installation of NO_X, PM and SO_2 emission reduction technologies and the shutdown schedule for power stations is shown in Figure 4-4.



FGD: flue gas desulphurisation
LNB: low NO_X Burner
ESP: Electrostatic precipitator
Station Shutdown

DSI: Dry Sorbent Injection
HFPS: high frequency power supply
DHP: Dust Handling Plant

Figure 4-4: Emission reduction installation schedule and the planned shutdown of power stations

4.2 Point Source Parameters

Stack parameters for the suite of power stations are included in the respective AIRs.

The stack emission rates for the suite of power station included in this cumulative assessment are shown in Table 4-1, with the equivalent emission concentrations in Table 4-2.

4.3 Point Source Maximum Emission Rates (Start Up, Shut-Down, Upset and Maintenance Conditions)

The estimated emission rates and equivalent emission concentrations that are used in the dispersion modelling for the power stations are shown in Table 4-1. The maximum anticipated emissions during each period are used for simulation in the model. The boiler units are assumed to operate continuously, i.e. 24 hours a day. Since each future scenario is a snapshot of the period of operation (e.g. Scenario A = 2025 to 2030), the maximum anticipated emissions during that period, in a single year was selected for simulation in the model.

Table 4-1: Stack emission rates (tonnes/annum) for the suite of coal-fired power stations and 5 emission scenarios

Power station	Stack	SCENARIO 1 (Current)			SCENARIO A (2025)			SCENARIO B (2031)			SCENARIO C (2036)			SCENARIO D (MES)		
		NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}
Arnot	Stack 1	21 487	24 465	890	21 619	29 833	1 031	0	0	0	0	0	0	0	0	0
	Stack 2	21 487	24 465	890	21 619	29 833	1 031	0	0	0	0	0	0	0	0	0
Camden	Stack 1	8 914	11 941	460	10 730	14 438	473	0	0	0	0	0	0	0	0	0
	Stack 2	8 914	11 941	460	10 730	14 438	473	0	0	0	0	0	0	0	0	0
	Stack 3	8 914	11 941	460	10 730	14 438	473	0	0	0	0	0	0	0	0	0
	Stack 4	8 914	11 941	460	10 730	14 438	473	0	0	0	0	0	0	0	0	0
Duvha	Stack 1	23 685	44 424	1 819	17 200	36 647	1 137	15 709	33 472	692	0	0	0	0	0	0
	Stack 2	23 685	44 424	1 819	25 800	54 971	2 652	23 564	50 208	1 384	0	0	0	0	0	0
Grootvlei	Stack 1	4 894	8 339	143	11 944	23 618	270	0	0	0	0	0	0	0	0	0
	Stack 2	4 894	8 339	143	0	0	0	0	0	0	0	0	0	0	0	0
Hendrina	Stack 1	7 695	15 589	266	10 585	23 572	356	0	0	0	0	0	0	0	0	0
	Stack 2	7 695	15 589	266	10 585	23 572	356	0	0	0	0	0	0	0	0	0
Kendal	Stack 1	22 623	58 298	13 321	26 033	88 749	1 799	22 770	77 970	1 639	27 213	26 557	1 959	27 213	26 557	1 959
	Stack 2	22 623	58 298	13 321	26 033	88 749	1 799	22 770	77 970	1 639	27 213	26 557	1 959	27 213	26 557	1 959
Komati	Stack 1	1 042	1 076	57	0	0	0	0	0	0	0	0	0	0	0	0
	Stack 2	1 042	1 076	57	0	0	0	0	0	0	0	0	0	0	0	0
Kriel	Stack 1	39 460	46 038	7 802	36 937	42 577	5 639	0	0	0	0	0	0	0	0	0
	Stack 2	39 460	46 038	7 802	36 937	42 577	5 639	0	0	0	0	0	0	0	0	0
Kusile	Stack 1	24 940	21 281	737	30 178	46 428	371	23 777	25 752	293	26 703	28 922	329	26 703	28 922	329
	Stack 2	24 940	21 281	737	30 178	46 428	371	23 777	25 752	293	26 703	28 922	329	26 703	28 922	329
Lethabo	Stack 1	51 234	100 147	5 740	46 808	99 197	3 720	28 583	56 370	1 393	22 246	59 258	1 542	22 246	17 777	1 542
	Stack 2	51 234	100 147	5 740	46 808	99 197	3 720	28 583	56 370	1 393	22 246	59 258	1 542	22 246	17 777	1 542
Majuba	Stack 1	58 301	67 177	952	33 034	105 666	837	25 262	80 804	640	33 250	75 779	842	33 250	22 734	842
	Stack 2	58 301	67 177	952	33 034	105 666	837	25 262	80 804	640	33 250	75 779	842	33 250	22 734	842
Matla	Stack 1	49 710	41 603	10 608	49 301	72 014	4 769	38 853	56 752	1 879	0	0	0	0	0	0
	Stack 2	49 710	41 603	10 608	37 490	54 761	3 627	29 545	43 156	1 429	0	0	0	0	0	0
Tutuka	Stack 1	24 217	45 512	7 692	28 989	59 187	7 006	4 945	15 654	597	17 621	55 242	1 982	17 621	16 573	1 982
	Stack 2	24 217	45 512	7 692	28 989	59 187	7 006	4 945	15 654	597	17 621	55 242	1 982	17 621	16 573	1 982

Table 4-2: Stack emission concentration in mg/Nm^3 at 10% O_2 for the suite of coal-fired power stations and 5 emission scenarios

Power station	Stack	SCENARIO 1 (Current)			SCENARIO A (2025)			SCENARIO B (2031)			SCENARIO C (2036)			SCENARIO D (MES)		
		NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}
Arnot	Stack 1	334	381	14	587	810	28	0	0	0	0	0	0	0	0	0
	Stack 2	334	381	14	587	810	28	0	0	0	0	0	0	0	0	0
Camden	Stack 1	461	617	24	680	915	30	0	0	0	0	0	0	0	0	0
	Stack 2	461	617	24	680	915	30	0	0	0	0	0	0	0	0	0
	Stack 3	461	617	24	680	915	30	0	0	0	0	0	0	0	0	0
	Stack 4	461	617	24	680	915	30	0	0	0	0	0	0	0	0	0
Duvha	Stack 1	297	557	23	681	1 451	45	681	1 451	30	0	0	0	0	0	0
	Stack 2	297	557	23	681	1 451	70	681	1 451	40	0	0	0	0	0	0
Grootvlei	Stack 1	145	247	4	885	1 750	20	0	0	0	0	0	0	0	0	0
	Stack 2	145	247	4	0	0	0	0	0	0	0	0	0	0	0	0
Hendrina	Stack 1	150	305	5	595	1 325	20	0	0	0	0	0	0	0	0	0
	Stack 2	150	305	5	595	1 325	20	0	0	0	0	0	0	0	0	0
Kendal	Stack 1	269	694	159	550	1 875	38	528	1 808	38	528	515	38	528	515	38
	Stack 2	269	694	159	550	1 875	38	528	1 808	38	528	515	38	528	515	38
Komati	Stack 1	33	35	2	0	0	0	0	0	0	0	0	0	0	0	0
	Stack 2	33	34	2	0	0	0	0	0	0	0	0	0	0	0	0
Kriel	Stack 1	535	624	106	655	755	100	0	0	0	0	0	0	0	0	0
	Stack 2	535	624	106	655	755	100	0	0	0	0	0	0	0	0	0
Kusile	Stack 1	247	210	7.28	325	500	4	325	352	4	325	352	4	325	352	4
	Stack 2	247	210	7.28	325	500	4	325	352	4	325	352	4	325	352	4
Lethabo	Stack 1	696	1 360	78	755	1 600	60	718	1 416	35	505	1 345	35	505	404	35
	Stack 2	696	1 360	78	755	1 600	60	718	1 416	35	505	1 345	35	505	404	35
Majuba	Stack 1	573	660	9	750	2 399	19	750	2 399	19	750	1 709	19	750	513	19
	Stack 2	573	660	9	750	2 399	19	750	2 399	19	750	1 709	19	750	513	19
Matla	Stack 1	551	461	117	827	1 208	80	827	1 208	40	0	0	0	0	0	0
	Stack 2	551	461	118	827	1 208	80	827	1 208	40	0	0	0	0	0	0
Tutuka	Stack 1	244	458	77	600	1 225	145	290	918	35	400	1 254	45	400	376	45
	Stack 2	244	458	77	600	1 225	145	290	918	35	400	1 254	45	400	376	45

4.4 Fugitive Emissions

The methodology to estimate emission rates of particulates from the coal yard and ash dumping activities for the power stations is described in this section.

A general equation for emission estimation is: E = A x EF x (1-ER/100)

where: E = emissions;
A = activity rate;
EF = emission factor; and
ER = overall emission reduction efficiency (%)

An emission factor is a representative value that relates the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of the pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kg of particulate emitted per tonne of coal crushed). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality and are generally assumed to be representative of long-term averages for all facilities in the source category (USEPA, 2024b).

The emission factors used for the calculation of particulates in this study are the most recent factors published in the United States Environmental Protection Agency (US EPA), AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13: Section 13.2.4 Aggregate Handling and Storage Piles; Section 13.2.5 Industrial Wind Erosion; (USEPA, 2024b).

Wind entrainment of dust and PM_{10} from coal stockpiles and ash dumps is a function of the physical size of the facility and the nature of the exposed surface, i.e. the moisture content, silt content, amount of vegetation cover, size of the particles on the surface and wind speed.

In this assessment, the ash dumps are modelled under worst case conditions (e.g. drought conditions), where it is assumed that it is mostly dry and 80% of the surface area is exposed to wind erosion, providing a worst-case (environmentally conservative) scenario. The annual emission rates for the coal stockpiles and ash dumps are shown in Table 4-3. It is worth noting here that in the dispersion modelling the PM_{10} emission is modelled firstly as PM_{10}, then it is modelled as $PM_{2.5}$.

Table 4-3: Emission rates for PM_{10} in tonnes per annum from the fugitive sources

Power station	Source	PM_{10}
Arnot	Coal yard	163
	Ash Dump	3 594
Camden	Coal yard	10
	Ash Dump 1	1 039
	Ash Dump 2	974
Duvha	Coal yard	24
	Ash Dump	6 317
Grootvlei	Coal yard	9
	Ash Dump	1 430
Hendrina	Coal yard 1	8
	Coal yard 2	7
	Ash Dump	1 884
Kendal	Coal yard	48
	Ash Dump 1	3 050
	Ash Dump 2	1596
Komati	Coal yard	5
	Ash Dump	1 320
Kriel	Coal yard	22
	Ash Dump	2 609
Kusile	Coal yard	17
	Ash Dump	2 410
Lethabo	Coal yard	0
	Ash Dump	3 087
Majuba	Coal yard	42
	Ash Dump	3 564
Matla	Coal yard	23
	Ash Dump	4 702
Tutuka	Coal yard	34
	Ash Dump	2 506

5. BASELINE CONDITIONS

The description of the baseline conditions of the area provides an understanding on the receiving atmospheric environment so that changes as a result of the application or the effect of the application can be assessed. The baseline description therefore includes an overview of the climatology and meteorology of the area, and an assessment of ambient air quality over the last three years measured at monitoring stations in the area. Other sources of air pollution in the area are also discussed.

5.1 Climate and meteorology

The climate of a given location is affected by its latitude, terrain and altitude, as well as nearby water bodies and their currents. Climates are classified according to the average and typical ranges of different variables, most commonly temperature and precipitation.

The Highveld is located in temperate latitudes between 25° S and 26° S and 28° E to 29° E, and approximately 1 600 m above sea level. As a result, it experiences a temperate climate with summer rainfall and dry winters according to the Köppen Climate Classification system. Summer days are generally warm with maximum temperatures sometimes reaching 30 °C, and summer nights are mild. Winter days are mild and nights are cold. The Highveld receives approximately 650 mm of rainfall annually, with more than 85% of its rainfall October and March The area receives an average of 693 mm of rainfall annually, with more than 85% of.

5.2 Air Pollution Dispersion Potential

The air pollution dispersion of an area refers to the ability of atmospheric processes, or meteorological mechanisms, to disperse and remove pollutants from the atmosphere. Dispersion comprises both vertical and horizontal components of motion. The vertical component is defined by the stability of the atmosphere and the depth of the surface mixing layer. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field and atmospheric stability. The wind speed determines the rate of downwind transport and wind direction and the variability in wind direction determines the general path of the pollutant. Atmospheric stability, or instability, determines the ability of the atmosphere to mix and dilute pollutants. Stability is a function of solar radiation (thermal turbulence) and wind speed and surface roughness, which induce mechanical turbulence. The dispersion potential of an area therefore experiences diurnal and seasonal changes.

By day, with strong insolation (in-coming solar radiation) and stronger winds, the dispersion potential of the Highveld is generally efficient through vertical dilution and horizontal dispersion. The dispersion potential is generally better on summer days than winter days. At night, as the surface temperature inversion develops, the lowest layer of the atmosphere becomes more stable, reaching a maximum at sunrise. As a result, the dispersion potential typically becomes less efficient during the night and the poorest conditions generally occur towards sunrise. These are known as stable night-time conditions. Under these conditions pollutants released close to ground-level (such as residential fuel burning or waste burning) are often trapped below the surface inversion tend to accumulate near the point of release. The tall power station stacks together with hot buoyant emissions ensure that pollutants are released above the surface inversion.

5.3 Ambient Air Quality

Poor ambient air quality on the Highveld led to the declaration of the Highveld and Vaal Triangle Airshed Priority Areas in terms of Section 18.1. (a) and (b) of the National Environmental Management Air Quality Act, 2004 (Act No. 39 of 2004). Following the declaration was the development and implementation of Highveld Air Quality Management Plan (AQMP) in 2011. Recognition of importance of ambient air quality monitoring led to the expansion of the monitoring network. For this assessment, data for 2021, 2022 and 2023 at 24 ambient air quality monitoring stations (AQMS) were used to evaluate baseline air quality (Table 5-1). These AQMS are mostly located in residential area where ambient concentrations of SO_2, NO_2, PM_{10} and $PM_{2.5}$ are monitored to understand the exposure to the resident populations. The relative location of the AQMS to the power stations is shown in Figure 2-1.

Table 5-1: AQMS in the Highveld and Vaal Triangle assessment area

Receptor	UTMx	UTMy
Ermelo - Monitoring Station	795.958	7066.241
Grootdraai Dam - Monitoring Station	729.225	7023.458
Hendrina - Monitoring Station	773.405	7106.824
Middelburg - Monitoring Station	747.025	7144.589
Secunda - Monitoring Station	707.218	7061.881
Witbank - Monitoring Station	719.296	7136.019
Camden - Monitoring Station	809.577	7051.594
Kendal - Monitoring Station	698.242	7112.342
Komati - Monitoring Station	745.089	7111.212
Elandsfontein - Monitoring Station	741.853	7094.088
Kriel Village - Monitoring Station	724.814	7094.533
Kwazamokuhle - Monitoring Station	773.851	7106.121
Sharpeville - Monitoring Station	586.333	7047.627
Sebokeng - Monitoring Station	583.743	7058.929
Three Rivers - Monitoring Station	599.457	7051.167
Phola - Monitoring Station	703.970	7123.218
Grootvlei - Monitoring Station	647.357	7038.962
Zamdela - Monitoring Station	584.958	7030.458
Majuba - Monitoring Station	777.612	6997.974
Chicken Farm AQMS - Monitoring Station	694.498	7125.215
Rand Water AQMS - Monitoring Station	600.337	7047.863
Masakhane AQMS - Monitoring Station	731.596	7125.308
Sivukile AQMS - Monitoring Station	759.477	7039.486
Silobela AQMS - Monitoring Station	811.174	7111.050

Ambient SO_2 and NO_2 may be attributed to a number of sources, but mostly to industrial combustion of fossil fuels and the related stack emissions. They may also be attributed to domestic coal combustion and vehicle emissions.

Generally, annual average ambient SO_2 and NO_2 concentrations are below the respective NAAQS at the monitoring stations. However, exceedances of the limit value of the NAAQS for 10-minute, 1-hour and 24-hour averaging periods are exceeded at some AQMS. In all cases the frequency of exceedance is less than the permitted number. The number of exceedances are compared with the permitted number in Table 5-2. The annual average SO_2 and NO_2 at selected monitoring stations for 2021, 2022 and 2023 are shown in Figure 5-1 and Figure 5-2 with the limit value of the respective NAAQS.

Ambient PM_{10} and $PM_{2.5}$ may also be attributed to several sources, including industrial processes and the stack emissions. However, the largest sources of be PM_{10} and $PM_{2.5}$ are low-level sources and include, amongst others, mining activity, domestic coal combustion, agricultural processes, vehicle dust entrainment and wind-blown dust.

The annual average PM_{10} and $PM_{2.5}$ concentrations measured at selected monitoring stations for 2021, 2022 and 2023 are compared with the limit value of the respective NAAQS in Figure 5-3 and Figure 5-4. Exceedances of the NAAQS are seen at several AQMS in all years.

The ambient 24-hour PM_{10} and $PM_{2.5}$ concentrations are generally high and exceed the permitted frequency of the NAAQS several AQMS. The number of exceedances are compared with the permitted number in Table 5-2. Those that do not comply with the respective NAAQS are shown in red.

Table 5-2: Number of exceedances of the 24-hour limit value of the NAAQS for PM_{10} and $PM_{2.5}$ in 2021, 2022 and 2023

AQMS	Pollutant	Averaging Period	Permitted Number of Exceedances	2021	2022	2023
Masakhane	SO_2	10-min	526	8	7	9
		1-hour	88	0	1	5
		24-hour	4	0	1	0
	PM_{10}	24-hour	4	LD	84	64
		1-year	0	LD	1	1
	$PM_{2.5}$	24-hour	4	53	0	LD
		1-year	0	1	0	LD
eMalahleni	SO_2	10-min	526	LD	LD	LD
		1-hour	88	6	26	20
		24-hour	4	0	2	2
	PM_{10}	24-hour	4	13	42	71
		1-year	0	0	1	1
	$PM_{2.5}$	24-hour	4	32	25	48
		1-year	0	0	1	1
Kendal K2	SO_2	10-min	526	86	109	199
		1-hour	88	18	38	49
		24-hour	4	1	2	3
	PM_{10}	24-hour	4	142	118	133
		1-year	0	1	1	1
	$PM_{2.5}$	24-hour	4	0	4	LD
		1-year	0	0	0	LD

AQMS	Pollutant	Averaging Period	Permitted Number of Exceedances	2021	2022	2023
Three Rivers	SO_2	10-min	526	LD	LD	LD
		1-hour	88	5	LD	3
		24-hour	4	0	LD	0
	PM_{10}	24-hour	4	98	LD	75
		1-year	0	1	LD	1
	$PM_{2.5}$	24-hour	4	45	LD	113
		1-year	0	1	LD	1
Sharpeville	SO_2	10-min	526	LD	LD	LD
		1-hour	88	LD	1	4
		24-hour	4	LD	0	0
	PM_{10}	24-hour	4	LD	86	107
		1-year	0	LD	1	1
	$PM_{2.5}$	24-hour	4	LD	67	97
		1-year	0	LD	1	1
Kriel	SO_2	10-min	526	31	10	22
		1-hour	88	13	6	11
		24-hour	4	0	0	0
		1-year	0	0	0	0
	PM_{10}	24-hour	4	30	59	71
		1-year	0	1	1	1
	$PM_{2.5}$	24-hour	4	25	25	8
		1-year	0	1	1	0
Majuba	SO_2	10-min	526	46	33	42
		1-hour	88	7	4	7
		24-hour	4	0	0	0
	PM_{10}	24-hour	4	LD	65	LD
		1-year	0	LD	1	LD
	$PM_{2.5}$	24-hour	4	2	81	35
		1-year	0	0	1	1
Sivukile	SO_2	10-min	526	114	22	1
		1-hour	88	47	10	0
		24-hour	4	2	3	0
	PM_{10}	24-hour	4	49	58	30
		1-year	0	0	1	1

LD: Data capture less than 50% and not used in averaging.

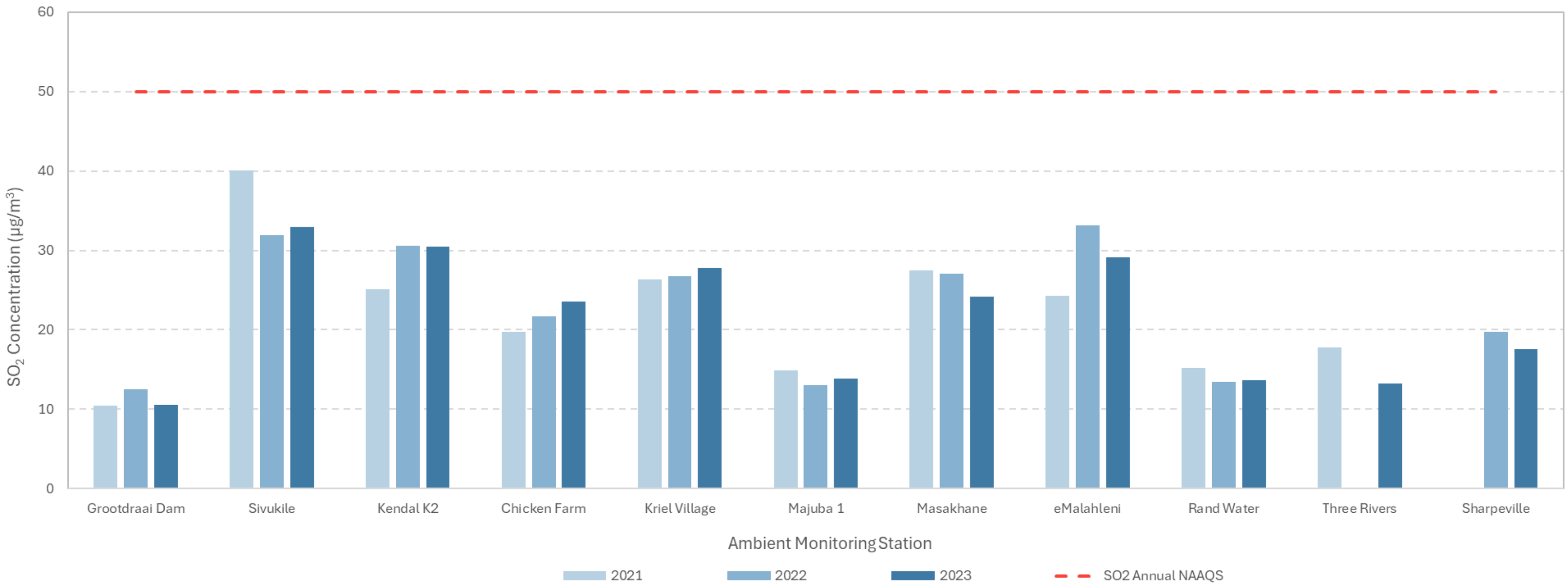


Figure 5-1: Annual average SO_2 concentrations at AQMS in the Highveld assessment area

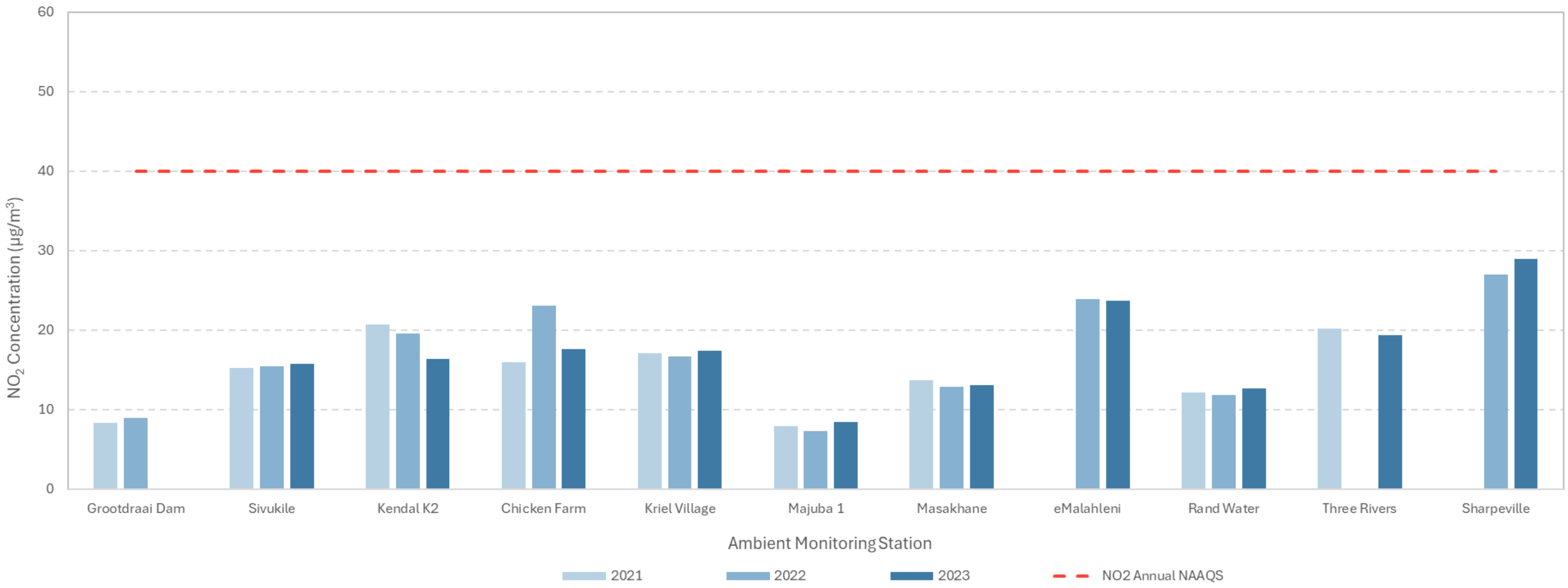


Figure 5-2: Annual average NO_2 concentrations at AQMS in the Highveld assessment area

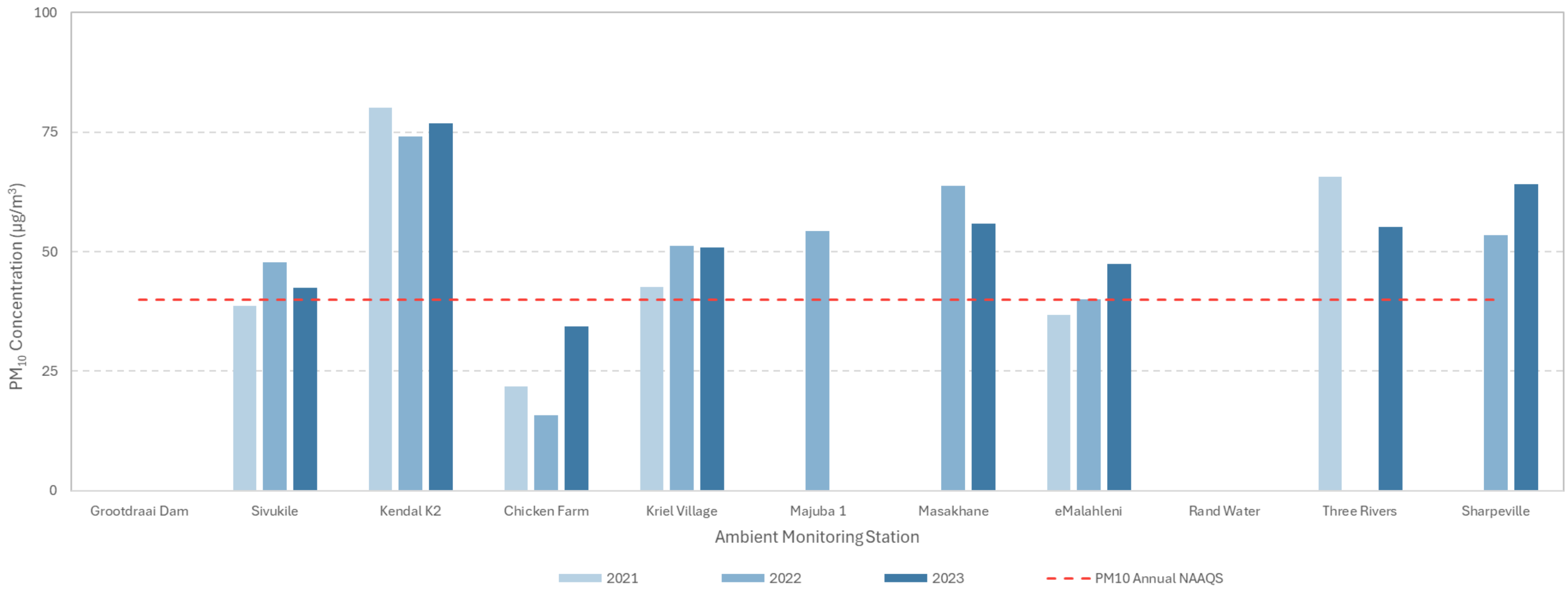


Figure 5-3: Annual average PM_{10} concentrations at AQMS in the Highveld assessment area

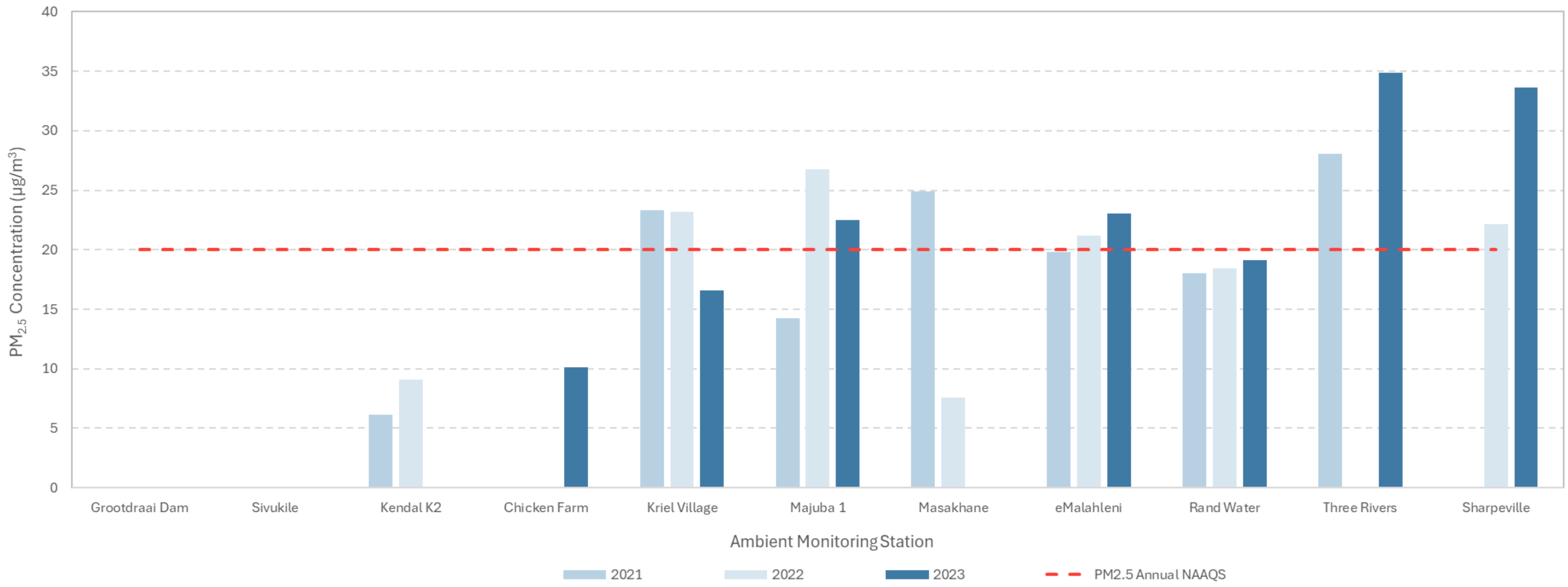


Figure 5-4: Annual average $PM_{2.5}$ concentrations at AQMS in the Highveld assessment area

6. IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT

6.1 Dispersion Modelling

6.1.1 Models used

A Level 3 air quality assessment must be conducted in situations where the purpose of the assessment requires a detailed understanding of the air quality impacts (time and space variation of the concentrations) and when it is important to account for causality effects, calms, non-linear plume trajectories, spatial variations in turbulent mixing, multiple source types and chemical transformations (DEA, 2014a). A Level 3 assessment may be used in situations where there is a need to evaluate air quality consequences under a permitting or environmental assessment process for large industrial developments that have considerable social, economic and potential environmental consequences. Under these circumstances, the cumulative assessment clearly demonstrates the need for a Level 3 assessment.

The CALPUFF suite of models are approved by the US EPA (http://www.src.com/calpuff/calpuff1.htm) and by the DEA for Level 3 assessments (DEA, 2014a). It consists of a meteorological pre-processor, CALMET, the dispersion model, CALPUFF, and the post-processor, CALPOST. It is an appropriate air dispersion model for the purpose of this assessment as it is well suited to simulate dispersion from several sources. It also has capability to simulate dispersion in the atmosphere's complex land-sea interface. More information about the model can be found in the User's Guide for the CALPUFF Dispersion Model (US EPA, 1995).

The Air Pollution Model (TAPM) (Hurley, 2000; Hurley et al., 2001; Hurley et al., 2002) is used to model surface and upper air metrological data for the study domain. TAPM uses global gridded synoptic-scale meteorological data with observed surface data to simulate surface and upper air meteorology at given locations in the domain, taking the underlying topography and land cover into account. The global gridded data sets that are used are developed from surface and upper air data that are submitted routinely by all meteorological observing stations to the Global Telecommunication System of the World Meteorological Organisation. TAPM has been used successfully in Australia where it was developed (Hurley, 2000; Hurley et al., 2001; Hurley et al., 2002). It is an ideal tool for modelling applications where meteorological data does not adequately meet requirements for dispersion modelling. TAPM modelled output data is therefore used to augment the site-specific surface meteorological data for input to CALPUFF.

6.1.2 TAPM and CALPUFF parameterisation

The TAPM diagnostic meteorological model is used to generate a 3-dimensional temporally and spatially continuous meteorological field for 2021, 2022 and 2023 in hourly increments for the modelling domain.

TAPM is set-up in a nested configuration of two domains, centred on the town of Embalenhle, in the Mpumalanga Highveld. The outer domain is 768 km by 576 km at a

16 km grid resolution and the inner domain is 384 km by 288 km at an 8 km grid resolution (Figure 6-1). The nesting configuration ensures that topographical effects on meteorology are captured, and that meteorology is well resolved and characterised across the boundaries of the inner domain. Twenty-seven vertical levels are modelled in each nest from 10 m to 5 000 m, with a finer resolution in the lowest 1 000 m. The subset of the entire TAPM model output in the form of pre-processed gridded surface meteorological data fields is input into the dispersion model.

The 3-dimensional TAPM meteorological output on the inner grid includes hourly wind speed and direction, temperature, relative humidity, total solar radiation, net radiation, sensible heat flux, evaporative heat flux, convective velocity scale, precipitation, mixing height, friction velocity and Obukhov length. The spatially and temporally resolved TAPM surface and upper air meteorological data is used as input to the CALPUFF meteorological pre-processor, CALMET.

The CALPUFF modelling domain covers an area of 97 200 km^2, where the domain extends 360 km (west-east) by 270 km (north-south) (Figure 6-1). It consists of a uniformly spaced receptor grid with 2 km spacing, giving 24 300 grid cells (180 x 135 grid cells). The size of the modelling domain was informed by previous modelling where the CALPUFF domain of 360 km (west-east) by 270 km (north-south) adequately captured the influence of 13 power stations (Naledzi, 2018). In this case the predicted annual average concentrations were low at the western edge of the domain, i.e. for SO_2 less than for 5 µg/m^3, for NO_2 less than 2 µg/m^3 and for PM_{10} and $PM_{2.5}$ less than 1 µg/m^3.

The topographical and land use for the respective modelling domains is obtained from the dataset accompanying the Commonwealth Scientific and Industrial Research Organisation (CSIRO) The Air Pollution Model (TAPM) modelling package (CSIRO, 2008). This dataset includes global terrain elevation and land use classification data on a longitude/latitude grid at 30-second grid spacing from the US Geological Survey, Earth Resources Observation Systems (EROS) Data Center.

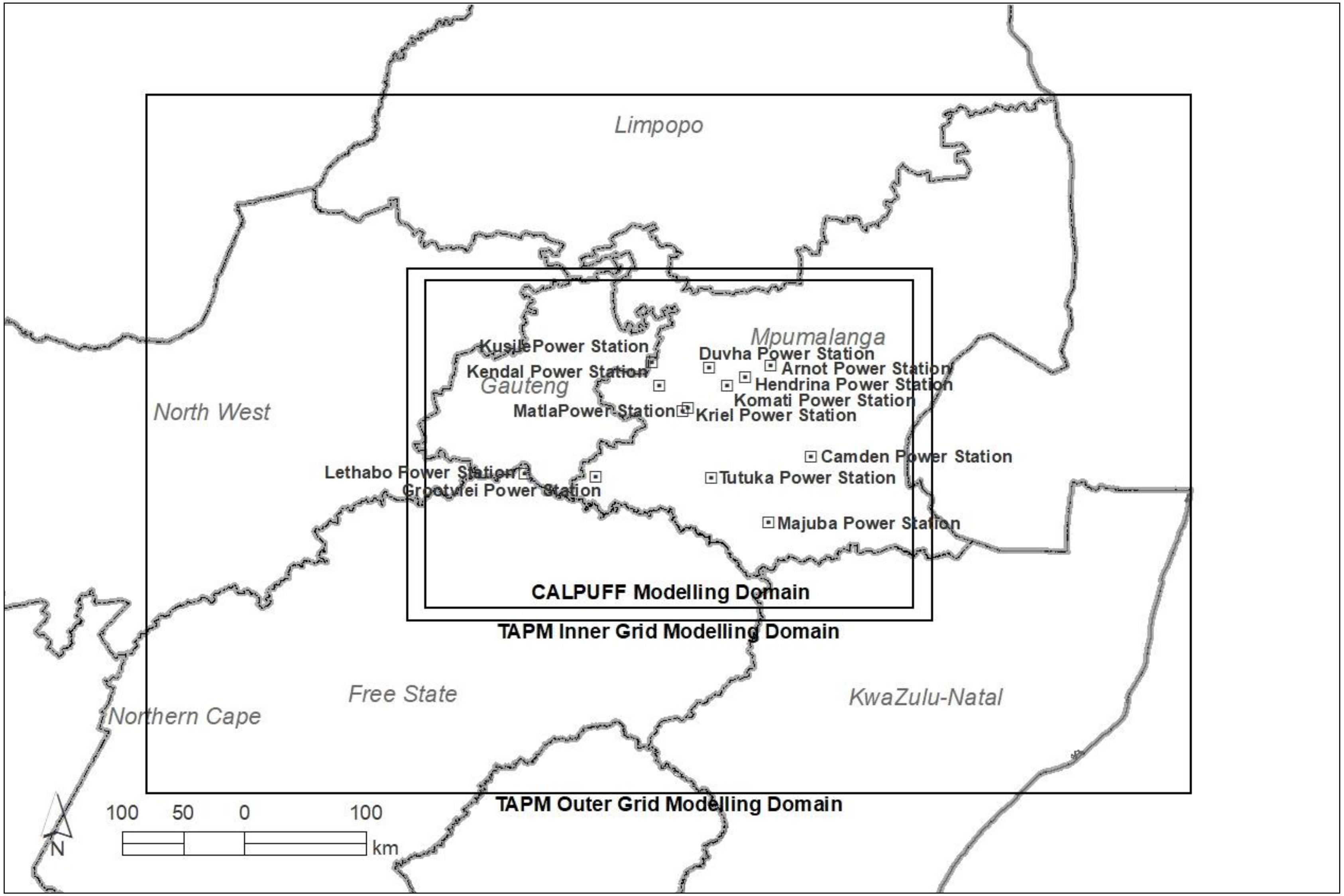


Figure 6-1: TAPM and CALPUFF modelling domains centred on the central Highveld

The parameterisation of key variables that will apply in CALMET and CALPUFF are indicated in Table 6-1 and Table 6-2 respectively.

Table 6-1: Parameterisation of key variables for CALMET

Parameter	Model value
12 vertical cell face heights (m)	0, 20, 40, 80, 160, 320, 640, 1000, 1500, 2000, 2500, 3000, 4000
Coriolis parameter (per second)	0.0001
Empirical constants for mixing height equation	Neutral, mechanical: 1.41 Convective: 0.15 Stable: 2400 Overwater, mechanical: 0.12
Minimum potential temperature lapse rate (K/m)	0.001
Depth of layer above convective mixing height through which lapse rate is computed (m)	200
Wind field model	Diagnostic wind module
Surface wind extrapolation	Similarity theory
Restrictions on extrapolation of surface data	No extrapolation as modelled upper air data field is applied
Radius of influence of terrain features (km)	5
Radius of influence of surface stations (km)	Not used as continuous surface data field is applied

Table 6-2: Parameterisation of key variables for CALPUFF

Parameter	Model value
Chemical transformation	Default NO_2 conversion factor is applied
Wind speed profile	Rural
Calm conditions	Wind speed < 0.5 m/s
Plume rise	Transitional plume rise, stack tip downwash, and partial plume penetration is modelled
Dispersion	CALPUFF used in PUFF mode
Dispersion option	Pasquill-Gifford coefficients are used for rural and McElroy-Pooler coefficients are used for urban
Terrain adjustment method	Partial plume path adjustment

6.1.3 Model accuracy

Air quality models attempt to predict ambient concentrations based on “known” or measured parameters, such as wind speed, temperature profiles, solar radiation and emissions. There are however, variations in the parameters that are not measured, the so-called “unknown” parameters as well as unresolved details of atmospheric turbulent flow. Variations in these “unknown” parameters can result in deviations of the predicted concentrations of the same event, even though the “known” parameters are fixed.

There are also "reducible" uncertainties that result from inaccuracies in the model, errors in input values and errors in the measured concentrations. These might include poor quality or unrepresentative meteorological, geophysical and source emission data, errors in the measured concentrations that are used to compare with model predictions and inadequate model physics and formulation used to predict the concentrations. "Reducible" uncertainties can be controlled or minimised. This is done by using accurate input data, preparing the input files correctly, checking and re-checking for errors, correcting for odd model behaviour, ensuring that the errors in the measured data are minimised and applying appropriate model physics.

Models recommended in the DEA dispersion modelling guideline (DEA, 2014a) have been evaluated using a range of modelling test kits (http://www.epa.gov./scram001). CALPUFF is one of the models that have been evaluated and it is therefore not mandatory to perform any modelling evaluations. Rather the accuracy of the modelling in this assessment is enhanced by every effort to minimise the "reducible" uncertainties in input data and model parameterisation.

6.1.4 Assessment scenarios

The dispersion modelling includes 13 coal-fired power stations on the Highveld and the Free State Province for 5 emission scenarios. The scenarios are:

Scenario 1 (Current): The baseline scenario using actual monthly tonnage of pollutants emitted per stack for 2021-2023 and fugitive emissions from the coal yards and ash dumps for all current operational power stations.

Scenario A (2025): Eskom's planned emissions from 2025 and fugitive emissions from the coal yards and ash dumps for all operational power stations in 2025.

Scenario B (2031): Eskom's planned 2031 stack emissions and fugitive emissions from the coal yards and ash dumps for all operational power stations in 2031.

Scenario C (2036): Eskom's planned 2036 emissions and fugitive emissions from the coal yards and ash dumps for all operational power stations in 2036.

Scenario D (MES): Full compliance with MES and fugitive emissions from the coal yards and ash dumps for all operational power stations in 2036.

6.2 Dispersion Modelling Results

The dispersion modelling results are compared with the NAAQS for SO_2, NO_2, PM_{10} and $PM_{2.5}$ (Table 3-3). It is not possible to apportion the PM_{10} and $PM_{2.5}$ portion of the total PM emitted from the stack emissions. Therefore, the total PM emission is assumed to be firstly PM_{10} and then assumed to be $PM_{2.5}$. For consistency in approach, fugitive emissions of PM_{10} are modelled as $PM_{2.5}$. This is a very conservative assumption. The CALPUFF modelling suite provides for the chemical conversion of SO_2 and NO_X to secondary particulates, i.e. sulphate and nitrate in the modelling results. The predicted PM_{10} and $PM_{2.5}$ concentrations presented are therefore a result of the stack PM emission plus secondary particulate formation.

The ambient SO_2, NO_2, PM_{10} and $PM_{2.5}$ concentrations from the dispersion modelling for the five emission scenarios are presented as isopleth maps over the modelling domain. The DEA (2012c) recommend the 99th percentile concentrations for short-term assessment with the NAAQS since the highest predicted ground-level concentrations can be considered outliers due to complex variability of meteorological processes. In addition, the limit value in the NAAQS is the 99th percentile.

The impact assessment therefore compares the predicted 99th percentile concentrations with the respective NAAQS (limit values and the permitted frequency of exceedance) for the five scenarios.

6.2.1 Maximum predicted ambient concentrations

The maximum predicted annual SO_2, NO_2, PM_{10} and $PM_{2.5}$ concentrations and the 99th percentile of the 24-hour and 1-hour predicted concentrations are discussed here and are listed in Table 6-3 for the 5 scenarios. Exceedances of the limit value of the NAAQS are shown in red font.

For SO_2, the predicted concentrations are attributed only to the stack emissions. The maximum predicted annual average concentrations for the 5 scenarios are low relative to the limit values of the NAAQS. The highest annual concentrations are predicted in a band extending across the highveld from the centrally located power stations to the southeast to Majuba. Noteworthy is the systematic decrease in the predicted maximum and 99th percentile concentrations from 2025 to 2035 for all averaging periods due to station shutdowns (Arnot, Camden, Hendrina, Kriel, Grootvlei), with most generating units also shutdown at Duvha and Matla by 2035, and completion of DSI installation project at Majuba and semi-dry FGD at Kendal, as well as the benefits of load curtailment at selected stations, and the efficiency improvement projects planned.

The predicted the 99th percentile of the 24-hour SO_2 concentrations are also relatively low compared to the limit value of the NAAQS, except in Scenario A (2025) when the limit value is exceeded. The 99th percentile of the predicted 1-hour concentrations are higher, but are below the limit value of the NAAQS for all five scenarios.

For NO_2, the predicted concentrations are attributed only to the stack emissions. The predicted maximum and 99th percentile concentrations are low relative to the limit values of the respective NAAQS for the 5 scenarios. The predicted maximum NO_2 concentration occur on the central Highveld. Noteworthy is the systematic decrease in the predicted maximum and 99th percentile concentrations from 2025 to 2035 for all averaging periods due to station shutdowns (Arnot, Camden, Hendrina, Kriel, Grootvlei), and completion of LNB installations at Majuba and Tutuka, as well as the benefits of load curtailment at selected stations, and the efficiency improvement projects planned.

For PM_{10} and $PM_{2.5}$, the predicted concentrations are attributed to stack emissions, the low-level fugitive sources (coal yard and ash dump) and the contribution from secondary particulate formation. The total PM emissions are not speciated into PM_{10} or $PM_{2.5}$, rather all PM emitted is assumed to be firstly PM_{10}, and then all PM emitted is assumed to be $PM_{2.5}$.

For PM_{10} and $PM_{2.5}$, the maximum predicted annual average concentrations exceed the limit values of the respective NAAQS in all scenarios. Similarly, the 99th percentile of the 24-hour PM_{10} and $PM_{2.5}$ concentrations exceeds the limit value of the NAAQS. The predicted maximum PM_{10} and $PM_{2.5}$ concentrations occur close to the power stations where the high predicted PM_{10} and $PM_{2.5}$ are mostly attributed to the low-level fugitive sources. It is noteworthy therefore that the maximum predicted concentrations decrease significantly from 2025 when 13 power stations are in operation to 2031 with the shutdown of 5 power stations, and as a result of PM abatement projects at Kendal, Tutuka, Lethabo, Duvha and Matla being completed, as well as most Duvha and Matla generating nearing completion of shutdown by 2035.

Table 6-3: Maximum predicted ambient annual SO_2, NO_2 PM_{10}, and $PM_{2.5}$ concentrations in µg/m³ and the predicted 99th percentile concentrations for 24-hour and 1-hour averaging periods, with the South African NAAQS

Scenario and Pollutant	Averaging time		
Predicted maximum SO_2	**Annual**	**24-hour**	**1-hour**
Scenario 1 (Current)	13.5	81.7	150.8
Scenario A (2025)	24.3	**173.3**	349.5
Scenario B (2031)	18.7	124.0	310.0
Scenario C (2035)	14.2	114.4	246.6
Scenario D (MES)	7.3	61.6	151.5
NAAQS	50	125	350
Predicted maximum NO_2	**Annual**		**1-hour**
Scenario 1 (Current)	5.5		94.4
Scenario A (2025)	7.3		114.6
Scenario B (2031)	4.9		106.5
Scenario C (2035)	4.9		109.9
Scenario D (MES)	4.9		109.9
NAAQS	40		200
Predicted maximum PM_{10}	**Annual**	**24-hour**	
Scenario 1 (Current)	**278.4**	**1 634.3**	
Scenario A (2025)	**278.8**	**1 638.5**	
Scenario B (2031)	**95.6**	**380.7**	
Scenario C (2035)	**94.2**	**330.9**	
Scenario D (MES)	**93.9**	**328.8**	
NAAQS	40	75	
Predicted maximum $PM_{2.5}$	**Annual**	**24-hour**	
Scenario 1 (Current)	**278.4**	**1 634.3**	
Scenario A (2025)	**278.8**	**1 638.5**	
Scenario B (2031)	**95.6**	**380.7**	
Scenario C (2035)	**94.2**	**330.9**	
Scenario D (MES)	**93.9**	**328.8**	
NAAQS	**20**	**40**	Up to 31 Dec 2029
NAAQS	**15**	**25**	From 01 Jan 2030

6.2.2 Predicted concentrations at AQMS and sensitive receptors

The predicted annual SO_2, NO_2, PM_{10} and $PM_{2.5}$ concentrations and the 99th percentile of the 24-hour and 1-hour predicted concentrations at AQMS in the Highveld modelling area are presented in Table 6-4 to Table 6-7. The measured annual averages in 2021, 2022 and 2023 presented with the modelled annual average concentration for Scenario 1: (Current).

For SO_2 and NO_2 the predicted ambient concentrations result from the respective power station stack emissions only. At all the AQMS the modelled concentrations are lower than the monitored concentrations. This is to be expected since AQMS are exposed to all sources of SO_2 and NO_2. The difference between the predicted concentrations and the measured concentrations provides an indication of the contribution of the power station stack emissions at the respective AQMS.

For PM_{10} and $PM_{2.5}$ the predicted ambient concentrations result from the respective power station stack emissions and the fugitive low-level sources, i.e. the coal yards and the ash dumps at each power station. At all the AQMS the modelled concentrations are considerably lower than the monitored concentrations. This is to be expected since AQMS are exposed to all sources of PM_{10} and $PM_{2.5}$. The difference between the predicted concentrations and the measured concentrations provides an indication of the contribution of the power station stack emissions at the respective AQMS.

Table 6-4: Measured annual average SO_2 concentration at the Highveld AQMS compared with predicted concentrations in µg/m^3 for Scenario 1 (Current)

Receptor	2021	2022	2023	Modelled
Grootdraai Dam AQMS	10.4	12.5	10.5	4.3
eMalahleni AQMS	24.2	33.1	29.1	3.0
Kendal AQMS	25.1	30.6	30.4	4.4
Kriel Village AQMS	26.3	26.7	27.8	3.8
Three Rivers AQMS	17.8	-	13.3	2.8
Majuba AQMS	14.9	13.1	13.9	11.5
Chicken Farm AQMS	19.8	21.7	23.5	5.4
Rand Water AQMS	15.2	13.5	13.7	3.2
Masakhane AQMS	27.5	27.1	24.2	3.2
Sivukile AQMS	40.1	31.0	32.9	5.4
Sharpville AQMS	-	19.8	17.5	3.1

Table 6-5: Measured annual average NO_2 concentration at the Highveld AQMS compared with predicted concentrations in µg/m³ for Scenario 1 (Current)

Receptor	2021	2022	2023	Modelled
Grootdraai Dam AQMS	8.4	8.9	-	0.9
eMalahleni AQMS	-	23.9	23.7	1.1
Kendal AQMS	20.7	19.6	16.3	2.1
Kriel Village AQMS	17.1	16.6	17.4	1.4
Three Rivers AQMS	20.2	-	19.4	0.6
Majuba AQMS	8.0	7.3	8.4	3.3
Chicken Farm AQMS	15.9	23.1	17.6	2.9
Rand Water AQMS	12.2	11.8	12.6	0.7
Masakhane AQMS	13.7	12.9	13.0	1.1
Sivukile AQMS	15.2	15.5	15.7	1.2
Sharpville AQMS	-	27.0	29.0	0.7

Table 6-6: Measured annual average PM_{10} concentration at the Highveld AQMS compared with predicted concentrations in µg/m³ for Scenario 1 (Current)

Receptor	2021	2022	2023	Modelled
Grootdraai Dam AQMS	-	-	-	2.9
eMalahleni AQMS	36.7	40.1	47.5	1.4
Kendal AQMS	80.2	74.1	76.8	15.4
Kriel Village AQMS	42.7	51.2	50.8	2.3
Three Rivers AQMS	65.6	-	56.1	3.3
Majuba AQMS	-	54.3	-	9.9
Chicken Farm AQMS	21.9	15.8	34.4	12.6
Rand Water AQMS	-	-	-	7.6
Masakhane AQMS	-	63.8	55.8	1.4
Sivukile AQMS	38.7	47.7	42.4	2.3
Sharpville AQMS	-	53.4	64.0	3.9

Table 6-7: Measured annual average $PM_{2.5}$ concentration at the Highveld AQMS compared with predicted concentrations in µg/m³ for Scenario 1 (Current)

Receptor	2021	2022	2023	Modelled
Grootdraai Dam AQMS	-	-	-	2.9
eMalahleni AQMS	19.8	21.2	23.1	1.4
Kendal AQMS	6.1	9.1	-	15.4
Kriel Village AQMS	23.2	23.2	16.6	2.3
Three Rivers AQMS	28.1	-	34.9	3.3
Majuba AQMS	14.3	26.8	22.5	9.9
Chicken Farm AQMS	-	-	10.1	12.6
Rand Water AQMS	18.0	18.5	19.1	7.6
Masakhane AQMS	24.9	7.5	-	1.4
Sivukile AQMS	-	-	-	2.3
Sharpville AQMS	-	22.1	33.0	3.9

In the Highveld and Vaal Triangle study area 405 sensitive receptors were identified. These are listed in Annexure 1. Predicted ambient concentrations for SO_2 NO_2, PM_{10} and $PM_{2.5}$ for the five scenarios are presented in Annexure 2. The predicted concentrations at the sensitive receptors are discussed here. As discussed, exceedance of the NAAQS limit does not indicate non-compliance with the standard as in terms of the standard there is a number of times which exceedance of the limit is permitted. The isopleth (maps of concentration) discussed in the following section illustrate the extent of NAAQS non-compliance.

For SO_2, predicted concentrations result from SO_2 emissions from the power station stacks. At all identified sensitive receptors the predicted SO_2 concentrations are below the respective NAAQS for all averaging periods. The highest predicted concentration occur for the proposed Scenario A (2025) emissions. Noteworthy is the systematic decrease in the predicted concentrations from 2025 to 2035 for all averaging periods at all sensitive receptors. The lowest predicted concentration occur for Scenario D (MES) emissions.

For NO_2, the predicted concentrations result from NO_X emissions from the power station stacks. At all identified sensitive receptors the predicted NO_2 concentrations are low and below the respective NAAQS for all averaging period. The highest predicted concentration occur for the proposed Scenario A (2025) emissions.

For PM_{10} and $PM_{2.5}$, it must be remembered that the predicted concentrations are attributed to stack emissions and the low-level fugitive sources (coal yard and ash dump). Furthermore, the total PM emission is not speciated into PM_{10} and $PM_{2.5}$, but rather all PM emitted is assumed to be PM_{10}, and all PM emitted is assumed to be $PM_{2.5}$. In addition, the predicted PM_{10} and $PM_{2.5}$ concentrations account for the formation of secondary particulates from SO_2 and NO_2 stack emissions. This is a very conservative approach.

For PM_{10} and $PM_{2.5}$, the predicted annual average concentrations are below the limit values of the NAAQS at all sensitive receptor points in all five scenarios. Exceedance of the 24-hour limit value of the NAAQS for PM_{10} and $PM_{2.5}$ are predicted in all five scenarios at several sensitive receptor points (Table 6-8). For Scenario A (2025) the exceedances of the limit value for PM_{10} occur at most sensitive receptor points. For $PM_{2.5}$, the limit value of the NAAQS drops from 40 μg/m^3 to 25 μg/m^3 in 2030. This results in an increase in the number of receptor points where the limit value is exceeded. For both PM_{10} and $PM_{2.5}$ the number of receptor points where the limit value is exceeded decreases as power stations are shutdown, and emissions from the associated fugitive sources cease, as well as the completion of the PM abatement projects at Kendal, Tutuka, Duvha, Matla and Lethabo

Table 6-8: Number of sensitive receptors where the limit value of the NAAQS is exceeded

Scenario	Number of sensitive receptors	
	PM_{10}	$PM_{2.5}$
Scenario 1 (Current)	26	129
Scenario A (2025)	29	149
Scenario B (2031)	9	157
Scenario C (2036)	0	53
Scenario D (MES)	0	45

6.2.3 Isopleth maps

Isopleth maps of predicted ambient SO_2, NO_2, PM_{10} and $PM_{2.5}$ concentrations are presented in the following sections. The predicted concentrations are shown as isopleths, lines of equal concentration, in µg/m^3 for the respective NAAQS averaging periods. The isopleths are depicted as coloured lines on the various maps, corresponding to a particular predicted ambient concentration. Areas within red isopleths indicate an area where exceedances of the respective NAAQS limit value are predicted to occur. Sensitive receptors are represented by green squares and AQMS are represented by white dots.

The South African NAAQS permits 4 exceedances of the 24-hour or daily limit value per annum, implying 12 permitted exceedances in a three-year modelling period. For the 24-hour or daily isopleth maps, areas within burgundy isopleths indicate areas where more than 12 exceedances of the limit value is predicted over a 3-year period. The predicted 24-hour concentrations in these areas do not comply with the NAAQS.

The South African NAAQS for SO_2 and NO_2 also permits 88 exceedances of the 1-hour or hourly limit value per annum, implying 264 permitted exceedances in a three-year modelling period. For the 1-hour or hourly isopleth maps, areas within burgundy isopleths indicate areas where more than 264 exceedances of the limit value is predicted over a 3-year period. The predicted 1-hour concentrations in these areas do not comply with the NAAQS.

6.2.3.1 Sulphur dioxide (SO_2)

The isopleth maps showing the predicted annual average SO_2 concentrations clearly demonstrate the effect of the predominant northwesterly winds, with dispersion generally to the southeast across the Highveld and Vaal modelling domain. In all scenarios the highest predicted annual average concentrations occur in a band from the power stations on the central highveld in a southeasterly direction towards Majuba. The predicted annual ambient concentrations are relatively low and are below the NAAQS in all scenarios throughout the modelling domain. Noteworthy is the consistent decrease in predicted ambient concentration with progressive scenarios and the systematic reduction in total SO_2 emissions (see in Figure 4-2).

For the 24-hour and 1-hour averaging periods, the highest predicted concentrations occur in Scenario A (2025) on the central Highveld where several power stations are relatively close together, then around Lethabo in the southwest, around Majuba in the southeast and around Camden in the east. The only predicted exceedance of the NAAQS is near Majuba where the 24-hour limit value is exceeded in a small area. The effect of the shutdown of Arnot, Camden, Hendrina, Grootvlei, Kriel by 2031 is evident in the isopleth plots for Scenario B (2031) by a marked decrease in the predicted ambient concentrations, with a further reduction in Scenario C (2036).

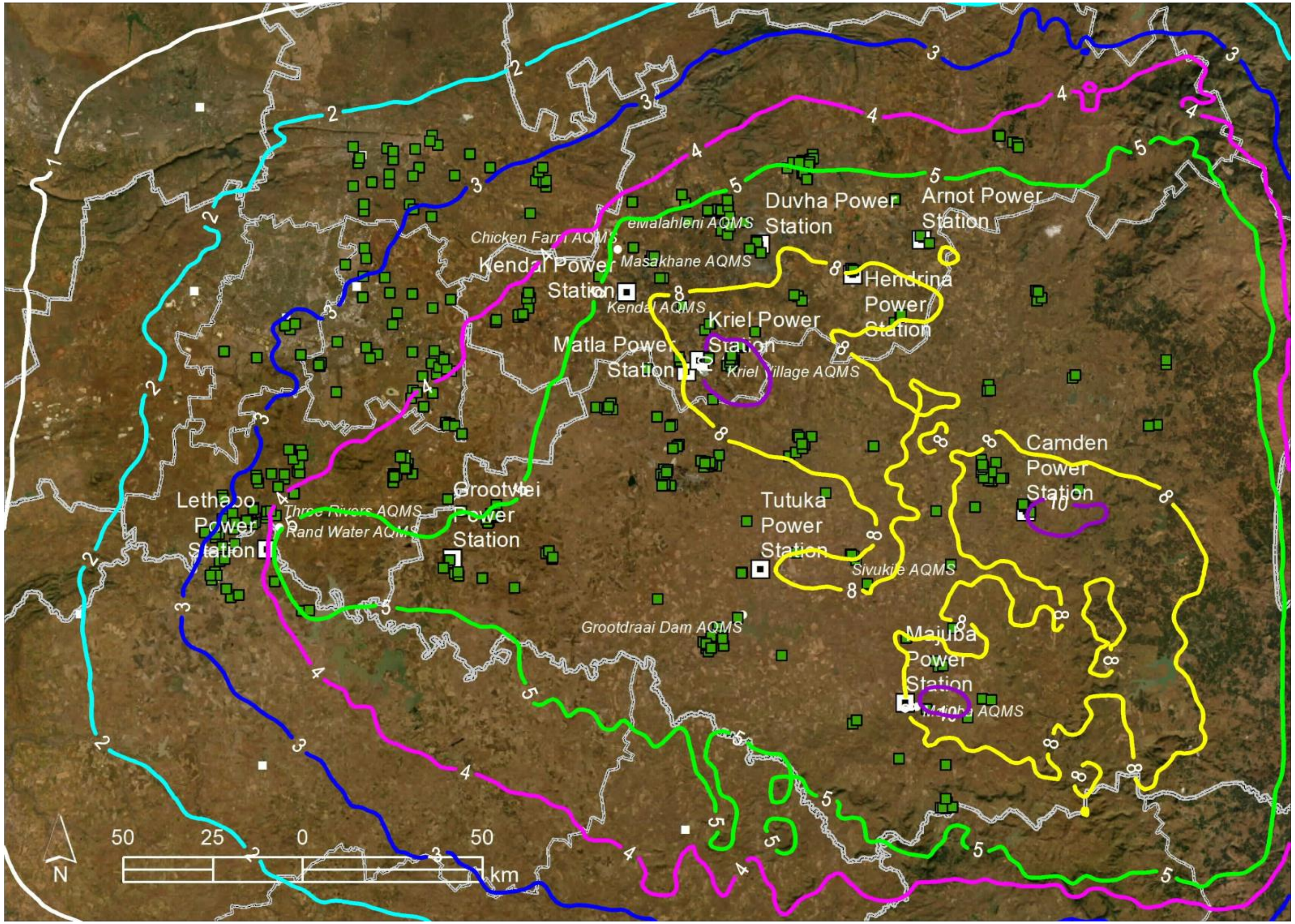


Figure 6-2: Predicted annual average SO_2 concentrations in µg/m³ for Scenario 1 (Current) (NAAQS Limit is 50 µg/m³)

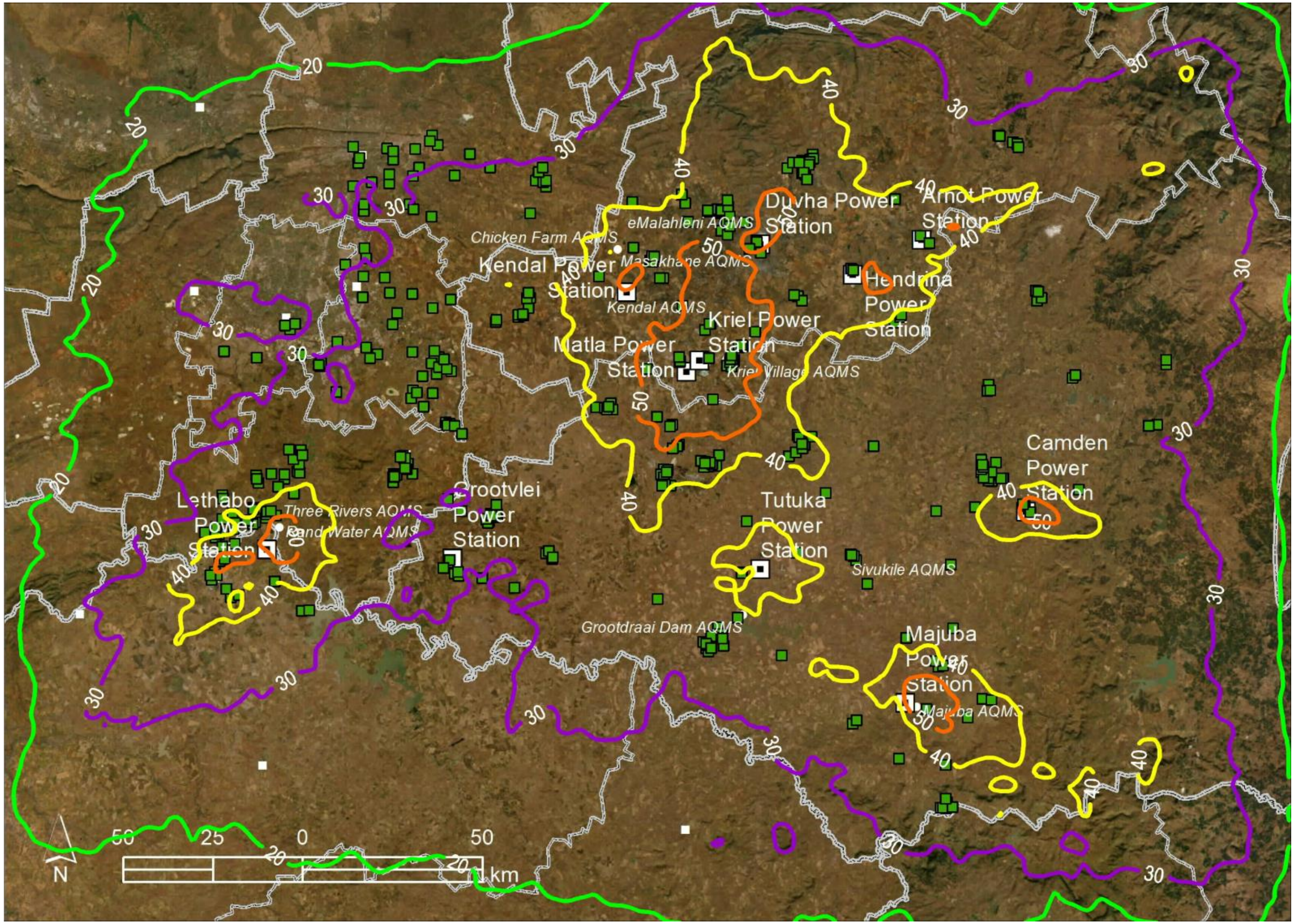


Figure 6-3: Predicted 99th percentile 24-hour SO_2 concentrations in μg/m³ for Scenario 1 (Current) (NAAQS Limit is 125 μg/m³)

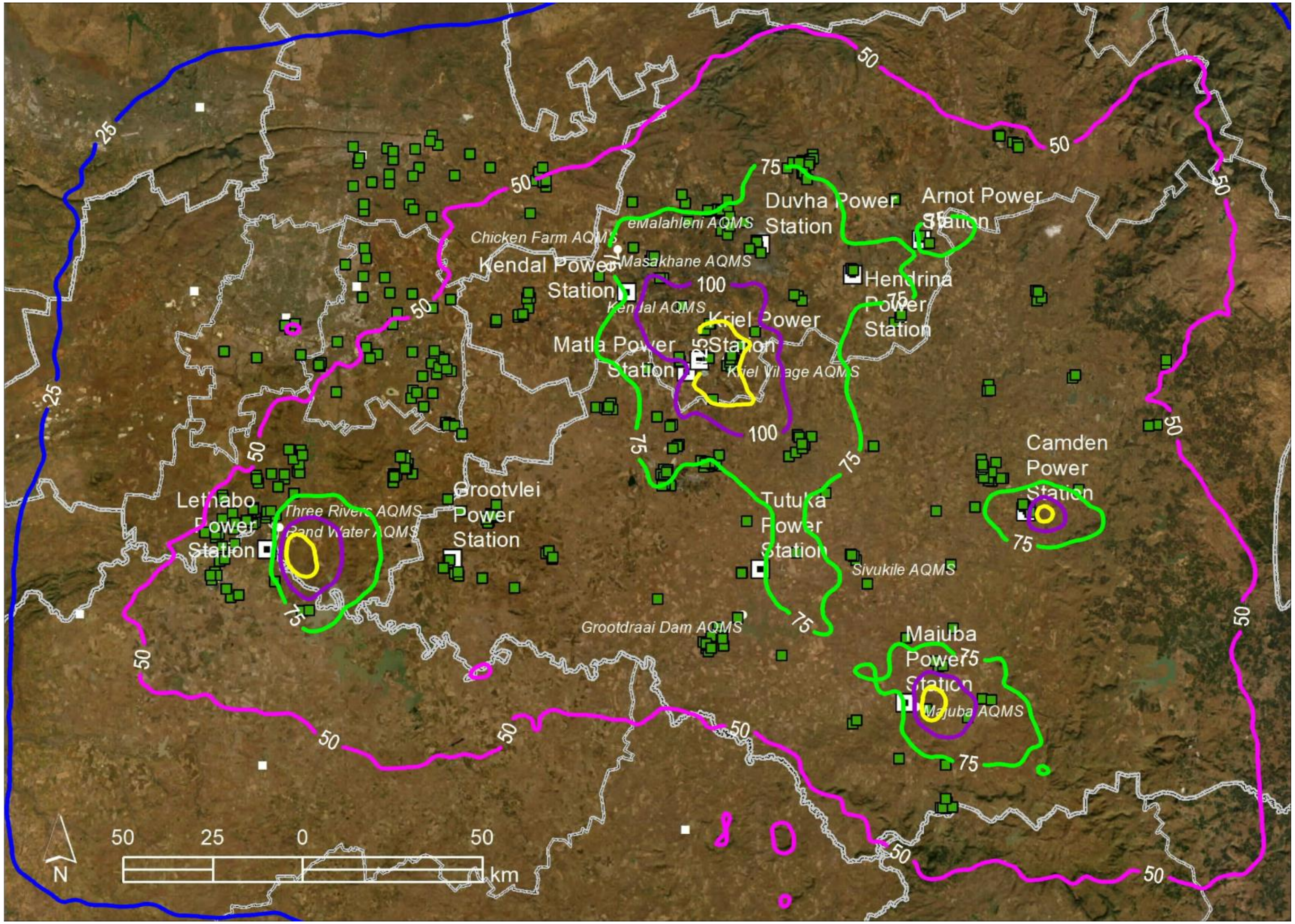


Figure 6-4: Predicted 99th percentile 1-hour SO_2 concentrations in µg/m³ for Scenario 1 (Current) (NAAQS Limit is 350 µg/m³)

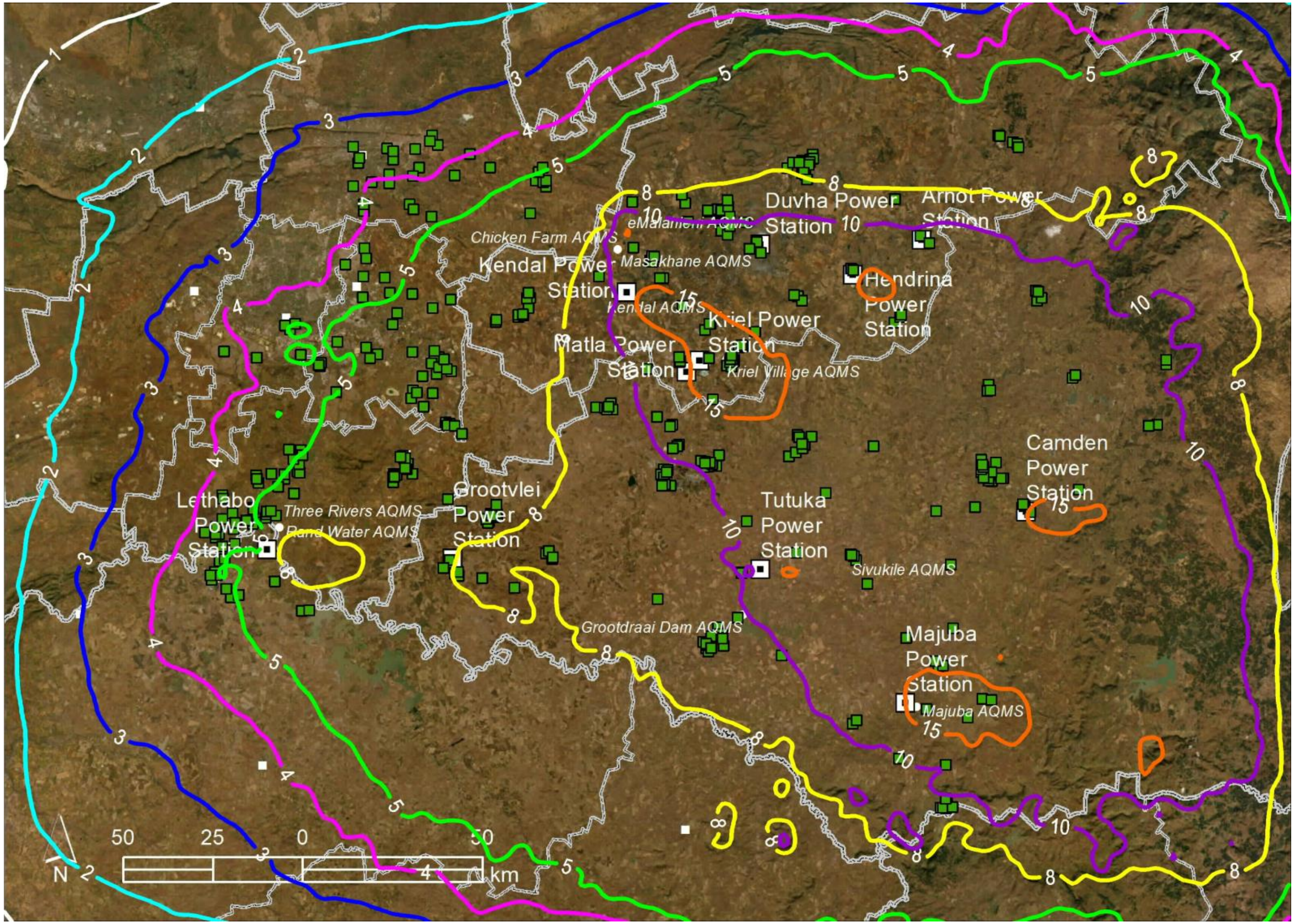


Figure 6-5: Predicted annual average SO_2 concentrations in µg/m³ for Scenario A (2025) (NAAQS Limit is 50 µg/m³)

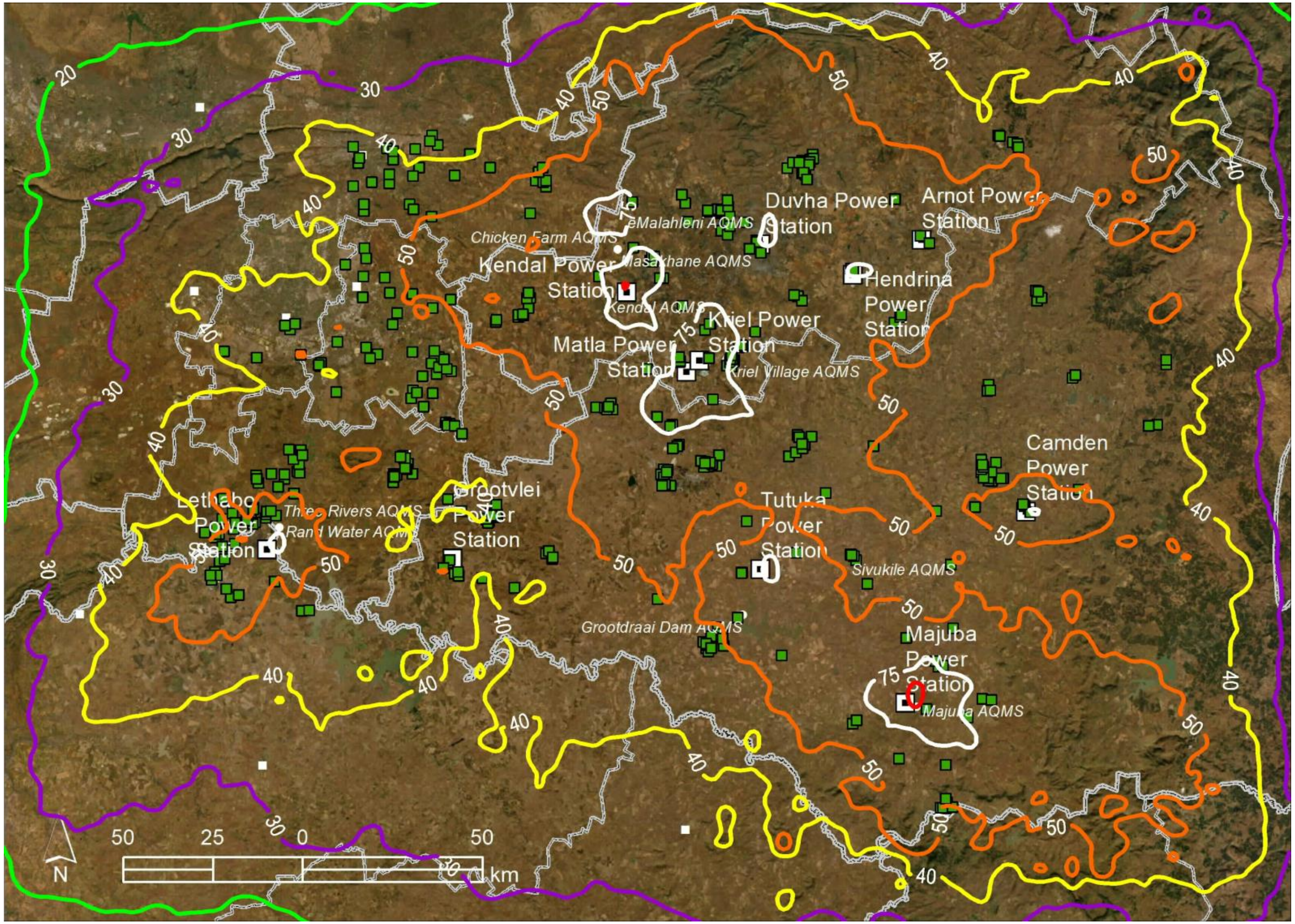


Figure 6-6: Predicted 99th percentile 24-hour SO_2 concentrations in µg/m³ for Scenario A (2025) (NAAQS Limit is 125 µg/m³)

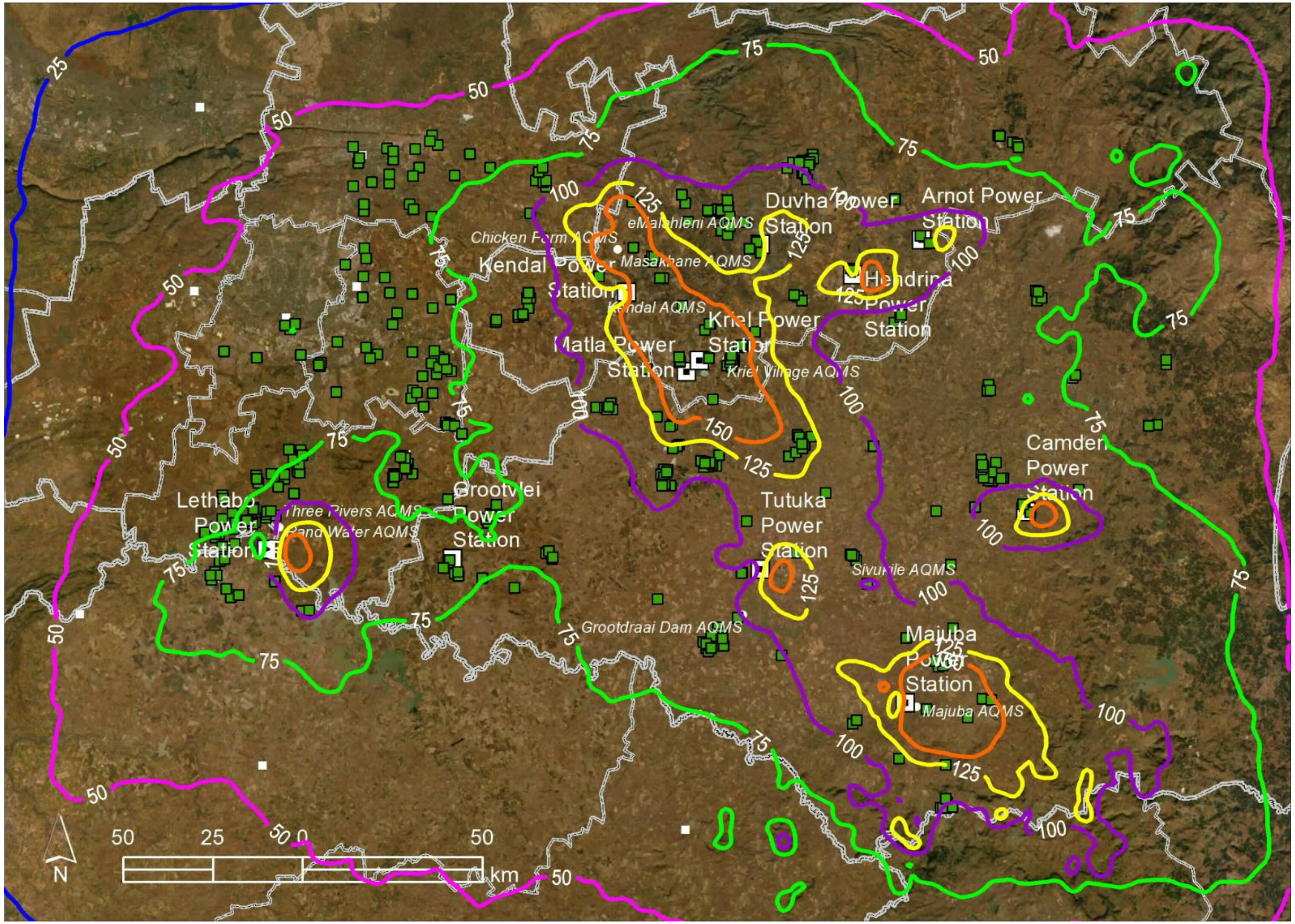


Figure 6-7: Predicted 99th percentile 1-hour SO_2 concentrations in μg/m³ for Scenario A (2025) (NAAQS Limit is 350 μg/m³)

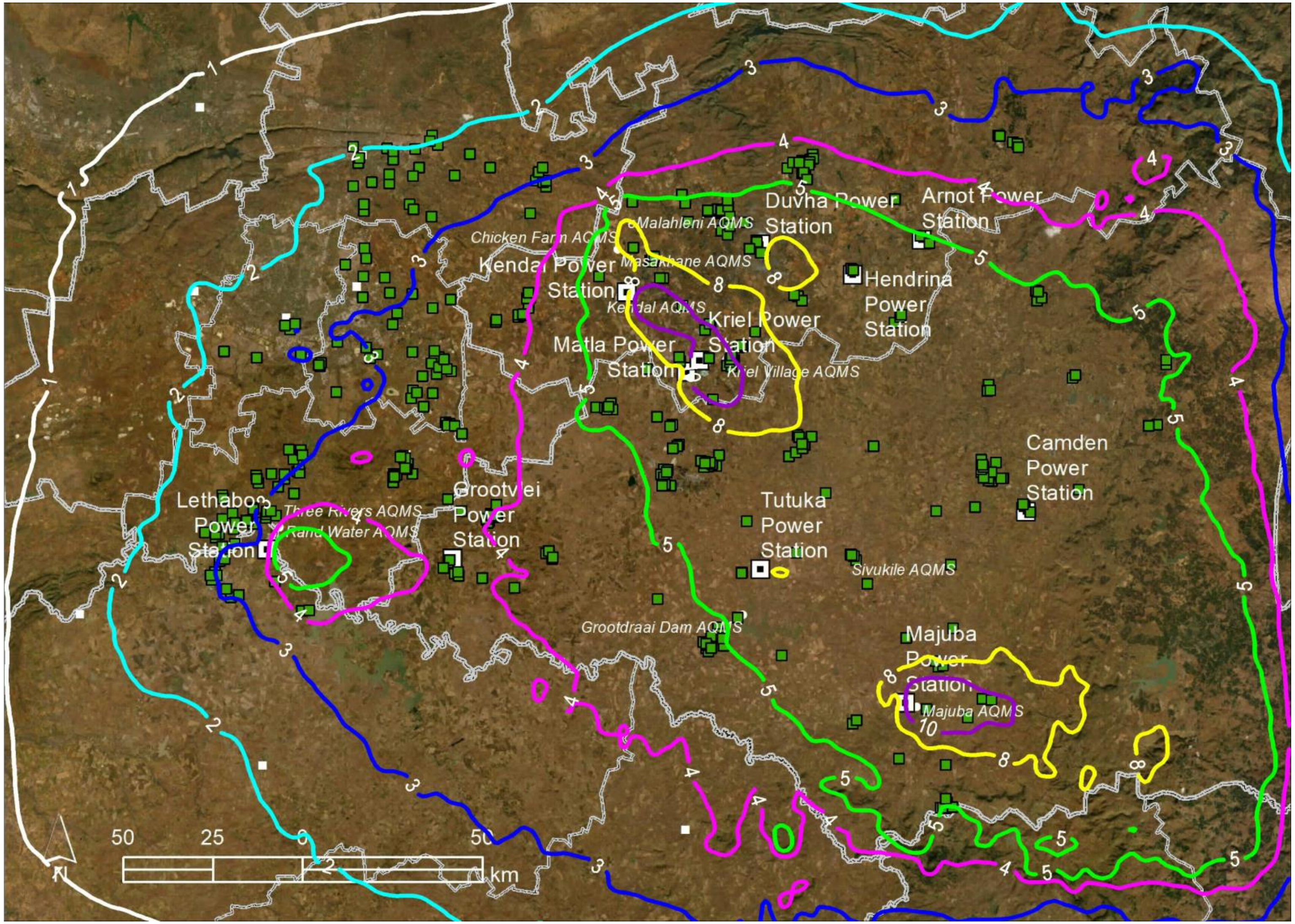


Figure 6-8: Predicted annual average SO_2 concentrations in µg/m³ for Scenario B (2031) (NAAQS Limit is 50 µg/m³)

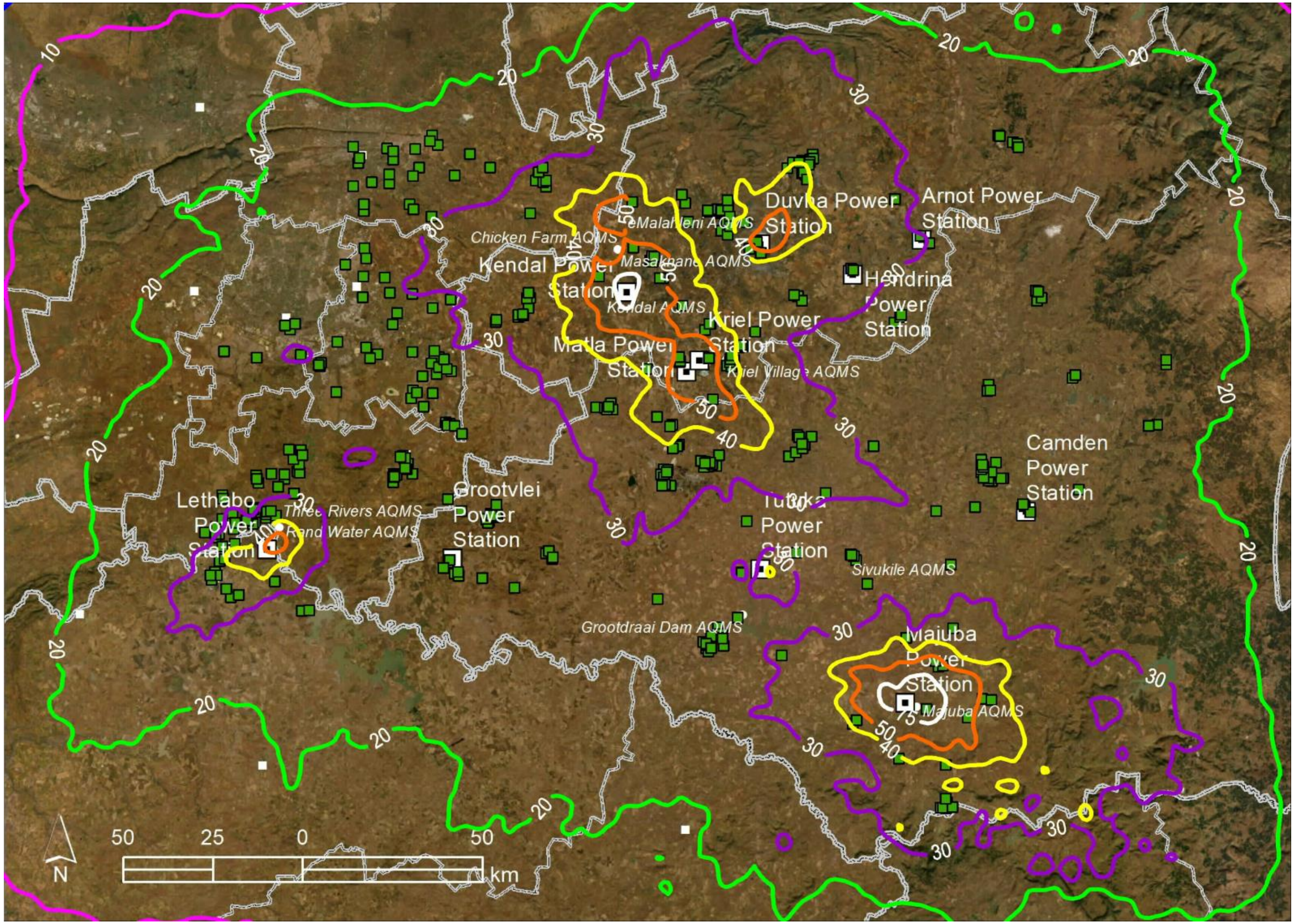


Figure 6-9: Predicted 99th percentile 24-hour SO_2 concentrations in µg/m^3 for Scenario B (2031) (NAAQS Limit is 125 µg/m^3)

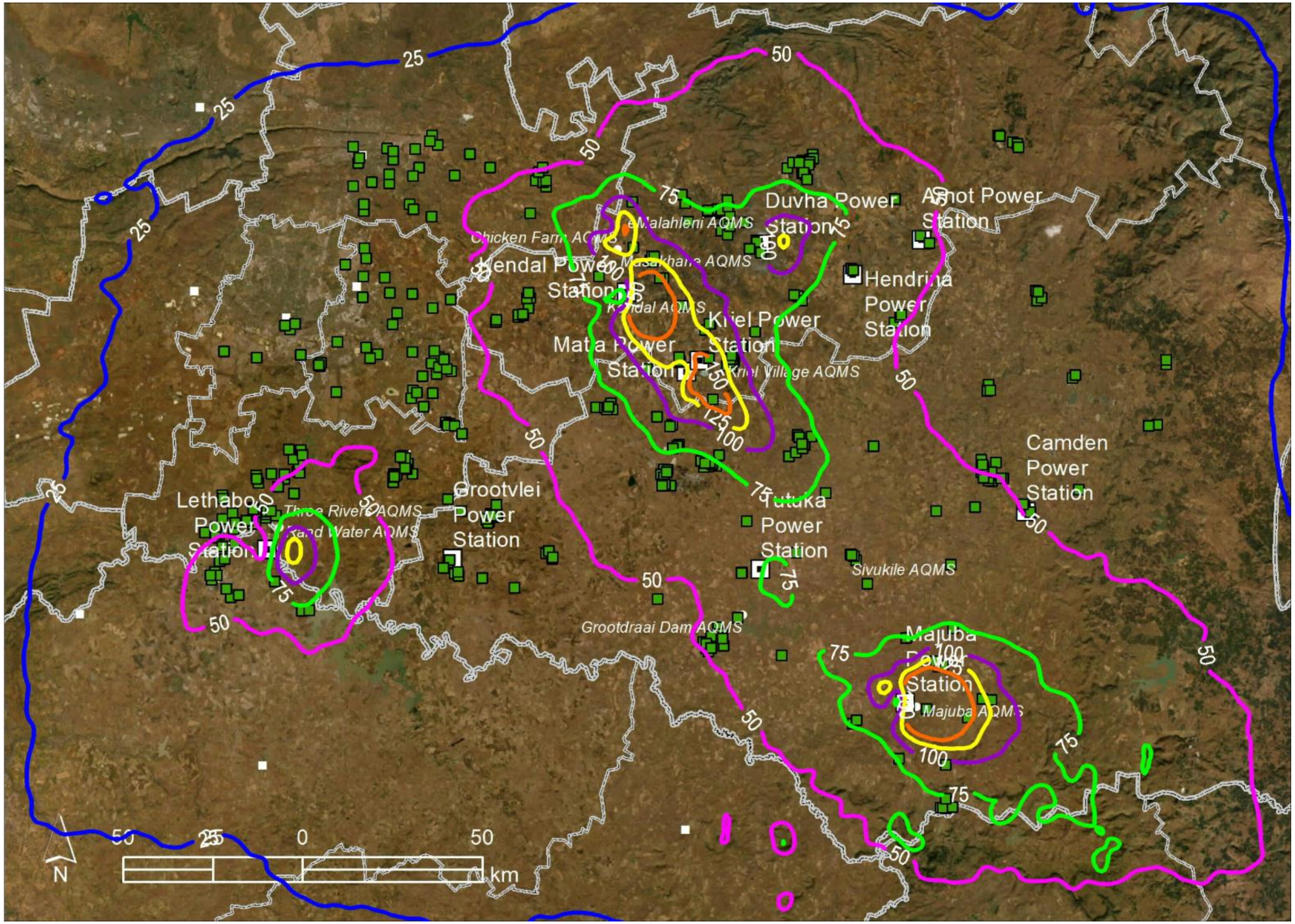


Figure 6-10: Predicted 99th percentile 1-hour SO_2 concentrations in µg/m³ for Scenario B (2031) (NAAQS Limit is 350 µg/m³)

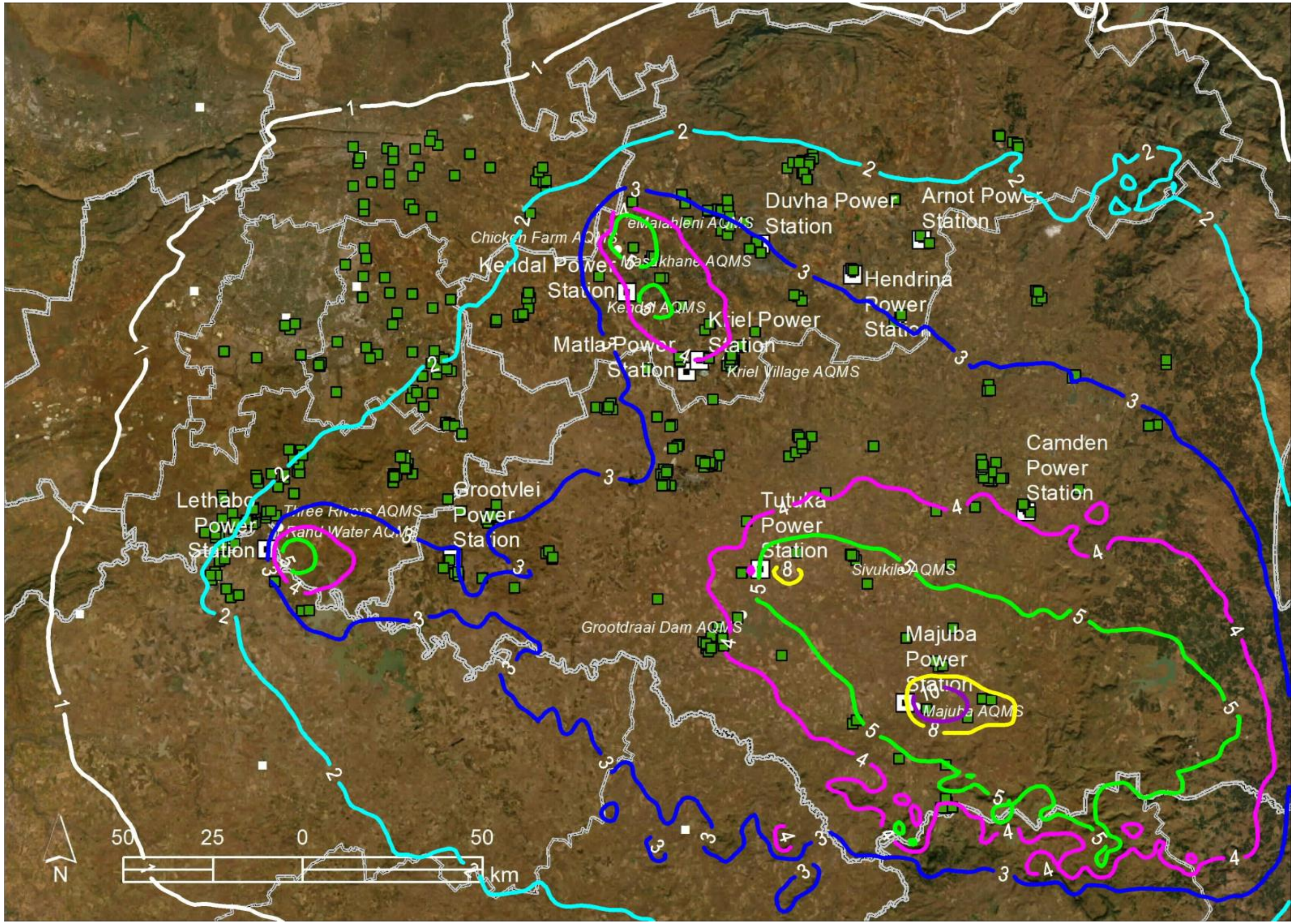


Figure 6-11: Predicted annual average SO_2 concentrations in μg/m³ for Scenario C (2036) (NAAQS Limit is 50 μg/m³)

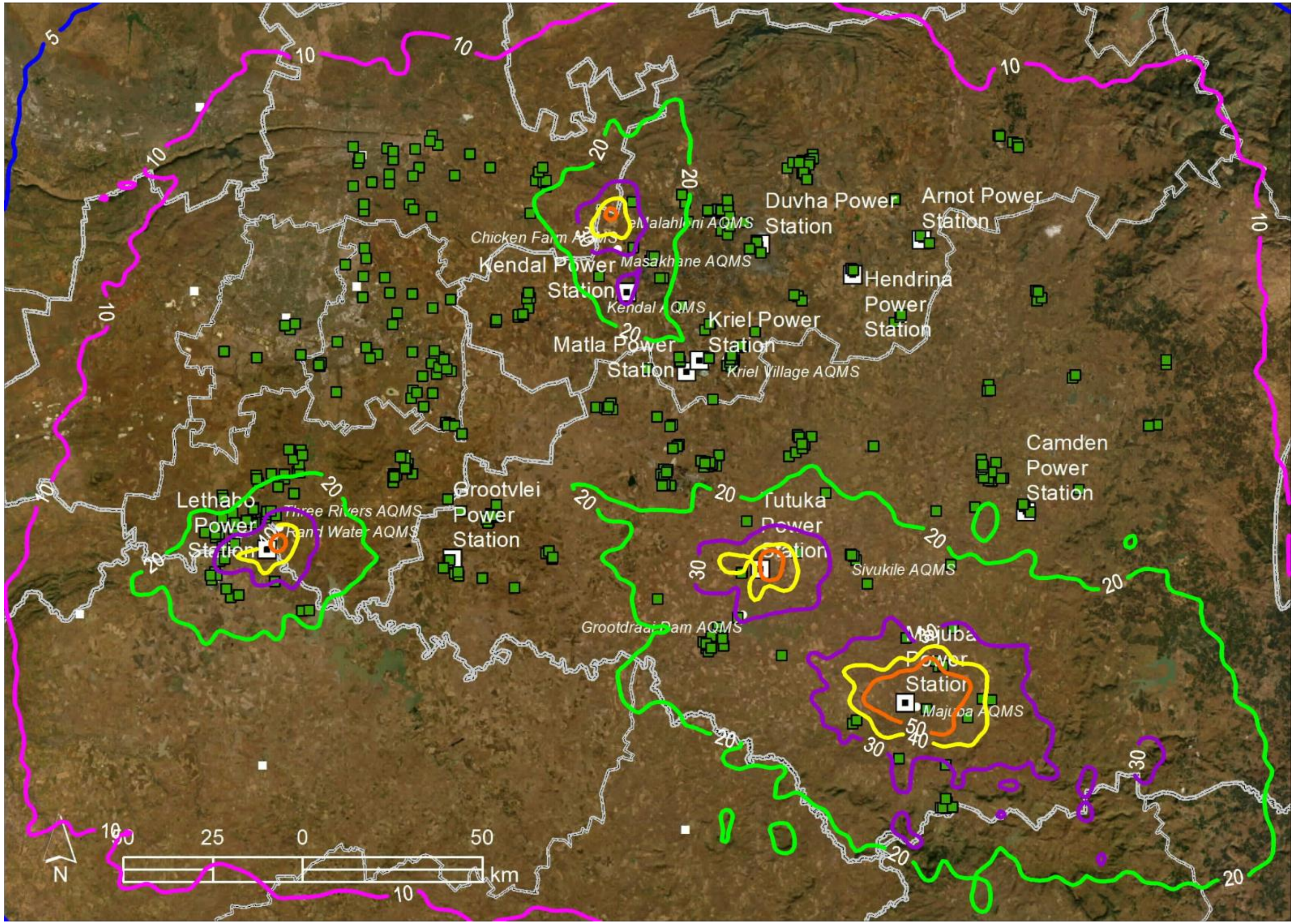


Figure 6-12: Predicted 99th percentile 24-hour SO_2 concentrations in µg/m³ for Scenario C (2036) (NAAQS Limit is 125 µg/m³)

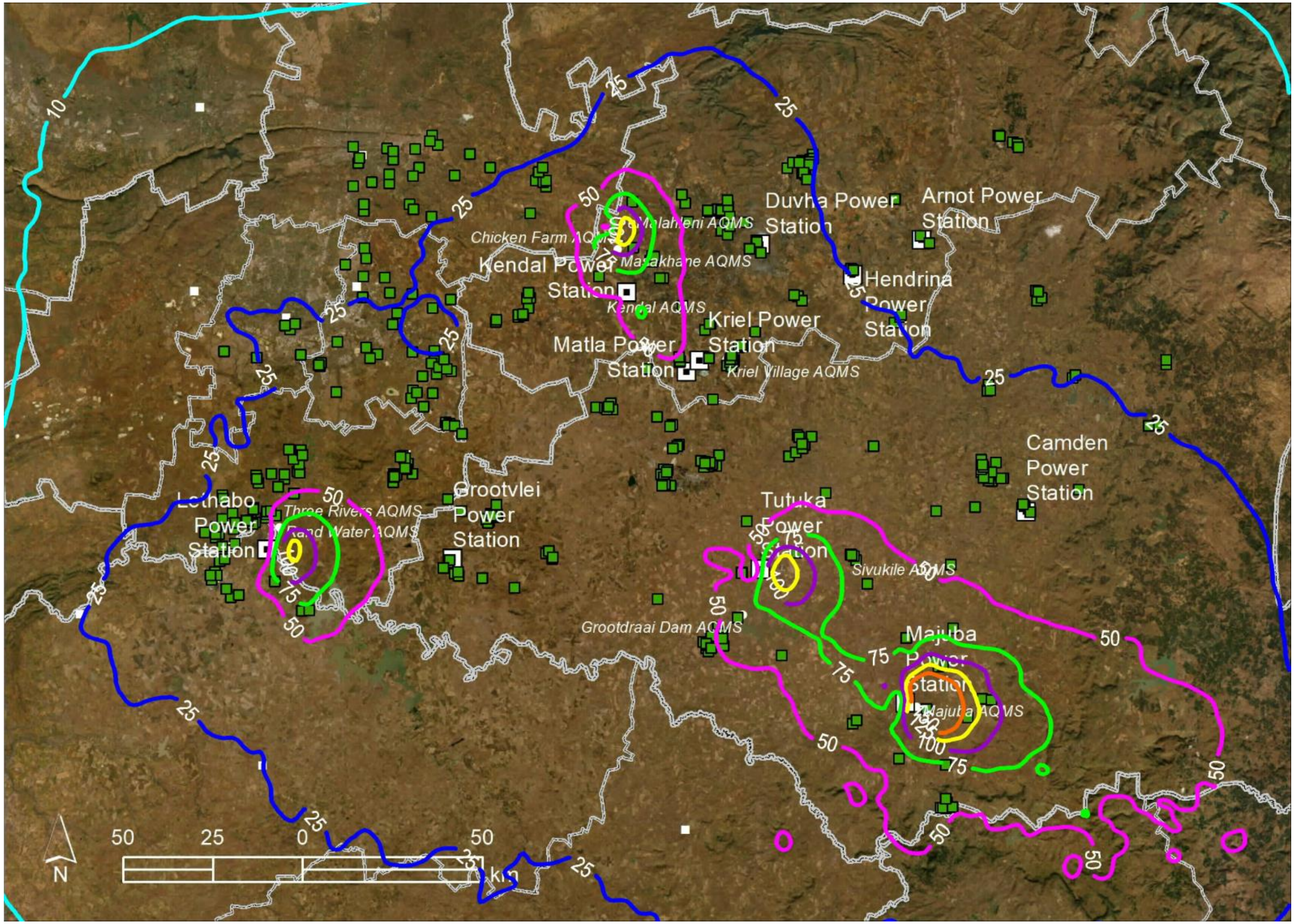


Figure 6-13: Predicted 99th percentile 1-hour SO_2 concentrations in µg/m^3 for Scenario C (2036) (NAAQS Limit is 350 µg/m^3)

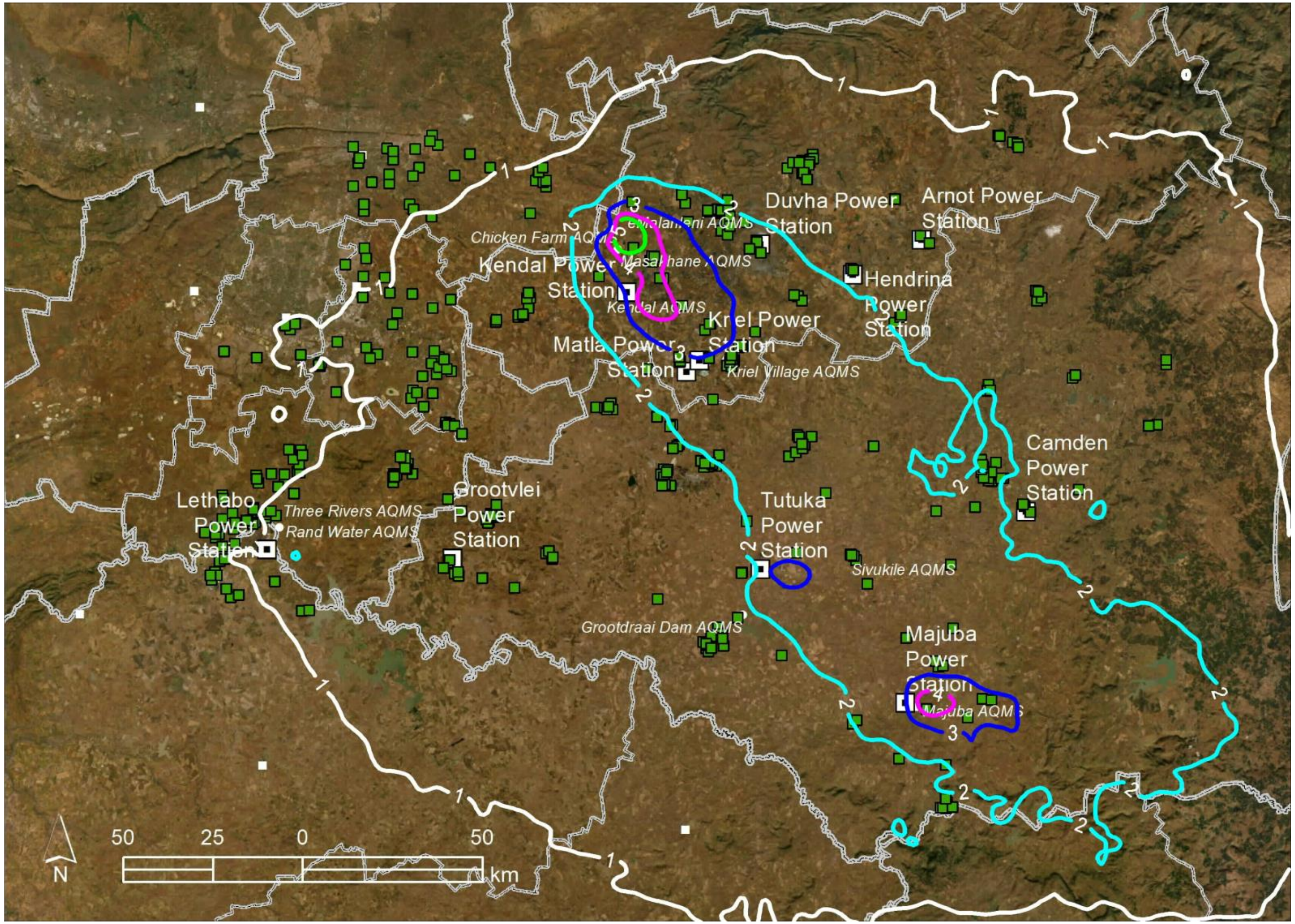


Figure 6-14: Predicted annual average SO_2 concentrations in µg/m^3 for Scenario D (MES) (NAAQS Limit is 50 µg/m^3)

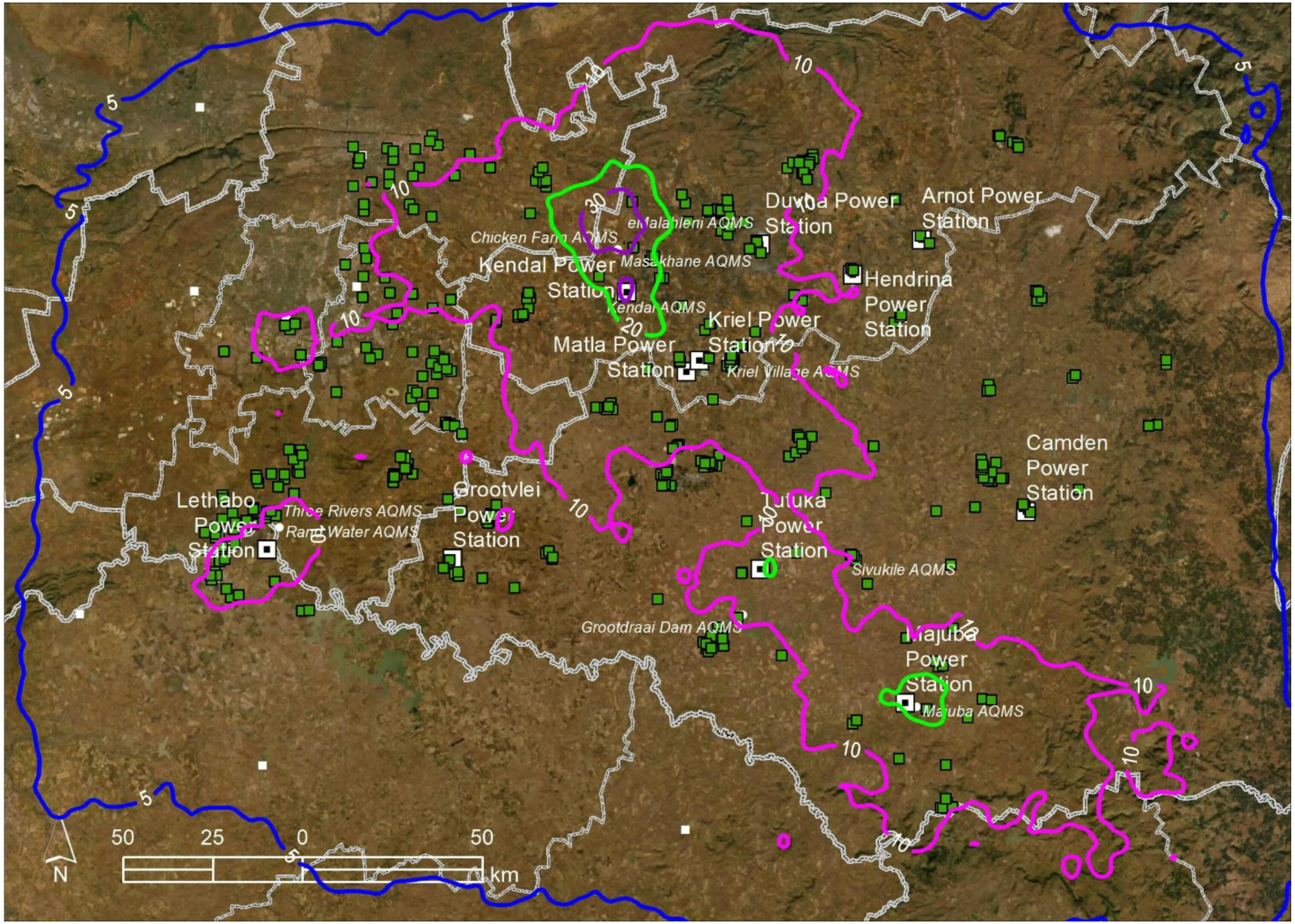


Figure 6-15: Predicted 99th percentile 24-hour SO_2 concentrations in µg/m³ for Scenario D (MES) (NAAQS Limit is 125 µg/m³)

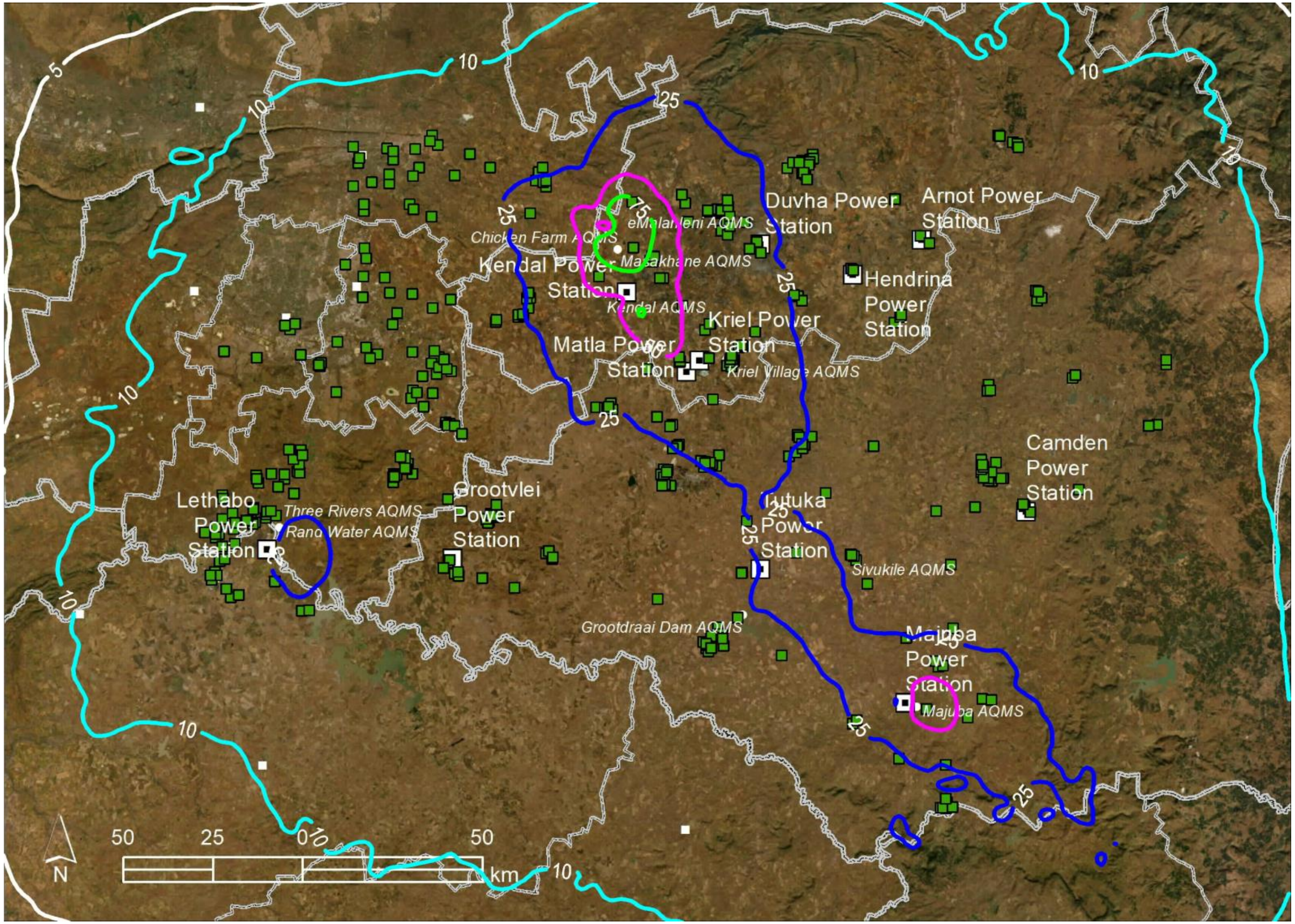


Figure 6-16: Predicted 99th percentile 1-hour SO_2 concentrations in µg/m³ for Scenario D (MES) (NAAQS Limit is 350 µg/m³)

6.2.3.2 Nitrogen dioxide (NO_2)

The isopleth maps showing the predicted annual average NO_2 concentrations clearly demonstrate the effect of the predominant northwesterly winds, with dispersion generally to the southeast across the Highveld and Vaal modelling domain. In all scenarios the highest predicted annual average concentrations occur in a band from the power stations on the central highveld in a southeasterly direction towards Majuba. The predicted annual ambient concentrations are relatively low and are below the NAAQS in all scenarios throughout the modelling domain. Noteworthy is the consistent decrease in predicted ambient concentration with progressive scenarios and the systematic reduction in total NO_X emissions (see in Figure 4-1).

For the 1-hour averaging period, the highest predicted concentrations occur in Scenario A (2025) on the central Highveld where several power stations are relatively close together, then around Lethabo in the southwest, around Majuba in the southeast and around Camden in the east. The effect of the shutdown of Arnot, Camden, Hendrina, Grootvlei, Kriel by 2031 is evident in the isopleth plots for Scenario B (2031) by a marked decrease in the predicted ambient concentrations, with a further reduction in Scenario C (2036).

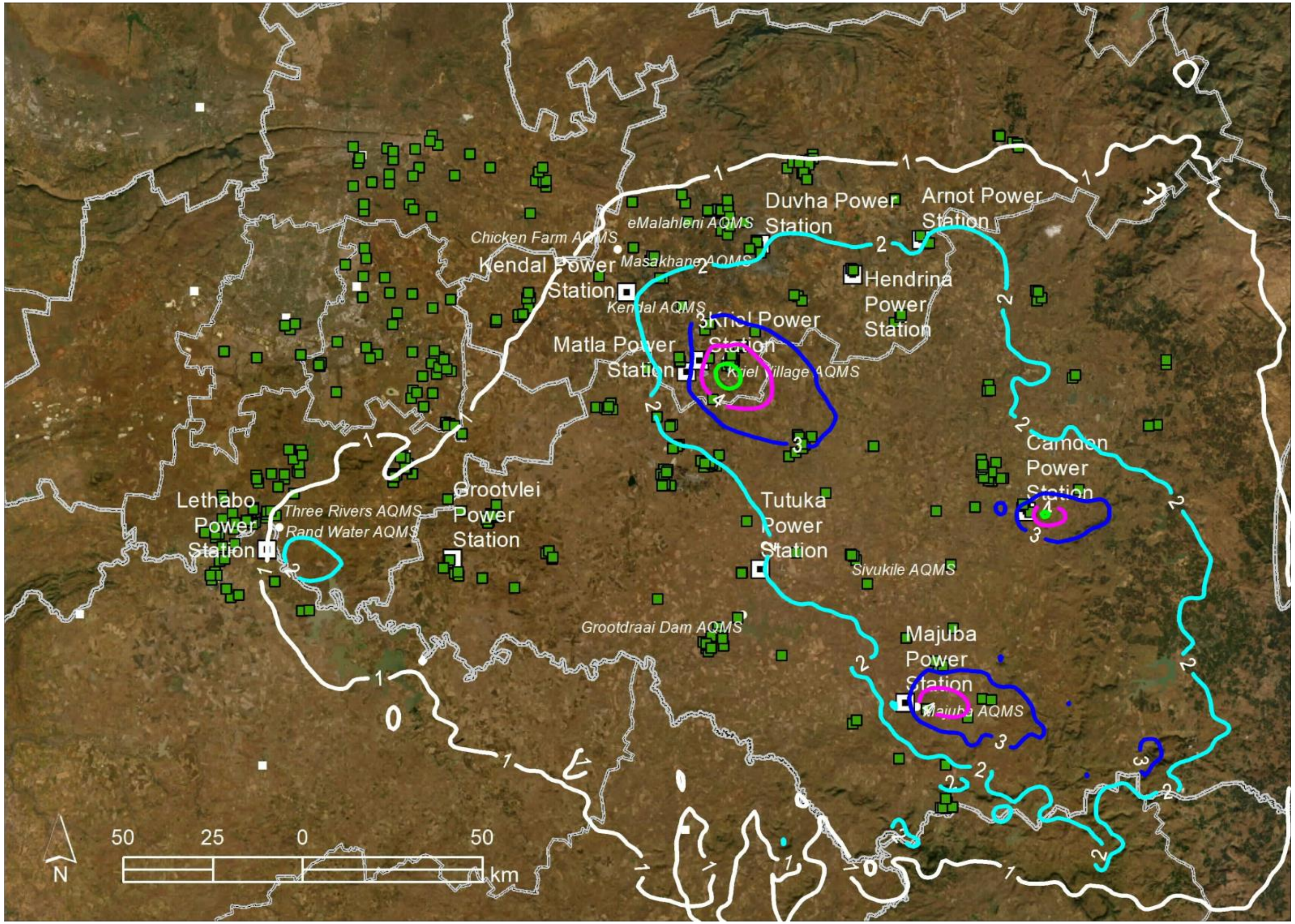


Figure 6-17: Predicted annual average NO_2 concentrations in µg/m^3 for Scenario 1 (Current) (NAAQS Limit is 40 µg/m^3)

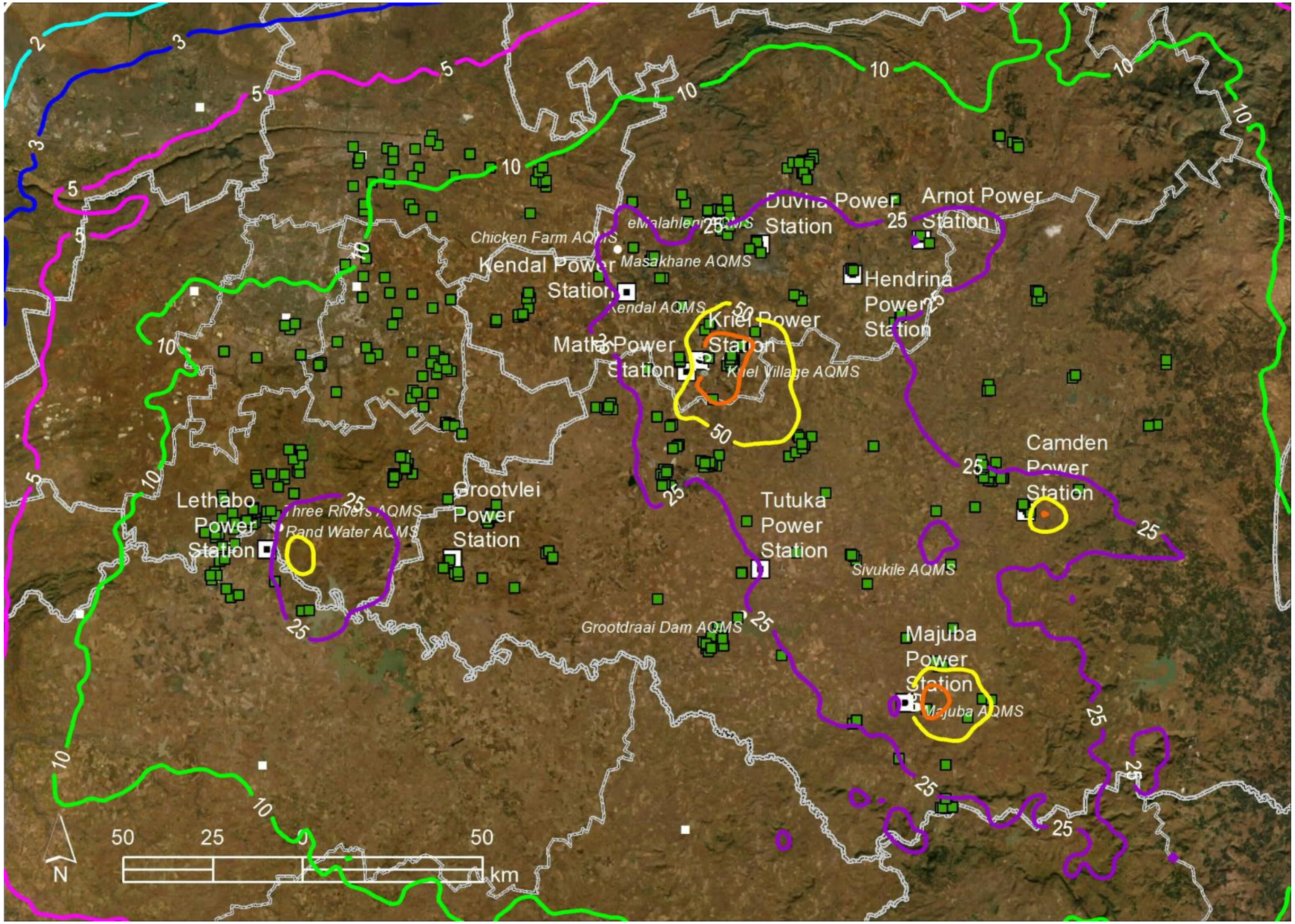


Figure 6-18: Predicted 99th percentile 1-hour NO_2 concentrations in µg/m³ for Scenario 1 (Current) (NAAQS Limit is 200 µg/m³)

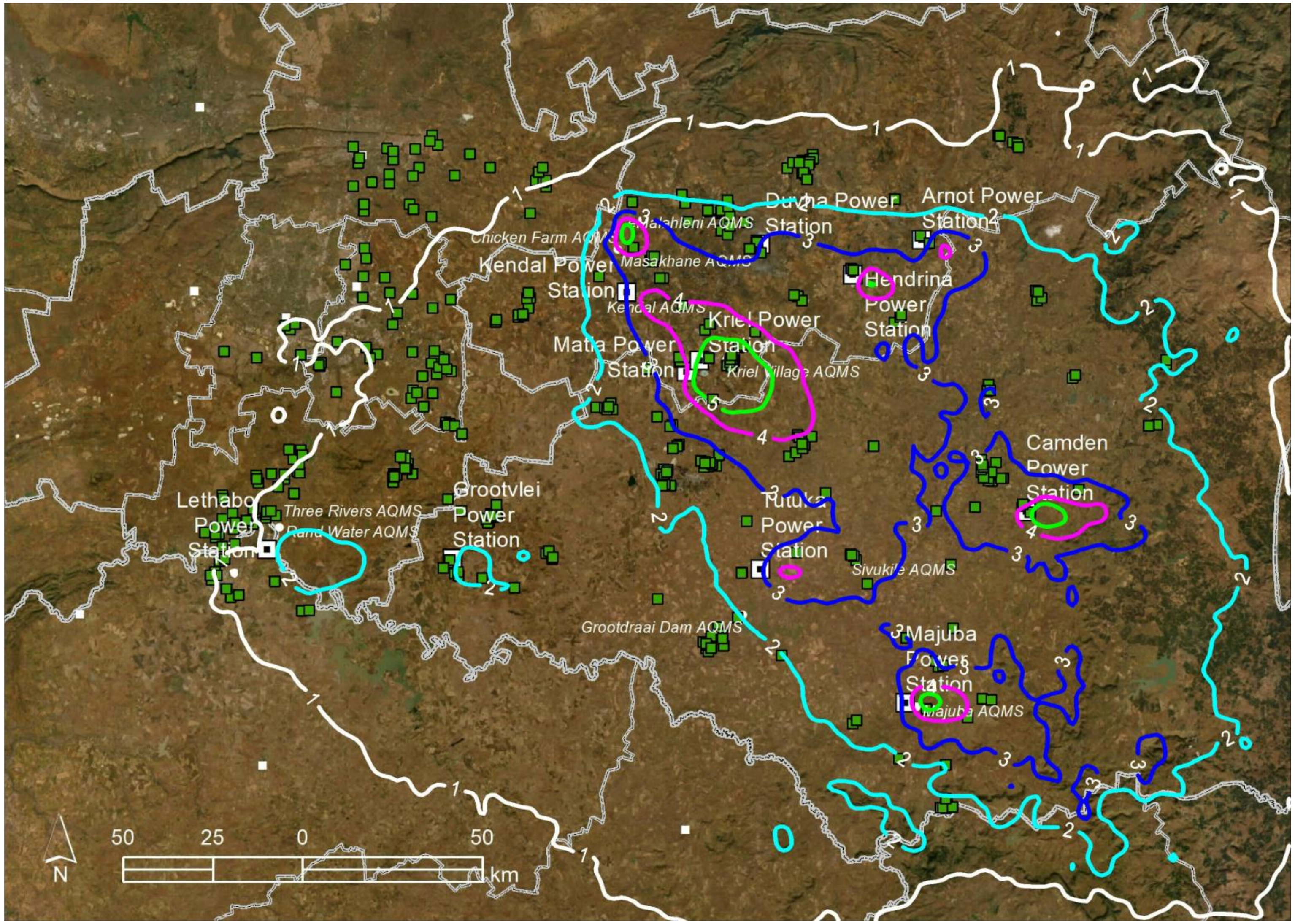


Figure 6-19: Predicted annual average NO_2 concentrations in µg/m³ for Scenario A (2025) (NAAQS Limit is 40 µg/m³)

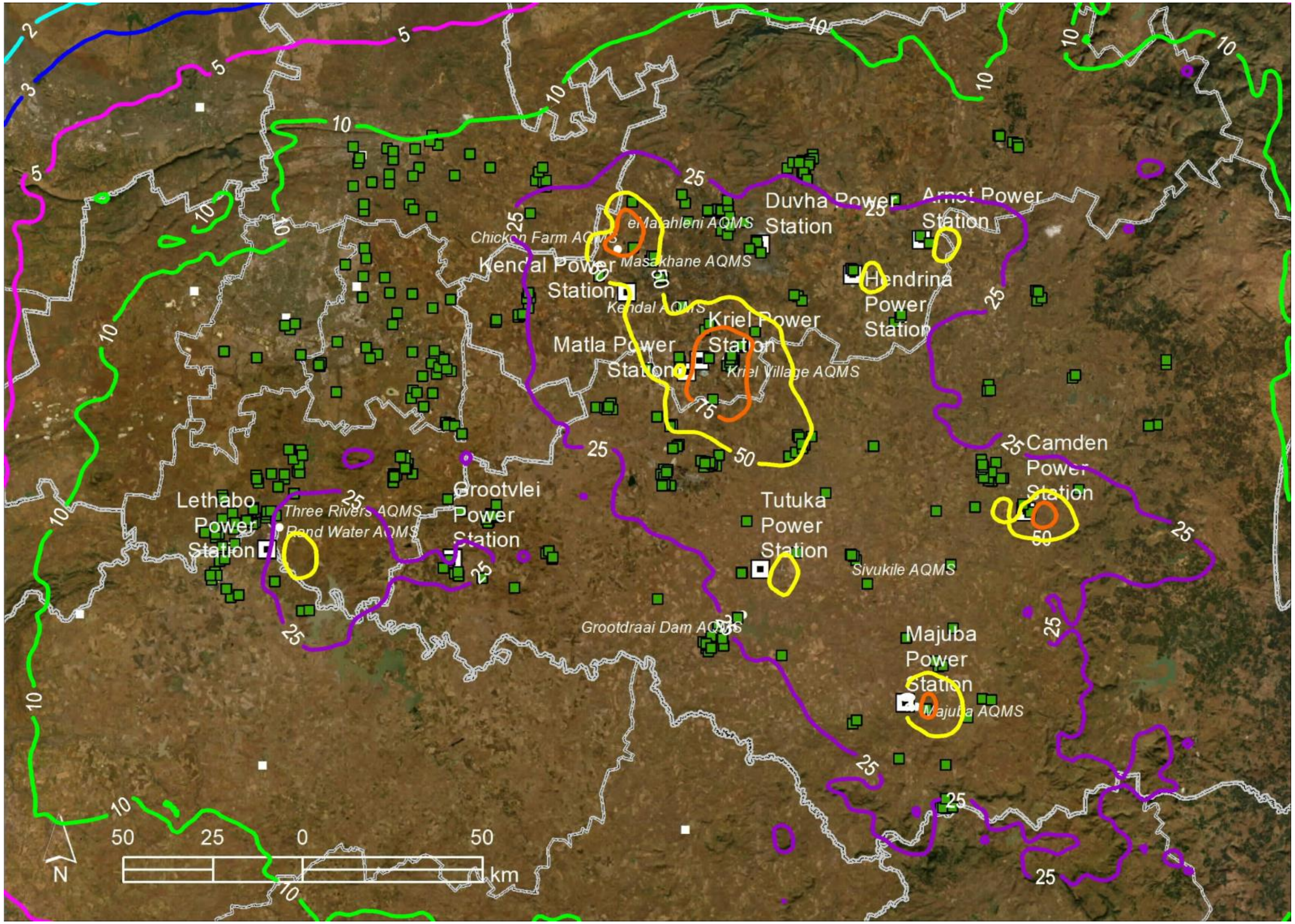


Figure 6-20: Predicted 99th percentile 1-hour NO_2 concentrations in µg/m³ for Scenario A (2025) (NAAQS Limit is 200 µg/m³)

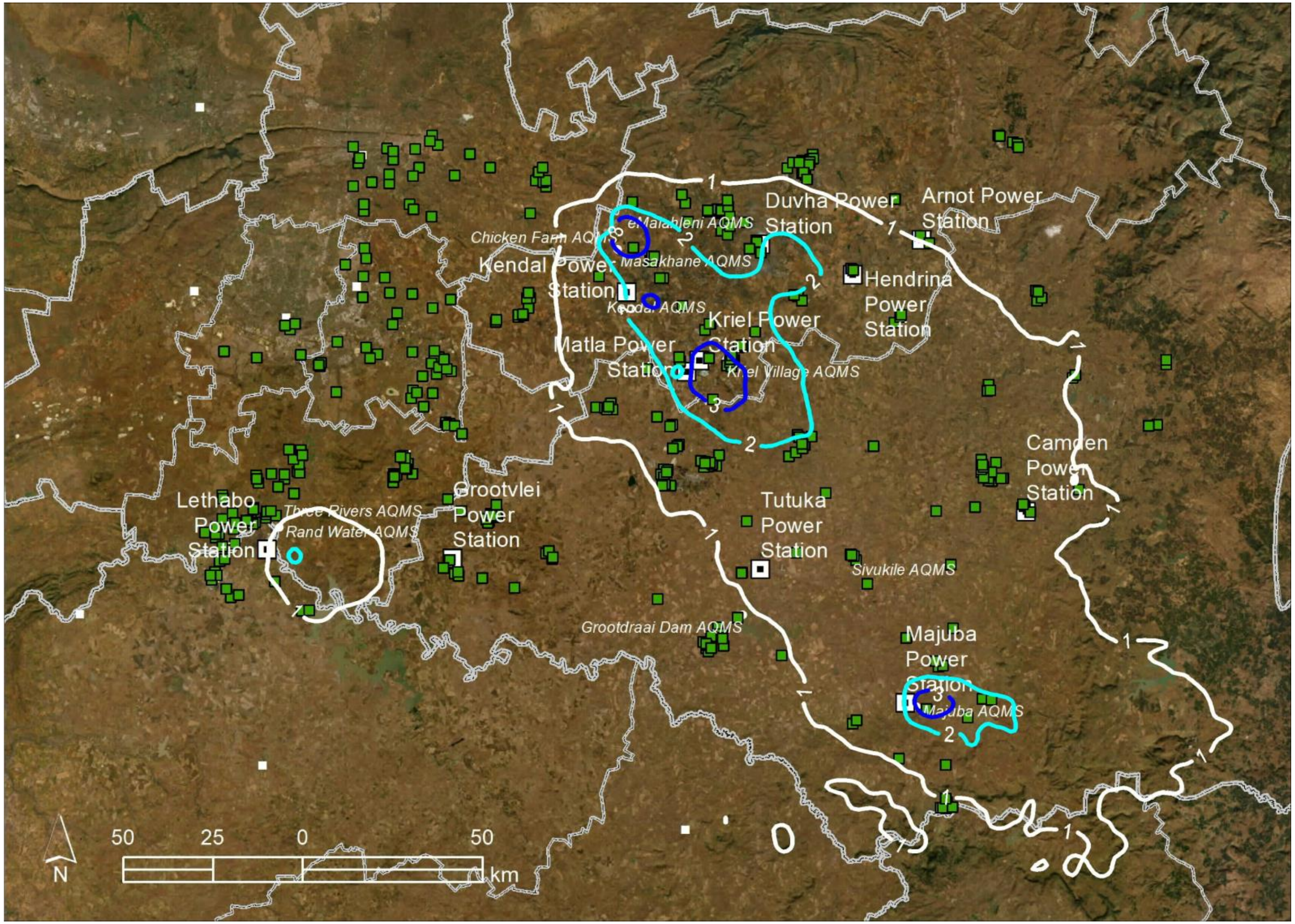


Figure 6-21: Predicted annual average NO_2 concentrations in µg/m³ for Scenario B (2031) (NAAQS Limit is 40 µg/m³)

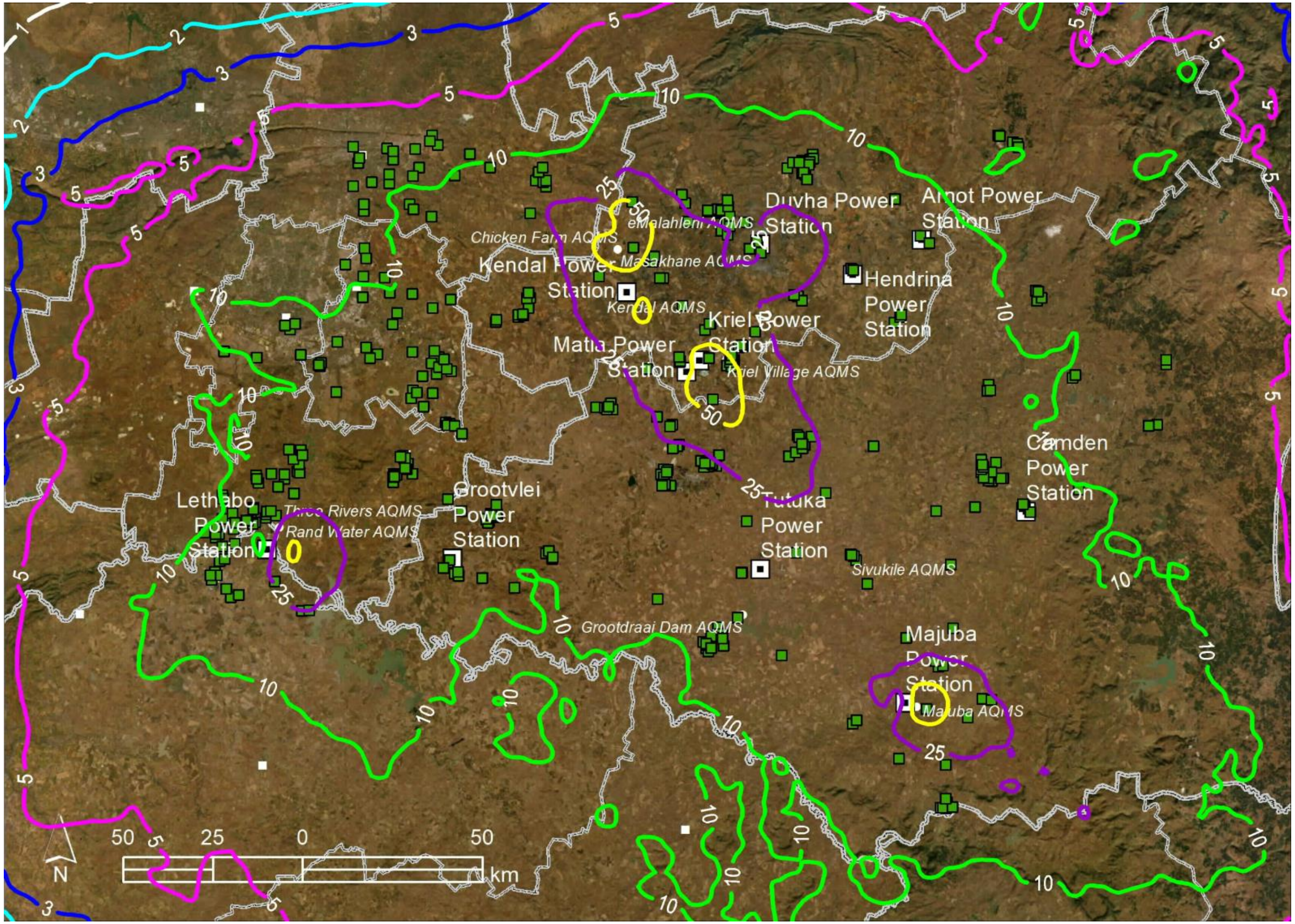


Figure 6-22: Predicted 99th percentile 1-hour NO_2 concentrations in µg/m³ for Scenario B (2031) (NAAQS Limit is 200 µg/m³)

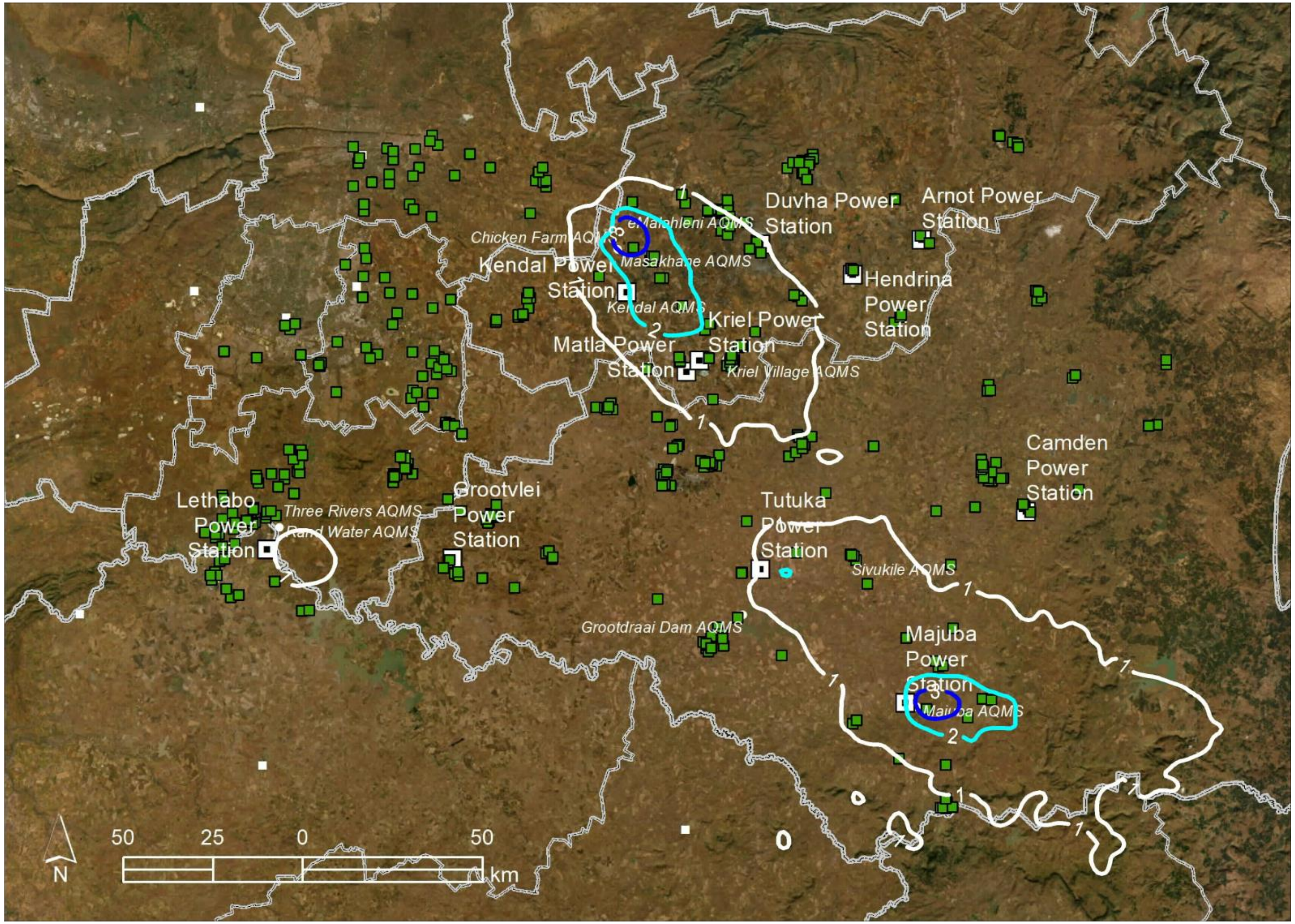


Figure 6-23: Predicted annual average NO_2 concentrations in µg/m³ for Scenario C (2036) (NAAQS Limit is 40 µg/m³)

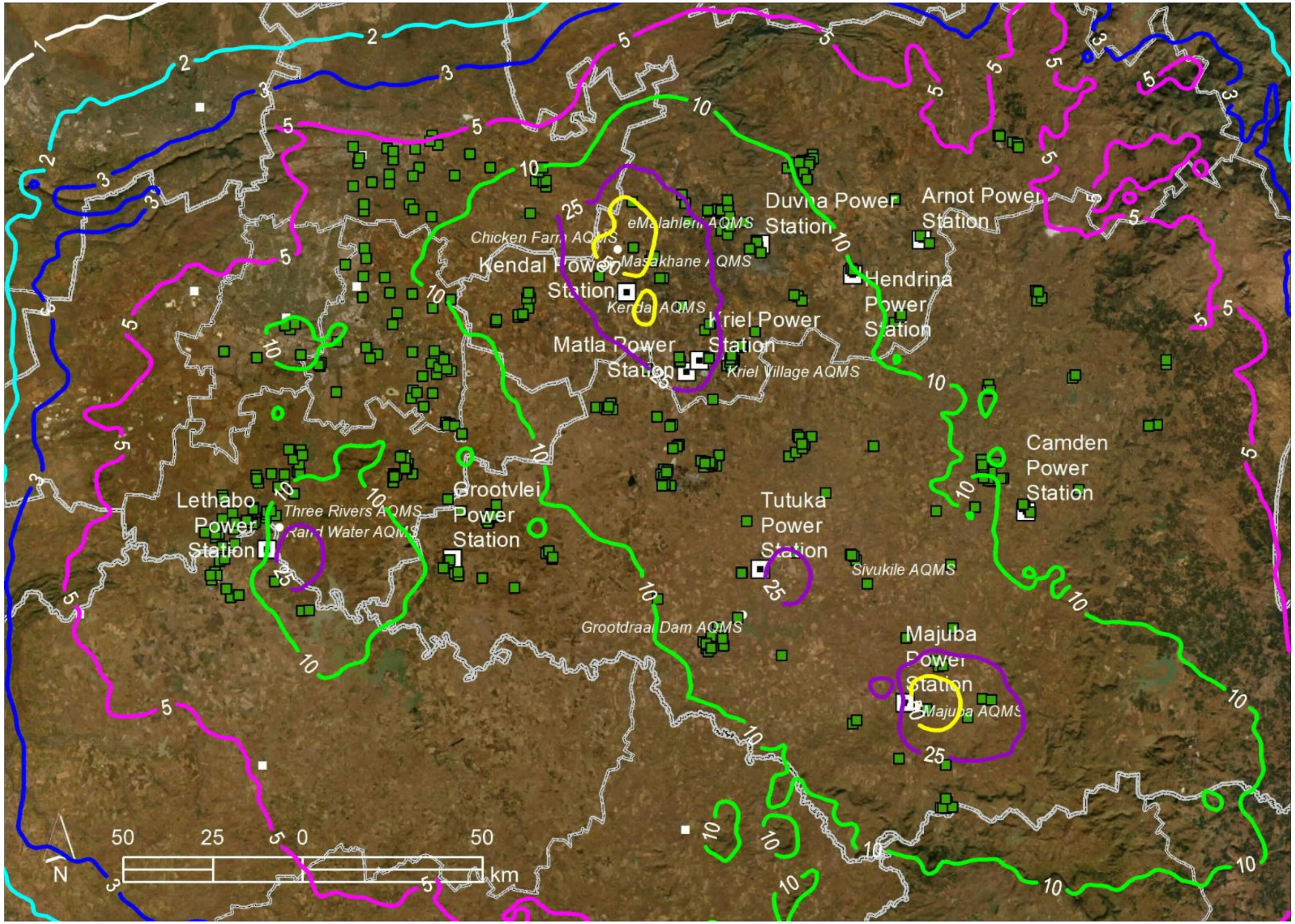


Figure 6-24: Predicted 99th percentile 1-hour NO_2 concentrations in µg/m³ for Scenario C (2036) (NAAQS Limit is 200 µg/m³)

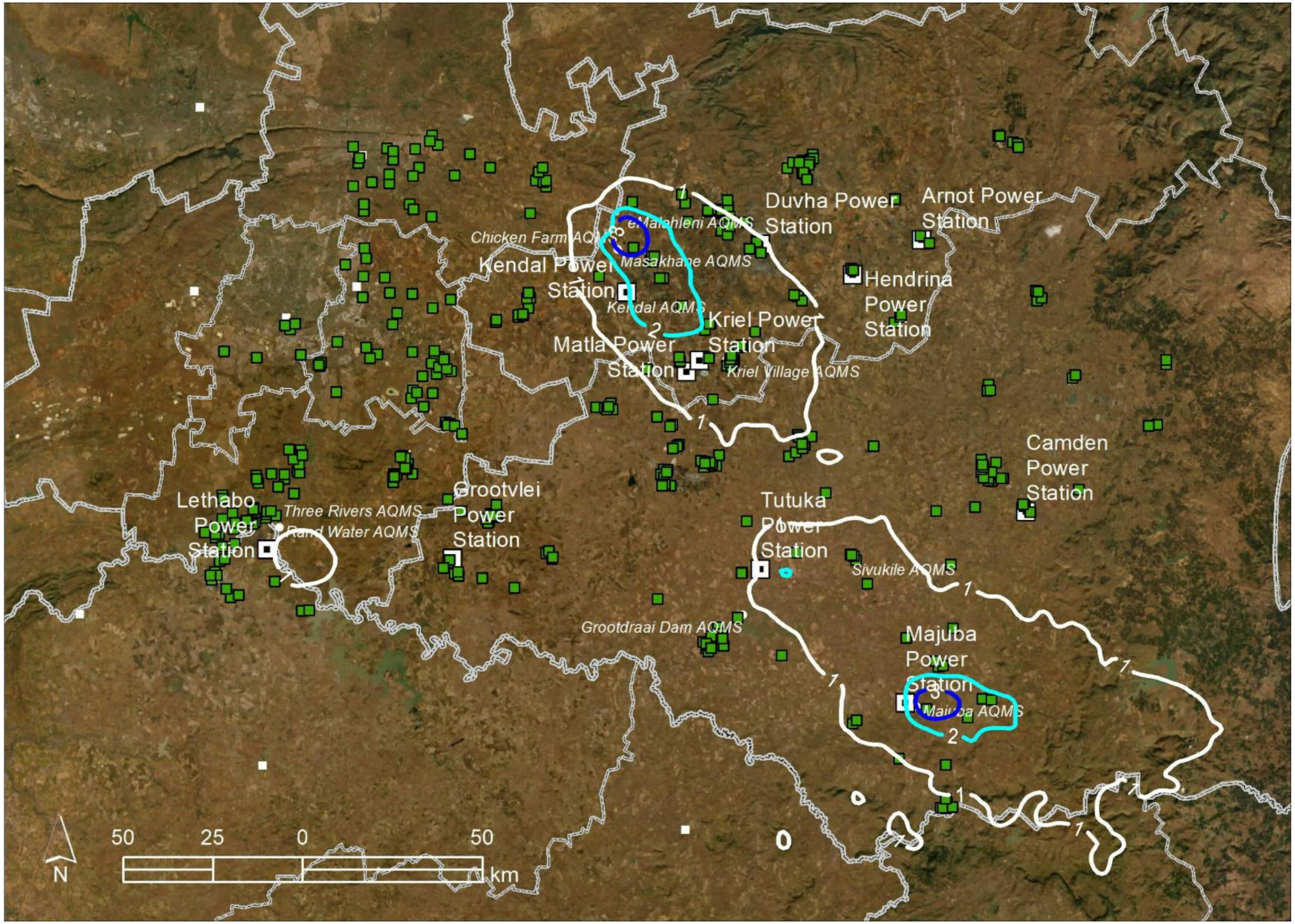


Figure 6-25: Predicted annual average NO_2 concentrations in µg/m³ for Scenario D (MES) (NAAQS Limit is 40 µg/m³)

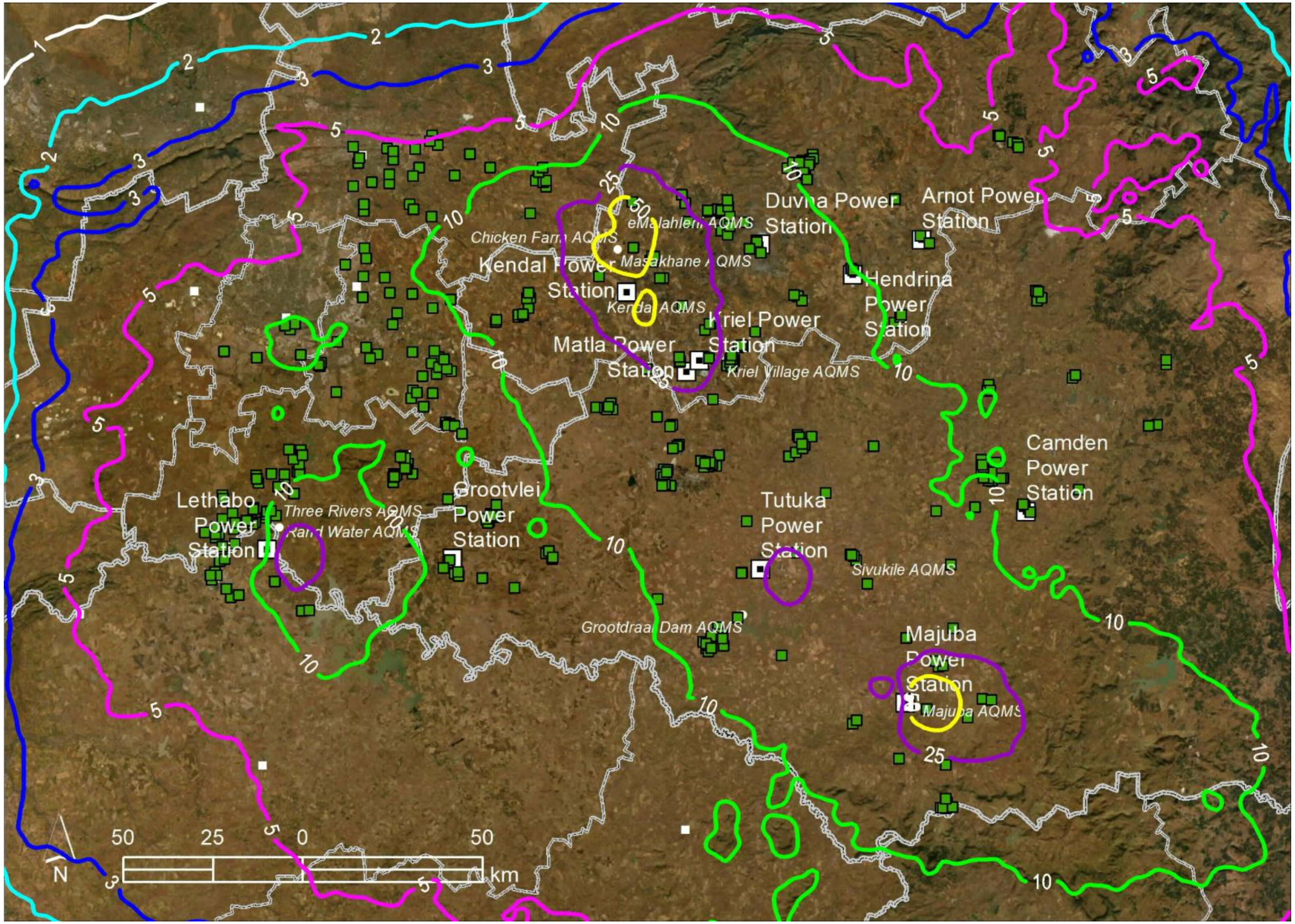


Figure 6-26: Predicted 99th percentile 1-hour NO_2 concentrations in µg/m³ for Scenario D (MES) (NAAQS Limit is 200 µg/m³)

6.2.3.3 Particulates (PM_{10})

The isopleth plots for PM_{10} are similar for all the scenarios due to the significant contribution of the low-level fugitive sources to the ambient concentrations. The fugitive emission from the coal yards and the ash dumps impact on ambient concentrations close to the source, resulting in the highest concentrations around the individual power stations. Noticeable is the effect of the shutdown of Arnot, Camden, Hendrina, Grootvlei, Kriel by 2031 on the isopleths for Scenario B (2031).

The predicted annual average concentrations exceed the NAAQS of 40 μg/m^3 in two small area on the central Highveld in Scenario 1 (Current), Scenario A (2025) and Scenario B (2031), with reductions seen in the subsequent scenarios as a result of the shutdowns. The biggest reductions are seen from Scenario A (2025) to Scenario B (2031) which considers station shutdowns, as well as completion of PM abatement projects.

The area where the predicted 24-hour concentrations exceed the limit value of 75 μg/m^3 (shaded area) is evident around all the power stations in Scenario 1 (Current) and Scenario A (2025) and Scenario B (2031) followed by a reduction in Scenario C (2036). A number of sensitive receptors are located in the areas where the NAAQS are exceeded.

It must be remembered that the predictions are conservative given the assumption that TPM = PM_{10} = $PM_{2.5}$. Remembering too that the fugitive emission have the greatest effect on ambient concentrations close to the source as a result of assumptions concerning the ash dump emissions (Section 2.6), while the effect of the stack emissions is generally further from the power station.

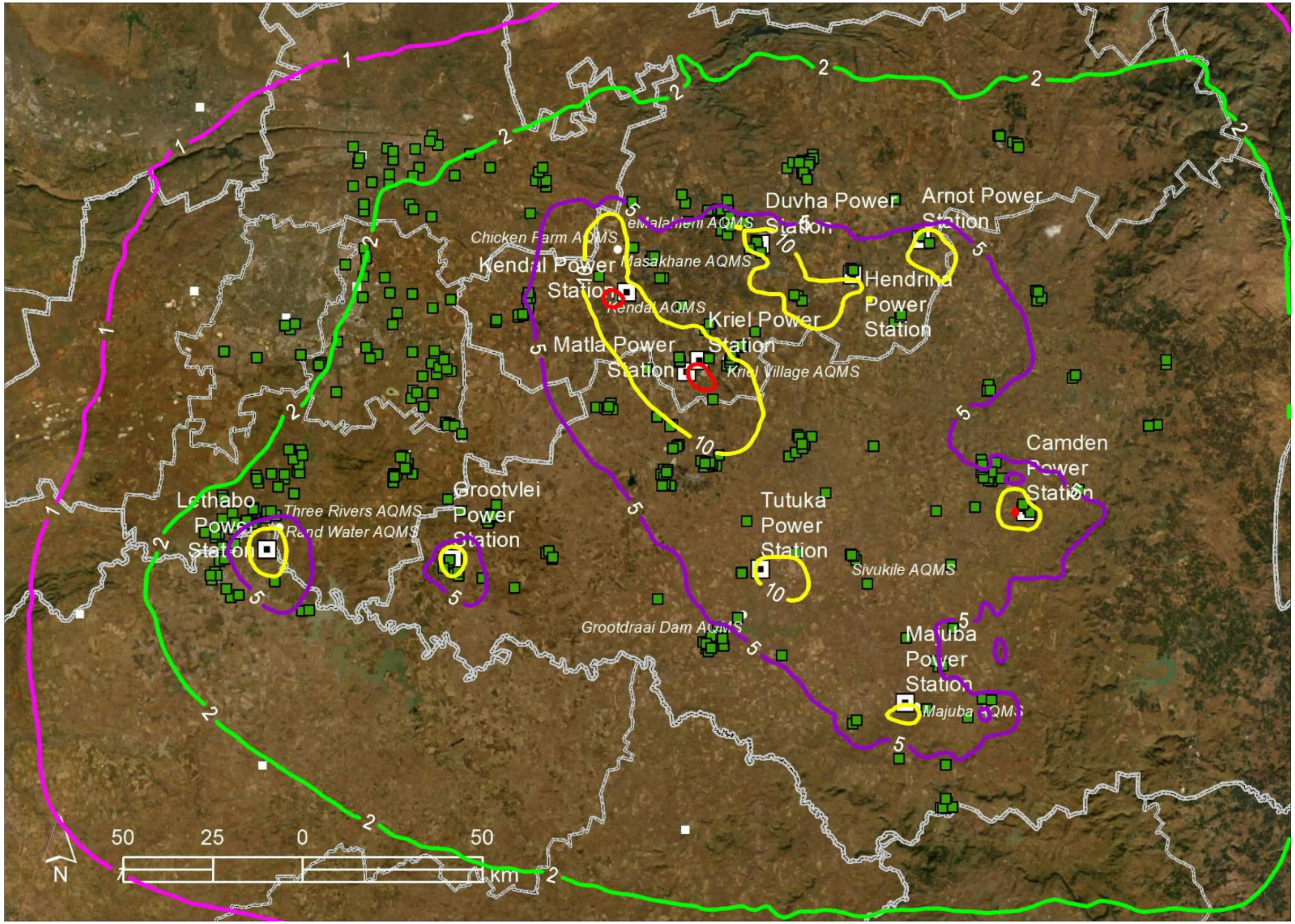


Figure 6-27: Predicted annual average PM_{10} concentrations in µg/m³ for Scenario 1 (Current) (NAAQS Limit is 40 µg/m³)

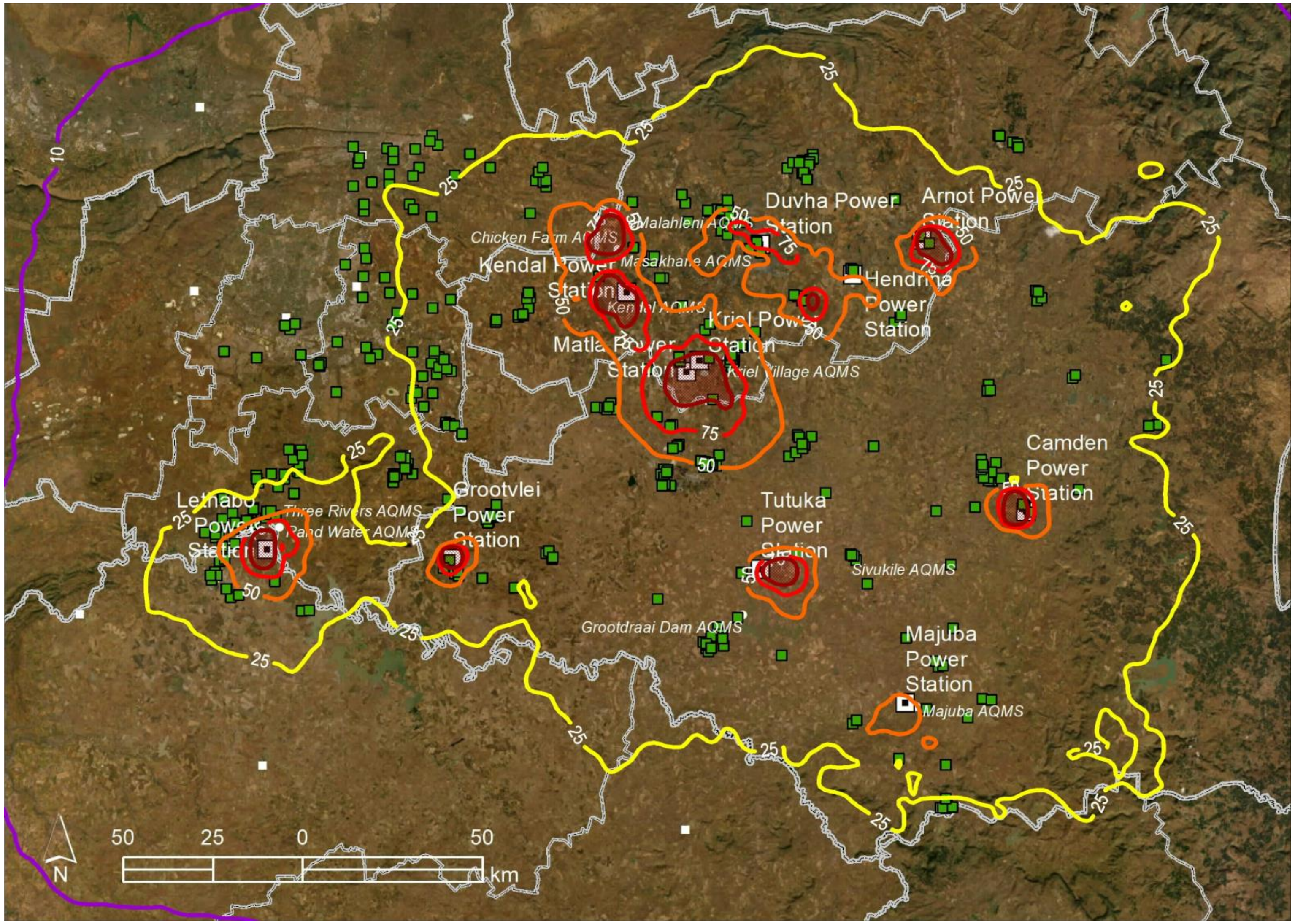


Figure 6-28: Predicted 99th percentile of the 24-hour PM_{10} concentrations in µg/m³ for Scenario 1 (Current) (NAAQS Limit is 75 µg/m³)

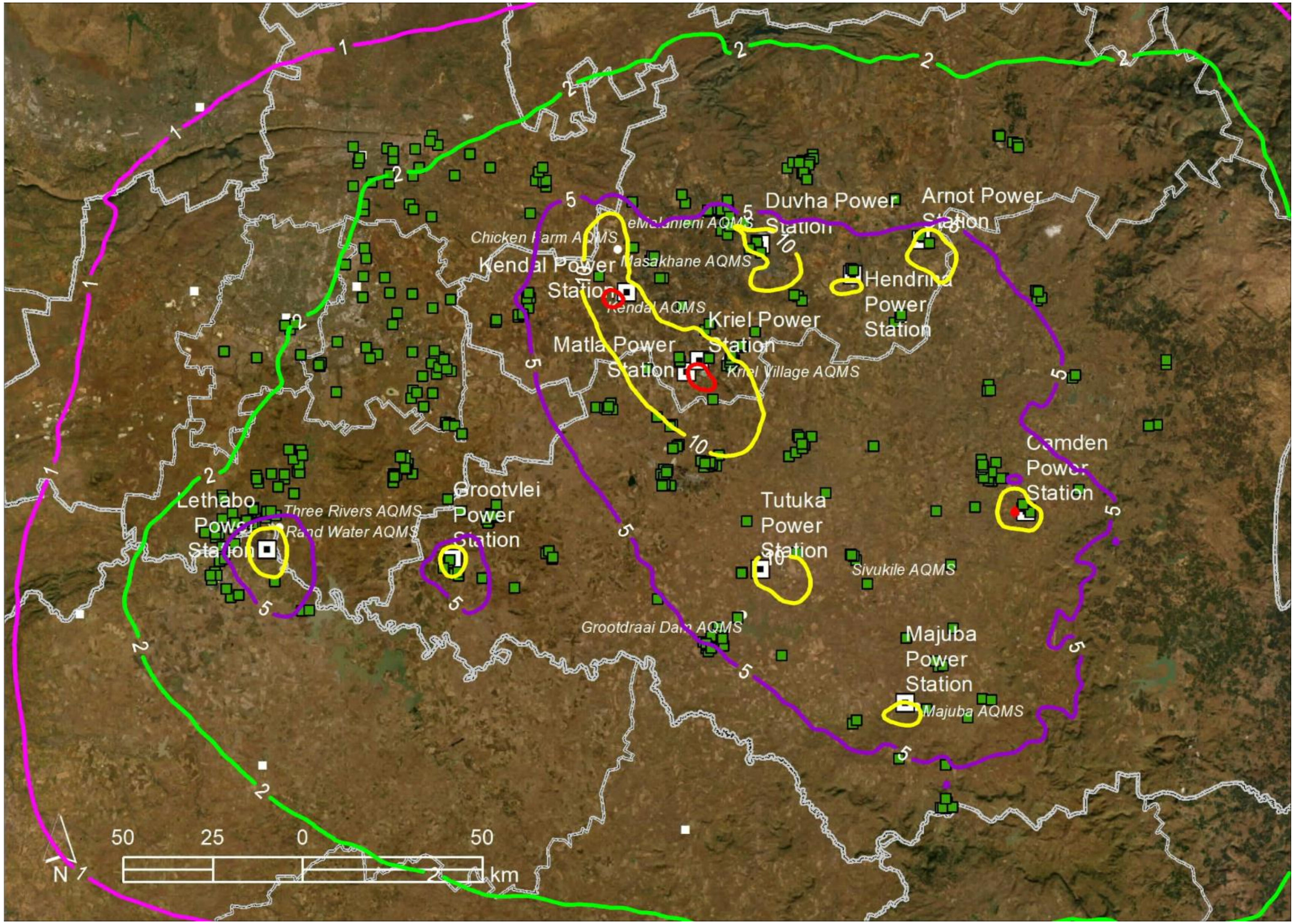


Figure 6-29: Predicted annual average PM_{10} concentrations in µg/m^3 for Scenario A (2025) (NAAQS Limit is 40 µg/m^3)

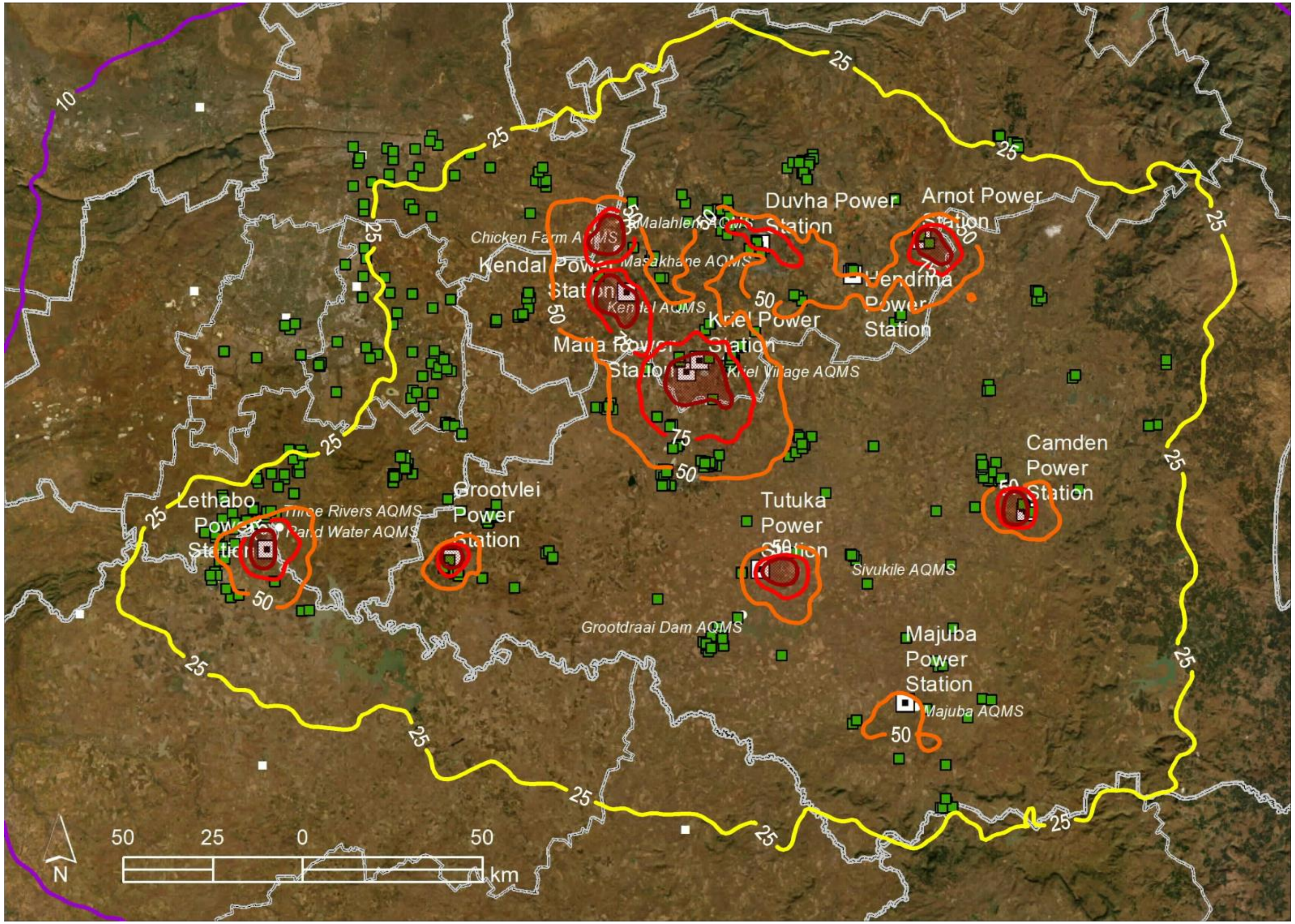


Figure 6-30: Predicted 99th percentile of the 24-hour PM_{10} concentrations in µg/m³ for Scenario A (2025) (NAAQS Limit is 75 µg/m³)

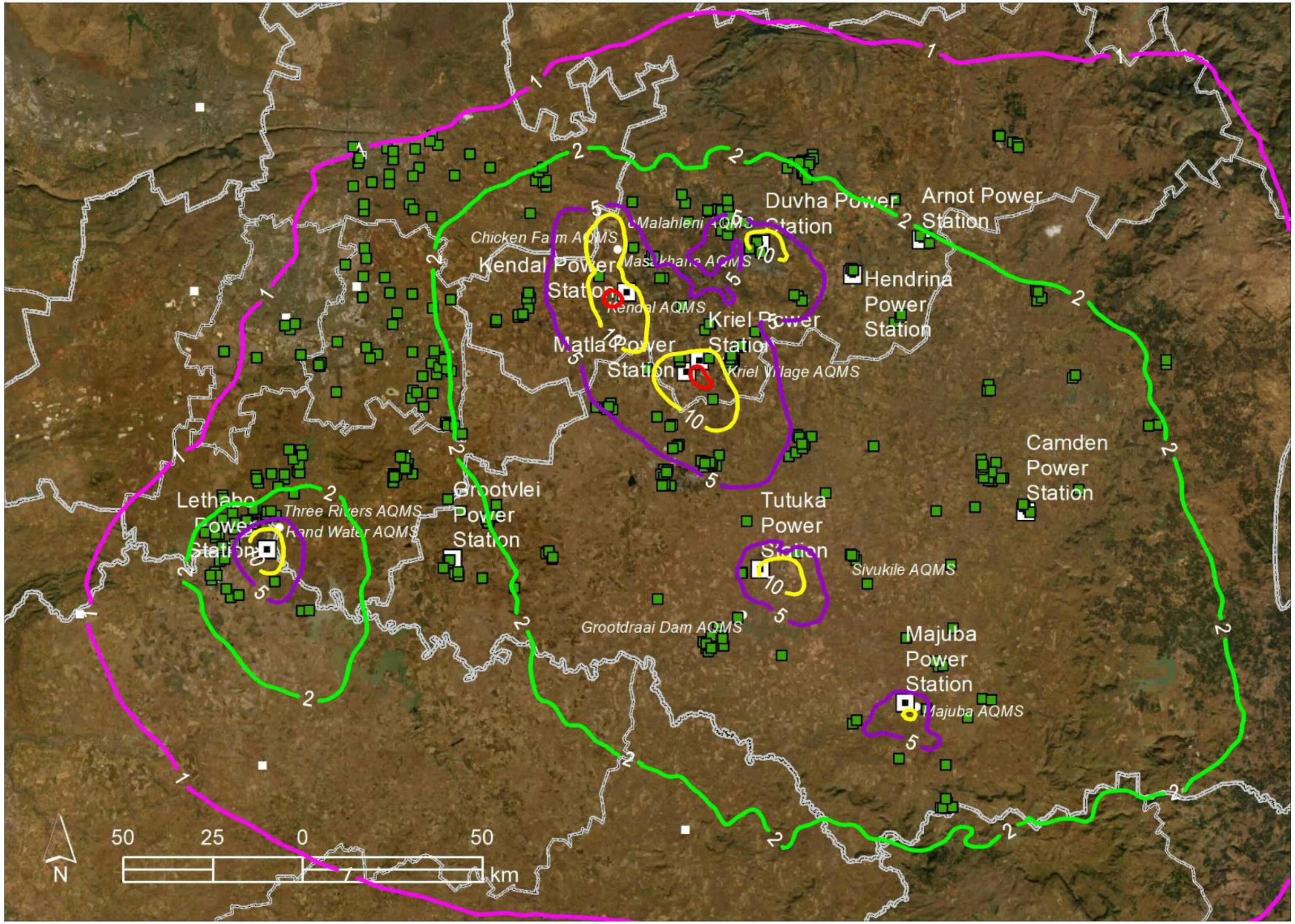


Figure 6-31: Predicted annual average PM_{10} concentrations in µg/m^3 for Scenario B (2031) (NAAQS Limit is 40 µg/m^3)

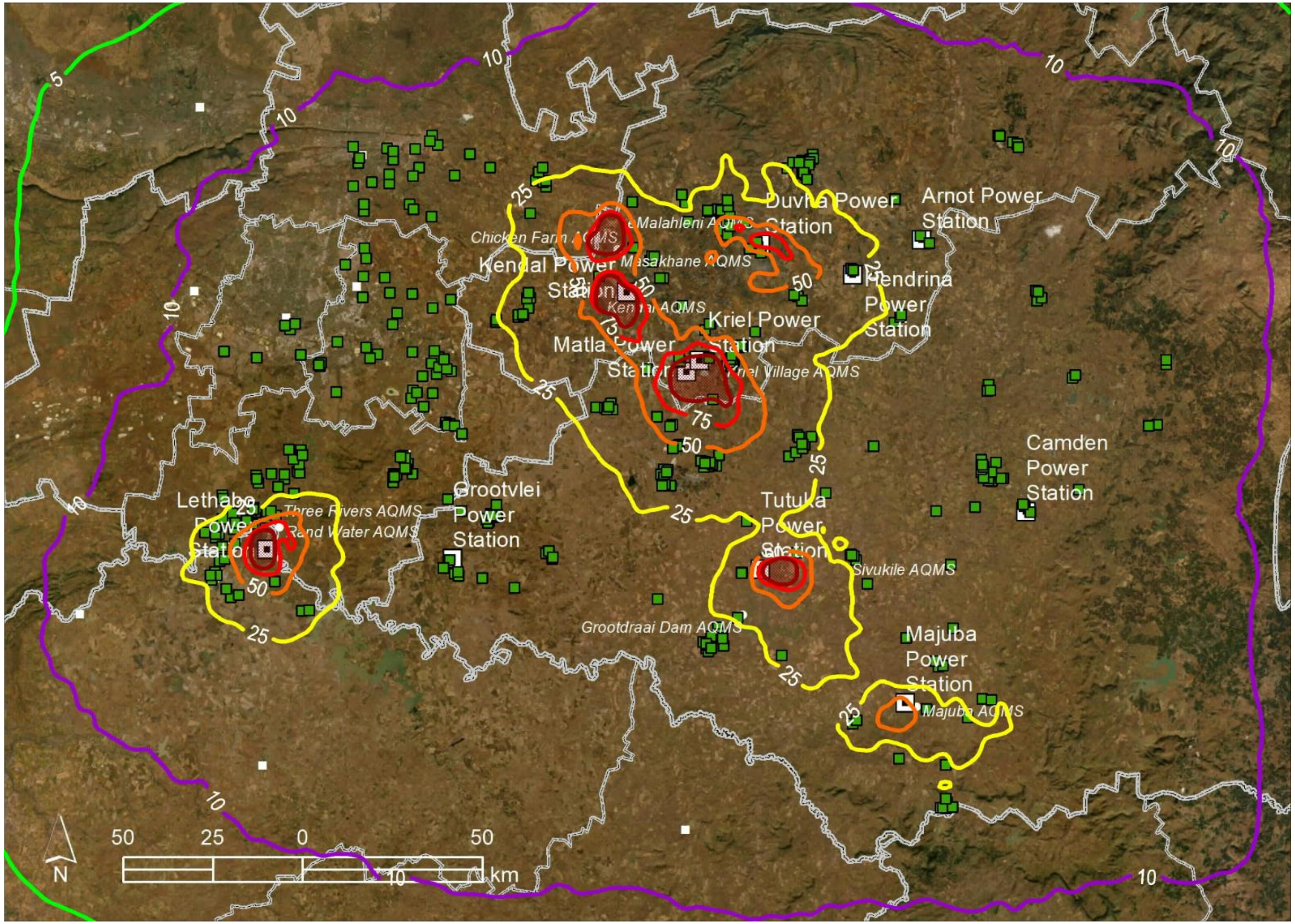


Figure 6-32: Predicted 99th percentile of the 24-hour PM_{10} concentrations in µg/m³ for Scenario B (2031) (NAAQS Limit is 75 µg/m³)

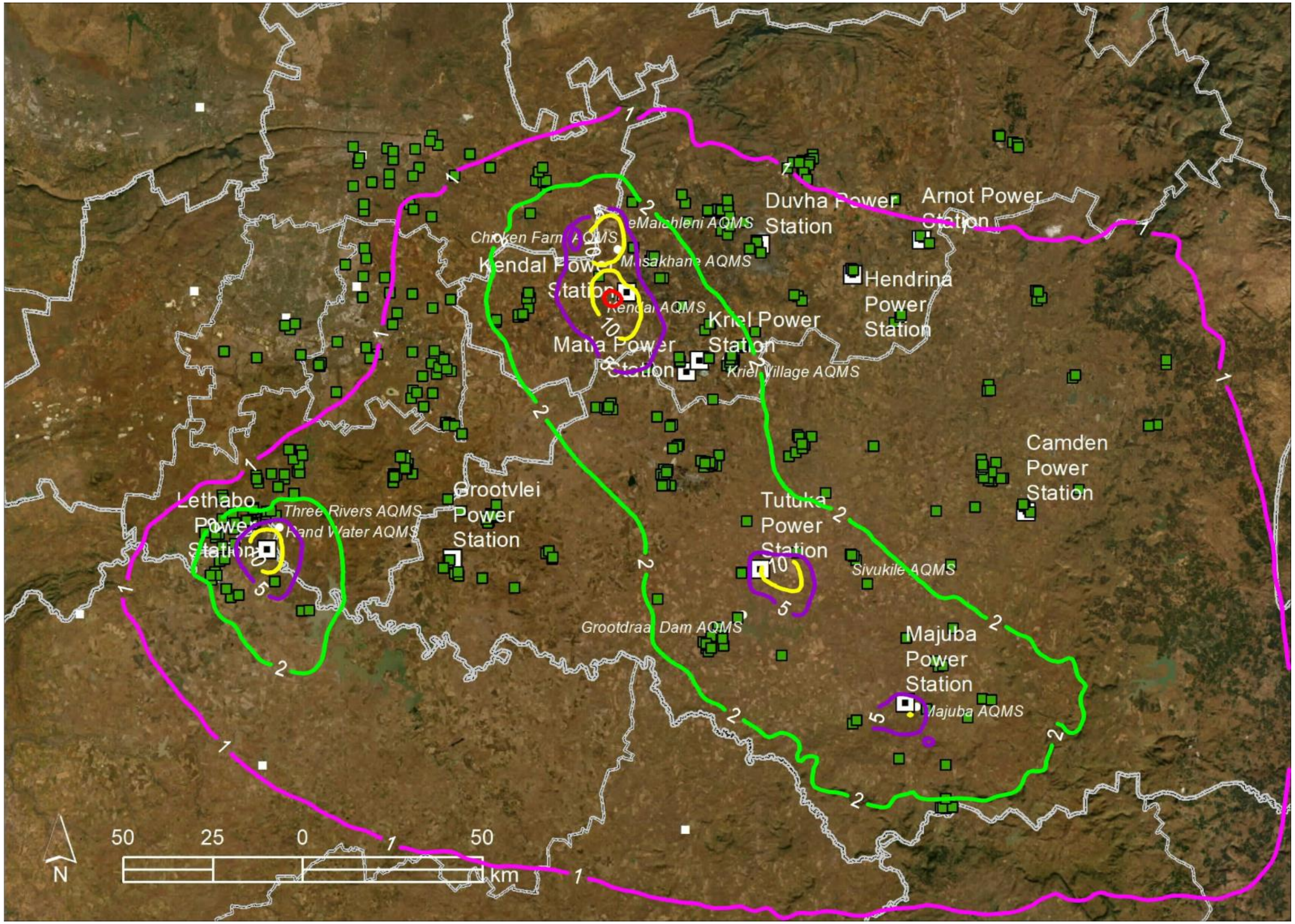


Figure 6-33: Predicted annual average PM_{10} concentrations in µg/m³ for Scenario C (2036) (NAAQS Limit is 40 µg/m³)

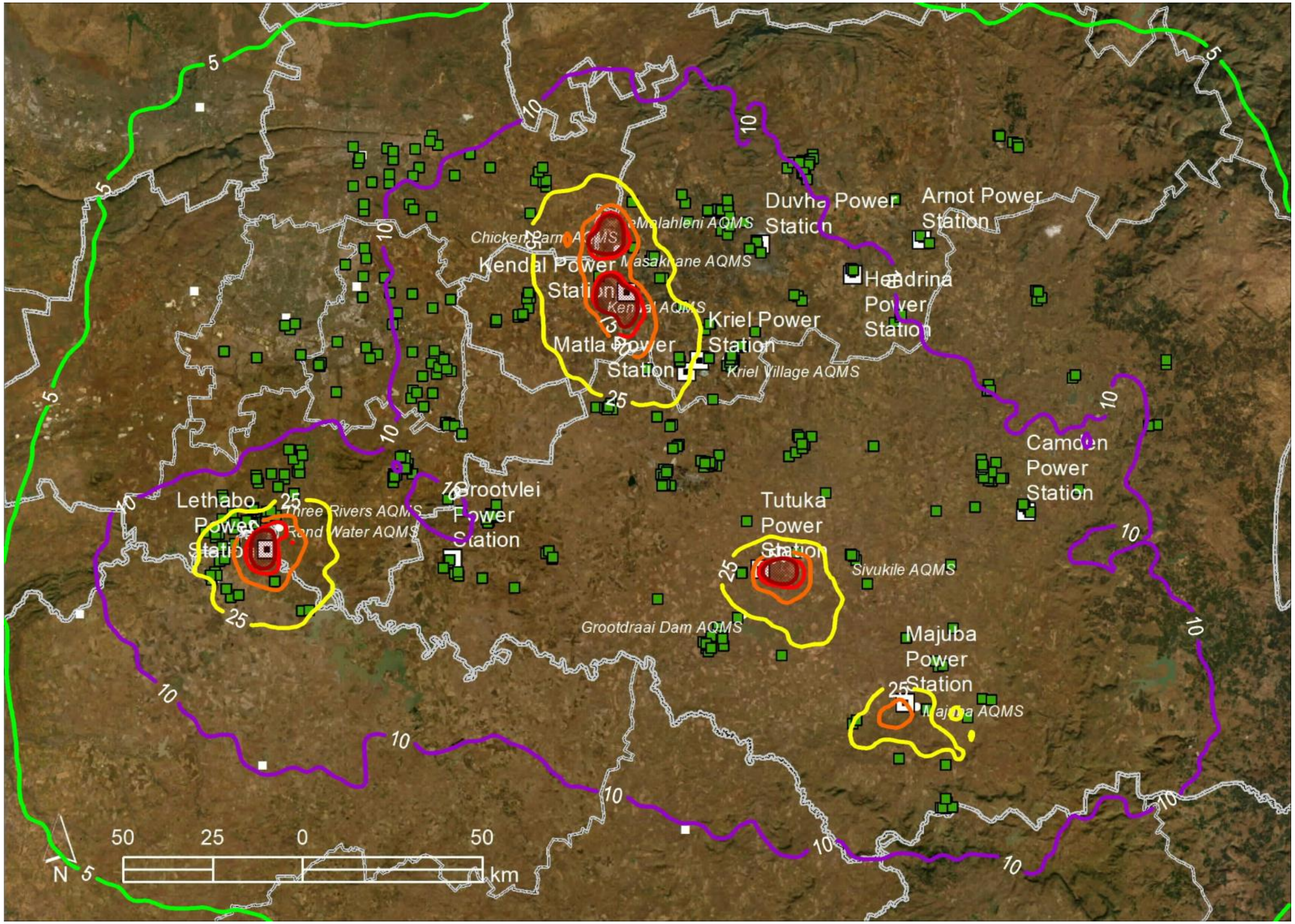


Figure 6-34: Predicted 99th percentile of the 24-hour PM_{10} concentrations in µg/m^3 for Scenario C (2036) (NAAQS Limit is 75 µg/m^3)

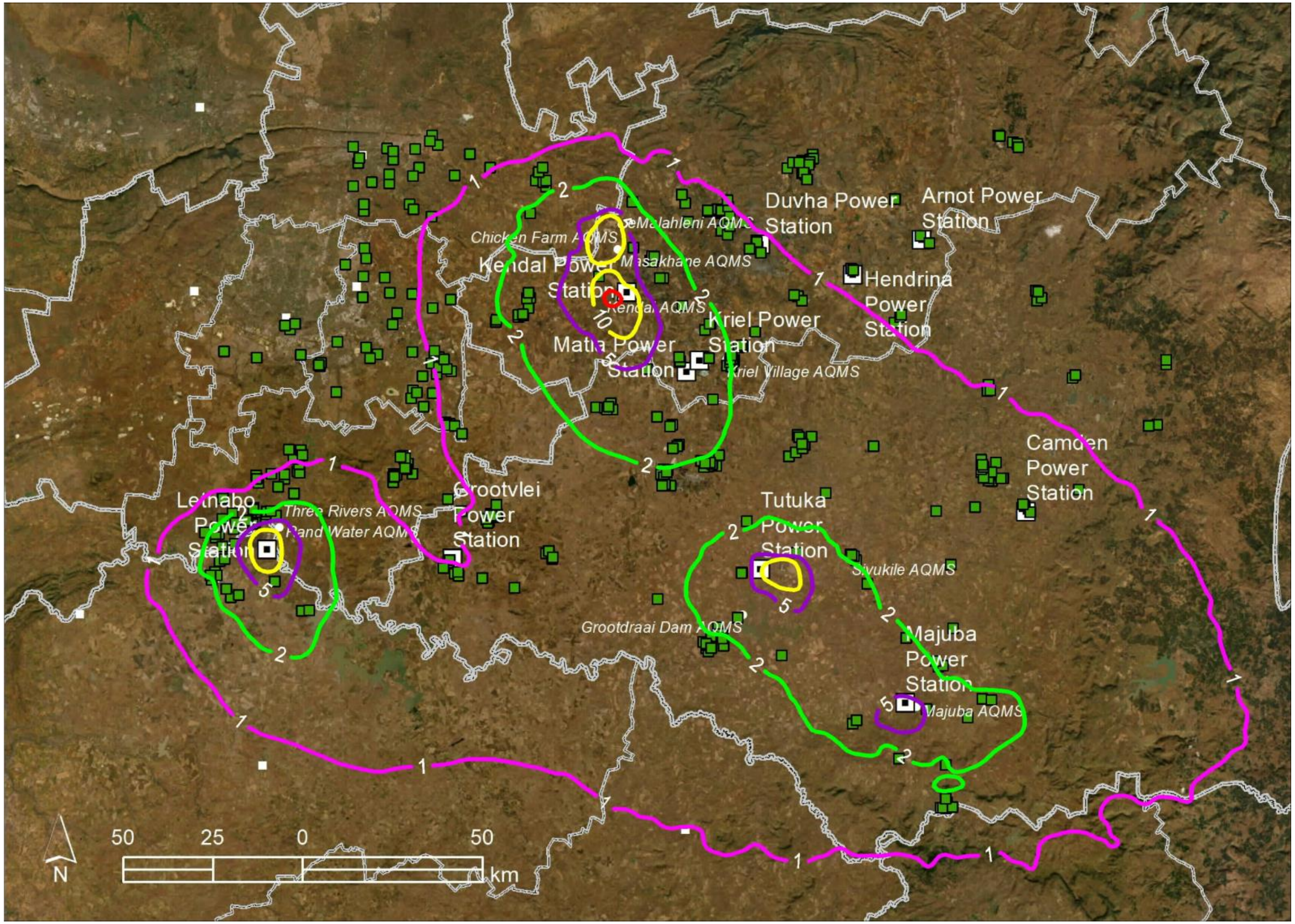


Figure 6-35: Predicted annual average PM_{10} concentrations in µg/m^3 for Scenario D (MES) (NAAQS Limit is 40 µg/m^3)

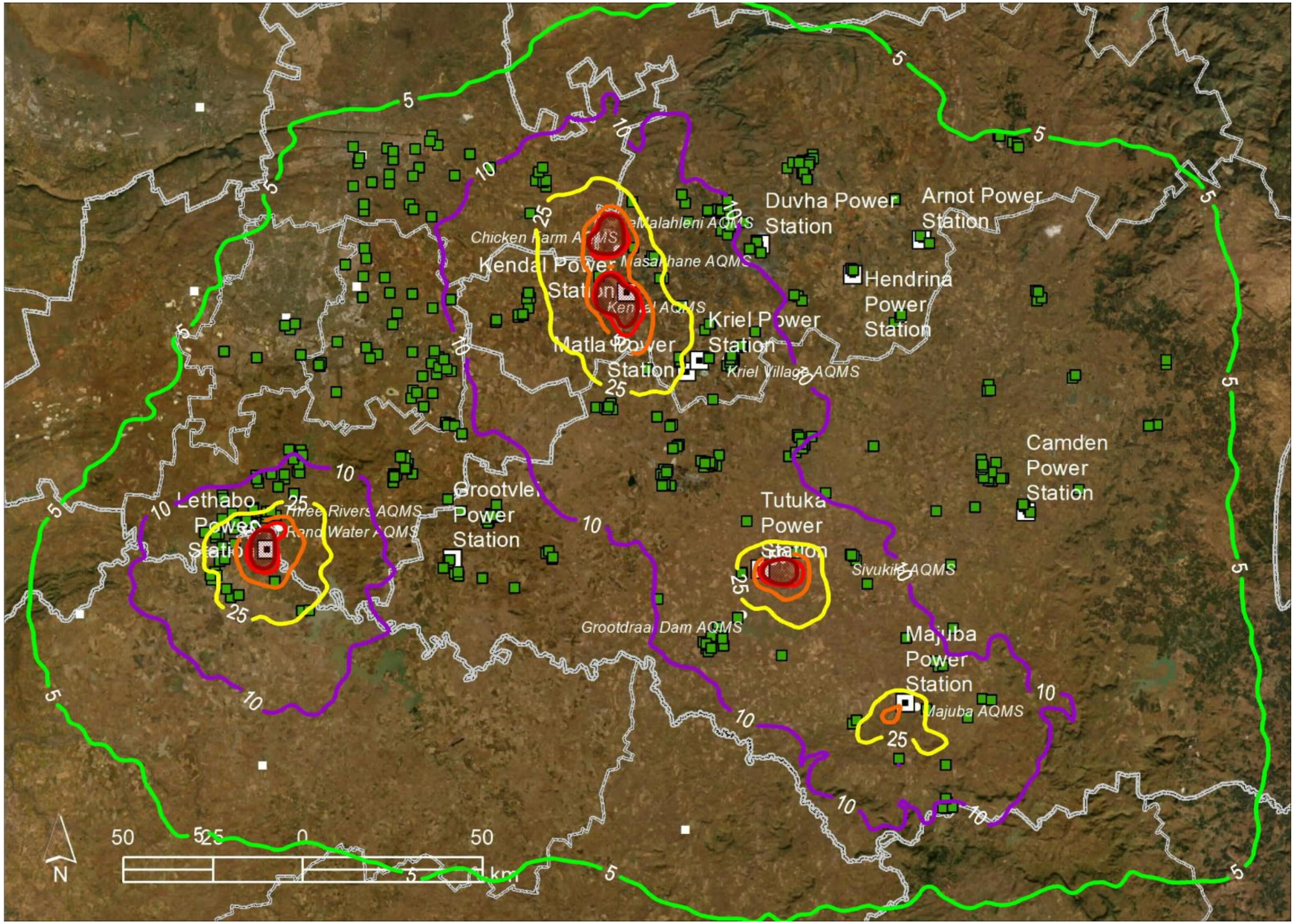


Figure 6-36: Predicted 99th percentile of the 24-hour PM_{10} concentrations in µg/m³ for Scenario D (MES) (NAAQS Limit is 75 µg/m³)

6.2.3.4 Particulates ($PM_{2.5}$)

The isopleth plots for $PM_{2.5}$ are similar for all scenarios due to the significant contribution of the low-level fugitive sources to the ambient concentrations. The fugitive emission from the coal yards and the ash dumps impact on ambient concentrations close to the source, resulting in the highest concentrations around the individual power stations. Noticeable is the effect of the shutdown of Arnot, Camden, Hendrina, Kriel by 2031 on the isopleths for Scenario B (2031).

The predicted annual average concentrations exceed the NAAQS of 20 µg/ around the individual power stations in Scenario 1 (Current) and Scenario A (2025), with reductions seen in the subsequent scenarios as a result of the shut downs. The biggest reductions are seen from Scenario A (2025) to Scenario B (2031) which considers station shutdowns, as well as completion of PM abatement projects.

The area where the predicted 24-hour concentrations exceed the limit value of 40 µg/m^3 (shaded area) is evident around all the operational power stations. The area is larger than for PM_{10} due the more stringent NAAQS being applied for $PM_{2.5}$. In all scenarios a number of sensitive receptors are located in the areas where the NAAQS are exceeded in Scenario 1 (Current) and Scenario A (2025) when the limit value of the NAAQS of 25 µg/m^3 applies. There is an increase in the number of receptor points where the limit value is exceeded in Scenario B (2031), Scenario C (2036) and Scenario D (MES) when a limit value of 25 µg/m^3 is in force.

It must be remembered that the predictions are conservative given the assumption that TPM = PM_{10} = $PM_{2.5}$. Remembering too that the fugitive emission have the greatest effect on ambient concentrations close to the source as a result of the assumptions concerning the ash dump emissions (Section 2.6), while the effect of the stack emissions is generally further from the power station.

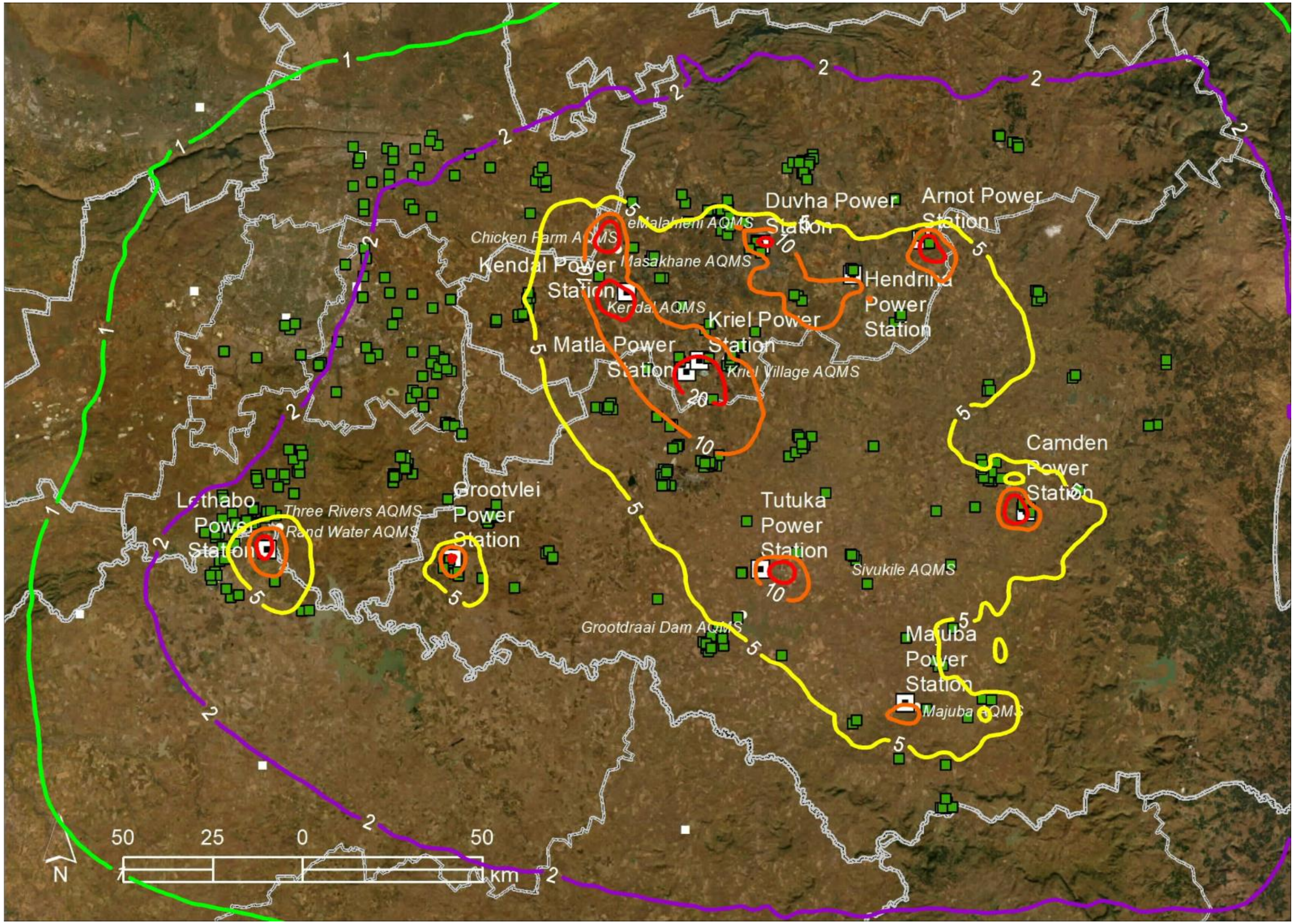


Figure 6-37: Predicted annual average $PM_{2.5}$ concentrations in $\mu g/m^3$ for Scenario 1 (Current) (NAAQS Limit is 20 $\mu g/m^3$)

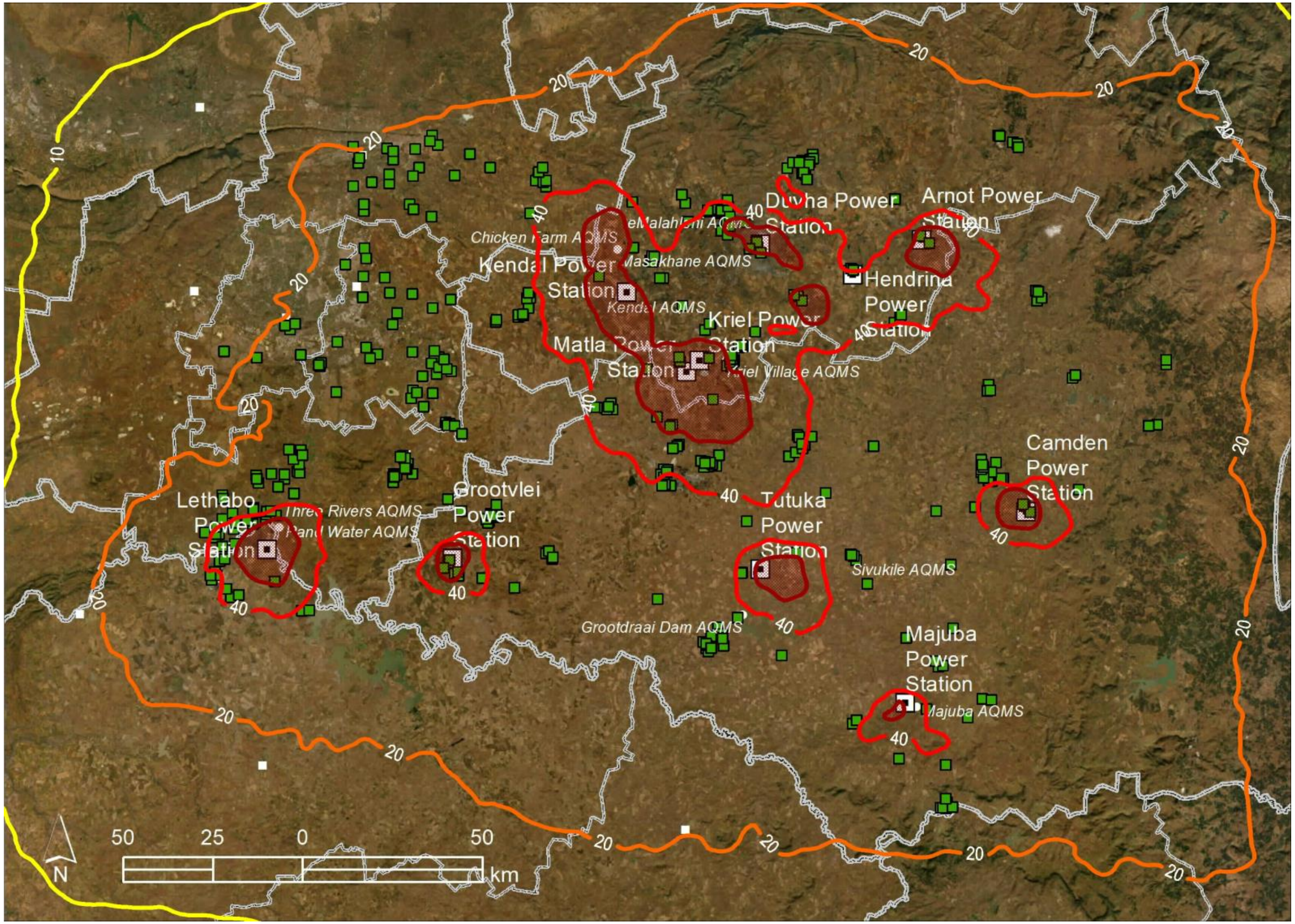


Figure 6-38: Predicted 99th percentile of the 24-hour $PM_{2.5}$ concentrations in µg/m³ for Scenario 1 (Current) (NAAQS Limit is 40 µg/m³)

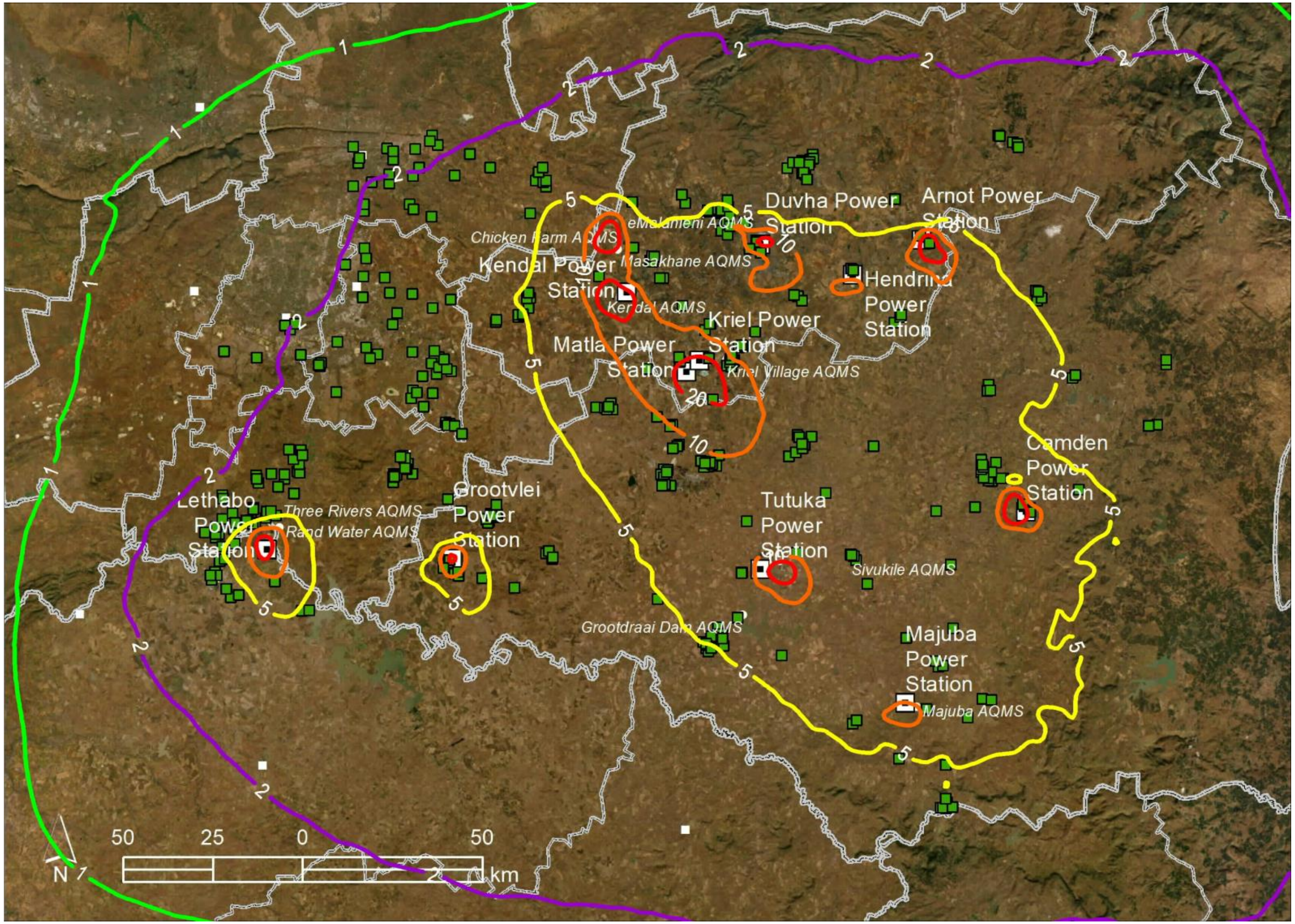


Figure 6-39: Predicted annual average $PM_{2.5}$ concentrations in µg/m^3 for Scenario A (2025) (NAAQS Limit is 20 µg/m^3)

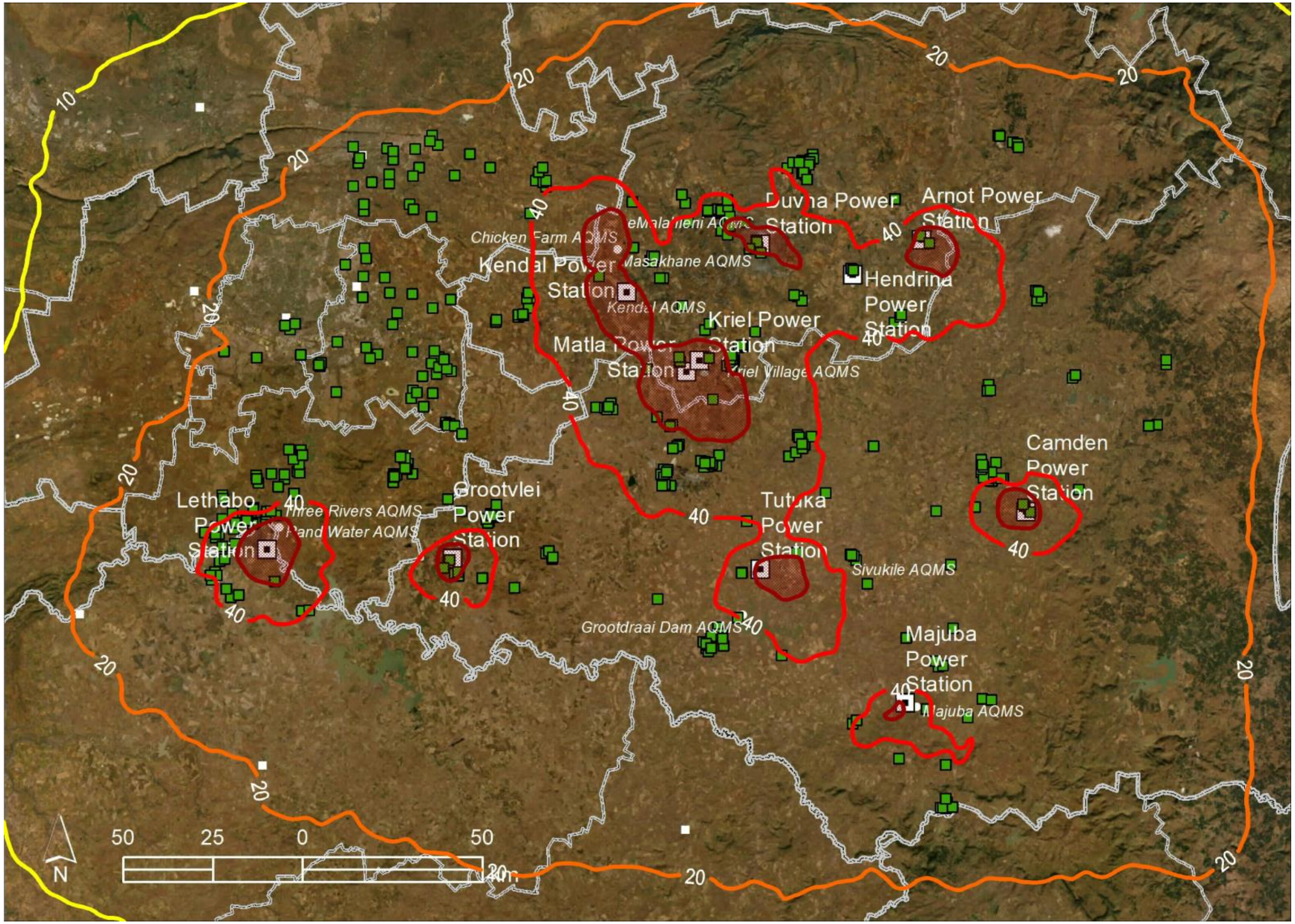


Figure 6-40: Predicted 99th percentile of the 24-hour $PM_{2.5}$ concentrations in µg/m³ for Scenario A (2025) (NAAQS Limit is 40 µg/m³)

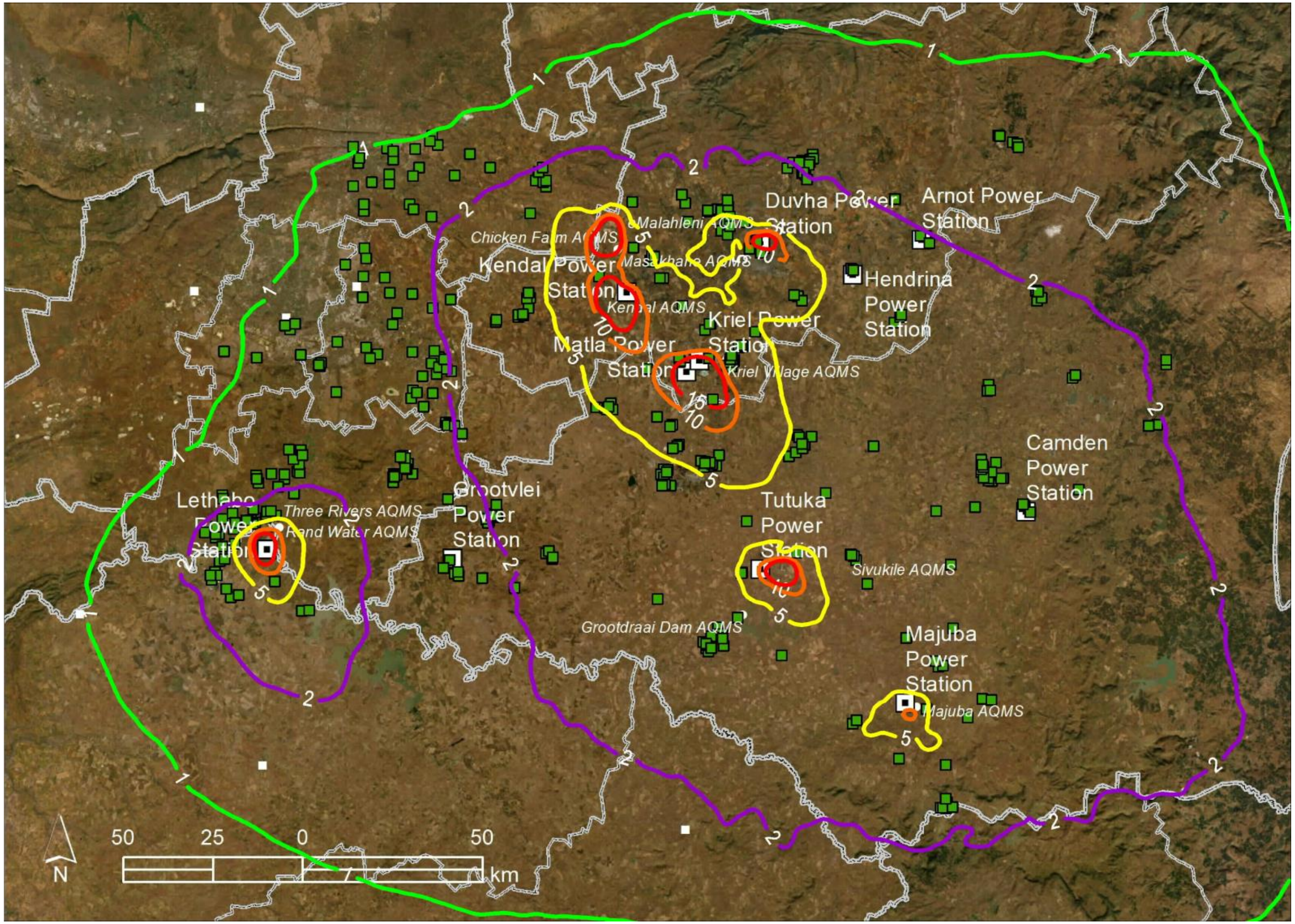


Figure 6-41: Predicted annual average $PM_{2.5}$ concentrations in µg/m³ for Scenario B (2031) (NAAQS Limit is 15 µg/m³)

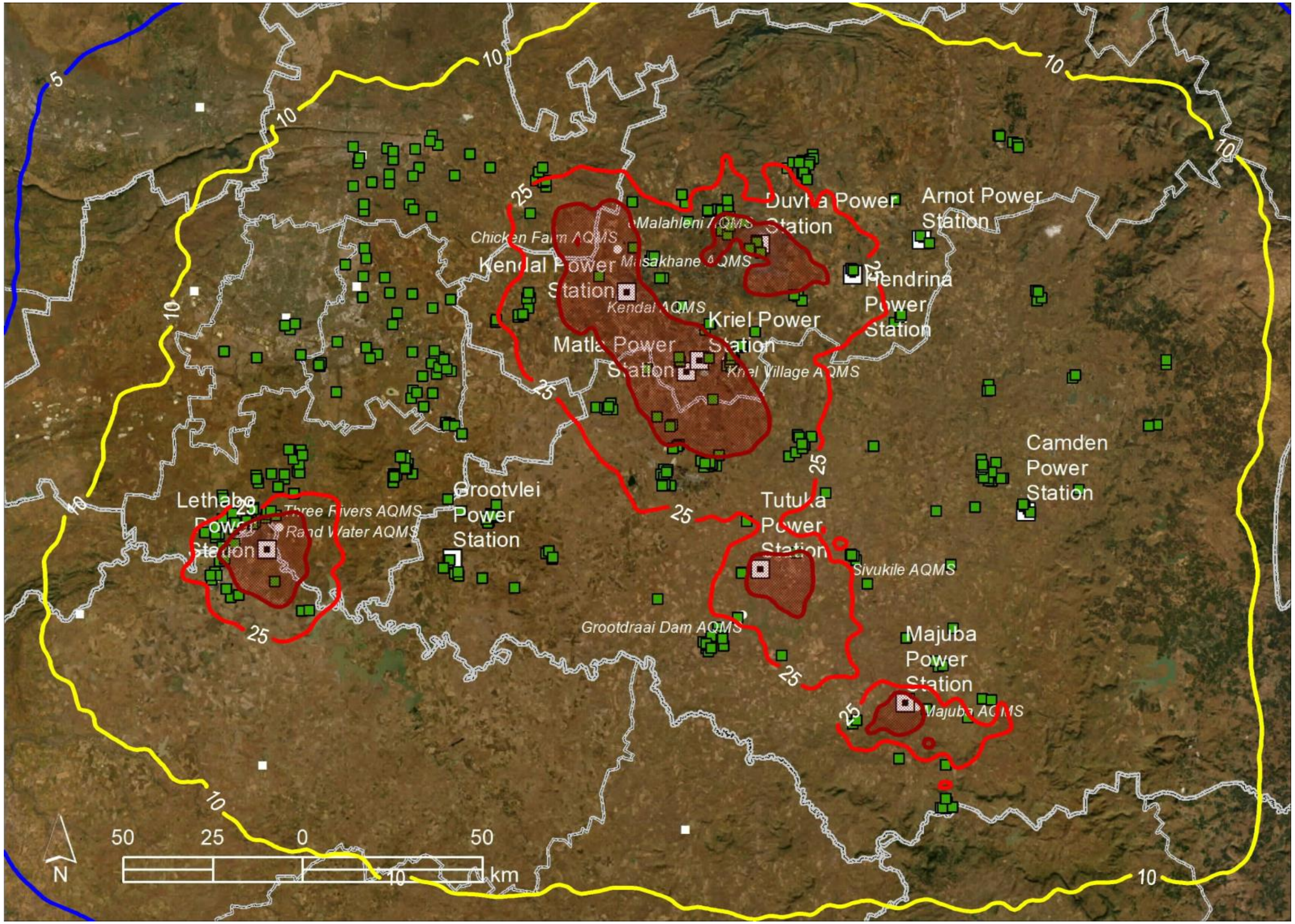


Figure 6-42: Predicted 99th percentile of the 24-hour $PM_{2.5}$ concentrations in µg/m^3 for Scenario B (2031) (NAAQS Limit is 25 µg/m^3)

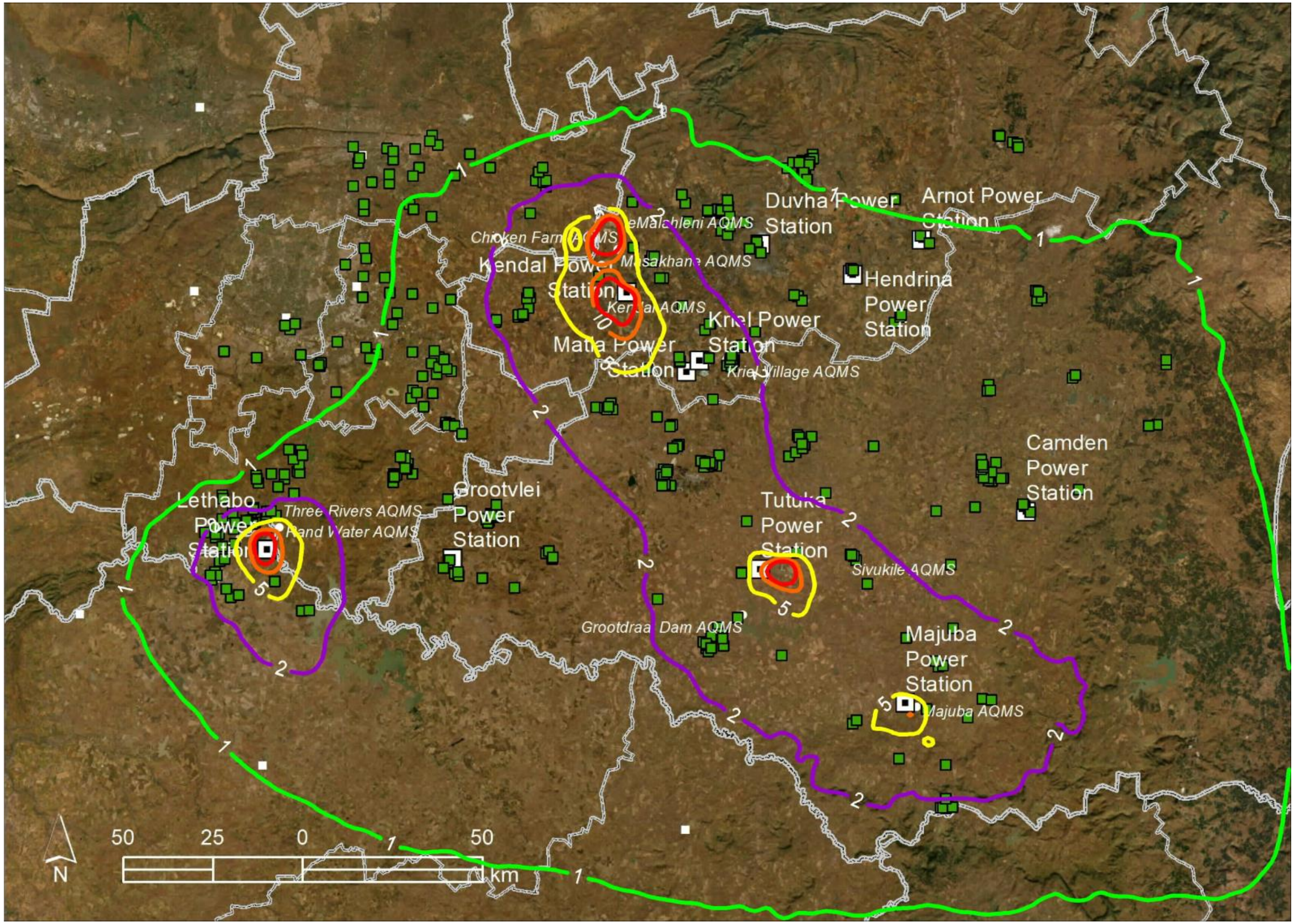


Figure 6-43: Predicted annual average $PM_{2.5}$ concentrations in µg/m³ for Scenario C (2036) (NAAQS Limit is 15 µg/m³)

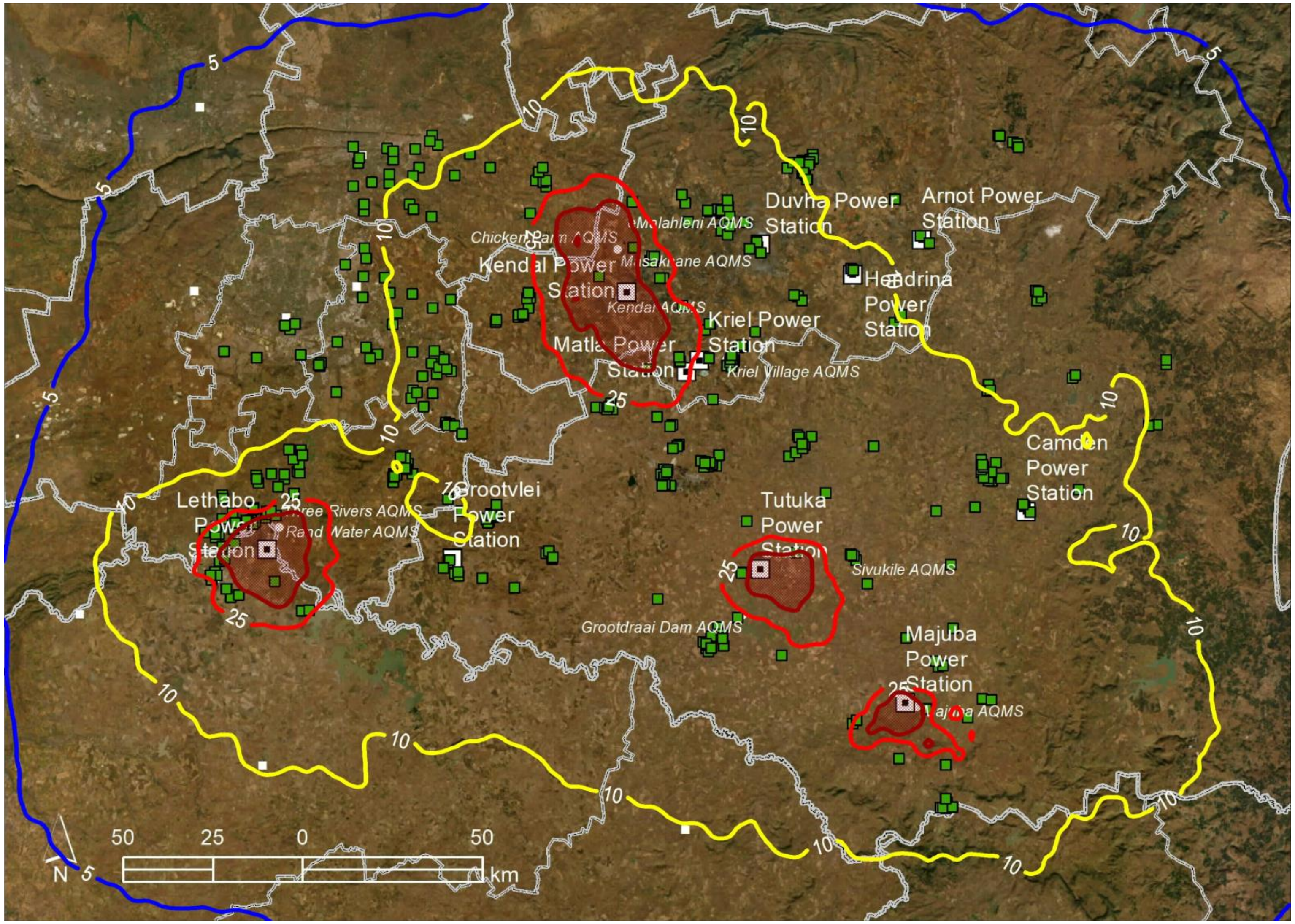


Figure 6-44: Predicted 99th percentile of the 24-hour $PM_{2.5}$ concentrations in µg/m³ for Scenario C (2036) (NAAQS Limit is 25 µg/m³)

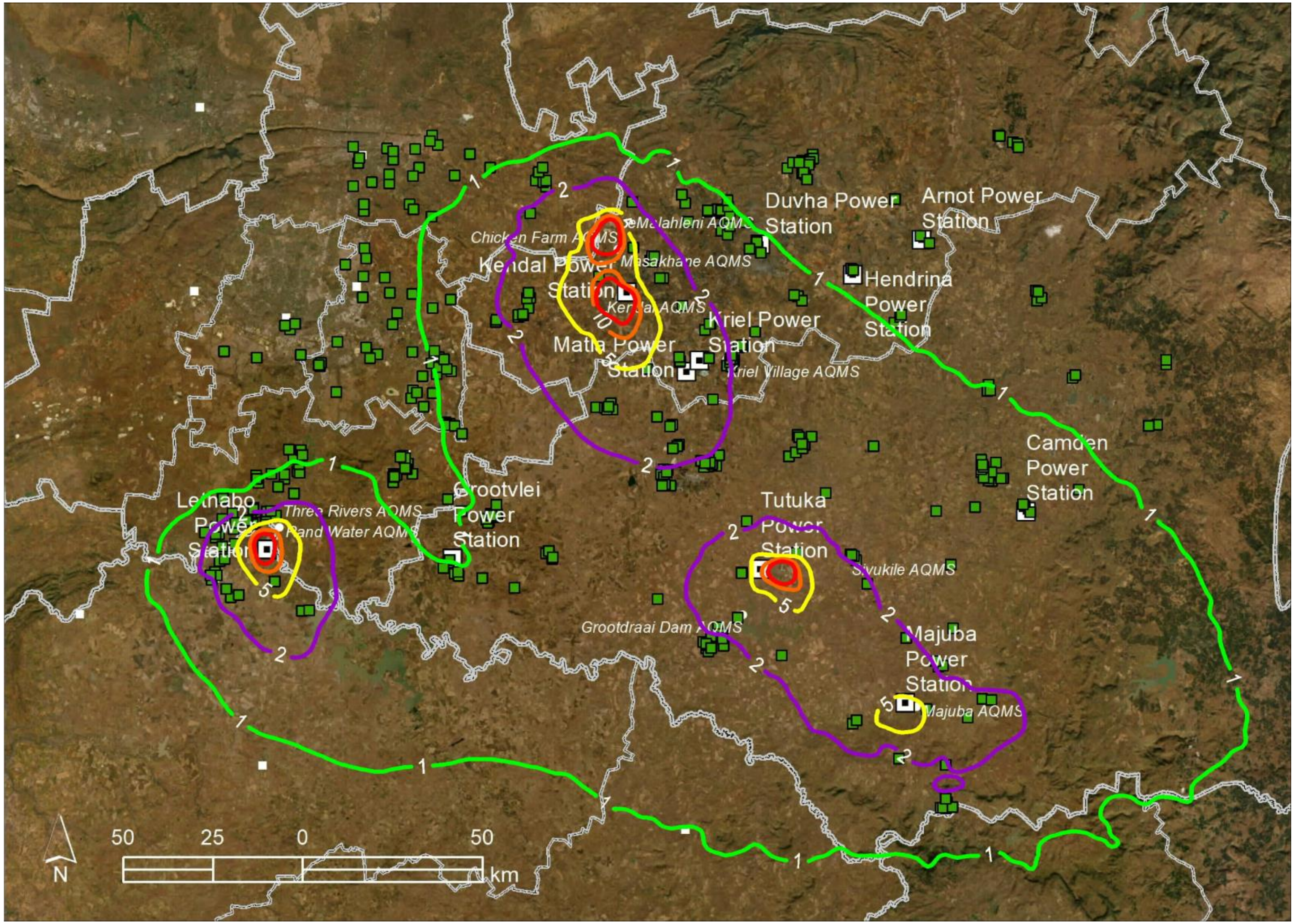


Figure 6-45: Predicted annual average $PM_{2.5}$ concentrations in $\mu g/m^3$ for Scenario D (MES) (NAAQS Limit is 15 $\mu g/m^3$)

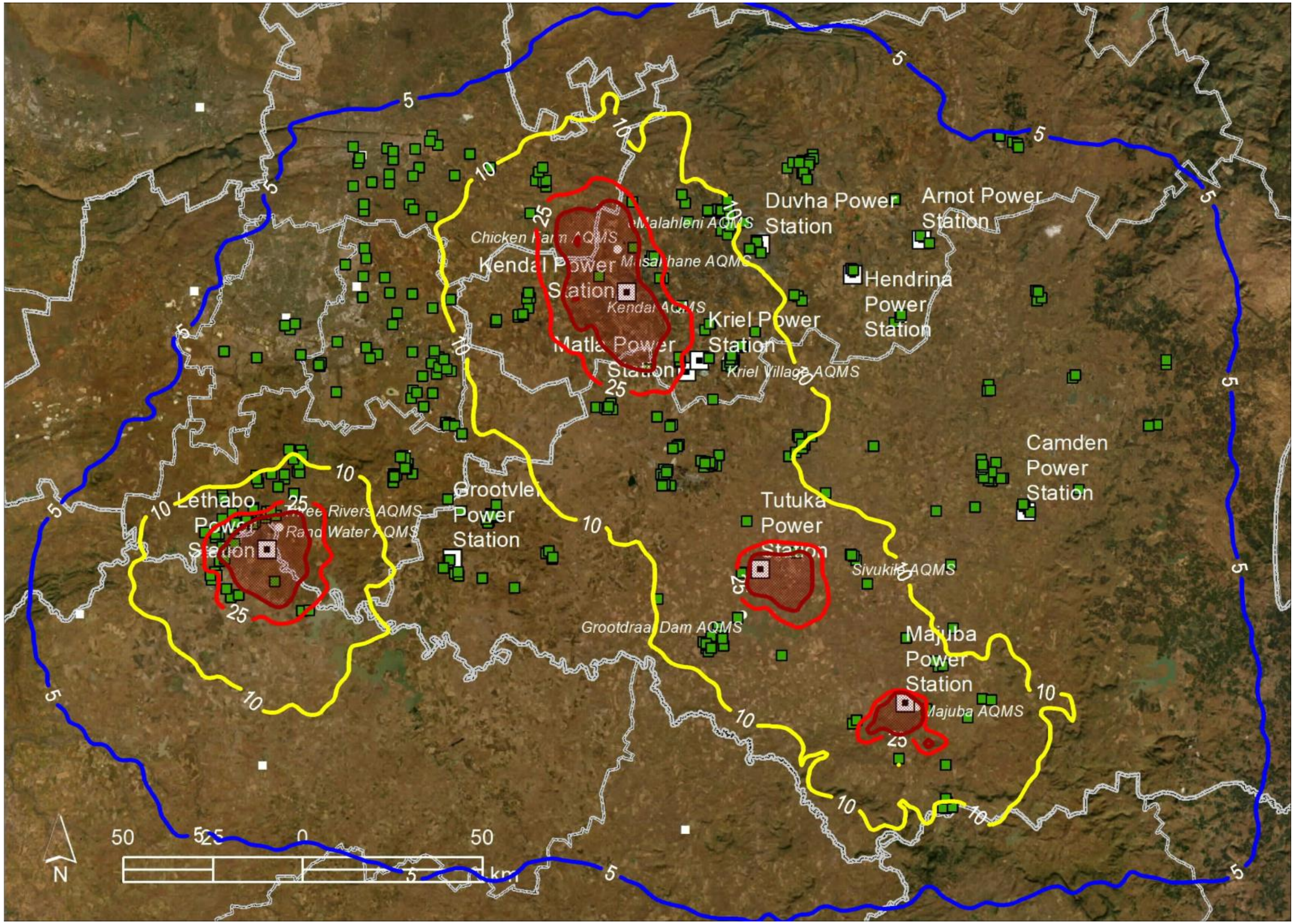


Figure 6-46: Predicted 99th percentile of the 24-hour $PM_{2.5}$ concentrations in µg/m³ for Scenario D (MES) (NAAQS Limit is 25 µg/m³)

7. SUMMARY AND CONCLUSION

In this AIR five emission scenarios are assessed collectively for the suite of 12 coal-fired power stations in the Highveld Priority Area and Lethabo in the Vaal Triangle Airshed Priority Area to support Eskom's application for exemption from the MES for 6 of the power stations. AIRs have been produced for the 6 power stations, i.e. Duvha, Kendal Lethabo, Majuba, Matla and Tutuka.

Dispersion modelling is used to demonstrate the effect of Eskom's emission reduction strategy by assessing 5 sequential emission scenarios. These are from Scenario 1 using actual emissions from 2021 to 2023, Scenario A using proposed 2025 emissions, Scenario B using proposed 2031 emissions and Scenario C using proposed 2036 emissions. Scenario D uses emissions that comply with the MES to demonstrate the relative effect of compliance.

Noteworthy findings from the modelling results may be summarised as follows:

i) Ambient SO_2 and NO_2 concentrations are attributed to stack emissions only, while ambient PM_{10} and $PM_{2.5}$ concentrations are attributed to the stack emissions and the low-level fugitive sources. The stack emissions generally have an effect some distance from the source, while low-level fugitive emissions have an effect close to the source.

ii) The predicted ambient concentrations are lower than the monitored concentrations for all pollutants at all AQMS. This is to be expected since AQMS are exposed to all sources of pollutants while the modelled concentrations result from power station emission only. The difference between the modelled concentrations and measured concentrations are indicative of the contribution of other sources at the respective AQMS.

iii) For Scenario 1 (Current):
   a. Predicted SO_2 and NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.
   b. Predicted PM_{10} and $PM_{2.5}$ concentrations generally comply with the NAAQS, except close to the power stations where the limit value of the 24-hour NAAQS are exceeded. Exceedances of the limit value for PM_{10} and $PM_{2.5}$ are predicted at 26 and 129 sensitive receptor points respectively.

iv) For Scenario A (2025):
   a. Predicted SO_2 and NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain, except for the 99^{th} percentile of the 24-hour SO_2 concentrations which exceed the limit value of the NAAQS.
   b. Predicted PM_{10} and $PM_{2.5}$ concentrations generally comply with the NAAQS, except close to the power stations where the limit value of the 24-hour NAAQS are exceeded. Exceedances of the limit value for PM_{10} and $PM_{2.5}$ are predicted at 29 and 149 sensitive receptor points respectively.

v) For Scenario B (2031):
   a. Predicted SO_2 and NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain. Predicted NO_2 concentrations show a reduction with the completion of LNB projects at Kendal and Tutuka.

b. Predicted PM_{10} and $PM_{2.5}$ concentrations generally comply with the NAAQS, except close to the power stations where the limit value of the 24-hour NAAQS are exceeded. The number of predicted exceedances for PM_{10} decrease to 9, while the number of exceedances for $PM_{2.5}$ increase to 157 sensitive receptor points. The increase corresponds to the more stringent $PM_{2.5}$ limit value of 25 µg/m^3 which is implemented in 2030.
c. The effect of the shutdown of Arnot, Camden, Hendrina, Kendal and Kriel by 2031 and the associated reduction in emissions is clearly evident, with the modelling showing lower ambient concentrations, i.e. improved air quality.

vi) For Scenario C: (2036):

a. Predicted SO_2 and NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.
b. Predicted PM_{10} and $PM_{2.5}$ concentrations comply with the NAAQS, except close to the power stations where the limit value of the 24-hour $PM_{2.5}$ NAAQS is exceeded. Exceedances of the limit value for $PM_{2.5}$ is predicted at 53 sensitive receptor points.
c. Reductions in predicted ambient PM concentrations are due to Duvha and Matla entering shutdown phase, as well as abatement improvements from Scenario B for PM. Ambient SO_2 reductions are due to the Majuba DSI and Kendal semi-dry FGD projects. Ambient NO_2 improvements are due to the Lethabo LNB project.

vii) For Scenario D:

a. Predicted SO_2 and NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.
b. Predicted PM_{10} and $PM_{2.5}$ concentrations generally comply with the NAAQS, except close to the power stations where the limit value of the 24-hour $PM_{2.5}$ NAAQS is exceeded. Exceedances of the limit value for $PM_{2.5}$ is predicted at 45 sensitive receptor points.

Given the conservative approach to the fugitive emission source simulations, and that this has provided an absolute worst-case emission scenario, and based on recommendations received from uMoya-Nilu, Eskom will be undertaking an additional modelling scenario, assessing only PM, SO_2, and NO_X stack emissions. NO_X and SO_2 emissions will be included in this scenario to ensure secondary particulate formation is accounted for. This will provide improved insight to impacts directly related to stack emissions, which are the focus of this exemption application.

8. REFERENCES

Auer, A.H. (1978): Correlation of Land Use and Cover with Meteorological Anomalies, Journal of Applied Meteorology, 17:636-643.

CARB (2024): https://ww2.arb.ca.gov/capp-resource-center/community-assessment /sensitive-receptor-assessment.

CSIRO (2008): TAPM V4. User Manual. Prepared by Peter Hurley, CSIRO Marine and Atmospheric Research Internal Report No. 5, October 2008, ISBN: 978-1-921424-73-1.

DEA (2009): National Ambient Air Quality Standards, Government Gazette, 32861, Vol. 1210, 24 December 2009.

DEA (2010): Listed Activities and Associated Minimum Emission Standards identified in terms of Section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Government Gazette 33064, Notice No. 248 of 31 March 2010.

DEA (2012): National Ambient Air Quality Standard for Particulate Matter of Aerodynamic Diameter less than 2.5 micrometers, Notice 486, 29 June 2012, Government Gazette, 35463.

DEA (2013a): Regulations Prescribing the Format of the Atmospheric Impact Report, Government Gazette 36904, Notice No. 747 of 11 October 2013.

DEA (2013b): Listed Activities and Associated Minimum Emission Standards identified in terms of Section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Government Gazette 37054, Notice No. 893 of 22 November 2013.

DEA (2014a): Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa, Government Notice R.533, Government Gazette, no. 37804, 11 July 2014.

DEA (2014b): Environmental Assessment Regulations, 2014 identified in terms of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Government Gazette 38282, Notice No. R 982 of 4 December 2014.

DEA (2019): Listed Activities and Associated Minimum Emission Standards identified in terms of Section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Government Gazette 42472, Notice No. 893 of 22 May 2019.

DEA (2020): Listed Activities and Associated Minimum Emission Standards identified in terms of Section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Government Gazette 43174, Notice No. 421 of 27 March 2020.

Hurley, P. (2000): Verification of TAPM meteorological predictions in the Melbourne region for a winter and summer month. Australian Meteorological Magazine, 49, 97-107.

Hurley, P.J., Blockley, A. and Rayner, K. (2001): Verification of a prognostic meteorological and air pollution model for year-long predictions in the Kwinana industrial region of Western Australia. Atmospheric Environment, 35(10), 1871-1880.

Hurley, P.J., Physick, W.L. and Ashok, K.L. (2002): The Air Pollution Model (TAPM) Version 2, Part 21: summary of some verification studies, CSIRO Atmospheric Research Technical Paper No. 57, 46 p.

Naledzi Environmental Consultants (2018), Cumulative Impact Assessment for the Combined Emissions from Eskom's Coal-Fired Power Stations in support of Eskom's application for postponement of the Minimum Emission Standards compliance timeframes, October 2018.

SANAS (2012): Tr 07-03 Supplementary Requirements for the Accreditation of Continuous Ambient Air Quality Monitoring Stations (pp. 112).

USEPA (1995): A user's guide for the CALPUFF dispersion model (version 5). Prepared by Scire, J., Strimaitis, D. and Yamartino, Robert.

USEPA (2005): Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions, 40 CFR Part 51, US Environmental Protection Agency 40 CFR Part 51.

USEPA (2024a): https://www.epa.gov/newenglandhc/environmental-issues-concern-urban- communities-resources.

USEPA (2024b): Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources. Chapter 13: Miscellaneous Sources. http://www.epa.gov/ttn/chief/ap42/ch13/index.html.

9. FORMAL DECLARATIONS

A declaration of the accuracy of the information contained in this Atmospheric Impact Report is included here. A declaration of the independence of the practitioners in the uMoya-NILU consultancy team that compiled this AIR is also included.

DECLARATION OF ACCURACY OF INFORMATION – APPLICANT

Name of Enterprise: uMoya-NILU Consulting (Pty) Ltd

Declaration of accuracy of information provided:

Atmospheric Impact Report in terms of Section 30 of the Act

I, Mark Zunckel [duly authorised], declare that the information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality office is a criminal office in terms of section 51(1)(g) of this Act.

Signed at Durban on this 4th day of November 2024.

SIGNATURE

Managing Director – uMoya-NILU Consulting
CAPACITY OF SIGNATORY

DECLARATION OF INDEPENDENCE – PRACTITIONER

Name of Practitioner: Mark Zunckel

Name of Registered Body: South African Council for Natural Scientific Professionals

Professional Registration Number: 400449/04

Declaration of independence and accuracy of information provided:

Atmospheric Impact Report in terms of Section 30 of the Act

I, Mark Zunckel declare that I am independent of the applicant. I have the necessary expertise to conduct the assessment required for the report and will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. I will disclose to the applicant and the air quality officer all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the air quality officer. The information provided in the atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality office is a criminal office in terms of section 51(1)(g) of this Act.

Signed at Durban on this 4th day of November 2024.

SIGNATURE

Managing Director – uMoya-NILU Consulting
CAPACITY OF SIGNATORY

ANNEXURE 1: HIGHVELD SENSITIVE RECEPTORS

Area	Sensitive Receptors	Latitude	longitude
Amersfoort	Elsie Ballot Memorial Hospital	-27.011944	29.858333°
	Laerskool Amersfoort	-27.008678°	29.869944°
	Embuzane Primary School	-27.118291°	29.826786°
	Sangqotho Primary School	-26.941649°	29.765980°
Ezamokuhle	Amersfoort Combined School	-26.997325°	29.850319°
Mooifontein	Injubuko Primary School	-26.914817°	29.897307°
Daggaskraal	Daggakraal Primary School	-27.089170°	29.983250°
	Sizenzele Primary School	-27.137908°	29.943203°
	Seme Secondary School	-27.091589°	30.008177°
	Louwra Primary School	-27.257713°	29.884864°
Perdekop	Perdekop Agricultural School	-27.159970°	29.620400°
	Vukuzenzele Combined School	-27.150944°	29.632386°
	Bambelelani Primary School	-27.175659°	29.749177°
	Gunwana Primary School	-27.244071°	29.752985°
Volksrust	Amajuba Memorial Hospital	-27.351190°	29.890921°
	Volksrust High School	-27.365400	29.87400
	Volksrust Municipal Clinic	-27.366264°	29.889272°
	C V O Skool Amajuba	-27.365329°	29.879851°
	Qhubulwazi Combined School	-27.363173°	29.907290°
	Volksrust Primary School	-27.341897°	29.886710°
Ermelo	New Ermelo	-26.534977°	30.026896°
	Ermelo Christian School	-26.543889	29.996389
	Savf Home For Aged	-26.527681°	29.988536°
	Ermelo Hospital	-26.523077°	29.974891°
	Mediclinic Ermelo	-26.542500	29.986389
	Hoerskool Ermelo	-26.526100	29.977900

Area	Sensitive Receptors	Latitude	longitude
	Ermelo Indian Combined School	-26.521100	29.965400
	Lungelo Combined School (Outside Town)	-26.622000	29.841700
	New Ermelo Primary School	-26.535600	30.020700
	Kwashashe (Outside Town)	-26.495602°	30.006254°
	Hts Ligbron	-26.536691°	29.986828°
	Laerskool Ermelo	-26.520178°	29.992883°
	JJ Vd Merwe Pre-Primary School	-26.535660°	29.972140°
Wesselton (Ermelo)	Lindile Secondary School	-26.513500	29.965500
	Emthonjeni Clinic	-26.508028°	29.971060°
	Reggie Masuku Secondary School	-26.489756°	29.964026°
	Cebisa Secondary School	-26.503265°	29.968324°
Camden	Camden	-26.603573°	30.089437°
	Camden Combined School	-26.618056	30.104444
	Camden School	-26.599100	30.083900
	Umzimvelo Secondary School (Rural Area)	-26.558600	30.238500
	BHEKIMFUNDO PRIMARY SCHOOL (Rural Area)	-26.609907°	29.950545°
	ESHWILENI PRIMARY SCHOOL (Rural Area)	-26.754375°	29.885636°
Davel	Davel Combined School	-26.462700	29.663000
Morgenzon	Morgenzon Landbou Akademie	-26.749100	29.621200
	Nqobangolwazi Secondary School	-26.738700	29.615000
	Siqondekhaya Pre Primary School	-26.734260°	29.604270°
	Sizakhele Primary School	-26.734486°	29.607360°
	Phezukwentaba Primary School (South Of Morgenzon)	-26.807276°	29.653596°
	Kwaggalaagte Primary School (North Of Morgenzon)	-26.581578°	29.531897°
	Sizakhele Clinic/Hospital	-26.735610°	29.608568°
Grootvlei	Grootvlei	-26.765600	28.483800
	Olive Grove Country Lodge	-26.785336°	28.467296°
Grootvlei Town	Grootvlei Town (South Of Power Station)	-26.798562°	28.505729°

Area	Sensitive Receptors	Latitude	longitude
	Laerskool Grootvlei	-26.799705°	28.499296°
	Tokoloho Primary School	-26.805037°	28.509491°
	Tshepeha Combined School	-26.794589°	28.507561°
	Warembo Lodge	-26.809803°	28.575820°
Balfour	Balfour	-26.647368°	28.597344°
	Siyathemba	-26.651574°	28.611242°
	Bonukukhanya Primary (Siyathemba)	-26.656389	28.610556
	Qalabocha Primary School (Siyathemba)	-26.648510°	28.610239°
	Vusumuzi Primary School	-26.649302°	28.614483°
	Gekombineerde Skool Balfour	-26.666111	28.593056
	Im Manchu Secondary School	-26.662885°	28.585658°
	Isifisosethu Secondary School (Siyathemba)	-26.654091°	28.616910°
	Setsheng Secondary School (Siyathemba)	-26.646036°	28.613849°
	Dr Nieuwoudt And Dr Kok	-26.670556	28.589722
	Balfour Clinic	-26.660521°	28.584954°
	Siyathemba Clinic	-26.651428°	28.598763°
	Mondoro Lodge	-26.641806°	28.515683°
	Wegelegen Manor	-26.625555°	28.612550°
	The Stone Cellar	-26.611667	28.478056
Greylingstad	Greylingstad	-26.744551°	28.753659°
	Nthorwane	-26.759041°	28.771550°
	Laerskool Greylingstad	-26.740120°	28.761680°
	Nthoroane Secondary School	-26.755300	28.772500
	Badgarleur Bush Lodge	-26.832190°	28.666044°
Matla	Matla Village	-26.259808°	29.119138°
	Sifundise Primary School	-26.257623°	29.120118°
	Kwanala Primary School	-26.249384°	29.199724°
	Matla Coal Health Centre	-26.247649°	29.116928°

Area	Sensitive Receptors	Latitude	longitude
	Gweda Primary School	-26.352145°	29.212688°
	Zithobe Primary School	-26.278423°	29.027500°
Kriel power station area	Kwanala Primary School	-26.249300	29.200000
Reedstream Park	Reedstream Park	-26.178723°	29.188144°
	Rietspruit Clinic	-26.162067°	29.202676°
	Lehlaka Combined School	-26.162533°	29.199891°
Blesboklaagte	Mbali Coal/Blesboklaagte Housing	-26.118280°	29.123520°
Kinross	Kinross	-26.417917°	29.100765°
	Kinross Settlement	-26.397865°	29.058050°
	Kinross Municipal Clinic	-26.421365°	29.094224°
Kriel	Kriel	-26.267078°	29.250870°
	Eagles Nest Guest House	-26.269553°	29.262920°
	Merlin Park Primary School	-26.251667	29.270000
	Kriel Medical Centre	-26.256300	29.269300
	Laerskool Krielpark	-26.258300	29.258500
	Laerskool Onverwacht	-26.250423°	29.265348°
	SILWER FLEUR AFTREE OORD (Old Age Home)	-26.251217°	29.260131°
Thubelihle	Thubelihle	-26.220737°	29.282778°
	Sibongamandla Secondary School	-26.215556	29.290000
	Ga-Nala Clinic	-26.241511°	29.263001°
	Impilo Primary School	-26.180232°	29.327259°
	Bonginhlanhla Primary School	-26.217923°	29.294090°
	Sibongamandla Secondary School	-26.215364°	29.290280°
Leandra	Leandra	-26.365552°	28.928450°
	Eendracht	-26.376131°	28.887873°
	Sidingulwazi Primary School	-26.377834°	28.910979°
	Ss Mshayisa Primary School	-26.381610°	28.933930°
	Chief Ampie Mayisa Secondary School	-26.381780°	28.918580°

Area	Sensitive Receptors	Latitude	longitude
	Lebogang Clinic	-26.375431°	28.921864°
Standerton	Kleuterskool Haas Das	-26.944550°	29.248400°
	Standerton Primary School	-26.941451°	29.250405°
	Laerskool Jeugkrag	-26.924090°	29.237685°
	Laerskool Standerton	-26.948786°	29.249351°
	Laerskool Kalie De Haas	-26.970223°	29.254828°
	Hoerskool Standerton	-26.941403°	29.250366°
	Standerton Provincial Government Hospital	-26.940531°	29.245199°
	Mar-Peh Medicare Private Hospital	-26.950190°	29.244825°
	Standerton Retirement Home	-26.952576°	29.244483°
	Standerton Ouetehuis/Old Age Home	-26.952129°	29.251705°
	Holmdene Secondary School	-26.854996°	29.068283°
	Cathuza Primary School (SE Of Town)	-26.991900°	29.417721°
Sakhile	Sizanani Pre Primary School	-26.965600°	29.219060°
	Hlobisa Primary School	-26.976914°	29.206318°
	Shukuma Primary School	-26.985407°	29.213005°
	Retsebile Primary School	-26.961930°	29.197353°
	Thuto-Thebe Secondary School	-26.947030°	29.220020°
	Jandrell Secondary School	-26.969768°	29.207290°
	Thobelani Secondary School	-26.965240°	29.206523°
	Standerton Tb Hospital	-26.977124°	29.219607°
Thuthukani	Thuthukani Pre Primary School	-26.786030°	29.303590°
	Ulwazi Primary School	-26.785680°	29.301080°
	Zikhetheleni Secondary School	-26.787403°	29.301062°
	Joubertsvlei Primary School (North Of Tutuka)	-26.657110°	29.312830°
	Amalumgelo Primary School (NE Of Tutuka)	-26.733160°	29.453775°
Grootdraai Dam	Grootdraaidam Primary School	-26.898947°	29.292610°
Secunda	Laerskool Secunda	-26.509385°	29.193941°

Area	Sensitive Receptors	Latitude	longitude
	Laerskool Kruinpark	-26.519159°	29.225740°
	Laerskool Oranjegloed Primary	-26.521260°	29.203110°
	Curro Castle Combined School	-26.523097°	29.191675°
	Hoërskool Oosterland	-26.515283°	29.214972°
	Mediclinic Secunda (Hospital)	-26.507573°	29.182451°
	Mediclinic Highveld (Hospital_Trichardt, Secunda)	-26.492055°	29.232606°
	Daviescourt/Davieshof Old Age Home	-26.511249°	29.198892°
	Highveld Park High School	-26.510499°	29.208618°
	Hoerskool Secunda	-26.512707°	29.194632°
EMBALENHLE	Basizeni Special School	-26.530052°	29.079094°
	Maphala-Gulube Primary School	-26.570566°	29.099115°
	Shapeve Primary School	-26.531614°	29.090534°
	Thomas Nhlabathi Secondary School	-26.543169°	29.071362°
	Embalenhle Hospital / Clinic	-26.550013°	29.080121°
	Vukuzithathe Primary School	-26.567722°	29.083243°
	K I Twala Secondary	-26.570501°	29.075089°
	Allan Makunga Primary School	-26.537324°	29.087230°
Evander	Evander Hospital Arv Clinic	-26.467000°	29.120000°
	Laerskool Hoeveld	-26.470539°	29.115757°
	Hoerskool Evander	-26.477655°	29.103231°
Delmas	Bernice Samuel Hospital	-26.152500°	28.667100°
	Hoerskool Delmas	-26.147355°	28.667599°
	Laerskool Delmas	-26.147749°	28.681442°
	Kangela Primary School (North Of Delpark)	-26.130000°	28.695000°
	Savf Ons Eie Ouetehuis / Old Age Home	-26.146154°	28.680927°
Eloff	Laerskool Eloff	-26.165971°	28.605106°
	Rietkol Primary School	-26.159963°	28.606432°
Botleng	Bazani Primary School	-26.104500°	28.699400°

Area	Sensitive Receptors	Latitude	longitude
	Phaphamani Secondary School	-26.105839°	28.690500°
	Vezimfundo Primary School	-26.091625°	28.694387°
Arbor	Arbor Primary School	-26.048219°	28.889804°
Ogies	Ogies Combined School	-26.049221°	29.068832°
	Umthombo Wolwazi Farm School	-26.156451°	28.930509°
	Kendal	-26.079592°	28.975296°
	Ogies Tb Clinic	-26.049669°	29.059596°
	Ogies Police Station	-26.049669°	29.059596°
Phola	Hlangu Phala Primary School	-26.006460°	29.032484°
	Sukumani Primary School	-26.005724°	29.036428°
	Thuthukani Primary School	-26.008877°	29.038899°
	Mehlwana Secondary School	-25.995286°	29.037621°
	Makause Combined School	-25.996758°	29.043456°
Wilge	Sibongindawo Primary School	-25.974651°	28.984930°
Balmoral	Laerskool Balmoral	-25.859262°	28.980030°
Emalahleni	Clewer Primary School	-25.906838°	29.136114°
	Witbank High School	-25.884914°	29.226438°
	Eden Park Retirement Village	-25.902283°	29.237194°
	Savf House Immergroen Old Age Home	-25.879707°	29.217916°
	MTHIMKULU Housing For The Aged	-25.881082°	29.189281°
	Emalahleni Private Hospital	-25.874996°	29.216316°
	Life Cosmos Hospital	-25.883956°	29.232671°
	Duvha Primary School	-25.928700°	29.228835°
	Laerskool Taalfees	-25.882069°	29.226736°
	Witbank Provincial Hospital	-25.876855°	29.226772°
	Nancy Shiba Primary School (Vosman)	-25.860442°	29.127636°
	Wh De Klerk Skool	-25.867762°	29.246453°
	Laerskool Panorama	-25.852265°	29.244652°

Area	Sensitive Receptors	Latitude	longitude
	Laerskool Duvhapark	-25.938354°	29.245539°
	Laerskool Klipfontein	-25.904014°	29.241984°
	Cambridge Academy	-25.893439°	29.251575°
	Besilindile Primary School	-25.839035°	29.116774°
	Reynopark High School	-25.916428°	29.252116°
	Bakenveld Golf Estate	-25.905932°	29.292706°
	Mms Primary School	-25.905558°	29.385417°
	Bongiduvha Primary School	-25.983853°	29.335681°
	Springvalley Primary School	-25.921086°	29.260948°
	Joy Crèche	-25.972528°	29.308427°
	Curro Bankenveld Preschool And Primary School	-25.905248°	29.277348°
	Little Eden Academy	-25.917056°	29.253835°
	Little Steps Pre School	-25.944674°	29.251428°
	Allendale Secondary School	-25.982387°	29.338986°
	Khayalethu Primary School	-25.877710°	29.189130°
	Illanga Secondary School	-25.955537°	29.327107°
	Joy Creche (Duvha)	-25.972408°	29.308161°
Middelburg	Linderus Old Age Home	-25.784009°	29.459212°
	Vergeet My Nie Old Age Home	-25.780787°	29.449413°
	Middleburg Frail Care Unit And Home For Elderly	-25.746481°	29.471782°
	Life Midmed Hospital	-25.763147°	29.457650°
	Middelburg Hospital	-25.775692°	29.450413°
	Makhathini Primary School	-25.749305°	29.448461°
	Laerskool Dennesig	-25.733488°	29.478283°
	Hoerskool Kanonkop	-25.742627°	29.479874°
	Laerskool Kanonkop	-25.751354°	29.470764°
	Steelcrest High School	-25.759514°	29.468012°
	Middelburg Primary	-25.778514°	29.453271°

Area	Sensitive Receptors	Latitude	longitude
	Middleburg Ext 6 Clinic	-25.768193°	29.407838°
	Sofunda Secondary School	-25.754358°	29.423801°
	Mhluzi Primary School	-25.753279°	29.440498°
	Highlands Primary School	-25.795886°	29.463428°
Komati	Blinkpan Primary School	-26.089884°	29.444406°
	Laerskool Koornfontein	-26.099868°	29.456226°
	Blinkpan	-26.086337°	29.433989°
Pullens Hope	Laerskool Kragveld	-26.016735°	29.590369°
	Pullens Hope	-26.020916°	29.597472°
Rietkuil / Arnot	Arnot Colliery Primary School	-25.932110°	29.780624°
	Laerskool Rietkuil	-25.949477°	29.807062°
	Beestepan Agricultural School	-25.841453°	29.709393°
Hendrina	Gekombineerde Skool Hendrina	-26.151386°	29.713726°
Kwazamokhule	Hendrina Primary School	-26.136847°	29.729098°
	Kwazamokuhle Secondary School	-26.131117°	29.732418°
Lothair	Ubuhle Bolwai Secondary School	-26.391734°	30.452159°
	Lothair Primary School	-26.394524°	30.428535°
Warburton	Warburton Combined School	-26.239852°	30.472477°
	Warburton Town	-26.227585°	30.472905°
Chrissiesmeer	Kwachibikhulu Clinic	-26.280125°	30.213918°
	Kwachibikhulu Primary School	-26.272378°	30.221621°
Carolina	Carolina Hospital	-26.074581°	30.111313°
	Zinikeleni Secondary School (Silobela)	-26.087874°	30.109848°
	Volkskool Carolina	-26.062907°	30.106394°
	Sobuza Primary School	-26.080382°	30.122447°
	Ons Eie Ouetehuis (Old Age Home)	-26.065018°	30.112066°
Breyten	Laerskool Breyten	-26.301603°	29.979961°
	Siyazi Primary School (Kwazanele)	-26.316644°	29.977882°

Area	Sensitive Receptors	Latitude	longitude
	Masizakhe Secondary School (Kwazanele)	-26.315348°	29.984385°
Belfast	Belfast Rusoord (Old Age Home)	-25.691737°	30.031956°
	Belfast Hospital	-25.696074°	30.043783°
	Platorand School	-25.704015°	30.047859°
	Belfast Primary School (Siyathuthuka)	-25.675303°	29.991119°
	Siyathuthuka Clinic	-25.676301°	29.995601°
Bethal	Life Bethal Hospital	-26.464532°	29.467456°
	Hoerskool Hoogenhout	-26.461930°	29.472023°
	Jim Van Tonderskool	-26.436887°	29.450970°
	Bethal Independent Primary School	-26.442824°	29.454517°
	Laerskool Marietjie Van Niekerk	-26.440565°	29.489773°
	Laerskool Hm Swart	-26.459925°	29.465474°
	Sakhisizwe Primary School (Emzinoni)	-26.492311°	29.427359°
	Alpheus D Nkosi Secondary School (Emzinoni)	-26.480923°	29.446290°
	Silwerjare Old Age Home	-26.470954°	29.465659°
	Residentia Palm Oord	-26.460488°	29.462766°
Bronkhorstspruit	Bronkhorspruit Hospital	-25.803183°	28.716819°
	Cultura High School	-25.824833°	28.739116°
	Bronkhorspruit Primary School	-25.809124°	28.710617°
	Bronkhorspruit Dam	-25.891281°	28.697112°
	Hoerskool Erasmus	-25.813056°	28.732392°
	Althea Independent School	-25.809393°	28.739630°
	Kgoro Primary School (Zithobeni)	-25.787526°	28.718686°
	Zithobeni Secondary School (Zithobeni)	-25.776080°	28.729297°
Sasolburg	Vaal Power Ah	-26.823034°	27.995199°
	Sasolburg Provincial Hospital	-26.801004°	27.827226°
	Moredou Old Age Home	-26.820627°	27.818609°
	Ons Gryse Jeug Old Age Home	-26.808971°	27.829287°

Area	Sensitive Receptors	Latitude	longitude
	Noord Primere Skool	-26.809079°	27.833205°
	Sasolburg High School	-26.809493°	27.815540°
Zamdela	Sakhubusa Secondary School	-26.864383°	27.872379°
	Bekezela Primary School	-26.858275°	27.895183°
	Isaac Mhlambi Primary	-26.843253°	27.860477°
Deneysville	Refenkgotso Primary School	-26.896796°	28.071849°
	Deneysville Primary School	-26.894767°	28.091936°
Vaalpark	Netcare Vaalpark Hospital	-26.772921°	27.840020°
	Vaalpark Articon Secondary School	-26.766998°	27.854563°
Vanderbijlpark	Mediclinic Emfuleni	-26.705051°	27.837480°
	Curro Vanderbijlpark	-26.721637°	27.881353°
	Jeugland Old Age Home	-26.714240°	27.829000°
	Herfsoord Huis Old Age Home	-26.705218°	27.828579°
	Vaal Christian Combined School	-26.760827°	27.945336°
	Pele-Ya-Pele Secondary School	-26.758447°	27.948168°
	Huis Prinscilla	-26.686758°	27.830074°
	Laerskool Emfulenipark	-26.736622°	27.848162°
	Nw University_Vaal Campus	-26.729104°	27.882396°
	Emfuleni Primary School	-26.701230°	27.798581°
Vereeniging	Mediclinic Vereeniging	-26.669380°	27.927271°
	Kopanong Provincial Hospital (Duncanville)	-26.638409°	27.933352°
	Pride Junior High School	-26.673626°	27.930727°
	Milton Primary School	-26.664438°	27.967937°
	Avondrus Eventide Old Age Home	-26.642726°	27.934453°
	Riviera On Vaal Resort	-26.675535°	27.939516°
	Selborne Primary School	-26.670181°	27.918206°
	Sedibeng TVET College	-26.679262°	27.931965°
	General Smuts High School	-26.672889°	27.917628°

Area	Sensitive Receptors	Latitude	longitude
	Eureuka School & Selbourne Primary	-26.670308°	27.914584°
Three Rivers	Midvaal Private Hospital (Three Rivers)	-26.663943°	27.969386°
	Three Rivers Retirement Village	-26.654433°	27.970966°
	Drie Riviere Aftreeoord Old Age Home	-26.648419°	27.972201°
	Fundamental Faculty And Factory	-26.662652°	27.979278°
	Mannabos Retirement Centre	-26.659008°	28.007140°
	Riverside High School	-26.657354°	27.997307°
	Hoërskool Drie Riviere	-26.658617°	27.974794°
	Laerskool Drie Riviere	-26.656514°	27.967703°
	Panfontein Intermediate School	-26.718701°	28.017031°
	Risiville Primary School	-26.645815°	27.982017°
Sebokeng	Sebokeng Hospital	-26.607161°	27.847550°
	Clinix-Naledzi Private Hospital	-26.616004°	27.848311°
Sharpville	Mohloli Secondary School	-26.691794°	27.878703°
	Tshirela Primary School (Boipatong)	-26.667125°	27.846609°
	Tsoaranang Primary School (Thepiso)	-26.672748°	27.875504°
	Thepiso Primary School	-26.652388°	27.875650°
	Emmanuel Primary School	-26.676238°	27.883255°
Rust Ter Vaal	Rust Ter Vaal Combined School	-26.575722°	27.947132°
Dadaville	Roshnee Primary School	-26.557834°	27.940930°
	Roshnee High School	-26.566323°	27.942320°
Meyerton	Hoerskool Dr Malan	-26.564977°	28.019234°
	Laerskool Voorwaarts	-26.601766°	28.046543°
	Meyerton Secondary School	-26.585957°	28.003034°
	Ratasetjhaba Primary School	-26.553412°	27.983147°
	Meyerton Primary School	-26.553487°	28.020296°
Henley On Klip	Oprah Leadership Academy	-26.547041°	28.055309°
	Henley River Retirement Village	-26.548818°	28.062594°

Area	Sensitive Receptors	Latitude	longitude
	Henley High & Preparatory School	-26.528413°	28.060892°
	Randvaal Clinic	-26.515421°	28.044906°
Daleside / Valley Settlements	Laerskool Japie Greyling	-26.492618°	28.065508°
	Thomas Nhlapo Primary	-26.506179°	28.069969°
	Randvaal Old Age Home	-26.491357°	28.032070°
Heidelberg	Laerskool Ag Visser	-26.527385°	28.364387°
	Lethaba Siyangobe	-26.535127°	28.363146°
	Shalimar Ridge Primary School	-26.512296°	28.352566°
	Jw Luckoff High School	-26.550141°	28.377976°
	Heidelberg Hospital	-26.505180°	28.350463°
	Thulatsatsi Operation (Rensburg)	-26.524848°	28.363676°
	Silwer Akker Tehuis	-26.510276°	28.356255°
	Riversands Retirement Village	-26.507195°	28.343400°
Ratanda	Qhaqholla Primary School	-26.550719°	28.325743°
	Ratanda Primary School	-26.571045°	28.323848°
	Boneha Primary School	-26.551890°	28.328050°
	Sithokomele Primary School	-26.552180°	28.332480°
	Ratanda Bertha Gxowa Primary School	-26.539078°	28.360724°
	Khanya Lesedi Secondary School	-26.558920°	28.323980°
	Ratanda Secondary School	-26.556930°	28.327600°
	New Ratanda Secondary School	-26.536066°	28.356365°
	Kgoro Ya Thuto Secondary School	-26.536087°	28.356288°
Katlehong	Ekurhuleni School For The Deaf	-26.345596°	28.163239°
Tsakane	Pholosong Hospital	-26.340323°	28.376981°
	Tsakane Home For Aged	-26.359892°	28.371919°
	Mmuso Primary School	-26.380790°	28.406465°
	Michael Zulu Primary School	-26.345305°	28.387950°
	Nkabinde Primary School (Thembilisha)	-26.303995°	28.403039°

Area	Sensitive Receptors	Latitude	longitude
Nigel	Nigel Clinic	-26.419586°	28.467950°
	Tehuis Vir Bejaardes	-26.422307°	28.479643°
	Hoerskool John Vorster	-26.427357°	28.472668°
	Laerskool Hannes Visagie	-26.427603°	28.494581°
	Nigel Secondary School	-26.447243°	28.514293°
	Laerskool Dunnottar	-26.346668°	28.431510°
Springs	Springs Retirement Village	-26.255461°	28.447029°
	Life Springs Parkland Hospital	-26.266018°	28.435500°
	Netcare N17 Hospital (Springs)	-26.271306°	28.427831°
	Springs Boys High School	-26.298323°	28.442511°
	Laerskool Selectionpark	-26.280731°	28.447617°
	Kwasa College Pre&Primary School	-26.290089°	28.483292°
	Edelweis Medical Centre	-26.285282°	28.469920°
	Laerskool Christiaan Beyers	-26.260785°	28.462528°
	Hoerskool Hugenote	-26.240027°	28.434373°
Brakpan	Brakpan Primary School	-26.243109°	28.373344°
Boksburg	Parkrand Primary School	-26.249653°	28.276180°
	Thabo Memorial Hospital	-26.232875°	28.244243°
	Sunward Park Hospital	-26.260136°	28.256683°
Alberton	Alberton High School	-26.281920°	28.117084°
	Netcare Clinton Hospital	-26.273268°	28.120227°
	Alberton Tuiste Vir Bejaardes	-26.278995°	28.113435°
Germiston	Bertha Gxowa Hospital	-26.220611°	28.165186°
Benoni	Linmed Hospital	-26.145829°	28.330060°
	Hoerskool Brandwag (Airfield)	-26.174468°	28.317457°
	Thepiso Noto Intermediate School	-26.110681°	28.478384°
	Laerskool Bredell	-26.095549°	28.309374°
	Sibonelo Primary School (Daveyton)	-26.133366°	28.428877°

Area	**Sensitive Receptors**	**Latitude**	**longitude**
	Petit High School (Kempton Park Nu)	-26.097238°	28.371925°
Kempton Park	Arwyp Medical Centre	-26.106876°	28.233229°
	Hoerskool Birchleigh	-26.055418°	28.234975°
	Curro Serengeti Acadamy	-26.056936°	28.294549°
JHB South	South Rand Hospital	-26.252897°	28.062148°
Soweto	Chris Hani Baragwanath Hospital	-26.261492°	27.940355°
	Thulani Primary School	-26.245828°	27.848300°
Johannesburg	University Of Witwatersrand	-26.189947°	28.031656°
	Milpark Hospital	-26.180234°	28.017865°
	Charlotte Maxixe Academic Hospital	-26.175864°	28.045603°
	Thembisa West Secondary School (Thembisa)	-26.026012°	28.184597°
	Lenmed Zamokuhle Private Hospital (Thembisa)	-25.983681°	28.237972°
	Ikusasa Comprehensive School	-26.009079°	28.242320°
Centurion	Gem Village Old Age Home	-25.890517°	28.235196°
	Rustoord Old Age Home	-25.828157°	28.203777°
	Cornwell Hill College (Irene)	-25.873186°	28.234287°
Pretoria East	Kleinfontein Sorg Sentrum Old Age Home (Donkerhoek)	-25.799673°	28.486162°
	Valtaki AH (Rayton)	-25.777795°	28.584606°
	Laerskool Rayton (Rayton)	-25.744732°	28.527243°
	Tierkop AH	-25.902813°	28.422585°
	Redford House The Hills Private School (Mooikloof Glen)	-25.872295°	28.361134°
	Rietvlei View Country Estate	-25.884742°	28.372901°
	Hazeldean Curro School (Tyger Valley)	-25.780919°	28.387427°
	Tyger Valley College	-25.801750°	28.369799°
	Pretoria East Hospital (Moreletapark)	-25.820584°	28.304652°
	Groenkloof Old Age Home	-25.770356°	28.217846°
Pretoria	Steve Biko Academic Hospital	-25.729693°	28.203318°
	Willow Ridge High School (Wilgers)	-25.760751°	28.315444°

Area	Sensitive Receptors	Latitude	longitude
	Hoerskool Waterkloof	-25.818863°	28.255795°
	Hoerskool Garsfontein	-25.797751°	28.304342°
	Afrikaanse Hoer Seunskool	-25.758166°	28.220742°
	Huis Silversig Savf Old Age Home (Silverton)	-25.732724°	28.297254°
	Laersekool Meyerspark (Meyerspark)	-25.740127°	28.313935°
Mamelodi	Curro Academy Mamelodi	-25.698567°	28.422449°
	Impendulo Primary School	-25.723669°	28.437518°
	Nellmapius Ext 6 Primary School	-25.733098°	28.375745°
	Mamelodi Home For Aged	-25.714091°	28.415290°

ANNEXURE 2: PREDICTED CONCENTRATIONS AT SENSITIVE RECEPTORS

Predicted concentrations in µg/m³ at the sensitive receptors for Scenario 1 (Current), together with the limit value of the NAAQS and number of exceedances (NoE)

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	350	125	50	200	40	75	12	40	40	12	20
Elsie Ballot Memorial Hospital	89.6	41.6	8.5	45.4	2.8	27.7		5.1	27.7		5.1
Laerskool Amersfoort	86.5	40.1	8.3	44.2	2.7	27.4		5.0	27.4		5.0
Embuzane Primary School	134.9	64.2	10.5	81.8	4.4	45.5		7.7	**45.5**	1	7.7
Sangqotho Primary School	73.3	38.3	8.1	30.3	2.4	29.3		5.5	29.3		5.5
Amersfoort Combined School	88.7	45.2	8.5	44.3	2.8	27.4		5.1	27.4		5.1
Injubuko Primary School	68.3	34.8	7.9	29.1	2.3	26.1		4.9	26.1		4.9
Daggakraal Primary School	94.1	41.0	9.5	53.4	3.6	28.5		5.0	28.5		5.0
Sizenzele Primary School	104.5	46.6	9.8	61.2	3.8	34.8		5.5	34.8		5.5
Seme Secondary School	88.8	41.4	9.6	50.1	3.6	30.7		5.2	30.7		5.2
Louwra Primary School	71.3	36.7	6.3	30.9	1.8	29.0		4.2	29.0		4.2
Perdekop Agricultural School	65.6	37.2	6.3	26.5	1.7	34.5		5.5	34.5		5.5
Vukuzenzele Combined School	68.7	36.5	6.4	26.9	1.7	34.1		5.5	34.1		5.5
Gunwana Primary School	66.4	36.2	6.0	25.3	1.6	25.9		4.1	25.9		4.1
Amajuba Memorial Hospital	59.4	32.5	5.5	23.1	1.4	23.2		3.5	23.2		3.5
Volksrust High School	60.3	33.7	5.5	23.2	1.4	23.9		3.5	23.9		3.5
Volksrust Municipal Clinic	59.4	33.0	5.4	22.8	1.4	22.4		3.4	22.4		3.4
C V O Skool Amajuba	60.3	33.4	5.4	23.0	1.4	23.4		3.4	23.4		3.4
Qhubulwazi Combined School	58.8	31.8	5.4	22.5	1.4	22.7		3.4	22.7		3.4
Volksrust Primary School	60.0	33.0	5.7	23.7	1.5	24.5		3.7	24.5		3.7
New Ermelo	65.0	34.1	8.4	26.0	2.4	35.4		5.5	35.4		5.5
Ermelo Christian School	67.1	36.3	8.6	27.7	2.6	35.4		5.6	35.4		5.6
SAVF Home For Aged	64.3	33.9	8.5	27.0	2.5	29.9		5.1	29.9		5.1
Ermelo Hospital	63.9	33.9	8.4	26.3	2.5	29.5		5.1	29.5		5.1
Mediclinic Ermelo	66.7	36.1	8.6	27.8	2.6	33.7		5.5	33.7		5.5
Hoerskool Ermelo	63.9	33.9	8.4	26.6	2.5	29.6		5.1	29.6		5.1

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Ermelo Indian Combined School	62.8	33.9	8.3	25.9	2.4	29.4		5.1	29.4		5.1
Lungelo Combined School (Outside Town)	63.5	34.2	7.8	26.1	2.3	27.8		5.3	27.8		5.3
New Ermelo Primary School	65.2	34.8	8.4	25.7	2.5	34.9		5.5	34.9		5.5
Kwashashe (Outside Town)	60.7	34.4	8.4	24.0	2.4	30.2		5.1	30.2		5.1
Hts Ligbron	66.0	36.1	8.5	27.1	2.5	31.8		5.3	31.8		5.3
Laerskool Ermelo	63.5	33.8	8.4	26.1	2.5	29.4		5.1	29.4		5.1
JJ Vd Merwe Pre-Primary School	66.0	35.8	8.5	27.6	2.5	30.5		5.3	30.5		5.3
Lindile Secondary School	62.9	33.1	8.2	25.6	2.4	29.2		5.0	29.2		5.0
Emthonjeni Clinic	62.2	33.9	8.3	25.3	2.4	29.5		5.0	29.5		5.0
Reggie Masuku Secondary School	60.7	34.1	8.2	24.0	2.4	29.2		5.0	29.2		5.0
Cebisa Secondary School	61.7	33.9	8.2	25.0	2.4	29.5		5.0	29.5		5.0
Camden	72.8	51.1	8.8	29.3	2.7	**188.2**	**78**	26.3	**188.2**	**222**	**26.3**
Camden Combined School	91.5	63.2	10.1	40.1	3.5	**107.2**	10	18.1	**107.2**	**113**	18.1
Camden School	78.7	47.5	9.1	32.9	2.9	**205.8**	**96**	27.7	**205.8**	**195**	**27.7**
Umzimvelo Secondary School (Rural Area)	72.3	38.2	8.9	29.9	2.7	32.1		4.9	32.1		4.9
Bhekimfundo Primary School (Rural Area)	70.3	38.4	8.6	30.0	2.6	37.0		6.4	37.0		6.4
Eshwileni Primary School (Rural Area)	64.3	36.2	7.9	25.2	2.2	28.1		5.2	28.1		5.2
Davel Combined School	72.4	35.0	8.4	33.0	2.7	32.8		6.2	32.8		6.2
Morgenzon Landbou Akademie	69.3	34.6	8.0	27.7	2.3	31.4		5.7	31.4		5.7
Nqobangolwazi Secondary School	68.8	33.9	7.9	27.6	2.3	31.2		5.7	31.2		5.7
Siqondekhaya Pre Primary School	68.1	34.3	7.9	28.0	2.3	31.7		5.7	31.7		5.7
Sizakhele Primary School	68.2	34.0	7.9	27.7	2.3	32.0		5.7	32.0		5.7
Phezukwentaba Primary School (South of Morgenzon)	66.8	33.1	8.0	26.8	2.3	32.0		5.7	32.0		5.7
Kwaggalaagte Primary School (North of Morgenzon)	74.9	36.9	7.6	34.0	2.3	34.4		6.1	34.4		6.1
Sizakhele Clinic/Hospital	68.1	34.1	7.9	27.7	2.3	31.8		5.7	31.8		5.7
Grootvlei	63.2	31.7	5.2	21.3	1.4	**163.2**	**82**	21.8	**163.2**	**211**	**21.8**
Olive Grove Country Lodge	66.1	34.9	5.4	23.0	1.4	**91.3**	1	9.3	**91.3**	**33**	9.3
Grootvlei Town (South of Power Station)	63.3	30.5	5.3	20.7	1.4	68.5		12.9	**68.5**	**34**	12.9
Laerskool Grootvlei	63.8	31.2	5.3	21.1	1.4	73.4		11.8	**73.4**	**44**	11.8

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Tokoloho Primary School	62.5	30.5	5.4	20.5	1.4	64.1		11.1	**64.1**	**16**	11.1
Tshepeha Combined School	64.3	30.7	5.3	20.8	1.4	**78.7**	1	14.9	**78.7**	**64**	14.9
Warembo Lodge	58.1	30.1	5.7	19.0	1.5	47.3		5.5	**47.3**	1	5.5
Balfour	57.8	30.6	5.1	19.0	1.3	27.7		3.6	27.7		3.6
Siyathemba	58.1	31.5	5.2	18.6	1.3	28.3		3.6	28.3		3.6
Bonukukhanya Primary (Siyathemba)	58.5	31.1	5.2	18.7	1.3	27.9		3.6	27.9		3.6
Qalabocha Primary School (Siyathemba)	58.2	31.5	5.1	18.8	1.3	28.0		3.6	28.0		3.6
Vusumuzi Primary School	58.2	32.1	5.2	18.8	1.3	28.0		3.6	28.0		3.6
Gekombineerde Skool Balfour	58.4	30.4	5.1	18.7	1.3	27.9		3.7	27.9		3.7
Im Manchu Secondary School	58.1	30.4	5.1	18.8	1.3	28.0		3.6	28.0		3.6
Isifisosethu Secondary School (Siyathemba)	58.4	32.1	5.2	18.8	1.3	27.9		3.6	27.9		3.6
Setsheng Secondary School (Siyathemba)	58.1	32.1	5.2	18.9	1.3	28.1		3.6	28.1		3.6
Dr Nieuwoudt And Dr Kok	58.7	30.5	5.2	18.8	1.3	27.9		3.7	27.9		3.7
Balfour Clinic	58.0	30.3	5.1	18.7	1.3	28.1		3.6	28.1		3.6
Siyathemba Clinic	58.5	30.7	5.1	19.0	1.3	28.4		3.6	28.4		3.6
Mondoro Lodge	57.6	31.1	4.9	19.9	1.3	26.9		3.4	26.9		3.4
Wegelegen Manor	57.6	31.4	5.0	18.5	1.2	28.1		3.5	28.1		3.5
The Stone Cellar	56.2	29.3	4.5	18.0	1.1	24.5		3.0	24.5		3.0
Greylingstad	58.9	32.4	5.7	19.2	1.4	26.8		3.7	26.8		3.7
Nthorwane	58.6	31.7	5.5	18.6	1.3	26.8		3.7	26.8		3.7
Laerskool Greylingstad	59.4	33.2	5.8	19.9	1.5	27.2		3.8	27.2		3.8
Nthoroane Secondary School	58.7	31.6	5.6	18.5	1.3	26.8		3.7	26.8		3.7
Badgarleur Bush Lodge	55.2	31.2	5.6	18.2	1.4	25.4		3.7	25.4		3.7
Matla Village	100.6	50.4	7.8	39.9	2.4	**155.5**	**27**	18.5	**155.5**	**102**	18.5
Sifundise Primary School	101.8	49.4	7.8	39.0	2.4	**146.3**	**21**	17.7	**146.3**	**92**	17.7
Matla Coal Health Centre	102.1	54.6	7.9	41.5	2.5	**100.8**	5	14.5	**100.8**	**54**	14.5
Gweda Primary School	130.1	65.2	9.4	77.2	3.7	**114.0**	**15**	22.3	**114.0**	**164**	**22.3**
Zithobe Primary School	85.5	51.9	6.5	33.5	1.8	**75.3**	1	11.6	**75.3**	**17**	11.6
Kwanala Primary School	150.8	81.3	10.5	83.9	4.3	**160.3**	**44**	19.4	**160.3**	**128**	19.4
Reedstream Park	124.8	72.5	9.7	63.8	3.4	61.2		9.9	**61.2**	1	9.9
Rietspruit Clinic	126.5	66.7	9.5	60.4	3.2	54.3		9.4	**54.3**	1	9.4

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Lehlaka Combined School	124.7	67.2	9.6	59.7	3.2	53.3		9.5	**53.3**	1	9.5
Mbali Coal/Blesboklaagte Housing	103.5	50.0	8.4	38.1	2.6	45.5		8.0	**45.5**	1	8.0
Kinross	91.2	57.7	7.2	47.3	2.3	**84.0**	1	10.0	**84.0**	**27**	10.0
Kinross Settlement	83.1	53.6	6.6	34.3	2.0	**79.0**	1	9.3	**79.0**	**14**	9.3
Kinross Municipal Clinic	89.6	57.0	7.1	44.3	2.2	**83.1**	1	9.6	**83.1**	**21**	9.6
Kriel	133.2	56.1	11.3	83.2	5.0	**98.1**	1	12.6	**98.1**	**30**	12.6
Eagles Nest Guest House	132.5	56.2	11.4	82.2	5.1	**101.0**	1	12.1	**101.0**	**19**	12.1
Merlin Park Primary School	129.3	59.2	11.1	82.1	4.7	**80.7**	1	10.3	**80.7**	6	10.3
Kriel Medical Centre	130.6	56.0	11.1	80.1	4.8	**82.9**	1	10.7	**82.9**	9	10.7
Laerskool Krielpark	135.4	57.3	11.2	83.7	4.9	**91.3**	1	11.4	**91.3**	**18**	11.4
Laerskool Onverwacht	131.6	59.6	11.1	83.7	4.7	73.0		10.3	**73.0**	9	10.3
Silwer Fleur Aftree Oord (Old Age Home)	134.8	57.7	11.2	85.2	4.7	74.4		10.6	**74.4**	**14**	10.6
Thubelihle	138.6	66.4	10.5	87.3	4.2	55.8		9.1	**55.8**	1	9.1
Sibongamandla Secondary School	135.5	63.6	10.4	85.3	4.1	54.9		9.4	**54.9**	1	9.4
Ga-Nala Clinic	141.1	63.0	10.9	89.4	4.5	66.6		9.7	**66.6**	3	9.7
Impilo Primary School	105.7	53.0	9.1	62.3	3.3	47.2		8.5	**47.2**	1	8.5
Bonginhlanhla Primary School	135.9	64.3	10.3	83.9	4.1	56.9		9.3	**56.9**	1	9.3
Sibongamandla Secondary School	135.1	63.4	10.3	85.4	4.1	55.3		9.4	**55.3**	1	9.4
Leandra	70.1	44.8	5.7	22.7	1.6	44.6		7.4	**44.6**	1	7.4
Eendracht	71.4	42.2	5.7	23.3	1.5	42.4		6.6	**42.4**	1	6.6
Sidingulwazi Primary School	70.9	43.9	5.7	22.8	1.5	44.2		6.9	**44.2**	1	6.9
Ss Mshayisa Primary School	69.6	43.7	5.7	22.6	1.5	47.3		7.1	**47.3**	1	7.1
Chief Ampie Mayisa Secondary School	70.0	44.4	5.7	22.9	1.5	44.6		6.9	**44.6**	1	6.9
Lebogang Clinic	70.7	43.8	5.7	22.9	1.5	44.6		7.1	**44.6**	1	7.1
Kleuterskool Haas Das	57.4	31.4	5.8	19.1	1.3	31.2		4.7	31.2		4.7
Standerton Primary School	56.7	31.7	5.8	19.3	1.3	31.4		4.8	31.4		4.8
Laerskool Jeugkrag	56.8	33.1	5.8	19.0	1.4	33.1		4.9	33.1		4.9
Laerskool Standerton	58.1	31.0	5.8	19.3	1.3	31.0		4.7	31.0		4.7
Laerskool Kalie De Haas	58.5	31.2	5.9	20.2	1.4	30.9		4.6	30.9		4.6
Hoerskool Standerton	56.7	31.8	5.8	19.3	1.3	31.4		4.8	31.4		4.8
Standerton Provincial Government Hospital	57.0	31.5	5.8	19.0	1.3	31.6		4.8	31.6		4.8

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Mar-Peh Medicare Private Hospital	57.8	30.7	5.8	19.1	1.3	31.0		4.7	31.0		4.7
Standerton Retirement Home	57.8	30.7	5.8	19.1	1.3	30.9		4.7	30.9		4.7
Standerton Ouetehuis/Old Age Home	58.3	31.1	5.8	19.6	1.4	30.8		4.7	30.8		4.7
Holmdene Secondary School	60.7	34.9	5.8	19.3	1.4	32.0		4.5	32.0		4.5
Cathuza Primary School (SE of Town)	62.6	36.0	6.2	23.7	1.5	33.5		5.2	33.5		5.2
Sizanani Pre Primary School	56.1	31.4	5.8	18.6	1.3	30.7		4.6	30.7		4.6
Hlobisa Primary School	55.0	31.6	5.7	17.9	1.3	30.1		4.5	30.1		4.5
Shukuma Primary School	54.7	31.5	5.7	18.4	1.3	30.4		4.4	30.4		4.4
Retsebile Primary School	55.7	31.8	5.8	17.9	1.3	30.7		4.6	30.7		4.6
Thuto-Thebe Secondary School	57.0	32.2	5.8	18.6	1.3	32.3		4.7	32.3		4.7
Jandrell Secondary School	55.5	31.5	5.8	18.1	1.3	30.4		4.6	30.4		4.6
Thobelani Secondary School	55.7	31.6	5.8	17.9	1.3	31.2		4.6	31.2		4.6
Standerton Tb Hospital	55.9	31.2	5.7	18.9	1.3	30.2		4.5	30.2		4.5
Thuthukani Pre Primary School	62.2	40.5	6.2	22.7	1.5	45.0		7.2	**45.0**	1	7.2
Ulwazi Primary School	61.9	40.1	6.2	22.1	1.5	43.4		7.0	**43.4**	1	7.0
Zikhetheleni Secondary School	62.1	40.1	6.2	22.0	1.5	44.1		7.0	**44.1**	1	7.0
Joubertsvlei Primary School (North of Tutuka)	71.6	36.5	6.8	27.0	1.8	35.0		6.4	35.0		6.4
Amalumgelo Primary School (NE of Tutuka)	84.2	40.1	8.0	34.7	2.3	53.3		7.8	**53.3**	1	7.8
Grootdraaidam Primary School	62.3	38.0	6.2	22.3	1.5	34.9		5.4	34.9		5.4
Laerskool Secunda	74.5	46.5	6.7	29.5	1.8	52.2		8.2	**52.2**	1	8.2
Laerskool Kruinpark	73.5	44.0	6.8	31.7	1.9	50.5		8.5	**50.5**	1	8.5
Laerskool Oranjegloed Primary	73.0	45.9	6.6	28.8	1.8	49.8		8.0	**49.8**	1	8.0
Curro Castle Combined School	73.4	44.5	6.5	27.5	1.8	48.4		7.7	**48.4**	1	7.7
Hoërskool Oosterland	73.8	45.4	6.8	30.1	1.9	50.1		8.5	**50.1**	1	8.5
Mediclinic Secunda (Hospital)	75.4	44.7	6.6	29.5	1.8	51.7		8.0	**51.7**	1	8.0
Mediclinic Highveld (Hospital_Trichardt, Secunda)	79.7	48.7	7.2	37.1	2.1	56.7		9.8	**56.7**	1	9.8
Daviescourt/Davieshof Old Age Home	73.7	46.6	6.7	29.3	1.9	52.9		8.2	**52.9**	1	8.2
Highveld Park High School	73.6	46.2	6.8	29.7	1.9	50.7		8.5	**50.7**	1	8.5
Hoerskool Secunda	73.9	46.4	6.6	29.3	1.8	51.7		8.1	**51.7**	1	8.1

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Basizeni Special School	79.8	46.6	6.2	29.4	1.7	44.7		6.3	**44.7**	1	6.3
Maphala-Gulube Primary School	74.0	40.8	6.2	26.4	1.6	37.3		5.9	37.3		5.9
Shapeve Primary School	78.5	44.1	6.3	29.1	1.7	42.2		6.4	**42.2**	1	6.4
Thomas Nhlabathi Secondary School	77.4	47.6	6.2	29.1	1.6	41.8		6.0	**41.8**	1	6.0
Embalenhle Hospital / Clinic	77.9	43.9	6.2	28.0	1.6	40.9		6.0	**40.9**	1	6.0
Vukuzithathe Primary School	74.9	41.1	6.2	27.0	1.6	38.8		5.9	38.8		5.9
K I Twala Secondary	75.7	42.0	6.2	27.4	1.6	39.3		5.8	39.3		5.8
Allan Makunga Primary School	78.3	43.1	6.2	28.9	1.7	41.9		6.3	**41.9**	1	6.3
Evander Hospital Arv Clinic	86.4	47.5	6.8	37.8	2.0	58.5		8.2	**58.5**	1	8.2
Laerskool Hoeveld	85.8	47.4	6.7	37.5	2.0	56.8		8.0	**56.8**	1	8.0
Hoerskool Evander	84.9	49.1	6.6	37.9	1.9	59.9		7.8	**59.9**	1	7.8
Bernice Samuel Hospital	61.0	38.0	4.3	17.3	1.0	34.9		4.6	34.9		4.6
Hoerskool Delmas	60.6	37.5	4.3	16.8	1.0	34.8		4.6	34.8		4.6
Laerskool Delmas	62.0	37.6	4.3	17.3	1.0	35.3		4.7	35.3		4.7
Kangela Primary School (North of Delpark)	60.0	37.7	4.3	17.6	1.0	37.0		5.0	37.0		5.0
Savf Ons Eie Ouetehuis / Old Age Home	61.8	37.5	4.3	17.1	1.0	35.1		4.7	35.1		4.7
Laerskool Eloff	60.1	38.1	4.2	16.7	1.0	32.6		4.1	32.6		4.1
Rietkol Primary School	59.9	38.3	4.2	16.9	0.9	32.5		4.1	32.5		4.1
Bazani Primary School	59.0	36.1	4.2	17.9	1.0	36.9		5.1	36.9		5.1
Phaphamani Secondary School	58.8	36.0	4.2	17.7	0.9	36.8		5.0	36.8		5.0
Vezimfundo Primary School	57.6	35.7	4.1	17.3	0.9	36.5		5.0	36.5		5.0
Arbor Primary School	70.0	43.9	4.9	23.8	1.2	**78.5**	1	12.8	**78.5**	**32**	12.8
Ogies Combined School	99.4	48.4	7.1	32.1	2.0	50.4		7.4	**50.4**	1	7.4
Ogies Tb Clinic	99.9	50.3	7.0	31.5	2.0	50.4		7.4	**50.4**	1	7.4
Ogies Police Station	99.9	50.3	7.0	31.5	2.0	50.4		7.4	**50.4**	1	7.4
Hlangu Phala Primary School	93.6	44.7	6.2	29.3	1.8	42.6		6.3	**42.6**	1	6.3
Sukumani Primary School	94.8	44.7	6.2	29.1	1.8	43.9		6.3	**43.9**	1	6.3
Thuthukani Primary School	94.5	44.4	6.2	28.7	1.8	42.1		6.3	**42.1**	1	6.3
Mehlwana Secondary School	93.7	46.1	6.1	28.4	1.7	46.5		6.4	**46.5**	1	6.4
Makause Combined School	93.1	42.5	6.2	28.3	1.8	43.3		6.4	**43.3**	1	6.4
Sibongindawo Primary School	98.7	44.0	6.0	33.1	1.8	72.0		8.7	**72.0**	8	8.7

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Laerskool Balmoral	66.2	37.8	4.3	24.1	1.1	37.5		4.4	37.5		4.4
Clewer Primary School	78.8	45.7	5.5	23.0	1.4	39.0		5.1	39.0		5.1
Witbank High School	76.4	47.8	5.5	22.1	1.4	55.4		6.4	**55.4**	1	6.4
Eden Park Retirement Village	79.7	47.4	5.7	23.7	1.5	67.5		7.9	**67.5**	8	7.9
Savf House Immergroen Old Age Home	74.7	46.2	5.4	21.6	1.3	50.4		5.8	**50.4**	1	5.8
Mthimkulu Housing For The Aged	75.5	44.1	5.3	20.9	1.3	42.1		5.0	**42.1**	1	5.0
Emalahleni Private Hospital	74.5	47.4	5.3	21.0	1.3	47.8		5.5	**47.8**	1	5.5
Life Cosmos Hospital	76.4	48.2	5.5	22.3	1.4	61.5		6.5	**61.5**	1	6.5
Duvha Primary School	83.3	46.4	5.9	26.2	1.5	57.0		7.5	**57.0**	1	7.5
Laerskool Taalfees	75.9	47.8	5.5	21.7	1.4	56.9		6.3	**56.9**	1	6.3
Witbank Provincial Hospital	74.5	47.8	5.4	21.8	1.3	51.8		5.9	**51.8**	1	5.9
Nancy Shiba Primary School (Vosman)	70.3	42.5	4.9	19.3	1.2	35.1		3.9	35.1		3.9
Wh De Klerk Skool	76.6	45.5	5.4	22.2	1.3	41.5		4.7	**41.5**	1	4.7
Laerskool Panorama	75.2	45.8	5.2	21.3	1.2	36.8		4.1	36.8		4.1
Laerskool Duvhapark	85.8	47.1	6.1	27.2	1.6	63.4		8.5	**63.4**	3	8.5
Laerskool Klipfontein	80.5	47.9	5.7	23.8	1.5	68.7		8.1	**68.7**	12	8.1
Cambridge Academy	79.1	47.0	5.7	23.2	1.4	64.1		7.2	**64.1**	4	7.2
Besilindile Primary School	68.9	39.8	4.7	18.5	1.1	33.1		3.7	33.1		3.7
Reynopark High School	83.0	47.7	5.9	25.7	1.5	**82.0**	1	9.8	**82.0**	**32**	9.8
Bakenveld Golf Estate	83.1	46.5	5.9	25.5	1.5	54.1		5.9	**54.1**	1	5.9
Allendale Secondary School	84.9	51.2	6.8	32.6	1.9	49.6		9.7	**49.6**	1	9.7
Khayalethu Primary School	74.6	44.2	5.2	20.9	1.3	41.9		4.9	**41.9**	1	4.9
Illanga Secondary School	87.3	56.5	6.5	30.6	1.8	**87.5**	1	18.9	**87.5**	**84**	18.9
Joy Creche (Duvha)	82.3	50.2	6.4	29.6	1.7	52.8		8.3	**52.8**	1	8.3
Linderus Old Age Home	74.8	42.6	5.1	21.1	1.1	30.7		3.2	30.7		3.2
Vergeet My Nie Old Age Home	75.3	43.8	5.1	20.5	1.1	30.8		3.2	30.8		3.2
Middleburg Frail Care Unit And Home For Elderly	70.6	43.2	4.8	18.2	1.0	29.1		2.9	29.1		2.9
Life Midmed Hospital	73.3	43.7	4.9	19.6	1.1	29.1		3.0	29.1		3.0
Middelburg Hospital	75.6	44.2	5.1	20.5	1.1	30.8		3.2	30.8		3.2
Makhathini Primary School	72.0	44.9	4.9	19.0	1.0	29.5		2.9	29.5		2.9

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Laerskool Dennesig	68.9	43.2	4.7	17.6	1.0	29.2		2.9	29.2		2.9
Hoerskool Kanonkop	69.4	43.0	4.8	18.4	1.0	29.0		2.9	29.0		2.9
Laerskool Kanonkop	70.8	43.4	4.8	18.6	1.0	29.2		2.9	29.2		2.9
Steelcrest High School	71.3	43.1	4.9	19.3	1.0	29.3		3.0	29.3		3.0
Middelburg Primary	75.5	43.5	5.1	20.8	1.1	30.5		3.2	30.5		3.2
Middleburg Ext 6 Clinic	76.0	46.9	5.1	20.9	1.1	35.1		3.6	35.1		3.6
Sofunda Secondary School	73.5	44.6	5.0	20.3	1.1	32.2		3.2	32.2		3.2
Mhluzi Primary School	73.0	45.0	4.9	19.3	1.0	29.9		3.0	29.9		3.0
Highlands Primary School	76.5	44.3	5.2	21.8	1.2	31.4		3.3	31.4		3.3
Blinkpan Primary School	86.7	47.9	8.1	37.1	2.5	60.0		12.0	**60.0**	5	12.0
Laerskool Koornfontein	87.4	45.8	8.1	36.8	2.5	**91.7**	1	19.6	**91.7**	**140**	19.6
Blinkpan	87.9	49.3	8.1	37.0	2.4	53.5		10.8	**53.5**	1	10.8
Laerskool Kragveld	83.4	47.9	8.0	33.3	2.4	39.6		6.9	39.6		6.9
Pullens Hope	84.5	47.3	8.0	32.1	2.4	39.6		7.1	39.6		7.1
Arnot Colliery Primary School	75.7	50.0	6.8	24.8	2.0	**90.8**	1	9.1	**90.8**	**26**	9.1
Laerskool Rietkuil	80.6	43.5	7.2	30.3	2.2	**144.1**	**93**	26.1	**144.1**	**217**	**26.1**
Beestepan Agricultural School	67.3	42.3	5.6	20.3	1.3	29.0		3.5	29.0		3.5
Gekombineerde Skool Hendrina	67.5	38.2	8.0	25.4	2.3	38.9		7.4	38.9		7.4
Hendrina Primary School	66.9	38.0	8.0	25.0	2.3	39.4		7.1	39.4		7.1
Kwazamokuhle Secondary School	67.1	39.3	8.1	25.3	2.3	40.8		7.0	**40.8**	1	7.0
Ubuhle Bolwai Secondary School	51.9	32.7	7.2	15.8	1.7	25.5		4.0	25.5		4.0
Lothair Primary School	51.7	32.9	7.3	16.1	1.8	25.5		4.1	25.5		4.1
Warburton Combined School	50.3	32.9	7.0	14.3	1.6	25.5		3.8	25.5		3.8
Warburton Town	50.7	33.0	7.0	14.3	1.6	25.5		3.8	25.5		3.8
Kwachibikhulu Clinic	53.8	33.7	7.4	16.9	1.8	27.7		4.5	27.7		4.5
Kwachibikhulu Primary School	54.1	33.7	7.4	16.7	1.9	27.7		4.5	27.7		4.5
Carolina Hospital	56.2	33.8	7.1	17.7	1.8	31.7		4.6	31.7		4.6
Zinikeleni Secondary School (Silobela)	55.7	33.5	7.1	17.4	1.8	31.6		4.6	31.6		4.6
Volkskool Carolina	56.4	34.2	7.1	18.4	1.8	32.7		4.6	32.7		4.6
Sobuza Primary School	55.8	33.6	7.1	16.9	1.8	31.6		4.6	31.6		4.6
Ons Eie Ouetehuis (Old Age Home)	56.4	34.2	7.1	18.3	1.9	32.5		4.6	32.5		4.6

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Laerskool Breyten	55.7	32.6	7.7	20.7	2.2	28.4		5.2	28.4		5.2
Siyazi Primary School (Kwazanele)	55.8	32.9	7.8	21.2	2.2	27.7		5.1	27.7		5.1
Masizakhe Secondary School (Kwazanele)	55.8	32.8	7.7	21.0	2.2	27.7		5.1	27.7		5.1
Belfast Rusoord (Old Age Home)	51.5	35.0	4.5	13.7	0.9	23.1		2.5	23.1		2.5
Belfast Hospital	51.6	34.9	4.6	14.1	1.0	23.2		2.5	23.2		2.5
Platorand School	52.4	35.2	4.7	14.4	1.0	23.2		2.5	23.2		2.5
Belfast Primary School (Siyathuthuka)	51.9	31.5	4.4	13.5	0.9	22.1		2.4	22.1		2.4
Siyathuthuka Clinic	51.8	31.7	4.4	13.6	0.9	22.0		2.4	22.0		2.4
Life Bethal Hospital	89.7	41.4	8.5	45.6	3.0	40.3		7.3	**40.3**	1	7.3
Hoerskool Hoogenhout	90.0	41.8	8.5	45.6	3.0	40.1		7.2	**40.1**	1	7.2
Jim Van Tonderskool	95.8	41.2	8.7	49.5	3.2	45.0		7.9	**45.0**	1	7.9
Bethal Independent Primary School	94.9	41.4	8.7	48.7	3.1	44.2		7.8	**44.2**	1	7.8
Laerskool Marietjie Van Niekerk	88.3	39.5	8.7	45.3	3.1	39.6		7.3	39.6		7.3
Laerskool Hm Swart	90.6	42.4	8.5	46.3	3.0	41.2		7.3	**41.2**	1	7.3
Sakhisizwe Primary School (Emzinoni)	86.7	41.8	8.1	44.7	2.7	42.6		7.6	**42.6**	1	7.6
Alpheus D Nkosi Secondary School (Emzinoni)	86.5	41.4	8.2	45.8	2.8	41.3		7.4	**41.3**	1	7.4
Silwerjare Old Age Home	88.1	42.4	8.4	44.7	2.9	41.0		7.2	**41.0**	1	7.2
Residentia Palm Oord	90.6	42.4	8.5	46.5	3.0	41.4		7.4	**41.4**	1	7.4
Bronkhorspruit Hospital	49.5	32.5	3.2	11.5	0.6	30.4		3.0	30.4		3.0
Cultura High School	52.8	33.9	3.4	12.9	0.6	35.4		3.4	35.4		3.4
Bronkhorspruit Primary School	50.2	32.3	3.2	12.0	0.6	30.5		3.0	30.5		3.0
Bronkhorspruit Dam	54.6	35.3	3.5	14.9	0.7	36.4		4.1	36.4		4.1
Hoerskool Erasmus	51.5	33.7	3.3	12.1	0.6	32.9		3.2	32.9		3.2
Althea Independent School	51.1	33.3	3.3	12.2	0.6	31.7		3.1	31.7		3.1
Kgoro Primary School (Zithobeni)	48.3	32.0	3.2	11.1	0.6	28.7		2.8	28.7		2.8
Zithobeni Secondary School (Zithobeni)	47.8	31.7	3.1	10.6	0.6	29.5		2.8	29.5		2.8
Vaal Power AH	74.1	41.0	4.3	24.4	1.2	68.8		9.1	**68.8**	**30**	9.1
Sasolburg Provincial Hospital	59.8	49.3	3.3	16.5	0.8	39.3		3.4	39.3		3.4
Moredou Old Age Home	58.4	47.1	3.3	15.5	0.8	35.0		3.1	35.0		3.1
Ons Gryse Jeug Old Age Home	58.1	48.9	3.3	16.0	0.8	36.6		3.3	36.6		3.3

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Noord Primere Skool	58.0	49.3	3.3	15.8	0.8	37.1		3.3	37.1		3.3
Sasolburg High School	58.5	48.1	3.2	15.9	0.8	38.0		3.1	38.0		3.1
Sakhubusa Secondary School	63.4	40.3	3.4	18.0	0.8	42.9		3.7	**42.9**	1	3.7
Bekezela Primary School	63.3	37.4	3.4	18.8	0.8	47.3		4.3	**47.3**	1	4.3
Isaac Mhlambi Primary	58.9	42.6	3.4	16.1	0.8	48.3		3.9	**48.3**	1	3.9
Refenkgotso Primary School	88.3	37.5	5.1	33.7	1.5	40.9		4.6	**40.9**	1	4.6
Deneysville Primary School	91.3	35.7	5.3	33.5	1.6	32.8		4.3	32.8		4.3
Netcare Vaalpark Hospital	58.6	51.6	3.3	16.0	0.8	50.4		4.4	**50.4**	1	4.4
Vaalpark Articon Secondary School	58.6	51.5	3.4	15.7	0.8	54.8		4.9	**54.8**	1	4.9
Mediclinic Emfuleni	53.2	37.3	3.0	14.0	0.7	43.4		3.5	**43.4**	1	3.5
Jeugland Old Age Home	53.3	39.6	3.0	14.0	0.7	37.6		3.4	37.6		3.4
Herfsoord Huis Old Age Home	53.5	36.4	3.0	13.8	0.7	38.4		3.2	38.4		3.2
Huis Prinscilla	50.9	35.6	3.0	13.3	0.7	36.9		3.1	36.9		3.1
Laerskool Emfulenipark	57.1	46.8	3.3	14.9	0.8	50.3		4.3	**50.3**	1	4.3
Nw University_Vaal Campus	54.4	44.2	3.2	14.2	0.7	60.6		5.6	**60.6**	4	5.6
Emfuleni Primary School	51.2	34.4	2.9	13.2	0.6	34.7		2.8	34.7		2.8
Mediclinic Vereeniging	52.7	39.0	3.2	13.1	0.7	46.5		4.5	**46.5**	1	4.5
Kopanong Provincial Hospital (Duncanville)	56.2	36.9	3.4	14.6	0.8	29.5		2.7	29.5		2.7
Avondrus Eventide Old Age Home	56.0	38.2	3.4	14.5	0.8	31.7		2.9	31.7		2.9
Riviera On Vaal Resort	52.2	39.3	3.3	13.4	0.8	54.5		5.2	**54.5**	1	5.2
Sedibeng Tvet College	52.2	38.1	3.3	13.4	0.7	56.2		5.3	**56.2**	1	5.3
General Smuts High School	53.3	41.0	3.3	13.8	0.7	46.6		4.5	**46.6**	1	4.5
Eureuka School & Selbourne Primary	53.0	39.5	3.2	13.7	0.7	45.9		4.3	**45.9**	1	4.3
Midvaal Private Hospital (Three Rivers)	62.0	47.3	3.7	16.5	0.9	54.4		4.8	**54.4**	1	4.8
Three Rivers Retirement Village	62.8	43.9	3.8	16.9	0.9	45.0		3.9	**45.0**	1	3.9
Drie Riviere Aftreeoord Old Age Home	62.9	43.2	3.8	17.0	0.9	38.6		3.5	38.6		3.5
Riverside High School	73.4	44.8	4.3	21.9	1.1	62.1		4.7	**62.1**	3	4.7
Risiville Primary School	66.4	41.8	3.9	18.1	0.9	36.5		3.5	36.5		3.5
Sebokeng Hospital	50.7	33.8	2.9	13.7	0.6	26.0		2.3	26.0		2.3
Clinix-Naledzi Private Hospital	50.8	35.1	2.9	13.7	0.6	26.8		2.4	26.8		2.4
Mohloli Secondary School	52.2	40.4	3.1	13.4	0.7	45.9		4.1	**45.9**	1	4.1

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Tshirela Primary School (Boipatong)	50.6	35.4	3.0	13.4	0.7	32.1		2.9	32.1		2.9
Tsoaranang Primary School (Thepiso)	50.3	39.4	3.1	13.3	0.7	37.9		3.5	37.9		3.5
Thepiso Primary School	50.7	40.8	3.1	13.8	0.7	37.1		3.1	37.1		3.1
Emmanuel Primary School	50.3	39.0	3.1	13.1	0.7	40.6		3.7	**40.6**	1	3.7
Rust Ter Vaal Combined School	52.1	35.4	3.2	14.4	0.7	25.0		2.3	25.0		2.3
Roshnee Primary School	50.8	33.9	3.1	14.0	0.7	23.2		2.2	23.2		2.2
Roshnee High School	51.0	35.2	3.2	14.2	0.7	24.8		2.2	24.8		2.2
Hoerskool Dr Malan	59.0	35.7	3.6	16.9	0.8	26.4		2.5	26.4		2.5
Laerskool Voorwaarts	72.9	41.8	4.2	22.6	1.0	29.0		2.9	29.0		2.9
Meyerton Secondary School	58.1	36.7	3.7	16.6	0.8	25.3		2.6	25.3		2.6
Ratasetjhaba Primary School	54.2	36.0	3.4	15.5	0.7	23.4		2.3	23.4		2.3
Meyerton Primary School	57.9	35.7	3.5	16.4	0.8	25.5		2.4	25.5		2.4
Oprah Leadership Academy	60.8	35.4	3.7	18.0	0.8	25.2		2.4	25.2		2.4
Henley River Retirement Village	60.9	34.3	3.8	18.3	0.9	24.9		2.4	24.9		2.4
Henley High & Preparatory School	59.3	34.6	3.6	17.5	0.8	23.7		2.3	23.7		2.3
Randvaal Clinic	55.9	34.8	3.4	16.7	0.8	23.6		2.3	23.6		2.3
Laerskool Japie Greyling	56.4	32.0	3.4	16.1	0.7	22.6		2.2	22.6		2.2
Thomas Nhlapo Primary	57.9	32.1	3.5	16.6	0.8	23.2		2.3	23.2		2.3
Randvaal Old Age Home	53.7	33.6	3.3	15.6	0.7	22.3		2.2	22.3		2.2
Laerskool Ag Visser	57.5	32.7	4.2	17.1	1.0	23.6		2.7	23.6		2.7
Lethaba Siyangobe	57.9	32.6	4.2	17.4	1.0	23.7		2.7	23.7		2.7
Shalimar Ridge Primary School	56.1	33.1	4.1	16.9	1.0	23.9		2.7	23.9		2.7
Jw Luckoff High School	59.0	33.0	4.4	18.3	1.1	23.9		2.7	23.9		2.7
Heidelberg Hospital	56.7	33.8	4.2	17.2	1.0	23.8		2.7	23.8		2.7
Thulatsatsi Operation (Rensburg)	57.8	32.8	4.2	17.0	1.0	23.7		2.7	23.7		2.7
Silwer Akker Tehuis	56.1	33.0	4.1	16.9	1.0	24.0		2.7	24.0		2.7
Riversands Retirement Village	57.1	34.0	4.2	17.5	1.0	23.6		2.7	23.6		2.7
Qhaqholla Primary School	59.5	32.1	4.2	17.8	1.0	23.2		2.6	23.2		2.6
Ratanda Primary School	60.7	32.2	4.3	19.1	1.0	22.9		2.6	22.9		2.6
Boneha Primary School	59.5	32.1	4.2	18.0	1.0	23.3		2.6	23.3		2.6
Sithokomele Primary School	59.6	32.2	4.2	17.9	1.0	23.4		2.6	23.4		2.6

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Ratanda Bertha Gxowa Primary School	58.3	32.9	4.3	17.4	1.0	23.7		2.7	23.7		2.7
Khanya Lesedi Secondary School	60.0	32.3	4.2	18.0	1.0	23.0		2.6	23.0		2.6
Ratanda Secondary School	59.7	32.4	4.2	18.0	1.0	23.2		2.6	23.2		2.6
New Ratanda Secondary School	58.1	32.7	4.2	17.2	1.0	23.6		2.7	23.6		2.7
Kgoro Ya Thuto Secondary School	58.1	32.7	4.2	17.2	1.0	23.6		2.7	23.6		2.7
Ekurhuleni School For The Deaf	52.1	30.1	3.4	13.5	0.7	21.9		2.1	21.9		2.1
Pholosong Hospital	55.8	33.4	3.9	16.1	0.9	25.1		2.7	25.1		2.7
Tsakane Home For Aged	56.5	32.9	4.0	17.0	0.9	24.9		2.7	24.9		2.7
Mmuso Primary School	58.3	35.7	4.2	17.9	1.0	25.5		2.8	25.5		2.8
Michael Zulu Primary School	56.5	33.4	4.0	16.7	0.9	25.4		2.7	25.4		2.7
Nkabinde Primary School (Thembilisha)	56.1	32.4	3.9	15.5	0.9	25.3		2.7	25.3		2.7
Nigel Clinic	57.7	36.8	4.2	16.5	1.0	25.7		3.0	25.7		3.0
Tehuis Vir Bejaardes	58.1	36.7	4.2	16.6	1.0	26.2		3.0	26.2		3.0
Hoerskool John Vorster	57.5	37.1	4.2	16.7	1.0	25.9		3.0	25.9		3.0
Laerskool Hannes Visagie	57.1	36.6	4.3	16.8	1.0	26.8		3.0	26.8		3.0
Nigel Secondary School	58.1	34.9	4.4	17.3	1.0	26.8		3.1	26.8		3.1
Laerskool Dunnottar	58.1	35.3	4.1	16.9	0.9	25.6		2.9	25.6		2.9
Springs Retirement Village	55.7	33.1	3.8	15.0	0.8	25.8		2.9	25.8		2.9
Life Springs Parkland Hospital	55.7	32.5	3.8	15.1	0.8	25.6		2.8	25.6		2.8
Netcare N17 Hospital (Springs)	56.0	32.1	3.8	15.1	0.8	25.5		2.8	25.5		2.8
Springs Boys High School	56.1	32.8	4.0	15.9	0.9	26.0		2.9	26.0		2.9
Laerskool Selectionpark	55.6	32.2	3.9	15.2	0.8	25.8		2.9	25.8		2.9
Kwasa College Pre&Primary School	57.1	32.7	4.0	15.9	0.9	26.2		3.0	26.2		3.0
Edelweis Medical Centre	57.2	32.3	4.0	15.6	0.9	26.3		2.9	26.3		2.9
Laerskool Christiaan Beyers	56.2	33.1	3.9	15.0	0.8	25.9		2.9	25.9		2.9
Hoerskool Hugenote	54.9	33.3	3.8	14.9	0.8	25.9		2.8	25.9		2.8
Brakpan Primary School	52.5	33.3	3.6	14.2	0.8	25.3		2.6	25.3		2.6
Parkrand Primary School	50.6	32.2	3.5	13.6	0.7	23.8		2.3	23.8		2.3
Thabo Memorial Hospital	49.7	30.8	3.4	13.8	0.7	23.4		2.2	23.4		2.2
Sunward Park Hospital	50.3	31.5	3.4	13.4	0.7	23.6		2.2	23.6		2.2
Alberton High School	48.5	30.9	3.2	13.1	0.7	21.6		2.0	21.6		2.0

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Netcare Clinton Hospital	48.3	30.7	3.1	13.1	0.6	21.3		2.0	21.3		2.0
Alberton Tuiste Vir Bejaardes	48.4	30.8	3.2	13.1	0.7	21.3		2.0	21.3		2.0
Bertha Gxowa Hospital	48.8	29.8	3.3	14.0	0.7	21.7		2.0	21.7		2.0
Linmed Hospital	49.4	33.5	3.4	14.0	0.7	24.4		2.4	24.4		2.4
Hoerskool Brandwag (Airfield)	50.4	32.0	3.5	14.2	0.8	24.8		2.4	24.8		2.4
Thepiso Noto Intermediate School	51.5	33.8	3.7	13.8	0.8	29.5		3.2	29.5		3.2
Laerskool Bredell	46.9	33.3	3.2	11.8	0.6	24.4		2.3	24.4		2.3
Sibonelo Primary School (Daveyton)	50.6	34.7	3.6	13.5	0.8	27.5		2.9	27.5		2.9
Petit High School (Kempton Park Nu)	48.6	34.2	3.4	12.7	0.7	26.1		2.6	26.1		2.6
Arwyp Medical Centre	46.6	31.6	3.2	12.4	0.6	22.9		2.1	22.9		2.1
Hoerskool Birchleigh	45.4	30.9	3.0	11.1	0.6	22.8		2.0	22.8		2.0
Curro Serengeti Acadamy	46.6	31.5	3.1	11.3	0.6	24.1		2.2	24.1		2.2
South Rand Hospital	49.5	30.5	3.3	15.6	0.8	21.3		1.9	21.3		1.9
Chris Hani Baragwanath Hospital	43.4	27.3	2.7	12.6	0.6	20.6		1.6	20.6		1.6
Thulani Primary School	40.1	26.1	2.4	11.6	0.5	18.9		1.5	18.9		1.5
University of Witwatersrand	50.3	30.6	3.2	16.0	0.7	20.9		1.8	20.9		1.8
Milpark Hospital	48.6	31.4	3.1	14.8	0.7	20.4		1.7	20.4		1.7
Charlotte Maxixe Academic Hospital	49.3	31.9	3.2	15.5	0.7	20.6		1.8	20.6		1.8
Thembisa West Secondary School (Thembisa)	42.0	30.3	2.8	9.9	0.5	21.7		1.9	21.7		1.9
Lenmed Zamokuhle Private Hospital (Thembisa)	43.2	29.1	2.8	10.0	0.5	22.6		2.0	22.6		2.0
Ikusasa Comprehensive School	43.9	29.8	2.9	10.3	0.5	21.9		2.0	21.9		2.0
Gem Village Old Age Home	43.0	30.6	2.7	9.7	0.5	23.1		1.9	23.1		1.9
Rustoord Old Age Home	43.0	30.0	2.6	9.2	0.4	23.9		1.8	23.9		1.8
Cornwell Hill College (Irene)	43.4	30.4	2.7	9.7	0.5	23.5		1.9	23.5		1.9
Kleinfontein Sorg Sentrum Old Age Home (Donkerhoek)	45.6	31.2	2.9	10.0	0.5	24.8		2.3	24.8		2.3
Valtaki AH (Rayton)	45.6	30.5	2.9	9.7	0.5	26.5		2.4	26.5		2.4
Laerskool Rayton (Rayton)	42.0	29.2	2.7	8.2	0.4	24.2		2.0	24.2		2.0
Tierkop AH	48.7	33.1	3.1	12.1	0.6	26.9		2.5	26.9		2.5

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Redford House The Hills Private School (Mooikloof Glen)	49.4	30.4	3.0	11.8	0.6	26.6		2.3	26.6		2.3
Rietvlei View Country Estate	48.8	31.5	3.0	12.0	0.6	26.7		2.3	26.7		2.3
Hazeldean Curro School (Tyger Valley)	43.5	29.4	2.6	8.5	0.4	22.7		1.8	22.7		1.8
Tyger Valley College	44.8	29.0	2.7	9.3	0.4	24.2		1.9	24.2		1.9
Pretoria East Hospital (Moreletapark)	46.2	28.1	2.7	10.1	0.5	24.4		2.0	24.4		2.0
Groenkloof Old Age Home	41.4	28.8	2.5	8.6	0.4	21.9		1.7	21.9		1.7
Steve Biko Academic Hospital	39.5	27.6	2.3	7.6	0.4	19.7		1.5	19.7		1.5
Willow Ridge High School (Wilgers)	42.0	29.1	2.5	8.1	0.4	21.7		1.7	21.7		1.7
Hoerskool Waterkloof	44.6	30.5	2.7	9.9	0.5	24.5		1.9	24.5		1.9
Hoerskool Garsfontein	44.7	28.2	2.6	9.3	0.4	23.8		1.9	23.8		1.9
Afrikaanse Hoer Seunskool	40.6	28.4	2.4	8.2	0.4	21.2		1.6	21.2		1.6
Huis Silversig SAVF Old Age Home (Silverton)	40.6	27.7	2.4	7.4	0.4	20.8		1.6	20.8		1.6
Laersekool Meyerspark (Meyerspark)	41.6	28.1	2.4	7.6	0.4	21.2		1.6	21.2		1.6
Curro Academy Mamelodi	39.1	26.5	2.3	6.7	0.3	21.2		1.6	21.2		1.6
Impendulo Primary School	40.6	27.8	2.4	7.2	0.4	21.8		1.7	21.8		1.7
Nellmapius Ext 6 Primary School	40.7	28.1	2.4	7.0	0.4	21.2		1.6	21.2		1.6
Mamelodi Home For Aged	40.0	27.6	2.4	6.9	0.4	21.2		1.6	21.2		1.6

Predicted concentrations in μg/m³ at the sensitive receptors for Scenario A (2025), together with the limit value of the NAAQS and number of exceedances (NoE)

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	350	125	50	200	40	75	12	40	40	12	20
Elsie Ballot Memorial Hospital	176.0	74.9	14.2	40.7	3.1	30.9		5.6	30.9		5.6
Laerskool Amersfoort	166.5	67.7	13.9	38.9	3.0	30.3		5.5	30.3		5.5
Embuzane Primary School	344.0	121.1	23.0	81.7	5.3	51.0		8.4	**51.0**	1	8.4
Sangqotho Primary School	115.3	52.9	13.0	32.9	3.0	32.2		6.0	32.2		6.0
Amersfoort Combined School	161.8	75.1	14.0	38.8	3.1	30.7		5.6	30.7		5.6
Injubuko Primary School	110.7	53.2	12.6	29.5	2.7	29.7		5.4	29.7		5.4
Daggakraal Primary School	168.0	65.4	16.6	38.5	3.5	30.9		5.5	30.9		5.5
Sizenzele Primary School	206.0	71.7	17.6	47.4	3.9	39.3		6.1	39.3		6.1
Seme Secondary School	156.0	62.9	16.7	36.4	3.6	33.9		5.8	33.9		5.8
Louwra Primary School	125.7	59.3	10.5	30.0	2.1	33.7		4.7	33.7		4.7
Perdekop Agricultural School	110.1	57.5	10.5	30.3	2.2	39.3		6.0	39.3		6.0
Vukuzenzele Combined School	114.5	59.0	10.6	31.5	2.2	39.0		6.0	39.0		6.0
Gunwana Primary School	113.1	60.8	9.9	29.8	1.9	30.5		4.6	30.5		4.6
Amajuba Memorial Hospital	101.9	52.2	8.9	23.7	1.7	26.8		4.0	26.8		4.0
Volksrust High School	101.4	51.5	8.8	23.9	1.6	27.3		3.9	27.3		3.9
Volksrust Municipal Clinic	100.7	50.9	8.6	23.3	1.6	25.7		3.8	25.7		3.8
C V O Skool Amajuba	100.5	51.2	8.7	23.4	1.6	26.3		3.9	26.3		3.9
Qhubulwazi Combined School	99.1	49.1	8.7	22.9	1.6	26.2		3.9	26.2		3.9
Volksrust Primary School	104.6	52.7	9.2	24.6	1.8	28.0		4.1	28.0		4.1
New Ermelo	91.2	49.9	12.6	29.7	3.1	38.5		5.8	38.5		5.8
Ermelo Christian School	92.2	47.5	13.1	32.6	3.3	38.0		5.9	38.0		5.9
SAVF Home For Aged	89.4	47.8	12.9	30.8	3.2	31.0		5.4	31.0		5.4
Ermelo Hospital	88.2	46.7	12.7	29.9	3.2	30.4		5.3	30.4		5.3
Mediclinic Ermelo	91.3	48.0	13.1	32.6	3.3	35.9		5.8	35.9		5.8
Hoerskool Ermelo	89.0	47.2	12.8	30.1	3.2	30.4		5.4	30.4		5.4
Ermelo Indian Combined School	87.0	45.2	12.6	29.2	3.1	30.8		5.3	30.8		5.3
Lungelo Combined School (Outside Town)	94.0	48.7	12.2	30.2	2.9	30.3		5.6	30.3		5.6
New Ermelo Primary School	90.9	46.2	12.7	29.7	3.1	38.1		5.8	38.1		5.8

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Kwashashe (Outside Town)	85.1	47.3	12.9	27.2	3.2	31.9		5.4	31.9		5.4
Hts Ligbron	89.4	47.9	13.0	31.5	3.3	33.0		5.6	33.0		5.6
Laerskool Ermelo	87.9	47.7	12.8	29.8	3.2	30.7		5.4	30.7		5.4
JJ Vd Merwe Pre-Primary School	90.6	47.3	12.9	31.1	3.3	33.4		5.6	33.4		5.6
Lindile Secondary School	86.8	45.2	12.5	28.4	3.1	30.5		5.3	30.5		5.3
Emthonjeni Clinic	86.4	46.3	12.6	28.7	3.1	29.9		5.3	29.9		5.3
Reggie Masuku Secondary School	83.4	45.4	12.5	27.6	3.0	29.3		5.2	29.3		5.2
Cebisa Secondary School	85.4	45.9	12.6	28.6	3.1	29.8		5.3	29.8		5.3
Camden	101.1	66.4	13.2	33.9	3.5	**189.8**	**78**	26.7	**189.8**	**218**	**26.7**
Camden Combined School	128.5	85.1	15.0	54.7	4.5	**111.6**	8	18.5	**111.6**	**111**	18.5
Camden School	112.5	60.6	13.5	39.5	3.6	**209.4**	**95**	28.1	**209.4**	**195**	**28.1**
Umzimvelo Secondary School (Rural Area)	96.2	51.7	13.1	34.7	3.3	35.1		5.3	35.1		5.3
Bhekimfundo Primary School (Rural Area)	100.1	50.5	13.4	36.4	3.5	42.3		6.8	**42.3**	1	6.8
Eshwileni Primary School (Rural Area)	94.4	50.1	12.3	29.3	2.8	30.3		5.6	30.3		5.6
Davel Combined School	101.4	51.0	13.4	35.6	3.5	34.7		6.2	34.7		6.2
Morgenzon Landbou Akademie	100.8	48.3	12.7	33.1	3.1	34.1		6.2	34.1		6.2
Nqobangolwazi Secondary School	101.6	47.4	12.5	32.9	3.0	33.2		6.1	33.2		6.1
Siqondekhaya Pre Primary School	101.7	47.6	12.4	33.0	3.0	35.4		6.2	35.4		6.2
Sizakhele Primary School	101.4	47.5	12.4	33.2	3.0	35.3		6.1	35.3		6.1
Phezukwentaba Primary School (South of Morgenzon)	99.5	48.5	12.7	31.3	3.0	34.2		6.2	34.2		6.2
Kwaggalaagte Primary School (North of Morgenzon)	114.4	53.4	12.2	40.0	3.1	37.2		6.4	37.2		6.4
Sizakhele Clinic/Hospital	101.5	47.6	12.4	32.9	3.0	35.0		6.1	35.0		6.1
Grootvlei	81.1	45.5	7.3	22.3	1.6	**170.0**	**79**	22.0	**170.0**	**211**	**22.0**
Olive Grove Country Lodge	94.7	53.4	7.9	29.5	1.9	**95.6**	1	9.6	**95.6**	**29**	9.6
Grootvlei Town (South of Power Station)	92.2	44.8	8.2	29.2	2.0	73.5		13.2	**73.5**	**35**	13.2
Laerskool Grootvlei	93.0	47.7	8.1	28.8	1.9	**78.6**	1	12.1	**78.6**	**42**	12.1
Tokoloho Primary School	90.9	45.2	8.2	29.3	2.0	68.8		11.4	**68.8**	**16**	11.4
Tshepeha Combined School	92.8	45.3	8.3	29.4	2.0	**83.6**	1	15.2	**83.6**	**63**	15.2
Warembo Lodge	75.8	40.4	8.7	23.8	2.1	51.3		5.8	**51.3**	1	5.8

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Balfour	73.0	42.4	7.3	20.5	1.6	30.2		3.8	30.2		3.8
Siyathemba	74.7	42.1	7.5	20.8	1.6	30.3		3.9	30.3		3.9
Bonukukhanya Primary (Siyathemba)	74.7	41.8	7.5	20.8	1.6	30.6		3.9	30.6		3.9
Qalabocha Primary School (Siyathemba)	74.5	42.1	7.5	20.7	1.6	29.9		3.9	29.9		3.9
Vusumuzi Primary School	75.1	42.7	7.6	21.1	1.6	30.7		3.9	30.7		3.9
Gekombineerde Skool Balfour	73.7	40.5	7.4	20.8	1.6	31.0		3.9	31.0		3.9
Im Manchu Secondary School	73.6	40.3	7.3	20.5	1.6	30.9		3.9	30.9		3.9
Isifisosethu Secondary School (Siyathemba)	75.4	42.6	7.6	21.3	1.7	30.8		3.9	30.8		3.9
Setsheng Secondary School (Siyathemba)	74.9	42.7	7.5	21.0	1.6	29.8		3.9	29.8		3.9
Dr Nieuwoudt And Dr Kok	73.9	40.5	7.4	21.0	1.6	31.6		4.0	31.6		4.0
Balfour Clinic	73.0	40.2	7.3	20.4	1.6	31.1		3.9	31.1		3.9
Siyathemba Clinic	73.9	42.0	7.4	20.7	1.6	30.5		3.9	30.5		3.9
Mondoro Lodge	73.9	39.6	7.0	21.3	1.5	29.0		3.6	29.0		3.6
Wegelegen Manor	73.5	42.3	7.3	20.7	1.5	29.6		3.8	29.6		3.8
The Stone Cellar	72.1	38.3	6.3	18.8	1.3	27.2		3.2	27.2		3.2
Greylingstad	77.5	44.8	8.4	22.4	1.8	30.0		4.1	30.0		4.1
Nthorwane	76.6	45.1	8.2	21.3	1.7	30.8		4.0	30.8		4.0
Laerskool Greylingstad	79.5	45.6	8.6	22.9	1.9	30.0		4.1	30.0		4.1
Nthoroane Secondary School	76.6	45.3	8.2	21.2	1.7	30.5		4.0	30.5		4.0
Badgarleur Bush Lodge	73.3	41.4	8.4	20.8	1.9	29.9		4.0	29.9		4.0
Matla Village	168.5	77.0	13.6	56.7	3.7	**159.5**	**27**	18.6	**159.5**	**96**	18.6
Sifundise Primary School	167.1	78.4	13.7	55.3	3.7	**150.4**	**21**	17.8	**150.4**	**89**	17.8
Matla Coal Health Centre	171.2	80.3	13.9	58.1	3.8	**105.5**	5	14.6	**105.5**	**53**	14.6
Gweda Primary School	224.5	87.1	16.2	97.4	5.3	**120.8**	**14**	22.4	**120.8**	**158**	**22.4**
Zithobe Primary School	144.3	68.2	11.0	49.9	2.8	**79.3**	1	11.8	**79.3**	**18**	11.8
Kwanala Primary School	221.7	99.8	18.0	107.8	6.1	**164.0**	**43**	19.5	**164.0**	**126**	19.5
Reedstream Park	180.7	90.8	16.3	68.5	4.6	65.2		9.7	**65.2**	1	9.7
Rietspruit Clinic	176.3	90.3	16.0	66.1	4.5	58.7		9.2	**58.7**	1	9.2
Lehlaka Combined School	174.9	88.5	16.0	64.0	4.5	58.2		9.2	**58.2**	1	9.2
Mbali Coal/Blesboklaagte Housing	165.2	67.5	15.5	47.3	4.0	49.6		7.8	**49.6**	1	7.8
Kinross	147.8	80.2	11.5	55.7	3.0	**89.9**	1	10.3	**89.9**	**25**	10.3

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Kinross Settlement	128.2	78.9	10.6	40.1	2.6	**83.1**	1	9.6	**83.1**	12	9.6
Kinross Municipal Clinic	141.8	77.7	11.3	51.1	2.9	**88.9**	1	9.9	**88.9**	**16**	9.9
Kriel	179.2	77.1	18.6	90.5	6.7	**104.8**	1	12.6	**104.8**	**27**	12.6
Eagles Nest Guest House	176.3	72.9	18.6	87.3	6.7	**106.0**	1	12.0	**106.0**	**16**	12.0
Merlin Park Primary School	167.7	71.1	17.7	85.7	6.1	**81.8**	1	10.3	**81.8**	5	10.3
Kriel Medical Centre	167.8	70.8	17.8	86.3	6.2	**87.9**	1	10.7	**87.9**	9	10.7
Laerskool Krielpark	172.1	75.3	18.1	89.2	6.4	**95.0**	1	11.3	**95.0**	**16**	11.3
Laerskool Onverwacht	171.6	73.0	17.8	88.5	6.1	**76.8**	1	10.3	**76.8**	9	10.3
Silwer Fleur Aftree Oord (Old Age Home)	175.2	75.3	17.9	90.6	6.2	**78.4**	1	10.5	**78.4**	**14**	10.5
Thubelihle	179.4	75.4	16.7	92.1	5.3	57.5		9.0	**57.5**	1	9.0
Sibongamandla Secondary School	175.1	73.5	16.5	89.9	5.2	57.9		9.1	**57.9**	1	9.1
Ga-Nala Clinic	178.8	76.0	17.5	91.7	5.9	72.0		9.7	**72.0**	1	9.7
Impilo Primary School	140.9	65.1	14.8	64.9	4.3	47.1		8.2	**47.1**	1	8.2
Bonginhlanhla Primary School	170.6	73.7	16.4	86.7	5.2	60.8		9.1	**60.8**	1	9.1
Sibongamandla Secondary School	175.1	73.4	16.5	89.6	5.2	57.9		9.1	**57.9**	1	9.1
Leandra	108.7	59.8	9.3	29.9	2.2	49.4		7.7	**49.4**	1	7.7
Eendracht	103.5	57.1	9.1	29.4	2.1	46.1		6.9	**46.1**	1	6.9
Sidingulwazi Primary School	105.4	57.3	9.2	29.5	2.1	48.1		7.2	**48.1**	1	7.2
Ss Mshayisa Primary School	109.2	58.3	9.3	30.1	2.2	52.4		7.4	**52.4**	1	7.4
Chief Ampie Mayisa Secondary School	107.5	56.0	9.2	29.2	2.1	49.7		7.2	**49.7**	1	7.2
Lebogang Clinic	107.1	57.2	9.3	30.0	2.2	50.0		7.4	**50.0**	1	7.4
Kleuterskool Haas Das	88.3	47.3	9.0	23.3	1.8	35.7		5.2	35.7		5.2
Standerton Primary School	88.3	48.0	9.1	23.3	1.8	36.0		5.2	36.0		5.2
Laerskool Jeugkrag	88.8	48.5	9.1	23.4	1.8	37.5		5.4	37.5		5.4
Laerskool Standerton	88.1	48.5	9.1	23.4	1.8	35.6		5.2	35.6		5.2
Laerskool Kalie De Haas	89.7	50.0	9.1	24.3	1.8	34.9		5.1	34.9		5.1
Hoerskool Standerton	88.3	48.0	9.1	23.2	1.8	36.0		5.2	36.0		5.2
Standerton Provincial Government Hospital	86.8	47.2	9.0	23.1	1.8	35.7		5.2	35.7		5.2
Mar-Peh Medicare Private Hospital	87.5	48.1	9.0	22.9	1.7	35.3		5.1	35.3		5.1
Standerton Retirement Home	87.2	48.6	9.0	22.9	1.7	35.0		5.1	35.0		5.1
Standerton Ouetehuis/Old Age Home	88.2	49.5	9.1	23.7	1.8	35.6		5.1	35.6		5.1

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Holmdene Secondary School	83.8	48.1	8.8	21.3	1.7	35.3		4.9	35.3		4.9
Cathuza Primary School (SE of Town)	97.0	51.0	9.9	26.1	2.0	38.4		5.6	38.4		5.6
Sizanani Pre Primary School	86.3	45.9	9.0	21.8	1.8	34.8		5.1	34.8		5.1
Hlobisa Primary School	85.1	45.5	8.9	21.3	1.7	34.0		4.9	34.0		4.9
Shukuma Primary School	83.8	46.8	8.8	21.7	1.7	33.6		4.8	33.6		4.8
Retsebile Primary School	84.3	46.4	9.0	21.5	1.7	34.5		5.0	34.5		5.0
Thuto-Thebe Secondary School	85.5	45.9	9.0	22.6	1.8	36.0		5.2	36.0		5.2
Jandrell Secondary School	85.0	45.4	9.0	21.8	1.7	34.3		5.0	34.3		5.0
Thobelani Secondary School	85.1	45.5	9.0	21.8	1.8	34.5		5.0	34.5		5.0
Standerton Tb Hospital	85.8	46.5	8.9	21.9	1.7	34.2		4.9	34.2		4.9
Thuthukani Pre Primary School	98.9	61.5	10.1	29.2	2.2	50.4		7.6	**50.4**	1	7.6
Ulwazi Primary School	98.3	62.0	10.1	29.4	2.2	49.2		7.5	**49.2**	1	7.5
Zikhetheleni Secondary School	98.7	58.3	10.1	28.9	2.2	49.8		7.4	**49.8**	1	7.4
Joubertsvlei Primary School (North of Tutuka)	102.9	47.3	10.6	32.2	2.4	39.5		6.7	39.5		6.7
Amalumgelo Primary School (NE of Tutuka)	132.3	60.5	13.3	46.4	3.4	57.4		8.4	**57.4**	1	8.4
Grootdraaidam Primary School	96.4	54.7	9.6	26.5	1.9	38.9		5.8	38.9		5.8
Laerskool Secunda	107.6	58.5	10.5	35.5	2.5	59.2		8.5	**59.2**	1	8.5
Laerskool Kruinpark	108.4	54.8	10.8	36.7	2.6	55.5		8.8	**55.5**	1	8.8
Laerskool Oranjegloed Primary	104.9	57.3	10.4	34.4	2.4	54.6		8.3	**54.6**	1	8.3
Curro Castle Combined School	103.8	57.1	10.2	32.9	2.4	54.6		8.0	**54.6**	1	8.0
Hoërskool Oosterland	108.6	56.7	10.7	36.9	2.6	55.9		8.8	**55.9**	1	8.8
Mediclinic Secunda (Hospital)	107.6	59.7	10.4	35.6	2.4	59.0		8.3	**59.0**	1	8.3
Mediclinic Highveld (Hospital_Trichardt, Secunda)	115.1	56.5	11.4	42.6	2.9	62.2		10.0	**62.2**	1	10.0
Daviescourt/Davieshof Old Age Home	107.2	58.3	10.5	35.7	2.5	57.8		8.5	**57.8**	1	8.5
Highveld Park High School	108.6	56.9	10.7	36.2	2.6	56.3		8.8	**56.3**	1	8.8
Hoerskool Secunda	106.8	58.4	10.5	34.9	2.5	57.8		8.4	**57.8**	1	8.4
Basizeni Special School	111.0	62.7	9.6	32.0	2.2	50.4		6.6	**50.4**	1	6.6
Maphala-Gulube Primary School	102.9	58.3	9.5	29.1	2.1	43.0		6.3	**43.0**	1	6.3
Shapeve Primary School	112.3	62.4	9.7	32.1	2.2	48.2		6.7	**48.2**	1	6.7

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Thomas Nhlabathi Secondary School	110.9	61.9	9.5	31.4	2.1	48.0		6.3	**48.0**	1	6.3
Embalenhle Hospital / Clinic	109.5	61.4	9.5	30.6	2.1	46.4		6.3	**46.4**	1	6.3
Vukuzithathe Primary School	106.5	59.5	9.5	29.4	2.1	44.5		6.2	**44.5**	1	6.2
K I Twala Secondary	107.6	59.5	9.4	29.5	2.0	45.0		6.1	**45.0**	1	6.1
Allan Makunga Primary School	111.2	62.3	9.6	31.5	2.1	47.7		6.6	**47.7**	1	6.6
Evander Hospital Arv Clinic	124.6	68.5	10.8	41.9	2.7	64.5		8.5	**64.5**	1	8.5
Laerskool Hoeveld	123.3	69.8	10.7	41.8	2.6	63.8		8.3	**63.8**	1	8.3
Hoerskool Evander	123.8	70.1	10.5	40.5	2.6	67.1		8.1	**67.1**	1	8.1
Bernice Samuel Hospital	87.3	56.6	6.7	23.5	1.4	36.8		4.8	36.8		4.8
Hoerskool Delmas	87.9	57.2	6.7	23.7	1.4	36.8		4.8	36.8		4.8
Laerskool Delmas	88.4	56.5	6.8	24.3	1.4	37.0		4.9	37.0		4.9
Kangela Primary School (North of Delpark)	89.3	55.2	6.9	24.9	1.4	39.0		5.2	39.0		5.2
Savf Ons Eie Ouetehuis / Old Age Home	88.8	56.7	6.8	24.3	1.4	37.2		4.9	37.2		4.9
Laerskool Eloff	83.5	54.1	6.5	22.5	1.3	35.3		4.3	35.3		4.3
Rietkol Primary School	83.1	54.3	6.5	22.6	1.3	35.1		4.3	35.1		4.3
Bazani Primary School	88.1	52.1	6.8	24.6	1.4	37.9		5.3	37.9		5.3
Phaphamani Secondary School	86.9	53.7	6.7	24.5	1.4	37.7		5.2	37.7		5.2
Vezimfundo Primary School	87.8	47.5	6.7	25.2	1.4	39.2		5.2	39.2		5.2
Arbor Primary School	131.8	70.2	9.2	47.5	2.3	**83.3**	1	13.0	**83.3**	**30**	13.0
Ogies Combined School	179.4	74.7	14.3	48.7	3.8	52.5		7.4	**52.5**	1	7.4
Ogies Tb Clinic	186.0	76.3	14.2	50.5	3.8	55.0		7.4	**55.0**	1	7.4
Ogies Police Station	186.0	76.3	14.2	50.5	3.8	55.0		7.4	**55.0**	1	7.4
Hlangu Phala Primary School	165.5	77.1	12.8	54.4	3.7	48.6		6.5	**48.6**	1	6.5
Sukumani Primary School	165.6	76.2	12.8	53.8	3.6	48.6		6.5	**48.6**	1	6.5
Thuthukani Primary School	166.6	76.4	12.9	52.8	3.6	49.0		6.4	**49.0**	1	6.4
Mehlwana Secondary School	157.7	78.4	12.7	53.6	3.7	52.2		6.6	**52.2**	1	6.6
Makause Combined School	156.7	75.3	12.8	52.7	3.7	49.7		6.6	**49.7**	1	6.6
Sibongindawo Primary School	186.5	74.3	13.6	81.1	4.4	**77.2**	1	8.9	**77.2**	8	8.9
Laerskool Balmoral	151.6	72.9	9.0	60.9	2.5	41.4		4.6	**41.4**	1	4.6
Clewer Primary School	117.5	60.1	10.1	36.5	2.6	43.5		5.3	**43.5**	1	5.3
Witbank High School	108.1	64.4	9.6	30.2	2.3	60.7		6.7	**60.7**	1	6.7

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Eden Park Retirement Village	112.1	61.8	10.0	31.1	2.4	68.5		8.1	**68.5**	6	8.1
Savf House Immergroen Old Age Home	107.8	64.8	9.4	29.7	2.2	54.9		6.1	**54.9**	1	6.1
Mthimkulu Housing For The Aged	107.4	63.4	9.2	30.3	2.2	44.9		5.2	**44.9**	1	5.2
Emalahleni Private Hospital	106.3	65.3	9.3	29.1	2.2	52.2		5.8	**52.2**	1	5.8
Life Cosmos Hospital	108.6	63.6	9.6	29.5	2.3	62.5		6.7	**62.5**	1	6.7
Duvha Primary School	119.7	58.6	10.4	34.9	2.6	61.2		7.7	**61.2**	1	7.7
Laerskool Taalfees	108.9	64.4	9.6	30.0	2.2	62.3		6.5	**62.3**	1	6.5
Witbank Provincial Hospital	106.6	63.4	9.4	29.1	2.2	56.7		6.1	**56.7**	1	6.1
Nancy Shiba Primary School (Vosman)	108.3	59.8	8.7	32.2	2.1	36.2		4.1	36.2		4.1
Wh De Klerk Skool	105.7	62.1	9.1	28.0	2.1	47.9		4.9	**47.9**	1	4.9
Laerskool Panorama	103.6	61.5	8.7	26.2	1.9	41.8		4.4	**41.8**	1	4.4
Laerskool Duvhapark	119.9	59.9	10.6	35.8	2.6	66.1		8.7	**66.1**	1	8.7
Laerskool Klipfontein	112.1	60.8	10.0	31.3	2.4	70.3		8.3	**70.3**	10	8.3
Cambridge Academy	109.9	62.9	9.9	30.4	2.4	67.6		7.4	**67.6**	6	7.4
Besilindile Primary School	108.2	61.8	8.3	31.3	1.9	34.8		3.9	34.8		3.9
Reynopark High School	117.0	58.6	10.3	33.7	2.5	**86.8**	1	10.0	**86.8**	**31**	10.0
Bakenveld Golf Estate	114.4	60.9	10.0	33.2	2.4	55.8		6.1	**55.8**	1	6.1
Allendale Secondary School	112.3	66.2	11.7	34.6	3.0	53.3		9.7	**53.3**	1	9.7
Khayalethu Primary School	106.3	63.4	9.2	29.6	2.1	45.5		5.1	**45.5**	1	5.1
Illanga Secondary School	114.6	73.4	11.4	34.2	2.9	**91.4**	1	19.0	**91.4**	**81**	19.0
Joy Creche (Duvha)	115.2	60.7	11.0	34.6	2.7	56.3		8.4	**56.3**	1	8.4
Linderus Old Age Home	101.7	61.1	7.9	23.2	1.5	33.1		3.4	33.1		3.4
Vergeet My Nie Old Age Home	100.9	63.1	7.9	23.3	1.5	33.5		3.5	33.5		3.5
Middleburg Frail Care Unit And Home For Elderly	96.3	57.6	7.4	20.9	1.4	30.7		3.1	30.7		3.1
Life Midmed Hospital	99.0	61.5	7.7	22.2	1.4	31.7		3.3	31.7		3.3
Middelburg Hospital	101.0	63.3	7.8	23.1	1.5	32.4		3.4	32.4		3.4
Makhathini Primary School	96.4	58.4	7.5	22.0	1.4	31.4		3.2	31.4		3.2
Laerskool Dennesig	94.6	56.6	7.3	20.4	1.3	30.9		3.1	30.9		3.1
Hoerskool Kanonkop	95.8	57.3	7.4	20.5	1.3	31.1		3.1	31.1		3.1
Laerskool Kanonkop	97.4	57.7	7.5	21.1	1.4	30.9		3.1	30.9		3.1

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Steelcrest High School	98.3	58.5	7.6	21.7	1.4	31.7		3.2	31.7		3.2
Middelburg Primary	101.1	61.9	7.9	23.2	1.5	33.1		3.4	33.1		3.4
Middleburg Ext 6 Clinic	101.6	59.6	7.9	23.5	1.6	38.3		3.8	38.3		3.8
Sofunda Secondary School	99.5	60.0	7.7	22.3	1.5	33.8		3.4	33.8		3.4
Mhluzi Primary School	98.5	59.9	7.6	22.5	1.4	32.5		3.3	32.5		3.3
Highlands Primary School	102.3	61.7	8.1	24.4	1.6	34.5		3.6	34.5		3.6
Blinkpan Primary School	115.1	57.8	13.5	40.5	3.5	51.1		8.7	**51.1**	1	8.7
Laerskool Koornfontein	115.4	57.6	13.5	41.1	3.5	52.0		8.6	**52.0**	1	8.6
Blinkpan	114.7	58.1	13.5	40.7	3.5	52.2		8.7	**52.2**	1	8.7
Laerskool Kragveld	119.9	69.1	13.0	37.5	3.3	44.9		7.0	**44.9**	1	7.0
Pullens Hope	114.0	70.6	12.9	35.8	3.3	45.7		7.2	**45.7**	1	7.2
Arnot Colliery Primary School	109.2	67.3	10.8	30.5	2.7	**96.1**	1	9.4	**96.1**	**26**	9.4
Laerskool Rietkuil	115.1	64.7	11.4	36.2	3.0	**150.5**	**94**	26.4	**150.5**	**214**	**26.4**
Beestepan Agricultural School	90.8	55.2	8.5	22.8	1.7	32.9		3.7	32.9		3.7
Gekombineerde Skool Hendrina	88.7	52.7	12.9	27.3	3.2	43.1		7.3	**43.1**	1	7.3
Hendrina Primary School	90.5	53.2	13.2	28.1	3.2	42.0		7.1	**42.0**	1	7.1
Kwazamokuhle Secondary School	91.1	53.3	13.2	28.4	3.3	43.5		7.1	**43.5**	1	7.1
Ubuhle Bolwai Secondary School	70.3	41.6	10.8	18.3	2.2	26.8		4.3	26.8		4.3
Lothair Primary School	71.1	42.0	10.9	18.5	2.2	26.7		4.4	26.7		4.4
Warburton Combined School	71.2	44.7	10.4	18.2	2.0	28.6		4.1	28.6		4.1
Warburton Town	71.9	45.1	10.4	18.3	2.1	28.4		4.1	28.4		4.1
Kwachibikhulu Clinic	74.1	46.2	11.4	19.0	2.4	30.7		4.9	30.7		4.9
Kwachibikhulu Primary School	74.3	46.0	11.4	19.3	2.4	30.4		4.8	30.4		4.8
Carolina Hospital	77.2	46.7	10.9	20.6	2.4	35.8		4.9	35.8		4.9
Zinikeleni Secondary School (Silobela)	77.5	46.0	10.9	20.9	2.4	35.5		4.9	35.5		4.9
Volkskool Carolina	78.5	47.4	10.9	21.0	2.4	35.8		4.9	35.8		4.9
Sobuza Primary School	76.6	46.6	10.9	20.3	2.4	35.0		4.9	35.0		4.9
Ons Eie Ouetehuis (Old Age Home)	78.3	47.4	11.0	21.1	2.4	36.1		4.9	36.1		4.9
Laerskool Breyten	78.7	47.1	12.4	23.3	3.0	30.5		5.5	30.5		5.5
Siyazi Primary School (Kwazanele)	78.6	48.2	12.6	23.7	3.0	29.8		5.4	29.8		5.4
Masizakhe Secondary School (Kwazanele)	78.6	47.9	12.5	23.7	3.0	29.7		5.4	29.7		5.4

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Belfast Rusoord (Old Age Home)	68.9	45.8	6.8	17.0	1.3	24.2		2.7	24.2		2.7
Belfast Hospital	70.4	46.4	7.0	17.9	1.4	24.2		2.7	24.2		2.7
Platorand School	71.4	47.2	7.2	18.8	1.4	24.6		2.8	24.6		2.8
Belfast Primary School (Siyathuthuka)	68.4	44.9	6.6	16.8	1.2	24.1		2.6	24.1		2.6
Siyathuthuka Clinic	68.1	45.2	6.6	16.9	1.2	24.1		2.6	24.1		2.6
Life Bethal Hospital	132.8	62.0	13.5	51.1	3.8	43.8		7.4	**43.8**	1	7.4
Hoerskool Hoogenhout	132.2	61.9	13.6	50.2	3.8	43.1		7.3	**43.1**	1	7.3
Jim Van Tonderskool	138.1	63.1	14.1	53.9	4.1	48.3		8.0	**48.3**	1	8.0
Bethal Independent Primary School	137.8	63.0	14.0	52.8	4.0	47.7		7.8	**47.7**	1	7.8
Laerskool Marietjie Van Niekerk	129.6	61.6	14.0	49.5	4.0	42.2		7.3	**42.2**	1	7.3
Laerskool Hm Swart	134.3	62.1	13.6	51.3	3.8	44.1		7.4	**44.1**	1	7.4
Sakhisizwe Primary School (Emzinoni)	135.0	65.4	13.0	52.8	3.5	47.7		7.7	**47.7**	1	7.7
Alpheus D Nkosi Secondary School (Emzinoni)	134.0	63.8	13.1	51.7	3.6	46.2		7.6	**46.2**	1	7.6
Silwerjare Old Age Home	133.0	61.6	13.4	50.1	3.7	43.1		7.3	**43.1**	1	7.3
Residentia Palm Oord	134.5	62.2	13.5	51.8	3.8	44.5		7.4	**44.5**	1	7.4
Bronkhorspruit Hospital	83.7	53.3	5.1	20.4	0.9	33.2		3.1	33.2		3.1
Cultura High School	91.7	57.4	5.5	24.0	1.0	39.1		3.6	39.1		3.6
Bronkhorspruit Primary School	86.7	52.8	5.2	20.8	0.9	33.1		3.2	33.1		3.2
Bronkhorspruit Dam	100.7	57.3	5.8	28.5	1.2	40.1		4.3	**40.1**	1	4.3
Hoerskool Erasmus	87.5	55.6	5.3	21.8	1.0	36.2		3.4	36.2		3.4
Althea Independent School	86.7	54.9	5.3	21.4	1.0	34.9		3.3	34.9		3.3
Kgoro Primary School (Zithobeni)	81.5	50.1	5.0	18.6	0.9	31.8		3.0	31.8		3.0
Zithobeni Secondary School (Zithobeni)	79.9	49.6	4.9	17.9	0.9	32.0		3.0	32.0		3.0
Vaal Power AH	97.9	49.7	6.1	28.2	1.4	72.5		9.3	**72.5**	**28**	9.3
Sasolburg Provincial Hospital	80.6	55.4	4.9	20.4	1.0	42.4		3.6	**42.4**	1	3.6
Moredou Old Age Home	82.9	59.5	4.8	20.7	1.0	37.8		3.3	37.8		3.3
Ons Gryse Jeug Old Age Home	82.1	58.1	4.9	20.3	1.0	39.6		3.5	39.6		3.5
Noord Primere Skool	82.2	57.9	4.9	20.4	1.0	40.2		3.6	**40.2**	1	3.6
Sasolburg High School	80.3	58.0	4.8	20.1	1.0	40.0		3.4	40.0		3.4
Sakhubusa Secondary School	86.8	56.8	5.0	22.9	1.0	45.0		4.0	**45.0**	1	4.0

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Bekezela Primary School	88.0	52.7	5.0	23.1	1.0	50.9		4.6	**50.9**	1	4.6
Isaac Mhlambi Primary	82.1	55.9	4.9	21.4	1.0	49.9		4.1	**49.9**	1	4.1
Refenkgotso Primary School	103.3	46.7	6.9	33.8	1.7	45.9		4.8	**45.9**	1	4.8
Deneysville Primary School	106.4	45.6	7.1	34.3	1.8	38.1		4.5	38.1		4.5
Netcare Vaalpark Hospital	81.2	63.1	4.9	20.3	1.0	53.3		4.7	**53.3**	1	4.7
Vaalpark Articon Secondary School	80.1	64.1	5.0	20.1	1.0	55.9		5.1	**55.9**	1	5.1
Mediclinic Emfuleni	74.2	47.5	4.5	17.3	0.9	46.2		3.7	**46.2**	1	3.7
Jeugland Old Age Home	75.2	52.2	4.5	17.4	0.9	40.7		3.6	**40.7**	1	3.6
Herfsoord Huis Old Age Home	73.8	48.0	4.5	17.3	0.9	41.3		3.4	**41.3**	1	3.4
Huis Prinscilla	72.7	45.5	4.5	17.2	0.9	39.8		3.3	39.8		3.3
Laerskool Emfulenipark	79.1	56.0	4.8	18.6	0.9	52.8		4.5	**52.8**	1	4.5
Nw University_Vaal Campus	78.1	51.6	4.8	19.0	0.9	62.6		5.8	**62.6**	2	5.8
Emfuleni Primary School	71.3	43.6	4.3	16.4	0.8	36.7		3.0	36.7		3.0
Mediclinic Vereeniging	76.7	49.7	4.8	17.4	1.0	49.5		4.7	**49.5**	1	4.7
Kopanong Provincial Hospital (Duncanville)	76.8	46.4	4.9	17.9	1.0	33.2		3.0	33.2		3.0
Avondrus Eventide Old Age Home	77.7	47.0	4.9	18.2	1.0	34.4		3.1	34.4		3.1
Riviera On Vaal Resort	76.9	50.6	4.9	17.4	1.0	56.6		5.4	**56.6**	1	5.4
Sedibeng Tvet College	77.6	50.7	4.9	17.4	1.0	58.5		5.5	**58.5**	1	5.5
General Smuts High School	78.4	51.1	4.9	17.8	1.0	49.4		4.7	**49.4**	1	4.7
Eureuka School & Selbourne Primary	78.4	53.0	4.8	17.9	1.0	48.8		4.5	**48.8**	1	4.5
Midvaal Private Hospital (Three Rivers)	85.1	57.2	5.3	20.1	1.1	57.5		5.0	**57.5**	1	5.0
Three Rivers Retirement Village	85.6	55.0	5.4	20.4	1.1	48.3		4.2	**48.3**	1	4.2
Drie Riviere Aftreeoord Old Age Home	86.2	57.9	5.3	20.5	1.1	41.8		3.8	**41.8**	1	3.8
Riverside High School	97.0	54.4	5.8	25.2	1.3	65.0		4.9	**65.0**	3	4.9
Risiville Primary School	90.0	49.7	5.4	21.6	1.1	39.9		3.7	39.9		3.7
Sebokeng Hospital	71.7	49.0	4.3	17.2	0.8	29.8		2.5	29.8		2.5
Clinix-Naledzi Private Hospital	71.5	50.2	4.4	17.2	0.8	31.2		2.6	31.2		2.6
Mohloli Secondary School	75.6	52.1	4.7	17.4	0.9	48.7		4.4	**48.7**	1	4.4
Tshirela Primary School (Boipatong)	72.3	49.1	4.5	17.3	0.9	35.3		3.2	35.3		3.2
Tsoaranang Primary School (Thepiso)	74.2	56.2	4.7	17.4	0.9	40.6		3.7	**40.6**	1	3.7
Thepiso Primary School	73.5	52.9	4.6	17.2	0.9	40.2		3.3	**40.2**	1	3.3

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Emmanuel Primary School	74.1	57.2	4.7	17.4	0.9	43.8		4.0	**43.8**	1	4.0
Rust Ter Vaal Combined School	71.6	47.6	4.7	17.3	0.9	26.6		2.5	26.6		2.5
Roshnee Primary School	70.3	47.1	4.6	17.3	0.9	25.5		2.4	25.5		2.4
Roshnee High School	71.0	47.4	4.6	17.3	0.9	26.3		2.5	26.3		2.5
Hoerskool Dr Malan	78.7	44.6	5.0	19.7	1.0	29.4		2.7	29.4		2.7
Laerskool Voorwaarts	92.2	49.0	5.7	24.8	1.2	32.6		3.1	32.6		3.1
Meyerton Secondary School	79.1	46.8	5.1	19.5	1.0	28.2		2.8	28.2		2.8
Ratasetjhaba Primary School	73.7	45.2	4.8	18.9	0.9	25.7		2.5	25.7		2.5
Meyerton Primary School	76.2	44.1	5.0	19.3	1.0	28.8		2.6	28.8		2.6
Oprah Leadership Academy	80.1	43.2	5.1	20.9	1.0	28.7		2.6	28.7		2.6
Henley River Retirement Village	80.4	43.9	5.2	21.1	1.0	27.0		2.7	27.0		2.7
Henley High & Preparatory School	76.0	42.7	5.1	20.3	1.0	26.1		2.6	26.1		2.6
Randvaal Clinic	73.6	43.8	5.0	19.7	1.0	25.8		2.5	25.8		2.5
Laerskool Japie Greyling	72.4	44.0	4.9	19.4	1.0	24.6		2.5	24.6		2.5
Thomas Nhlapo Primary	73.9	43.2	5.0	19.5	1.0	25.3		2.5	25.3		2.5
Randvaal Old Age Home	71.5	45.0	4.9	19.5	1.0	24.6		2.4	24.6		2.4
Laerskool Ag Visser	71.0	41.4	5.9	18.2	1.2	26.2		2.9	26.2		2.9
Lethaba Siyangobe	71.1	41.9	6.0	18.9	1.2	26.3		2.9	26.3		2.9
Shalimar Ridge Primary School	70.1	43.4	5.9	18.3	1.1	26.5		2.9	26.5		2.9
Jw Luckoff High School	71.2	41.4	6.1	18.9	1.3	26.6		3.0	26.6		3.0
Heidelberg Hospital	70.9	43.8	5.9	18.6	1.2	26.9		2.9	26.9		2.9
Thulatsatsi Operation (Rensburg)	70.8	41.4	5.9	18.3	1.2	26.2		2.9	26.2		2.9
Silwer Akker Tehuis	70.3	43.2	5.8	18.2	1.1	26.5		2.9	26.5		2.9
Riversands Retirement Village	70.7	44.1	5.9	18.8	1.2	26.9		2.9	26.9		2.9
Qhaqholla Primary School	72.0	41.6	5.9	19.1	1.2	25.5		2.9	25.5		2.9
Ratanda Primary School	73.4	40.8	5.9	19.6	1.2	25.7		2.9	25.7		2.9
Boneha Primary School	72.2	41.9	5.9	19.1	1.2	25.4		2.9	25.4		2.9
Sithokomele Primary School	72.2	42.0	5.9	19.2	1.2	25.4		2.9	25.4		2.9
Ratanda Bertha Gxowa Primary School	71.5	42.2	6.0	19.1	1.2	26.3		2.9	26.3		2.9
Khanya Lesedi Secondary School	72.5	40.9	5.9	19.4	1.2	25.5		2.9	25.5		2.9
Ratanda Secondary School	72.3	41.5	5.9	19.3	1.2	25.5		2.9	25.5		2.9

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
New Ratanda Secondary School	71.3	42.0	6.0	18.7	1.2	26.1		2.9	26.1		2.9
Kgoro Ya Thuto Secondary School	71.3	42.0	6.0	18.7	1.2	26.1		2.9	26.1		2.9
Ekurhuleni School For The Deaf	67.3	40.8	5.0	17.2	0.9	23.7		2.4	23.7		2.4
Pholosong Hospital	72.4	47.5	5.9	19.9	1.2	26.5		2.9	26.5		2.9
Tsakane Home For Aged	72.2	48.1	5.9	20.7	1.2	26.6		2.9	26.6		2.9
Mmuso Primary School	74.5	48.0	6.2	21.3	1.3	27.2		3.1	27.2		3.1
Michael Zulu Primary School	73.9	48.1	6.0	20.4	1.2	26.6		3.0	26.6		3.0
Nkabinde Primary School (Thembilisha)	73.7	48.6	5.8	19.4	1.2	26.5		3.0	26.5		3.0
Nigel Clinic	72.5	45.3	6.1	19.1	1.2	27.2		3.2	27.2		3.2
Tehuis Vir Bejaardes	73.1	44.0	6.1	19.0	1.2	27.4		3.2	27.4		3.2
Hoerskool John Vorster	72.9	44.2	6.1	18.8	1.2	27.4		3.2	27.4		3.2
Laerskool Hannes Visagie	72.7	44.3	6.2	18.8	1.2	27.6		3.3	27.6		3.3
Nigel Secondary School	74.0	42.8	6.3	19.3	1.3	27.9		3.4	27.9		3.4
Laerskool Dunnottar	73.5	47.5	6.0	20.5	1.2	27.4		3.1	27.4		3.1
Springs Retirement Village	72.1	47.7	5.7	18.9	1.1	26.4		3.1	26.4		3.1
Life Springs Parkland Hospital	72.0	48.7	5.8	19.3	1.1	26.4		3.0	26.4		3.0
Netcare N17 Hospital (Springs)	71.7	48.6	5.8	19.0	1.1	26.3		3.0	26.3		3.0
Springs Boys High School	73.6	48.1	5.9	19.5	1.2	26.8		3.1	26.8		3.1
Laerskool Selectionpark	72.0	47.4	5.8	19.1	1.1	26.7		3.1	26.7		3.1
Kwasa College Pre&Primary School	72.7	46.9	5.9	18.9	1.2	27.9		3.2	27.9		3.2
Edelweis Medical Centre	72.7	46.6	5.9	19.0	1.2	27.3		3.2	27.3		3.2
Laerskool Christiaan Beyers	71.1	47.9	5.8	18.8	1.1	26.6		3.1	26.6		3.1
Hoerskool Hugenote	71.7	46.9	5.7	18.3	1.1	27.1		3.0	27.1		3.0
Brakpan Primary School	71.2	48.3	5.6	18.9	1.1	26.2		2.8	26.2		2.8
Parkrand Primary School	68.1	48.0	5.3	18.0	1.0	24.6		2.5	24.6		2.5
Thabo Memorial Hospital	65.5	47.1	5.1	17.9	1.0	23.8		2.4	23.8		2.4
Sunward Park Hospital	67.2	46.7	5.2	17.7	1.0	24.3		2.5	24.3		2.5
Alberton High School	67.5	41.7	4.8	17.9	0.9	22.9		2.2	22.9		2.2
Netcare Clinton Hospital	66.1	42.5	4.8	17.6	0.9	22.8		2.2	22.8		2.2
Alberton Tuiste Vir Bejaardes	67.5	42.4	4.8	17.9	0.9	22.8		2.2	22.8		2.2
Bertha Gxowa Hospital	67.8	47.3	5.1	19.0	1.0	23.4		2.2	23.4		2.2

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Linmed Hospital	66.6	47.1	5.3	18.8	1.1	25.6		2.6	25.6		2.6
Hoerskool Brandwag (Airfield)	67.5	47.6	5.4	18.5	1.1	25.2		2.6	25.2		2.6
Thepiso Noto Intermediate School	73.3	51.9	5.7	19.1	1.1	30.3		3.4	30.3		3.4
Laerskool Bredell	64.7	48.0	4.9	16.7	0.9	25.5		2.5	25.5		2.5
Sibonelo Primary School (Daveyton)	69.6	50.5	5.5	18.2	1.1	27.8		3.1	27.8		3.1
Petit High School (Kempton Park Nu)	67.8	49.5	5.3	18.7	1.0	27.2		2.8	27.2		2.8
Arwyp Medical Centre	65.0	45.1	4.8	17.5	0.9	24.8		2.3	24.8		2.3
Hoerskool Birchleigh	64.0	43.8	4.6	15.7	0.8	24.2		2.2	24.2		2.2
Curro Serengeti Acadamy	62.7	47.1	4.6	15.5	0.8	25.4		2.4	25.4		2.4
South Rand Hospital	74.1	50.3	5.2	22.5	1.1	23.1		2.1	23.1		2.1
Chris Hani Baragwanath Hospital	64.6	42.3	4.2	18.1	0.8	22.0		1.8	22.0		1.8
Thulani Primary School	58.8	41.0	3.8	17.0	0.7	20.2		1.7	20.2		1.7
University of Witwatersrand	74.0	48.1	5.0	23.7	1.1	22.5		2.0	22.5		2.0
Milpark Hospital	71.1	48.2	4.8	22.1	1.0	22.2		1.9	22.2		1.9
Charlotte Maxixe Academic Hospital	72.8	48.1	4.9	22.9	1.0	22.5		2.0	22.5		2.0
Thembisa West Secondary School (Thembisa)	60.4	42.3	4.2	13.8	0.7	23.6		2.0	23.6		2.0
Lenmed Zamokuhle Private Hospital (Thembisa)	62.0	43.9	4.2	14.6	0.7	24.2		2.1	24.2		2.1
Ikusasa Comprehensive School	62.4	44.5	4.4	15.0	0.8	25.0		2.2	25.0		2.2
Gem Village Old Age Home	63.3	44.8	3.9	13.6	0.6	24.3		2.0	24.3		2.0
Rustoord Old Age Home	63.0	42.4	3.8	13.6	0.6	23.2		1.9	23.2		1.9
Cornwell Hill College (Irene)	64.1	44.0	4.0	13.6	0.6	24.3		2.0	24.3		2.0
Kleinfontein Sorg Sentrum Old Age Home (Donkerhoek)	70.8	45.2	4.4	15.6	0.7	26.5		2.4	26.5		2.4
Valtaki AH (Rayton)	72.4	45.9	4.5	16.2	0.8	28.6		2.6	28.6		2.6
Laerskool Rayton (Rayton)	64.9	39.3	4.0	12.9	0.6	26.0		2.2	26.0		2.2
Tierkop AH	73.7	50.1	4.7	17.3	0.8	28.7		2.7	28.7		2.7
Redford House The Hills Private School (Mooikloof Glen)	72.6	47.3	4.5	16.8	0.8	26.9		2.4	26.9		2.4
Rietvlei View Country Estate	72.7	48.6	4.6	16.8	0.8	27.7		2.5	27.7		2.5

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Hazeldean Curro School (Tyger Valley)	63.5	40.9	3.8	12.8	0.6	23.4		2.0	23.4		2.0
Tyger Valley College	65.0	41.3	4.0	13.9	0.6	24.2		2.1	24.2		2.1
Pretoria East Hospital (Moreletapark)	66.8	42.6	4.1	14.9	0.7	24.8		2.1	24.8		2.1
Groenkloof Old Age Home	60.6	42.6	3.7	13.3	0.6	22.5		1.8	22.5		1.8
Steve Biko Academic Hospital	58.8	42.8	3.4	11.7	0.5	21.3		1.6	21.3		1.6
Willow Ridge High School (Wilgers)	61.0	41.3	3.7	12.4	0.6	23.3		1.9	23.3		1.9
Hoerskool Waterkloof	66.5	44.5	4.1	14.9	0.7	24.9		2.0	24.9		2.0
Hoerskool Garsfontein	63.9	40.9	3.9	14.1	0.6	24.2		2.0	24.2		2.0
Afrikaanse Hoer Seunskool	60.6	42.3	3.6	12.8	0.6	22.2		1.7	22.2		1.7
Huis Silversig SAVF Old Age Home (Silverton)	59.7	42.3	3.5	11.2	0.5	22.8		1.7	22.8		1.7
Laersekool Meyerspark (Meyerspark)	60.2	41.6	3.6	11.2	0.5	23.1		1.8	23.1		1.8
Curro Academy Mamelodi	56.6	35.8	3.4	10.1	0.5	21.9		1.7	21.9		1.7
Impendulo Primary School	59.3	36.5	3.6	11.0	0.5	22.6		1.8	22.6		1.8
Nellmapius Ext 6 Primary School	59.2	39.5	3.5	10.6	0.5	22.3		1.8	22.3		1.8
Mamelodi Home For Aged	58.4	35.8	3.5	10.6	0.5	22.1		1.8	22.1		1.8

Predicted concentrations in µg/m³ at the sensitive receptors for Scenario B (2031), together with the limit value of the NAAQS and number of exceedances (NoE)

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Elsie Ballot Memorial Hospital	138.5	53.6	8.4	30.2	1.6	20.2		3.3	20.2		3.3
Laerskool Amersfoort	131.7	50.8	8.2	28.3	1.6	19.6		3.2	19.6		3.2
Embuzane Primary School	289.2	95.8	17.2	68.6	3.9	39.4		6.2	**39.4**	1	6.2
Sangqotho Primary School	74.9	35.1	7.0	20.2	1.4	20.0		3.5	20.0		3.5
Amersfoort Combined School	126.6	54.8	8.1	27.9	1.6	18.9		3.3	18.9		3.3
Injubuko Primary School	77.7	33.5	6.8	18.0	1.2	17.1		2.9	17.1		2.9
Daggakraal Primary School	131.1	47.7	10.7	28.7	2.1	20.9		3.4	20.9		3.4
Sizenzele Primary School	162.2	51.8	11.7	36.4	2.4	27.5		4.0	**27.5**	1	4.0
Seme Secondary School	120.1	44.3	10.6	26.6	2.1	23.2		3.6	23.2		3.6
Louwra Primary School	89.2	39.1	6.3	19.8	1.1	21.3		2.9	21.3		2.9
Perdekop Agricultural School	77.2	39.4	6.2	19.1	1.2	28.7		4.1	**28.7**	1	4.1
Vukuzenzele Combined School	81.7	41.6	6.4	19.7	1.2	28.3		4.1	**28.3**	1	4.1
Gunwana Primary School	78.0	38.6	5.9	17.6	1.1	18.8		2.8	18.8		2.8
Amajuba Memorial Hospital	70.1	32.5	5.2	14.5	0.9	16.9		2.4	16.9		2.4
Volksrust High School	68.2	34.8	5.1	14.5	0.9	17.0		2.4	17.0		2.4
Volksrust Municipal Clinic	67.8	33.5	5.0	13.8	0.8	15.9		2.3	15.9		2.3
C V O Skool Amajuba	67.9	34.2	5.1	14.2	0.9	16.4		2.3	16.4		2.3
Qhubulwazi Combined School	66.5	31.8	5.1	13.6	0.9	16.5		2.3	16.5		2.3
Volksrust Primary School	71.4	34.3	5.4	15.2	0.9	18.2		2.5	18.2		2.5
New Ermelo	49.5	25.7	6.2	12.3	1.2	15.8		2.5	15.8		2.5
Ermelo Christian School	50.7	26.7	6.4	13.1	1.3	15.7		2.5	15.7		2.5
SAVF Home For Aged	50.0	26.6	6.3	12.8	1.3	15.8		2.5	15.8		2.5
Ermelo Hospital	49.8	25.9	6.3	12.8	1.2	15.8		2.5	15.8		2.5
Mediclinic Ermelo	50.7	26.5	6.4	13.2	1.3	15.7		2.6	15.7		2.6
Hoerskool Ermelo	49.8	26.1	6.3	12.9	1.2	15.8		2.5	15.8		2.5
Ermelo Indian Combined School	49.7	25.6	6.3	12.8	1.2	15.7		2.6	15.7		2.6
Lungelo Combined School (Outside Town)	55.9	27.7	6.2	14.8	1.2	17.1		2.8	17.1		2.8
New Ermelo Primary School	49.8	25.8	6.3	12.5	1.2	15.7		2.5	15.7		2.5

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Kwashashe (Outside Town)	49.7	26.0	6.5	12.9	1.3	15.6		2.5	15.6		2.5
Hts Ligbron	50.2	26.4	6.4	13.0	1.3	15.7		2.6	15.7		2.6
Laerskool Ermelo	50.2	26.4	6.3	12.7	1.2	15.8		2.5	15.8		2.5
JJ Vd Merwe Pre-Primary School	50.4	26.1	6.4	13.2	1.3	15.8		2.6	15.8		2.6
Lindile Secondary School	49.6	25.5	6.3	12.7	1.2	15.8		2.5	15.8		2.5
Emthonjeni Clinic	49.6	25.6	6.3	12.7	1.3	15.8		2.5	15.8		2.5
Reggie Masuku Secondary School	49.5	25.8	6.4	12.6	1.3	15.9		2.5	15.9		2.5
Cebisa Secondary School	49.6	25.6	6.3	12.7	1.3	15.9		2.5	15.9		2.5
Camden	49.6	26.9	6.1	11.8	1.1	15.6		2.4	15.6		2.4
Camden Combined School	49.5	26.5	6.0	11.7	1.1	15.7		2.4	15.7		2.4
Camden School	49.6	27.0	6.1	11.9	1.1	15.6		2.5	15.6		2.5
Umzimvelo Secondary School (Rural Area)	44.9	22.6	5.9	10.1	1.0	14.6		2.3	14.6		2.3
Bhekimfundo Primary School (Rural Area)	52.7	28.9	6.5	14.7	1.3	16.1		2.7	16.1		2.7
Eshwileni Primary School (Rural Area)	58.4	26.9	6.3	14.7	1.2	16.7		2.8	16.7		2.8
Davel Combined School	61.1	29.0	7.1	18.0	1.7	21.3		3.4	21.3		3.4
Morgenzon Landbou Akademie	61.3	25.2	6.5	17.8	1.3	21.6		3.5	21.6		3.5
Nqobangolwazi Secondary School	61.3	25.3	6.4	18.1	1.3	21.4		3.5	21.4		3.5
Siqondekhaya Pre Primary School	60.8	25.6	6.3	18.0	1.3	23.5		3.6	23.5		3.6
Sizakhele Primary School	61.2	25.5	6.4	17.9	1.3	23.4		3.5	23.4		3.5
Phezukwentaba Primary School (South of Morgenzon)	60.9	26.4	6.5	17.7	1.2	22.6		3.6	22.6		3.6
Kwaggalaagte Primary School (North of Morgenzon)	71.6	31.9	6.6	22.9	1.5	23.3		3.7	23.3		3.7
Sizakhele Clinic/Hospital	61.2	25.4	6.4	17.9	1.3	23.1		3.5	23.1		3.5
Grootvlei	43.0	22.1	3.9	11.9	0.8	14.5		1.8	14.5		1.8
Olive Grove Country Lodge	43.9	21.5	3.9	12.2	0.8	14.6		1.8	14.6		1.8
Grootvlei Town (South of Power Station)	42.5	21.3	3.8	11.5	0.8	14.0		1.8	14.0		1.8
Laerskool Grootvlei	42.6	21.4	3.9	11.6	0.8	14.0		1.8	14.0		1.8
Tokoloho Primary School	42.3	21.5	3.8	11.3	0.8	14.1		1.8	14.1		1.8
Tshepeha Combined School	42.4	21.2	3.8	11.4	0.8	14.1		1.8	14.1		1.8
Warembo Lodge	40.7	20.9	3.8	10.6	0.7	14.7		1.9	14.7		1.9

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Balfour	43.0	24.8	3.9	11.4	0.8	17.2		2.0	17.2		2.0
Siyathemba	43.7	24.3	4.0	11.6	0.8	17.6		2.1	17.6		2.1
Bonukukhanya Primary (Siyathemba)	43.5	24.3	4.0	11.5	0.8	17.5		2.0	17.5		2.0
Qalabocha Primary School (Siyathemba)	43.6	24.8	4.0	11.6	0.8	17.5		2.1	17.5		2.1
Vusumuzi Primary School	44.0	24.4	4.1	11.9	0.8	17.6		2.1	17.6		2.1
Gekombineerde Skool Balfour	43.1	24.3	3.9	11.3	0.8	17.0		2.0	17.0		2.0
Im Manchu Secondary School	42.9	24.5	3.9	11.2	0.8	17.0		2.0	17.0		2.0
Isifisosethu Secondary School (Siyathemba)	43.9	24.3	4.1	11.9	0.8	17.6		2.1	17.6		2.1
Setsheng Secondary School (Siyathemba)	43.7	24.9	4.1	11.8	0.8	17.6		2.1	17.6		2.1
Dr Nieuwoudt And Dr Kok	43.4	24.4	3.9	11.2	0.8	16.9		2.0	16.9		2.0
Balfour Clinic	42.7	24.5	3.9	11.1	0.8	17.1		2.0	17.1		2.0
Siyathemba Clinic	43.0	24.7	4.0	11.5	0.8	17.3		2.0	17.3		2.0
Mondoro Lodge	42.8	23.3	3.9	11.9	0.8	15.8		1.9	15.8		1.9
Wegelegen Manor	43.4	24.7	3.9	11.5	0.8	17.2		2.1	17.2		2.1
The Stone Cellar	41.8	20.6	3.5	10.6	0.7	14.8		1.8	14.8		1.8
Greylingstad	45.5	25.8	4.4	11.1	0.8	16.9		2.3	16.9		2.3
Nthorwane	45.4	24.4	4.3	10.5	0.8	17.2		2.2	17.2		2.2
Laerskool Greylingstad	46.5	25.8	4.5	11.7	0.8	17.2		2.3	17.2		2.3
Nthoroane Secondary School	45.5	24.4	4.3	10.5	0.8	17.3		2.3	17.3		2.3
Badgarleur Bush Lodge	41.5	22.1	4.1	10.7	0.8	15.7		2.0	15.7		2.0
Matla Village	129.9	57.3	8.6	36.8	2.3	**135.3**	**16**	14.6	**135.3**	**143**	14.6
Sifundise Primary School	129.8	58.0	8.7	37.5	2.3	**127.0**	**14**	13.9	**127.0**	**129**	13.9
Matla Coal Health Centre	132.6	54.3	8.8	38.5	2.3	**87.5**	1	11.2	**87.5**	**92**	11.2
Gweda Primary School	177.9	62.9	10.3	75.3	3.3	**102.7**	9	18.7	**102.7**	**278**	**18.7**
Zithobe Primary School	106.0	41.7	6.6	33.1	1.7	56.3		9.0	**56.3**	**50**	9.0
Kwanala Primary School	153.1	58.5	11.1	66.3	3.5	**132.0**	**27**	14.6	**132.0**	**158**	14.6
Reedstream Park	123.1	47.6	10.2	38.3	2.8	46.3		7.0	**46.3**	11	7.0
Rietspruit Clinic	119.6	43.5	10.0	36.3	2.7	41.6		6.5	**41.6**	2	6.5
Lehlaka Combined School	119.1	44.7	10.0	36.3	2.7	41.5		6.6	**41.5**	1	6.6
Mbali Coal/Blesboklaagte Housing	136.7	46.8	10.1	34.9	2.7	36.9		5.7	**36.9**	1	5.7
Kinross	93.7	43.7	6.6	31.7	1.7	67.4		7.4	**67.4**	**44**	7.4

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Kinross Settlement	84.3	43.9	6.1	25.6	1.5	57.2		6.9	**57.2**	**18**	6.9
Kinross Municipal Clinic	93.2	42.5	6.5	31.2	1.6	61.9		7.1	**61.9**	**39**	7.1
Kriel	122.2	42.6	10.4	55.2	3.3	**87.7**	1	8.7	**87.7**	**48**	8.7
Eagles Nest Guest House	116.6	40.9	10.4	53.3	3.2	**79.0**	1	8.2	**79.0**	**45**	8.2
Merlin Park Primary School	109.3	40.6	9.9	46.5	2.9	63.5		7.1	**63.5**	**19**	7.1
Kriel Medical Centre	110.7	40.3	9.9	46.7	3.0	67.5		7.3	**67.5**	**23**	7.3
Laerskool Krielpark	116.3	42.0	10.1	49.7	3.1	**80.9**	1	7.9	**80.9**	**36**	7.9
Laerskool Onverwacht	112.7	41.9	10.0	48.3	3.0	58.5		7.1	**58.5**	**22**	7.1
Silwer Fleur Aftree Oord (Old Age Home)	115.5	43.0	10.1	49.0	3.0	62.1		7.3	**62.1**	**26**	7.3
Thubelihle	103.0	41.0	9.7	41.2	2.7	41.0		6.1	**41.0**	1	6.1
Sibongamandla Secondary School	98.6	38.9	9.6	38.8	2.7	39.1		6.2	**39.1**	1	6.2
Ga-Nala Clinic	115.7	43.4	10.1	48.8	3.0	52.5		6.6	**52.5**	**19**	6.6
Impilo Primary School	87.9	35.2	8.6	28.6	2.3	33.4		5.5	**33.4**	1	5.5
Bonginhlanhla Primary School	98.9	39.6	9.5	38.8	2.7	39.9		6.1	**39.9**	1	6.1
Sibongamandla Secondary School	98.4	38.9	9.6	38.7	2.7	39.1		6.2	**39.1**	1	6.2
Leandra	70.7	35.7	5.3	20.8	1.2	31.8		5.5	**31.8**	1	5.5
Eendracht	67.5	34.5	5.2	19.2	1.2	29.7		4.9	**29.7**	1	4.9
Sidingulwazi Primary School	68.8	34.8	5.3	20.0	1.2	30.6		5.1	**30.6**	1	5.1
Ss Mshayisa Primary School	71.0	36.3	5.3	20.2	1.2	31.1		5.3	**31.1**	1	5.3
Chief Ampie Mayisa Secondary School	68.7	34.9	5.3	20.3	1.2	30.5		5.1	**30.5**	1	5.1
Lebogang Clinic	69.0	35.6	5.3	20.7	1.2	30.7		5.2	**30.7**	1	5.2
Kleuterskool Haas Das	52.7	26.9	4.9	12.0	0.8	21.3		3.3	21.3		3.3
Standerton Primary School	52.4	27.5	4.9	12.0	0.8	21.4		3.3	21.4		3.3
Laerskool Jeugkrag	51.7	26.9	4.9	11.6	0.8	23.2		3.4	23.2		3.4
Laerskool Standerton	52.9	26.6	4.9	12.0	0.8	21.4		3.2	21.4		3.2
Laerskool Kalie De Haas	54.6	25.9	5.0	12.2	0.8	20.9		3.1	20.9		3.1
Hoerskool Standerton	52.3	27.5	4.9	12.0	0.8	21.4		3.3	21.4		3.3
Standerton Provincial Government Hospital	51.9	27.7	4.9	11.8	0.8	21.3		3.3	21.3		3.3
Mar-Peh Medicare Private Hospital	52.8	26.2	4.9	12.0	0.8	21.0		3.2	21.0		3.2
Standerton Retirement Home	52.8	26.0	4.9	11.9	0.8	21.0		3.2	21.0		3.2
Standerton Ouetehuis/Old Age Home	53.8	26.6	5.0	12.2	0.8	21.1		3.2	21.1		3.2

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Holmdene Secondary School	47.4	27.0	4.7	10.6	0.8	20.8		3.0	20.8		3.0
Cathuza Primary School (SE of Town)	62.1	30.9	5.4	14.6	1.0	25.5		3.6	**25.5**	1	3.6
Sizanani Pre Primary School	51.9	25.5	4.9	11.4	0.8	20.4		3.1	20.4		3.1
Hlobisa Primary School	50.2	26.0	4.8	10.8	0.8	19.9		3.0	19.9		3.0
Shukuma Primary School	50.0	26.2	4.8	10.8	0.8	19.6		3.0	19.6		3.0
Retsebile Primary School	50.8	25.7	4.8	11.0	0.8	21.2		3.1	21.2		3.1
Thuto-Thebe Secondary School	51.4	25.4	4.9	11.6	0.8	21.6		3.3	21.6		3.3
Jandrell Secondary School	50.7	25.8	4.8	11.0	0.8	20.3		3.1	20.3		3.1
Thobelani Secondary School	51.3	26.0	4.9	11.1	0.8	20.6		3.1	20.6		3.1
Standerton Tb Hospital	51.2	26.6	4.8	11.1	0.8	19.8		3.0	19.8		3.0
Thuthukani Pre Primary School	63.7	31.1	5.8	16.0	1.1	37.9		5.5	**37.9**	1	5.5
Ulwazi Primary School	63.4	31.6	5.8	15.9	1.1	36.0		5.3	**36.0**	1	5.3
Zikhetheleni Secondary School	63.0	30.8	5.8	15.8	1.1	36.3		5.3	**36.3**	1	5.3
Joubertsvlei Primary School (North of Tutuka)	62.8	27.6	5.8	18.2	1.2	23.8		4.3	23.8		4.3
Amalumgelo Primary School (NE of Tutuka)	68.3	27.6	6.9	20.0	1.4	45.4		5.7	**45.4**	8	5.7
Grootdraaidam Primary School	54.7	27.8	5.2	12.6	0.9	25.7		3.8	**25.7**	1	3.8
Laerskool Secunda	71.3	32.3	6.0	22.3	1.4	42.1		5.8	**42.1**	2	5.8
Laerskool Kruinpark	71.3	32.5	6.2	23.4	1.4	37.8		6.0	**37.8**	1	6.0
Laerskool Oranjegloed Primary	69.3	31.5	5.9	21.8	1.3	39.0		5.6	**39.0**	1	5.6
Curro Castle Combined School	68.1	32.3	5.8	20.5	1.3	38.1		5.4	**38.1**	1	5.4
Hoërskool Oosterland	71.8	32.8	6.1	22.8	1.4	39.6		6.0	**39.6**	1	6.0
Mediclinic Secunda (Hospital)	70.0	32.7	5.9	21.2	1.3	44.5		5.7	**44.5**	3	5.7
Mediclinic Highveld (Hospital_Trichardt, Secunda)	78.8	34.4	6.6	27.7	1.6	45.7		7.0	**45.7**	**17**	7.0
Daviescourt/Davieshof Old Age Home	71.3	32.1	6.0	22.5	1.4	40.7		5.8	**40.7**	1	5.8
Highveld Park High School	72.2	33.2	6.1	23.2	1.4	40.2		6.0	**40.2**	3	6.0
Hoerskool Secunda	70.4	32.0	6.0	22.1	1.3	41.1		5.7	**41.1**	1	5.7
Basizeni Special School	68.0	34.6	5.3	19.1	1.1	33.1		4.5	**33.1**	1	4.5
Maphala-Gulube Primary School	63.9	35.1	5.2	16.8	1.0	27.6		4.1	**27.6**	1	4.1
Shapeve Primary School	68.7	34.3	5.4	18.5	1.1	32.2		4.5	**32.2**	1	4.5

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Thomas Nhlabathi Secondary School	66.9	34.1	5.2	18.2	1.1	30.5		4.2	**30.5**	1	4.2
Embalenhle Hospital / Clinic	65.9	34.2	5.2	17.6	1.1	29.9		4.2	**29.9**	1	4.2
Vukuzithathe Primary School	64.3	33.0	5.2	16.7	1.0	27.8		4.1	**27.8**	1	4.1
K I Twala Secondary	64.4	32.6	5.2	16.5	1.0	28.0		4.0	**28.0**	1	4.0
Allan Makunga Primary School	67.6	34.2	5.3	18.1	1.1	31.3		4.4	**31.3**	1	4.4
Evander Hospital Arv Clinic	78.7	38.2	6.1	25.1	1.4	45.2		5.9	**45.2**	4	5.9
Laerskool Hoeveld	78.7	38.8	6.0	24.1	1.4	45.5		5.8	**45.5**	3	5.8
Hoerskool Evander	76.7	39.1	5.9	23.3	1.4	45.0		5.6	**45.0**	10	5.6
Bernice Samuel Hospital	57.5	33.0	3.9	14.9	0.8	27.1		3.4	**27.1**	1	3.4
Hoerskool Delmas	57.3	34.0	3.9	14.9	0.8	26.9		3.5	**26.9**	1	3.5
Laerskool Delmas	58.4	34.6	3.9	15.4	0.8	27.4		3.6	**27.4**	1	3.6
Kangela Primary School (North of Delpark)	59.6	34.4	4.0	16.2	0.8	29.6		3.8	**29.6**	1	3.8
Savf Ons Eie Ouetehuis / Old Age Home	58.3	35.0	3.9	15.5	0.8	27.6		3.6	**27.6**	1	3.6
Laerskool Eloff	52.8	32.0	3.7	13.6	0.7	24.2		3.0	24.2		3.0
Rietkol Primary School	53.0	31.7	3.7	13.6	0.7	24.2		3.0	24.2		3.0
Bazani Primary School	59.2	33.4	3.9	17.0	0.8	27.9		4.0	**27.9**	1	4.0
Phaphamani Secondary School	58.4	33.1	3.9	16.3	0.8	27.6		3.9	**27.6**	1	3.9
Vezimfundo Primary School	58.0	31.0	3.9	16.3	0.8	28.2		4.0	**28.2**	1	4.0
Arbor Primary School	87.7	51.1	5.6	36.8	1.6	71.4		11.6	**71.4**	**113**	11.6
Ogies Combined School	153.2	53.6	9.3	40.0	2.7	42.2		5.6	**42.2**	1	5.6
Ogies Tb Clinic	157.6	57.7	9.3	41.8	2.7	44.6		5.6	**44.6**	2	5.6
Ogies Police Station	157.6	57.7	9.3	41.8	2.7	44.6		5.6	**44.6**	2	5.6
Hlangu Phala Primary School	129.3	60.4	8.1	44.2	2.7	38.5		5.0	**38.5**	1	5.0
Sukumani Primary School	129.4	60.6	8.1	43.6	2.7	38.5		5.0	**38.5**	1	5.0
Thuthukani Primary School	129.4	57.6	8.2	42.5	2.6	38.5		4.9	**38.5**	1	4.9
Mehlwana Secondary School	119.3	55.3	8.0	44.3	2.7	42.3		5.1	**42.3**	1	5.1
Makause Combined School	119.7	56.0	8.0	43.0	2.7	39.6		5.0	**39.6**	1	5.0
Sibongindawo Primary School	124.2	53.4	8.5	69.8	3.5	67.5		7.5	**67.5**	**37**	7.5
Laerskool Balmoral	102.2	48.8	5.4	51.1	1.8	32.5		3.5	**32.5**	1	3.5
Clewer Primary School	83.4	38.3	6.1	27.8	1.7	31.3		3.8	**31.3**	1	3.8
Witbank High School	78.6	38.9	5.7	22.0	1.4	49.4		5.0	**49.4**	10	5.0

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Eden Park Retirement Village	81.0	38.9	5.9	23.3	1.5	55.8		6.4	**55.8**	**47**	6.4
Savf House Immergroen Old Age Home	76.3	38.3	5.6	21.8	1.4	40.8		4.5	**40.8**	1	4.5
Mthimkulu Housing For The Aged	75.6	38.5	5.5	22.3	1.4	33.5		3.7	**33.5**	1	3.7
Emalahleni Private Hospital	75.4	38.1	5.5	21.0	1.4	38.5		4.2	**38.5**	1	4.2
Life Cosmos Hospital	78.5	38.9	5.7	21.7	1.4	50.3		5.1	**50.3**	**20**	5.1
Duvha Primary School	85.6	37.2	6.3	25.5	1.7	50.0		6.1	**50.0**	**30**	6.1
Laerskool Taalfees	78.1	38.6	5.7	21.9	1.4	49.8		4.9	**49.8**	**13**	4.9
Witbank Provincial Hospital	76.9	38.2	5.6	21.0	1.4	45.4		4.5	**45.4**	4	4.5
Nancy Shiba Primary School (Vosman)	75.3	38.4	5.2	24.4	1.4	24.4		2.8	24.4		2.8
Wh De Klerk Skool	77.2	39.7	5.5	20.1	1.3	33.6		3.4	**33.6**	1	3.4
Laerskool Panorama	74.2	38.1	5.2	19.4	1.2	27.6		2.9	**27.6**	1	2.9
Laerskool Duvhapark	86.6	38.0	6.4	25.8	1.7	55.3		6.9	**55.3**	**51**	6.9
Laerskool Klipfontein	81.8	38.7	6.0	23.4	1.5	56.4		6.6	**56.4**	**59**	6.6
Cambridge Academy	79.9	40.4	5.9	22.5	1.5	55.6		5.8	**55.6**	**30**	5.8
Besilindile Primary School	74.4	38.7	4.9	23.5	1.2	22.7		2.6	22.7		2.6
Reynopark High School	81.6	35.9	6.1	24.5	1.6	72.9		8.2	**72.9**	**87**	8.2
Bakenveld Golf Estate	81.7	41.0	6.0	23.5	1.5	42.8		4.4	**42.8**	**13**	4.4
Allendale Secondary School	74.9	46.4	7.1	21.6	1.8	42.3		7.7	**42.3**	7	7.7
Khayalethu Primary School	75.6	38.4	5.4	22.1	1.4	32.7		3.6	**32.7**	1	3.6
Illanga Secondary School	76.0	58.7	7.0	21.5	1.8	**80.0**	1	17.0	**80.0**	**230**	**17.0**
Joy Creche (Duvha)	77.7	38.2	6.5	22.2	1.7	43.1		6.5	**43.1**	**20**	6.5
Linderus Old Age Home	69.8	40.8	4.7	16.2	0.9	20.6		2.0	20.6		2.0
Vergeet My Nie Old Age Home	72.5	42.4	4.7	16.3	0.9	20.3		2.1	20.3		2.1
Middleburg Frail Care Unit And Home For Elderly	66.0	39.5	4.4	13.9	0.8	18.7		1.8	18.7		1.8
Life Midmed Hospital	68.9	41.1	4.5	14.7	0.8	19.0		1.9	19.0		1.9
Middelburg Hospital	71.3	42.0	4.6	15.7	0.9	19.7		2.0	19.7		2.0
Makhathini Primary School	66.9	39.4	4.4	14.3	0.8	18.8		1.8	18.8		1.8
Laerskool Dennesig	63.7	38.9	4.3	13.4	0.8	18.8		1.8	18.8		1.8
Hoerskool Kanonkop	65.2	38.9	4.3	13.8	0.8	18.7		1.8	18.7		1.8
Laerskool Kanonkop	66.5	39.7	4.4	14.2	0.8	18.6		1.8	18.6		1.8

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Steelcrest High School	68.1	40.1	4.5	14.6	0.8	18.7		1.9	18.7		1.9
Middelburg Primary	71.2	42.0	4.6	16.0	0.9	20.1		2.0	20.1		2.0
Middleburg Ext 6 Clinic	69.6	39.4	4.7	15.8	0.9	27.3		2.4	**27.3**	1	2.4
Sofunda Secondary School	68.6	39.5	4.5	15.2	0.9	21.3		2.1	21.3		2.1
Mhluzi Primary School	68.2	39.2	4.5	14.8	0.8	19.4		1.9	19.4		1.9
Highlands Primary School	70.4	39.7	4.8	16.8	0.9	21.9		2.1	21.9		2.1
Blinkpan Primary School	77.7	34.1	7.8	23.7	2.0	40.3		5.7	**40.3**	3	5.7
Laerskool Koornfontein	75.2	34.3	7.8	22.5	1.9	40.7		5.5	**40.7**	2	5.5
Blinkpan	78.6	35.4	7.9	24.3	2.0	41.4		5.8	**41.4**	3	5.8
Laerskool Kragveld	64.4	30.7	6.9	18.1	1.6	30.6		3.5	**30.6**	1	3.5
Pullens Hope	63.7	31.7	6.9	17.8	1.6	30.0		3.5	**30.0**	1	3.5
Arnot Colliery Primary School	53.5	30.7	5.1	12.9	1.0	19.6		2.1	19.6		2.1
Laerskool Rietkuil	52.3	29.9	5.2	12.9	1.0	19.2		2.1	19.2		2.1
Beestepan Agricultural School	59.1	31.7	4.6	12.4	0.8	18.3		1.9	18.3		1.9
Gekombineerde Skool Hendrina	50.9	28.2	6.5	12.9	1.4	22.7		3.1	22.7		3.1
Hendrina Primary School	51.1	28.1	6.5	13.2	1.4	23.7		3.0	23.7		3.0
Kwazamokuhle Secondary School	51.2	27.9	6.5	13.2	1.4	23.6		3.0	23.6		3.0
Ubuhle Bolwai Secondary School	39.0	22.8	5.3	8.7	0.9	13.9		2.0	13.9		2.0
Lothair Primary School	39.2	22.2	5.4	8.8	0.9	14.0		2.1	14.0		2.1
Warburton Combined School	39.2	24.2	5.1	9.1	0.8	13.7		1.9	13.7		1.9
Warburton Town	39.3	24.7	5.1	9.2	0.8	13.8		1.9	13.8		1.9
Kwachibikhulu Clinic	42.0	24.4	5.7	9.6	1.0	15.0		2.2	15.0		2.2
Kwachibikhulu Primary School	41.8	24.6	5.7	9.7	1.0	15.0		2.2	15.0		2.2
Carolina Hospital	41.3	25.0	5.2	9.3	0.9	16.8		2.1	16.8		2.1
Zinikeleni Secondary School (Silobela)	41.4	25.2	5.2	9.3	0.9	17.0		2.1	17.0		2.1
Volkskool Carolina	41.3	24.8	5.1	9.3	0.9	16.5		2.0	16.5		2.0
Sobuza Primary School	40.8	25.1	5.2	9.4	0.9	17.0		2.1	17.0		2.1
Ons Eie Ouetehuis (Old Age Home)	41.3	24.9	5.2	9.3	0.9	16.5		2.0	16.5		2.0
Laerskool Breyten	45.8	25.3	6.2	11.8	1.3	16.3		2.4	16.3		2.4
Siyazi Primary School (Kwazanele)	46.0	25.6	6.3	12.0	1.3	16.4		2.4	16.4		2.4
Masizakhe Secondary School (Kwazanele)	46.1	25.5	6.2	11.9	1.3	16.3		2.4	16.3		2.4

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Belfast Rusoord (Old Age Home)	41.0	26.1	3.6	9.1	0.6	12.8		1.4	12.8		1.4
Belfast Hospital	41.0	26.3	3.7	9.6	0.6	12.8		1.4	12.8		1.4
Platorand School	41.3	25.9	3.7	9.9	0.7	12.8		1.4	12.8		1.4
Belfast Primary School (Siyathuthuka)	41.0	24.7	3.5	8.9	0.6	12.8		1.4	12.8		1.4
Siyathuthuka Clinic	40.9	24.8	3.5	8.9	0.6	12.8		1.4	12.8		1.4
Life Bethal Hospital	83.5	34.8	7.5	27.9	1.9	27.6		4.4	**27.6**	1	4.4
Hoerskool Hoogenhout	83.1	34.6	7.5	27.4	1.9	27.0		4.4	**27.0**	1	4.4
Jim Van Tonderskool	86.4	35.5	7.8	29.6	2.1	32.4		4.8	**32.4**	1	4.8
Bethal Independent Primary School	86.3	35.1	7.7	28.9	2.0	31.5		4.7	**31.5**	1	4.7
Laerskool Marietjie Van Niekerk	78.4	35.2	7.8	25.9	2.0	27.1		4.3	**27.1**	1	4.3
Laerskool Hm Swart	83.6	34.8	7.5	28.1	1.9	27.7		4.4	**27.7**	1	4.4
Sakhisizwe Primary School (Emzinoni)	88.2	35.7	7.2	30.5	1.8	32.8		4.8	**32.8**	1	4.8
Alpheus D Nkosi Secondary School (Emzinoni)	86.5	36.4	7.3	28.9	1.8	31.1		4.6	**31.1**	1	4.6
Silwerjare Old Age Home	83.5	35.2	7.4	27.6	1.9	28.7		4.4	**28.7**	1	4.4
Residentia Palm Oord	83.7	34.9	7.5	28.5	1.9	28.2		4.5	**28.2**	1	4.5
Bronkhorspruit Hospital	52.8	32.2	2.9	14.0	0.6	23.4		2.2	23.4		2.2
Cultura High School	58.7	34.2	3.2	17.2	0.7	27.7		2.6	**27.7**	1	2.6
Bronkhorspruit Primary School	53.5	32.7	3.0	14.9	0.6	24.1		2.2	24.1		2.2
Bronkhorspruit Dam	63.6	34.1	3.4	20.1	0.8	30.3		3.3	**30.3**	1	3.3
Hoerskool Erasmus	55.3	33.1	3.0	15.3	0.6	25.9		2.4	**25.9**	1	2.4
Althea Independent School	55.2	34.0	3.0	15.1	0.6	25.0		2.3	25.0		2.3
Kgoro Primary School (Zithobeni)	51.1	31.3	2.8	13.1	0.5	21.9		2.1	21.9		2.1
Zithobeni Secondary School (Zithobeni)	49.0	31.2	2.8	12.7	0.5	22.2		2.0	22.2		2.0
Vaal Power AH	72.6	34.2	4.0	23.4	1.0	64.0		8.3	**64.0**	**86**	8.3
Sasolburg Provincial Hospital	56.3	38.9	3.0	14.9	0.6	32.1		2.7	**32.1**	1	2.7
Moredou Old Age Home	53.4	36.2	2.9	13.4	0.6	28.3		2.4	**28.3**	1	2.4
Ons Gryse Jeug Old Age Home	53.9	35.4	3.0	13.5	0.6	30.6		2.6	**30.6**	1	2.6
Noord Primere Skool	53.4	36.5	3.0	13.8	0.6	31.2		2.7	**31.2**	1	2.7
Sasolburg High School	53.4	33.5	2.9	13.9	0.6	30.7		2.5	**30.7**	1	2.5
Sakhubusa Secondary School	57.3	34.3	3.0	14.0	0.6	37.8		3.0	**37.8**	1	3.0

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Bekezela Primary School	57.1	33.1	3.0	13.7	0.6	43.1		3.6	**43.1**	11	3.6
Isaac Mhlambi Primary	57.9	36.4	3.1	14.7	0.7	42.0		3.2	**42.0**	2	3.2
Refenkgotso Primary School	70.3	27.4	4.2	24.9	1.1	35.3		3.6	**35.3**	1	3.6
Deneysville Primary School	69.8	26.5	4.4	24.8	1.1	28.2		3.3	**28.2**	1	3.3
Netcare Vaalpark Hospital	56.1	39.4	3.0	13.9	0.6	43.2		3.8	**43.2**	12	3.8
Vaalpark Articon Secondary School	57.2	39.4	3.1	14.3	0.7	46.4		4.2	**46.4**	**19**	4.2
Mediclinic Emfuleni	49.1	30.1	2.7	10.9	0.5	35.4		2.8	**35.4**	1	2.8
Jeugland Old Age Home	49.7	31.1	2.7	11.2	0.5	32.1		2.8	**32.1**	1	2.8
Herfsoord Huis Old Age Home	48.6	29.3	2.7	10.7	0.5	31.7		2.6	**31.7**	1	2.6
Huis Prinscilla	47.0	27.1	2.6	10.5	0.5	29.9		2.5	**29.9**	1	2.5
Laerskool Emfulenipark	53.9	33.6	2.9	12.5	0.6	43.9		3.6	**43.9**	7	3.6
Nw University_Vaal Campus	52.5	36.2	3.0	12.2	0.6	53.2		4.9	**53.2**	**28**	4.9
Emfuleni Primary School	46.4	28.0	2.5	9.9	0.5	26.8		2.2	**26.8**	1	2.2
Mediclinic Vereeniging	48.7	28.7	2.9	10.8	0.6	40.0		3.8	**40.0**	10	3.8
Kopanong Provincial Hospital (Duncanville)	48.4	27.5	2.9	10.9	0.6	23.6		2.1	23.6		2.1
Avondrus Eventide Old Age Home	48.8	27.9	2.9	10.8	0.6	24.5		2.2	24.5		2.2
Riviera On Vaal Resort	48.5	31.3	2.9	11.0	0.6	46.5		4.5	**46.5**	**17**	4.5
Sedibeng Tvet College	49.3	30.4	2.9	11.0	0.6	49.9		4.6	**49.9**	**21**	4.6
General Smuts High School	48.7	33.9	2.9	10.6	0.6	39.2		3.8	**39.2**	9	3.8
Eureuka School & Selbourne Primary	48.5	32.2	2.8	10.5	0.6	39.5		3.6	**39.5**	4	3.6
Midvaal Private Hospital (Three Rivers)	54.6	34.2	3.3	12.9	0.7	49.3		4.1	**49.3**	**20**	4.1
Three Rivers Retirement Village	55.4	32.9	3.3	13.0	0.7	39.4		3.2	**39.4**	8	3.2
Drie Riviere Aftreeoord Old Age Home	54.9	32.4	3.3	12.9	0.7	33.6		2.8	**33.6**	1	2.8
Riverside High School	69.6	34.6	3.6	18.8	0.8	57.2		4.0	**57.2**	**17**	4.0
Risiville Primary School	58.1	34.0	3.3	13.8	0.7	31.8		2.8	**31.8**	1	2.8
Sebokeng Hospital	41.9	27.9	2.5	9.8	0.5	20.0		1.7	20.0		1.7
Clinix-Naledzi Private Hospital	42.0	28.8	2.5	10.0	0.5	20.3		1.8	20.3		1.8
Mohloli Secondary School	46.9	33.9	2.8	10.6	0.6	39.3		3.5	**39.3**	4	3.5
Tshirela Primary School (Boipatong)	45.5	31.7	2.6	9.9	0.5	25.8		2.3	**25.8**	1	2.3
Tsoaranang Primary School (Thepiso)	45.4	32.1	2.7	10.0	0.5	31.2		2.8	**31.2**	1	2.8
Thepiso Primary School	46.2	32.9	2.7	10.1	0.5	29.9		2.5	**29.9**	1	2.5

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Emmanuel Primary School	46.1	34.7	2.8	10.3	0.5	34.9		3.1	**34.9**	1	3.1
Rust Ter Vaal Combined School	44.6	26.6	2.7	10.2	0.5	18.2		1.6	18.2		1.6
Roshnee Primary School	42.6	26.1	2.6	10.3	0.5	16.4		1.5	16.4		1.5
Roshnee High School	42.6	26.3	2.7	10.4	0.5	17.6		1.6	17.6		1.6
Hoerskool Dr Malan	49.6	27.6	3.0	13.1	0.6	20.0		1.8	20.0		1.8
Laerskool Voorwaarts	58.5	28.4	3.4	16.7	0.8	23.5		2.1	23.5		2.1
Meyerton Secondary School	50.7	29.8	3.0	12.6	0.6	19.3		1.9	19.3		1.9
Ratasetjhaba Primary School	46.1	27.7	2.8	11.1	0.5	16.7		1.6	16.7		1.6
Meyerton Primary School	48.0	28.1	2.9	12.5	0.6	19.4		1.7	19.4		1.7
Oprah Leadership Academy	50.5	25.1	3.0	13.2	0.6	20.3		1.7	20.3		1.7
Henley River Retirement Village	51.4	25.5	3.1	13.0	0.6	18.4		1.7	18.4		1.7
Henley High & Preparatory School	48.9	24.4	3.0	12.6	0.6	17.7		1.6	17.7		1.6
Randvaal Clinic	47.1	26.0	2.9	11.9	0.6	17.1		1.6	17.1		1.6
Laerskool Japie Greyling	45.6	25.2	2.9	11.5	0.6	15.3		1.5	15.3		1.5
Thomas Nhlapo Primary	46.7	24.7	2.9	12.0	0.6	16.5		1.6	16.5		1.6
Randvaal Old Age Home	45.2	26.7	2.8	11.4	0.6	15.2		1.5	15.2		1.5
Laerskool Ag Visser	43.9	23.7	3.4	10.9	0.6	15.1		1.7	15.1		1.7
Lethaba Siyangobe	43.8	23.5	3.5	11.0	0.7	15.2		1.7	15.2		1.7
Shalimar Ridge Primary School	44.4	24.6	3.4	10.8	0.6	15.1		1.7	15.1		1.7
Jw Luckoff High School	44.4	23.6	3.5	11.4	0.7	15.2		1.8	15.2		1.8
Heidelberg Hospital	44.7	25.2	3.4	10.8	0.6	15.2		1.7	15.2		1.7
Thulatsatsi Operation (Rensburg)	43.8	23.8	3.4	10.9	0.6	15.1		1.7	15.1		1.7
Silwer Akker Tehuis	44.3	24.6	3.4	10.8	0.6	15.1		1.7	15.1		1.7
Riversands Retirement Village	44.4	25.5	3.4	10.9	0.7	15.2		1.7	15.2		1.7
Qhaqholla Primary School	44.5	23.8	3.4	11.2	0.7	15.0		1.7	15.0		1.7
Ratanda Primary School	44.6	22.8	3.4	11.6	0.7	15.0		1.7	15.0		1.7
Boneha Primary School	44.3	23.6	3.4	11.3	0.7	15.0		1.7	15.0		1.7
Sithokomele Primary School	44.0	23.4	3.4	11.4	0.7	15.0		1.7	15.0		1.7
Ratanda Bertha Gxowa Primary School	44.2	23.3	3.5	11.2	0.7	15.2		1.7	15.2		1.7
Khanya Lesedi Secondary School	43.8	23.1	3.4	11.5	0.7	14.9		1.7	14.9		1.7
Ratanda Secondary School	43.8	23.1	3.4	11.5	0.7	14.9		1.7	14.9		1.7

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
New Ratanda Secondary School	44.0	23.6	3.4	11.1	0.7	15.2		1.7	15.2		1.7
Kgoro Ya Thuto Secondary School	44.0	23.6	3.4	11.1	0.7	15.2		1.7	15.2		1.7
Ekurhuleni School For The Deaf	41.1	24.6	2.9	10.7	0.5	13.5		1.4	13.5		1.4
Pholosong Hospital	44.3	28.1	3.3	11.9	0.7	15.5		1.7	15.5		1.7
Tsakane Home For Aged	45.2	27.5	3.4	11.9	0.7	15.4		1.8	15.4		1.8
Mmuso Primary School	46.5	26.9	3.5	12.4	0.7	16.3		1.8	16.3		1.8
Michael Zulu Primary School	44.8	28.2	3.4	12.0	0.7	15.8		1.8	15.8		1.8
Nkabinde Primary School (Thembilisha)	44.0	28.5	3.3	11.4	0.6	16.0		1.8	16.0		1.8
Nigel Clinic	45.4	25.6	3.5	11.0	0.6	16.9		1.9	16.9		1.9
Tehuis Vir Bejaardes	45.9	25.6	3.5	10.9	0.6	17.1		2.0	17.1		2.0
Hoerskool John Vorster	45.1	25.5	3.5	10.9	0.6	16.9		1.9	16.9		1.9
Laerskool Hannes Visagie	45.3	25.3	3.5	11.1	0.7	17.3		2.0	17.3		2.0
Nigel Secondary School	46.1	26.7	3.6	11.4	0.7	18.2		2.0	18.2		2.0
Laerskool Dunnottar	46.1	26.8	3.4	11.9	0.7	16.3		1.9	16.3		1.9
Springs Retirement Village	44.0	29.6	3.2	11.2	0.6	17.2		1.9	17.2		1.9
Life Springs Parkland Hospital	44.0	28.4	3.3	11.3	0.6	16.8		1.9	16.8		1.9
Netcare N17 Hospital (Springs)	43.9	28.8	3.3	11.2	0.6	16.7		1.9	16.7		1.9
Springs Boys High School	45.2	28.7	3.3	11.4	0.6	16.8		1.9	16.8		1.9
Laerskool Selectionpark	44.3	28.0	3.3	11.2	0.6	17.1		1.9	17.1		1.9
Kwasa College Pre&Primary School	44.8	27.5	3.4	11.5	0.6	17.3		2.0	17.3		2.0
Edelweis Medical Centre	44.2	27.8	3.3	11.2	0.6	17.4		2.0	17.4		2.0
Laerskool Christiaan Beyers	43.9	28.8	3.2	11.3	0.6	17.3		2.0	17.3		2.0
Hoerskool Hugenote	44.6	28.7	3.2	11.2	0.6	17.0		1.9	17.0		1.9
Brakpan Primary School	43.5	27.3	3.2	11.3	0.6	15.7		1.7	15.7		1.7
Parkrand Primary School	41.5	27.6	3.0	11.3	0.6	14.1		1.5	14.1		1.5
Thabo Memorial Hospital	40.8	28.4	3.0	11.1	0.6	13.6		1.4	13.6		1.4
Sunward Park Hospital	41.1	27.3	3.0	10.9	0.6	13.7		1.5	13.7		1.5
Alberton High School	40.5	26.0	2.8	10.9	0.5	12.8		1.3	12.8		1.3
Netcare Clinton Hospital	39.8	26.6	2.8	10.8	0.5	12.7		1.3	12.7		1.3
Alberton Tuiste Vir Bejaardes	40.4	26.4	2.8	11.0	0.5	12.8		1.3	12.8		1.3
Bertha Gxowa Hospital	41.3	28.3	3.0	11.6	0.6	13.3		1.3	13.3		1.3

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Linmed Hospital	40.7	28.0	3.1	11.5	0.6	15.2		1.6	15.2		1.6
Hoerskool Brandwag (Airfield)	41.8	29.5	3.1	11.6	0.6	14.7		1.6	14.7		1.6
Thepiso Noto Intermediate School	44.9	29.1	3.2	11.9	0.6	19.4		2.2	19.4		2.2
Laerskool Bredell	38.4	28.5	2.8	10.2	0.5	15.2		1.5	15.2		1.5
Sibonelo Primary School (Daveyton)	44.1	28.8	3.1	11.0	0.6	17.2		2.0	17.2		2.0
Petit High School (Kempton Park Nu)	40.1	29.9	3.0	11.4	0.6	16.4		1.7	16.4		1.7
Arwyp Medical Centre	37.6	28.1	2.8	11.0	0.6	14.0		1.4	14.0		1.4
Hoerskool Birchleigh	38.6	26.4	2.7	9.7	0.5	14.2		1.3	14.2		1.3
Curro Serengeti Acadamy	38.4	27.1	2.7	9.5	0.5	15.5		1.5	15.5		1.5
South Rand Hospital	46.5	31.6	3.1	13.9	0.7	13.2		1.2	13.2		1.2
Chris Hani Baragwanath Hospital	39.3	25.3	2.5	10.5	0.5	12.1		1.1	12.1		1.1
Thulani Primary School	34.8	24.0	2.2	10.1	0.4	11.0		0.9	11.0		0.9
University of Witwatersrand	44.9	28.9	2.9	14.0	0.6	13.0		1.2	13.0		1.2
Milpark Hospital	42.4	27.6	2.8	13.0	0.6	12.9		1.1	12.9		1.1
Charlotte Maxixe Academic Hospital	43.5	28.7	2.9	13.4	0.6	13.0		1.2	13.0		1.2
Thembisa West Secondary School (Thembisa)	36.7	23.7	2.4	8.3	0.4	13.8		1.2	13.8		1.2
Lenmed Zamokuhle Private Hospital (Thembisa)	38.5	25.2	2.4	8.9	0.4	14.7		1.3	14.7		1.3
Ikusasa Comprehensive School	39.1	25.8	2.5	8.9	0.5	14.8		1.3	14.8		1.3
Gem Village Old Age Home	38.0	23.9	2.3	8.5	0.4	14.5		1.3	14.5		1.3
Rustoord Old Age Home	37.4	25.7	2.2	8.3	0.4	14.0		1.2	14.0		1.2
Cornwell Hill College (Irene)	38.2	24.8	2.3	8.7	0.4	14.5		1.3	14.5		1.3
Kleinfontein Sorg Sentrum Old Age Home (Donkerhoek)	44.0	25.7	2.5	10.7	0.4	16.7		1.6	16.7		1.6
Valtaki AH (Rayton)	45.8	26.2	2.6	11.0	0.5	18.7		1.7	18.7		1.7
Laerskool Rayton (Rayton)	39.7	25.0	2.3	8.8	0.4	16.3		1.4	16.3		1.4
Tierkop AH	45.3	29.9	2.8	11.2	0.5	17.9		1.8	17.9		1.8
Redford House The Hills Private School (Mooikloof Glen)	44.7	27.6	2.6	10.7	0.5	16.5		1.6	16.5		1.6
Rietvlei View Country Estate	45.0	28.4	2.7	10.9	0.5	16.6		1.6	16.6		1.6

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Hazeldean Curro School (Tyger Valley)	38.7	23.6	2.2	8.3	0.3	13.9		1.2	13.9		1.2
Tyger Valley College	40.1	24.4	2.3	8.9	0.4	14.4		1.3	14.4		1.3
Pretoria East Hospital (Moreletapark)	40.7	25.5	2.3	9.4	0.4	14.9		1.3	14.9		1.3
Groenkloof Old Age Home	37.2	27.0	2.1	8.5	0.3	13.0		1.1	13.0		1.1
Steve Biko Academic Hospital	35.4	23.7	2.0	7.5	0.3	12.6		1.0	12.6		1.0
Willow Ridge High School (Wilgers)	37.6	25.6	2.1	8.1	0.3	13.2		1.1	13.2		1.1
Hoerskool Waterkloof	40.0	26.4	2.3	9.6	0.4	14.6		1.3	14.6		1.3
Hoerskool Garsfontein	39.7	25.5	2.2	9.0	0.4	14.0		1.2	14.0		1.2
Afrikaanse Hoer Seunskool	36.7	25.3	2.1	8.1	0.3	12.7		1.1	12.7		1.1
Huis Silversig SAVF Old Age Home (Silverton)	36.4	24.8	2.0	7.3	0.3	12.8		1.0	12.8		1.0
Laersekool Meyerspark (Meyerspark)	36.6	24.4	2.0	7.4	0.3	13.0		1.1	13.0		1.1
Curro Academy Mamelodi	34.2	21.9	1.9	6.7	0.3	12.5		1.0	12.5		1.0
Impendulo Primary School	36.5	22.3	2.0	7.3	0.3	13.4		1.1	13.4		1.1
Nellmapius Ext 6 Primary School	36.5	22.5	2.0	6.7	0.3	13.0		1.1	13.0		1.1
Mamelodi Home For Aged	35.2	21.9	2.0	6.9	0.3	12.8		1.0	12.8		1.0

Predicted concentrations in µg/m³ at the sensitive receptors for Scenario C (2036), together with the limit value of the NAAQS and number of exceedances (NoE)

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Elsie Ballot Memorial Hospital	122.9	52.9	6.9	35.9	1.6	16.7		2.5	16.7		2.5
Laerskool Amersfoort	116.1	45.6	6.7	34.0	1.6	16.3		2.4	16.3		2.4
Embuzane Primary School	241.0	79.7	13.3	79.0	3.9	35.2		5.5	**35.2**	1	5.5
Sangqotho Primary School	69.0	32.2	5.8	16.5	1.3	16.1		2.6	16.1		2.6
Amersfoort Combined School	110.7	51.2	6.7	32.6	1.6	16.1		2.5	16.1		2.5
Injubuko Primary School	68.1	31.8	5.6	16.8	1.2	13.9		2.1	13.9		2.1
Daggakraal Primary School	116.3	40.3	8.8	36.6	2.3	17.9		2.7	17.9		2.7
Sizenzele Primary School	140.8	42.6	9.6	44.1	2.6	24.3		3.3	24.3		3.3
Seme Secondary School	107.1	38.0	8.6	32.8	2.2	20.2		2.9	20.2		2.9
Louwra Primary School	75.9	31.4	5.0	20.8	1.1	16.9		2.4	16.9		2.4
Perdekop Agricultural School	62.6	34.2	4.8	17.1	1.0	25.3		3.4	**25.3**	1	3.4
Vukuzenzele Combined School	64.3	36.8	4.8	18.1	1.1	24.9		3.4	24.9		3.4
Gunwana Primary School	62.9	32.0	4.6	18.5	1.0	15.5		2.3	15.5		2.3
Amajuba Memorial Hospital	55.3	23.5	4.1	15.2	0.8	12.7		1.9	12.7		1.9
Volksrust High School	55.0	24.1	4.0	14.5	0.8	13.0		1.9	13.0		1.9
Volksrust Municipal Clinic	54.2	22.2	3.9	14.4	0.8	11.9		1.8	11.9		1.8
C V O Skool Amajuba	53.8	22.9	4.0	14.7	0.8	12.6		1.8	12.6		1.8
Qhubulwazi Combined School	52.9	22.0	4.0	14.2	0.8	12.4		1.8	12.4		1.8
Volksrust Primary School	56.2	23.6	4.2	16.2	0.9	13.8		2.0	13.8		2.0
New Ermelo	32.8	17.7	3.7	9.5	0.8	11.1		1.5	11.1		1.5
Ermelo Christian School	33.6	18.2	3.8	10.1	0.8	11.0		1.6	11.0		1.6
SAVF Home For Aged	32.7	17.9	3.8	10.0	0.8	11.0		1.5	11.0		1.5
Ermelo Hospital	32.4	18.1	3.7	9.9	0.8	11.0		1.5	11.0		1.5
Mediclinic Ermelo	33.6	18.0	3.8	10.1	0.8	11.0		1.6	11.0		1.6
Hoerskool Ermelo	32.5	18.1	3.7	10.0	0.8	11.0		1.5	11.0		1.5
Ermelo Indian Combined School	32.4	18.3	3.7	9.8	0.8	10.9		1.5	10.9		1.5

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	350	125	50	200	40	75	12	40	40	12	20
Lungelo Combined School (Outside Town)	39.8	19.0	4.0	10.3	0.8	11.8		1.7	11.8		1.7
New Ermelo Primary School	32.9	18.2	3.8	9.7	0.8	11.1		1.5	11.1		1.5
Kwashashe (Outside Town)	31.5	17.9	3.8	10.3	0.8	11.1		1.5	11.1		1.5
Hts Ligbron	33.2	17.9	3.8	10.1	0.8	11.0		1.5	11.0		1.5
Laerskool Ermelo	32.3	17.8	3.7	9.9	0.8	11.1		1.5	11.1		1.5
JJ Vd Merwe Pre-Primary School	32.7	18.1	3.8	10.2	0.8	11.0		1.6	11.0		1.6
Lindile Secondary School	32.0	18.3	3.7	9.7	0.8	10.8		1.5	10.8		1.5
Emthonjeni Clinic	32.0	18.3	3.7	9.9	0.8	10.8		1.5	10.8		1.5
Reggie Masuku Secondary School	31.2	18.3	3.7	10.0	0.8	10.4		1.5	10.4		1.5
Cebisa Secondary School	31.9	18.3	3.7	9.9	0.8	10.8		1.5	10.8		1.5
Camden	34.0	18.8	3.8	8.9	0.7	10.7		1.5	10.7		1.5
Camden Combined School	34.0	19.3	3.9	8.7	0.7	10.5		1.5	10.5		1.5
Camden School	34.2	18.8	3.8	9.0	0.8	10.8		1.5	10.8		1.5
Umzimvelo Secondary School (Rural Area)	30.5	18.7	3.7	8.1	0.7	10.2		1.5	10.2		1.5
Bhekimfundo Primary School (Rural Area)	35.8	18.9	4.0	10.4	0.9	11.3		1.6	11.3		1.6
Eshwileni Primary School (Rural Area)	46.8	21.2	4.7	10.9	1.0	11.3		1.8	11.3		1.8
Davel Combined School	33.6	17.1	3.7	12.4	0.9	11.9		1.7	11.9		1.7
Morgenzon Landbou Akademie	64.1	22.4	5.5	14.7	1.2	17.5		2.3	17.5		2.3
Nqobangolwazi Secondary School	63.5	23.3	5.3	14.6	1.1	17.3		2.3	17.3		2.3
Siqondekhaya Pre Primary School	63.7	23.9	5.3	14.7	1.1	19.0		2.3	19.0		2.3
Sizakhele Primary School	63.1	23.6	5.3	14.6	1.1	18.8		2.3	18.8		2.3
Phezukwentaba Primary School (South of Morgenzon)	61.5	22.0	5.7	14.6	1.2	17.9		2.5	17.9		2.5
Kwaggalaagte Primary School (North of Morgenzon)	43.4	21.0	4.0	13.2	0.9	13.6		1.9	13.6		1.9

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Sizakhele Clinic/Hospital	63.5	23.7	5.3	14.8	1.1	18.5		2.3	18.5		2.3
Grootvlei	36.6	17.5	3.0	8.9	0.6	10.1		1.3	10.1		1.3
Olive Grove Country Lodge	37.7	17.8	3.1	9.2	0.6	10.5		1.3	10.5		1.3
Grootvlei Town (South of Power Station)	35.7	16.7	3.0	8.8	0.6	10.4		1.3	10.4		1.3
Laerskool Grootvlei	36.3	16.8	3.0	8.9	0.6	10.5		1.3	10.5		1.3
Tokoloho Primary School	35.8	16.4	3.0	8.7	0.6	10.5		1.3	10.5		1.3
Tshepeha Combined School	35.7	16.8	3.0	8.8	0.6	10.4		1.3	10.4		1.3
Warembo Lodge	33.5	17.5	3.0	8.4	0.6	10.1		1.3	10.1		1.3
Balfour	31.9	16.1	2.8	8.8	0.5	10.3		1.4	10.3		1.4
Siyathemba	31.9	16.5	2.9	9.2	0.6	10.4		1.4	10.4		1.4
Bonukukhanya Primary (Siyathemba)	31.8	16.3	2.9	9.2	0.6	10.5		1.4	10.5		1.4
Qalabocha Primary School (Siyathemba)	31.8	16.5	2.9	9.1	0.6	10.4		1.4	10.4		1.4
Vusumuzi Primary School	31.9	16.6	2.9	9.3	0.6	10.5		1.4	10.5		1.4
Gekombineerde Skool Balfour	32.3	15.9	2.9	8.7	0.6	10.3		1.4	10.3		1.4
Im Manchu Secondary School	32.1	15.7	2.9	8.6	0.5	10.3		1.3	10.3		1.3
Isifisosethu Secondary School (Siyathemba)	32.1	16.5	2.9	9.5	0.6	10.6		1.4	10.6		1.4
Setsheng Secondary School (Siyathemba)	32.0	16.5	2.9	9.2	0.6	10.5		1.4	10.5		1.4
Dr Nieuwoudt And Dr Kok	32.5	15.6	2.9	8.7	0.6	10.2		1.4	10.2		1.4
Balfour Clinic	31.8	15.6	2.8	8.6	0.5	10.3		1.3	10.3		1.3
Siyathemba Clinic	31.6	16.1	2.8	8.9	0.5	10.4		1.4	10.4		1.4
Mondoro Lodge	32.3	14.6	2.8	9.0	0.5	10.0		1.3	10.0		1.3
Wegelegen Manor	31.2	15.4	2.8	8.7	0.5	10.6		1.4	10.6		1.4
The Stone Cellar	30.7	14.0	2.5	7.6	0.4	9.6		1.2	9.6		1.2
Greylingstad	31.9	17.9	3.2	9.3	0.6	11.2		1.5	11.2		1.5
Nthorwane	31.6	17.9	3.1	8.9	0.6	11.1		1.5	11.1		1.5

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Laerskool Greylingstad	32.3	17.8	3.2	9.7	0.6	11.2		1.6	11.2		1.6
Nthoroane Secondary School	31.5	17.6	3.1	8.8	0.6	11.1		1.5	11.1		1.5
Badgarleur Bush Lodge	31.8	19.6	3.1	8.6	0.6	10.5		1.4	10.5		1.4
Matla Village	49.4	18.7	3.9	32.4	1.5	30.5		3.6	**30.5**	1	3.6
Sifundise Primary School	49.2	19.0	3.9	32.4	1.5	29.8		3.6	**29.8**	1	3.6
Matla Coal Health Centre	49.8	18.5	3.9	32.5	1.5	29.1		3.6	**29.1**	1	3.6
Gweda Primary School	39.9	17.1	3.5	22.5	1.1	19.5		2.5	19.5		2.5
Zithobe Primary School	39.8	16.5	3.2	23.9	1.1	39.2		4.9	**39.2**	12	4.9
Kwanala Primary School	42.3	18.2	4.0	26.9	1.5	23.4		2.8	23.4		2.8
Reedstream Park	44.0	17.2	4.4	29.3	1.9	24.2		2.8	24.2		2.8
Rietspruit Clinic	42.0	17.3	4.3	27.4	1.9	21.9		2.6	21.9		2.6
Lehlaka Combined School	42.2	17.1	4.4	27.7	1.9	22.1		2.6	22.1		2.6
Mbali Coal/Blesboklaagte Housing	49.8	18.3	4.7	35.5	2.3	26.7		3.0	**26.7**	1	3.0
Kinross	35.5	15.7	3.2	17.9	0.9	21.3		2.9	21.3		2.9
Kinross Settlement	34.0	15.4	3.1	16.5	0.9	23.5		3.1	23.5		3.1
Kinross Municipal Clinic	34.6	15.7	3.2	17.4	0.9	20.4		2.8	20.4		2.8
Kriel	38.6	16.9	3.8	22.9	1.4	18.9		2.4	18.9		2.4
Eagles Nest Guest House	37.6	17.0	3.8	22.1	1.3	18.6		2.3	18.6		2.3
Merlin Park Primary School	37.4	16.5	3.8	22.6	1.4	17.7		2.3	17.7		2.3
Kriel Medical Centre	37.5	16.6	3.8	22.3	1.4	17.9		2.3	17.9		2.3
Laerskool Krielpark	38.2	16.6	3.8	22.8	1.4	18.2		2.3	18.2		2.3
Laerskool Onverwacht	37.6	16.5	3.8	22.9	1.4	17.8		2.3	17.8		2.3
Silwer Fleur Aftree Oord (Old Age Home)	37.9	16.5	3.8	22.9	1.4	18.1		2.3	18.1		2.3
Thubelihle	36.5	16.2	3.9	21.1	1.5	17.4		2.2	17.4		2.2
Sibongamandla Secondary School	35.7	16.2	3.9	20.6	1.5	17.3		2.1	17.3		2.1
Ga-Nala Clinic	37.8	16.4	3.8	23.5	1.4	17.5		2.3	17.5		2.3
Impilo Primary School	33.4	15.8	3.7	19.2	1.4	15.2		1.9	15.2		1.9

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Bonginhlanhla Primary School	35.6	16.3	3.8	20.4	1.5	17.2		2.1	17.2		2.1
Sibongamandla Secondary School	35.8	16.2	3.9	20.6	1.5	17.3		2.1	17.3		2.1
Leandra	32.8	16.5	3.0	15.6	0.8	23.9		3.4	23.9		3.4
Eendracht	32.6	17.1	3.0	16.1	0.8	22.2		3.1	22.2		3.1
Sidingulwazi Primary School	32.7	17.1	3.0	15.5	0.8	22.0		3.2	22.0		3.2
Ss Mshayisa Primary School	32.6	16.5	3.0	15.4	0.8	22.0		3.2	22.0		3.2
Chief Ampie Mayisa Secondary School	32.9	17.2	3.0	15.2	0.8	21.8		3.1	21.8		3.1
Lebogang Clinic	33.4	16.8	3.0	15.6	0.8	22.9		3.2	22.9		3.2
Kleuterskool Haas Das	50.4	24.2	3.9	12.4	0.7	17.4		2.4	17.4		2.4
Standerton Primary School	50.8	24.5	3.9	12.4	0.7	17.8		2.4	17.8		2.4
Laerskool Jeugkrag	50.0	26.7	3.9	12.6	0.7	19.3		2.5	19.3		2.5
Laerskool Standerton	50.3	24.3	3.9	12.5	0.7	17.3		2.4	17.3		2.4
Laerskool Kalie De Haas	52.2	24.8	4.0	12.9	0.7	16.5		2.3	16.5		2.3
Hoerskool Standerton	50.8	24.5	3.9	12.4	0.7	17.8		2.4	17.8		2.4
Standerton Provincial Government Hospital	50.0	24.0	3.9	12.3	0.7	17.6		2.4	17.6		2.4
Mar-Peh Medicare Private Hospital	50.6	23.6	3.9	12.5	0.7	16.8		2.4	16.8		2.4
Standerton Retirement Home	50.3	23.4	3.9	12.5	0.7	16.7		2.4	16.7		2.4
Standerton Ouetehuis/Old Age Home	51.1	23.8	3.9	12.7	0.7	17.3		2.4	17.3		2.4
Holmdene Secondary School	39.2	22.3	3.5	10.4	0.6	13.6		2.1	13.6		2.1
Cathuza Primary School (SE of Town)	58.2	24.8	4.4	14.6	0.9	19.5		2.7	19.5		2.7
Sizanani Pre Primary School	48.3	23.1	3.8	11.9	0.7	16.8		2.3	16.8		2.3
Hlobisa Primary School	47.2	22.8	3.8	11.6	0.7	15.9		2.2	15.9		2.2
Shukuma Primary School	46.3	22.1	3.8	11.5	0.7	14.7		2.2	14.7		2.2
Retsebile Primary School	48.3	23.3	3.8	11.8	0.7	17.7		2.3	17.7		2.3
Thuto-Thebe Secondary School	49.2	23.9	3.8	12.3	0.7	18.4		2.4	18.4		2.4
Jandrell Secondary School	47.5	22.5	3.8	11.7	0.7	16.8		2.3	16.8		2.3
Thobelani Secondary School	48.2	22.6	3.8	11.9	0.7	17.1		2.3	17.1		2.3

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Standerton Tb Hospital	47.1	22.2	3.8	11.8	0.7	15.2		2.2	15.2		2.2
Thuthukani Pre Primary School	50.1	38.8	4.3	14.0	0.9	33.9		4.1	**33.9**	1	4.1
Ulwazi Primary School	50.8	40.0	4.3	14.1	0.9	31.8		4.0	**31.8**	1	4.0
Zikhetheleni Secondary School	51.0	39.4	4.3	14.4	0.9	33.1		4.0	**33.1**	1	4.0
Joubertsvlei Primary School (North of Tutuka)	42.7	25.0	4.0	16.1	0.9	15.2		2.3	15.2		2.3
Amalumgelo Primary School (NE of Tutuka)	111.9	40.5	6.4	26.4	1.5	42.4		4.2	**42.4**	8	4.2
Grootdraaidam Primary School	55.8	27.1	4.2	13.8	0.8	21.6		2.8	21.6		2.8
Laerskool Secunda	35.0	16.5	3.3	15.5	0.8	17.1		2.3	17.1		2.3
Laerskool Kruinpark	34.9	16.0	3.4	15.7	0.9	16.5		2.2	16.5		2.2
Laerskool Oranjegloed Primary	34.7	16.9	3.3	15.0	0.8	16.7		2.2	16.7		2.2
Curro Castle Combined School	34.3	16.9	3.2	15.0	0.8	16.9		2.2	16.9		2.2
Hoërskool Oosterland	35.2	16.4	3.3	15.7	0.9	17.0		2.3	17.0		2.3
Mediclinic Secunda (Hospital)	34.4	16.5	3.2	15.5	0.8	17.3		2.3	17.3		2.3
Mediclinic Highveld (Hospital_Trichardt, Secunda)	35.8	15.5	3.4	17.1	0.9	16.7		2.3	16.7		2.3
Daviescourt/Davieshof Old Age Home	34.8	16.6	3.3	15.4	0.8	17.2		2.3	17.2		2.3
Highveld Park High School	34.6	16.4	3.3	15.7	0.8	17.2		2.3	17.2		2.3
Hoerskool Secunda	34.8	16.7	3.3	15.4	0.8	17.1		2.3	17.1		2.3
Basizeni Special School	33.3	17.4	3.0	12.5	0.7	16.4		2.3	16.4		2.3
Maphala-Gulube Primary School	33.6	17.7	3.1	11.8	0.7	15.2		2.2	15.2		2.2
Shapeve Primary School	32.9	17.5	3.1	12.7	0.7	16.7		2.3	16.7		2.3
Thomas Nhlabathi Secondary School	33.1	17.3	3.0	11.6	0.7	16.3		2.3	16.3		2.3
Embalenhle Hospital / Clinic	33.7	17.5	3.0	11.6	0.7	15.8		2.2	15.8		2.2
Vukuzithathe Primary School	33.7	17.0	3.1	11.6	0.7	15.7		2.2	15.7		2.2
K I Twala Secondary	34.0	17.1	3.1	11.6	0.7	15.6		2.2	15.6		2.2
Allan Makunga Primary School	33.2	17.4	3.1	12.5	0.7	16.3		2.3	16.3		2.3

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Evander Hospital Arv Clinic	33.7	16.4	3.2	15.9	0.8	18.5		2.6	18.5		2.6
Laerskool Hoeveld	33.6	16.4	3.2	15.6	0.8	18.8		2.6	18.8		2.6
Hoerskool Evander	33.3	16.3	3.1	14.9	0.8	19.1		2.5	19.1		2.5
Bernice Samuel Hospital	28.9	15.0	2.2	13.0	0.6	20.9		2.5	20.9		2.5
Hoerskool Delmas	29.2	14.9	2.2	13.0	0.6	20.8		2.5	20.8		2.5
Laerskool Delmas	29.8	15.1	2.3	13.6	0.6	21.1		2.6	21.1		2.6
Kangela Primary School (North of Delpark)	30.7	14.4	2.3	14.7	0.6	22.1		2.8	22.1		2.8
Savf Ons Eie Ouetehuis / Old Age Home	29.9	15.0	2.3	13.6	0.6	21.1		2.6	21.1		2.6
Laerskool Eloff	27.3	14.8	2.2	11.5	0.5	18.2		2.1	18.2		2.1
Rietkol Primary School	27.2	15.0	2.2	11.4	0.5	18.1		2.1	18.1		2.1
Bazani Primary School	29.6	14.9	2.2	14.5	0.6	21.6		3.0	21.6		3.0
Phaphamani Secondary School	29.2	15.0	2.2	13.9	0.6	21.1		3.0	21.1		3.0
Vezimfundo Primary School	29.8	14.8	2.2	14.5	0.6	21.7		3.0	21.7		3.0
Arbor Primary School	58.9	24.0	3.4	37.9	1.4	61.6		10.4	**61.6**	**98**	10.4
Ogies Combined School	61.2	23.0	4.9	42.3	2.5	34.9		3.4	**34.9**	1	3.4
Ogies Tb Clinic	64.7	23.1	4.9	44.5	2.5	36.3		3.6	**36.3**	2	3.6
Ogies Police Station	64.7	23.1	4.9	44.5	2.5	36.3		3.6	**36.3**	2	3.6
Hlangu Phala Primary School	72.1	25.8	5.0	49.2	2.6	32.3		3.5	**32.3**	1	3.5
Sukumani Primary School	70.7	24.7	5.0	48.5	2.6	32.2		3.5	**32.2**	1	3.5
Thuthukani Primary School	69.8	24.4	5.0	47.4	2.6	31.9		3.4	**31.9**	1	3.4
Mehlwana Secondary School	70.7	24.6	5.1	48.5	2.6	35.3		3.5	**35.3**	1	3.5
Makause Combined School	70.5	23.4	5.0	47.4	2.6	33.3		3.4	**33.3**	1	3.4
Sibongindawo Primary School	105.5	31.6	6.2	75.0	3.5	62.3		6.1	**62.3**	**34**	6.1
Laerskool Balmoral	84.9	34.1	3.8	55.1	1.7	28.0		2.5	**28.0**	1	2.5
Clewer Primary School	46.1	19.8	3.6	28.8	1.5	16.9		1.7	16.9		1.7
Witbank High School	36.0	18.1	3.0	19.7	1.1	14.7		1.4	14.7		1.4
Eden Park Retirement Village	36.3	18.1	3.1	20.4	1.1	14.8		1.4	14.8		1.4

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Savf House Immergroen Old Age Home	36.1	18.4	3.0	19.5	1.0	14.8		1.4	14.8		1.4
Mthimkulu Housing For The Aged	37.9	18.4	3.0	21.3	1.1	15.0		1.4	15.0		1.4
Emalahleni Private Hospital	35.9	18.2	2.9	19.2	1.0	14.5		1.4	14.5		1.4
Life Cosmos Hospital	35.5	18.0	3.0	19.3	1.0	14.5		1.4	14.5		1.4
Duvha Primary School	37.8	17.8	3.3	22.5	1.2	13.8		1.5	13.8		1.5
Laerskool Taalfees	35.8	18.2	3.0	19.4	1.0	14.8		1.4	14.8		1.4
Witbank Provincial Hospital	35.4	18.4	2.9	18.9	1.0	14.4		1.4	14.4		1.4
Nancy Shiba Primary School (Vosman)	43.5	20.7	3.1	25.8	1.2	15.2		1.4	15.2		1.4
Wh De Klerk Skool	33.4	18.1	2.8	17.3	0.9	13.0		1.3	13.0		1.3
Laerskool Panorama	33.4	18.2	2.7	16.6	0.9	13.2		1.2	13.2		1.2
Laerskool Duvhapark	36.1	17.7	3.2	21.2	1.2	13.3		1.4	13.3		1.4
Laerskool Klipfontein	36.1	18.0	3.1	20.4	1.1	14.7		1.4	14.7		1.4
Cambridge Academy	34.9	17.9	3.0	18.8	1.0	14.0		1.4	14.0		1.4
Besilindile Primary School	44.2	20.9	2.9	24.9	1.1	14.3		1.4	14.3		1.4
Reynopark High School	35.8	18.0	3.2	20.2	1.2	14.3		1.4	14.3		1.4
Bakenveld Golf Estate	32.1	17.1	2.9	17.1	1.0	11.8		1.3	11.8		1.3
Allendale Secondary School	30.4	16.8	3.1	16.9	1.1	12.2		1.3	12.2		1.3
Khayalethu Primary School	37.7	18.5	3.0	21.1	1.1	14.8		1.4	14.8		1.4
Illanga Secondary School	31.5	16.2	3.1	17.3	1.1	12.4		1.3	12.4		1.3
Joy Creche (Duvha)	32.4	16.5	3.2	18.3	1.1	12.6		1.4	12.6		1.4
Linderus Old Age Home	25.7	16.3	2.2	9.3	0.5	10.1		1.0	10.1		1.0
Vergeet My Nie Old Age Home	26.0	16.1	2.2	9.4	0.5	10.1		1.0	10.1		1.0
Middleburg Frail Care Unit And Home For Elderly	25.5	16.7	2.1	8.9	0.5	9.6		0.9	9.6		0.9
Life Midmed Hospital	25.7	16.8	2.1	9.0	0.5	9.8		1.0	9.8		1.0
Middelburg Hospital	25.9	16.4	2.2	9.3	0.5	10.0		1.0	10.0		1.0
Makhathini Primary School	26.1	16.7	2.1	9.2	0.5	9.7		0.9	9.7		0.9
Laerskool Dennesig	25.4	16.5	2.1	8.7	0.5	9.6		0.9	9.6		0.9

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Hoerskool Kanonkop	25.3	16.6	2.1	8.7	0.5	9.7		0.9	9.7		0.9
Laerskool Kanonkop	25.4	16.8	2.1	8.9	0.5	9.6		0.9	9.6		0.9
Steelcrest High School	25.5	16.6	2.1	8.9	0.5	9.7		0.9	9.7		0.9
Middelburg Primary	25.8	16.1	2.2	9.3	0.5	10.0		1.0	10.0		1.0
Middleburg Ext 6 Clinic	27.6	17.4	2.3	10.5	0.6	10.5		1.0	10.5		1.0
Sofunda Secondary School	27.0	17.1	2.2	9.9	0.5	10.2		1.0	10.2		1.0
Mhluzi Primary School	26.5	16.7	2.1	9.5	0.5	9.9		1.0	9.9		1.0
Highlands Primary School	25.8	15.6	2.2	9.4	0.5	10.1		1.0	10.1		1.0
Blinkpan Primary School	28.0	15.7	3.3	14.0	1.1	12.2		1.4	12.2		1.4
Laerskool Koornfontein	27.9	15.9	3.3	13.7	1.1	12.2		1.4	12.2		1.4
Blinkpan	28.1	15.6	3.3	14.3	1.1	12.3		1.4	12.3		1.4
Laerskool Kragveld	24.9	15.3	2.8	10.3	0.7	10.4		1.2	10.4		1.2
Pullens Hope	24.9	15.2	2.8	10.1	0.7	10.4		1.2	10.4		1.2
Arnot Colliery Primary School	22.4	14.6	2.4	7.7	0.5	9.5		1.0	9.5		1.0
Laerskool Rietkuil	22.4	15.0	2.4	7.5	0.5	9.4		1.1	9.4		1.1
Beestepan Agricultural School	21.8	13.2	2.2	7.0	0.5	9.0		1.0	9.0		1.0
Gekombineerde Skool Hendrina	25.3	15.0	3.0	9.5	0.8	10.2		1.3	10.2		1.3
Hendrina Primary School	25.0	14.4	2.9	9.4	0.7	10.0		1.3	10.0		1.3
Kwazamokuhle Secondary School	24.9	14.5	2.9	9.3	0.7	9.9		1.3	9.9		1.3
Ubuhle Bolwai Secondary School	25.2	15.6	3.1	6.8	0.6	9.7		1.3	9.7		1.3
Lothair Primary School	25.4	16.1	3.1	6.8	0.6	10.0		1.3	10.0		1.3
Warburton Combined School	22.9	14.5	2.8	7.0	0.5	9.6		1.2	9.6		1.2
Warburton Town	22.8	14.6	2.8	7.0	0.5	9.5		1.2	9.5		1.2
Kwachibikhulu Clinic	24.8	15.4	3.0	7.5	0.6	9.5		1.3	9.5		1.3
Kwachibikhulu Primary School	24.7	15.1	3.0	7.5	0.6	9.6		1.3	9.6		1.3
Carolina Hospital	21.7	14.2	2.6	6.8	0.5	9.3		1.1	9.3		1.1
Zinikeleni Secondary School (Silobela)	21.8	14.1	2.6	6.7	0.5	9.4		1.2	9.4		1.2
Volkskool Carolina	21.4	14.3	2.5	6.8	0.5	9.3		1.1	9.3		1.1

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Sobuza Primary School	21.7	14.0	2.6	6.8	0.5	9.3		1.1	9.3		1.1
Ons Eie Ouetehuis (Old Age Home)	21.6	14.2	2.6	6.9	0.5	9.3		1.1	9.3		1.1
Laerskool Breyten	25.5	15.9	3.2	9.6	0.8	9.9		1.3	9.9		1.3
Siyazi Primary School (Kwazanele)	26.0	16.3	3.3	10.1	0.8	10.0		1.4	10.0		1.4
Masizakhe Secondary School (Kwazanele)	25.9	16.5	3.3	10.0	0.8	10.0		1.4	10.0		1.4
Belfast Rusoord (Old Age Home)	18.2	12.0	1.9	6.8	0.4	7.2		0.8	7.2		0.8
Belfast Hospital	18.7	12.0	1.9	7.1	0.4	7.3		0.8	7.3		0.8
Platorand School	19.1	12.2	1.9	7.5	0.4	7.4		0.8	7.4		0.8
Belfast Primary School (Siyathuthuka)	17.9	12.3	1.8	6.6	0.4	7.1		0.8	7.1		0.8
Siyathuthuka Clinic	18.0	12.2	1.8	6.7	0.4	7.1		0.8	7.1		0.8
Life Bethal Hospital	34.8	17.7	3.6	14.1	1.0	13.1		1.8	13.1		1.8
Hoerskool Hoogenhout	34.4	17.6	3.6	14.3	1.0	12.9		1.8	12.9		1.8
Jim Van Tonderskool	34.5	17.4	3.6	15.1	1.0	13.4		1.9	13.4		1.9
Bethal Independent Primary School	34.5	17.5	3.6	14.7	1.0	13.2		1.8	13.2		1.8
Laerskool Marietjie Van Niekerk	35.0	17.2	3.7	14.4	1.0	13.1		1.8	13.1		1.8
Laerskool Hm Swart	34.6	17.6	3.6	14.2	1.0	13.1		1.8	13.1		1.8
Sakhisizwe Primary School (Emzinoni)	35.6	19.0	3.6	14.1	0.9	13.8		1.9	13.8		1.9
Alpheus D Nkosi Secondary School (Emzinoni)	34.4	18.9	3.6	13.8	0.9	13.3		1.9	13.3		1.9
Silwerjare Old Age Home	34.7	17.9	3.6	14.1	1.0	13.1		1.8	13.1		1.8
Residentia Palm Oord	34.6	17.7	3.6	14.1	1.0	13.2		1.8	13.2		1.8
Bronkhorspruit Hospital	28.8	16.6	1.7	12.4	0.4	17.1		1.5	17.1		1.5
Cultura High School	32.1	19.3	1.9	15.2	0.5	21.1		1.9	21.1		1.9
Bronkhorspruit Primary School	29.3	16.7	1.8	13.0	0.4	17.7		1.5	17.7		1.5
Bronkhorspruit Dam	33.4	18.9	2.1	16.5	0.6	22.6		2.4	22.6		2.4
Hoerskool Erasmus	30.5	17.4	1.8	13.8	0.5	18.7		1.7	18.7		1.7
Althea Independent School	29.9	17.2	1.8	13.2	0.5	18.3		1.6	18.3		1.6

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Kgoro Primary School (Zithobeni)	27.7	18.0	1.7	10.8	0.4	15.5		1.4	15.5		1.4
Zithobeni Secondary School (Zithobeni)	26.9	18.2	1.7	10.0	0.4	15.3		1.4	15.3		1.4
Vaal Power AH	63.1	27.8	3.0	16.4	0.7	61.1		7.9	**61.1**	**86**	7.9
Sasolburg Provincial Hospital	41.2	29.9	2.2	9.8	0.4	27.8		2.3	**27.8**	1	2.3
Moredou Old Age Home	36.7	25.7	2.1	8.4	0.4	24.2		2.1	24.2		2.1
Ons Gryse Jeug Old Age Home	38.0	27.9	2.1	9.0	0.4	25.7		2.3	**25.7**	1	2.3
Noord Primere Skool	38.5	27.3	2.2	9.1	0.4	26.6		2.3	**26.6**	1	2.3
Sasolburg High School	39.0	27.9	2.1	9.2	0.4	25.3		2.1	**25.3**	1	2.1
Sakhubusa Secondary School	39.7	25.5	2.2	9.0	0.4	33.2		2.7	**33.2**	1	2.7
Bekezela Primary School	41.1	25.7	2.2	8.9	0.4	39.8		3.3	**39.8**	11	3.3
Isaac Mhlambi Primary	42.0	26.0	2.2	9.4	0.5	38.6		2.8	**38.6**	2	2.8
Refenkgotso Primary School	68.9	22.5	3.4	18.2	0.7	32.1		3.2	**32.1**	1	3.2
Deneysville Primary School	68.4	22.5	3.6	18.2	0.8	25.0		2.9	25.0		2.9
Netcare Vaalpark Hospital	40.2	30.9	2.2	9.1	0.5	39.4		3.4	**39.4**	11	3.4
Vaalpark Articon Secondary School	41.8	34.3	2.3	9.4	0.5	43.6		3.9	**43.6**	**19**	3.9
Mediclinic Emfuleni	32.3	25.6	1.9	7.8	0.4	31.8		2.5	**31.8**	1	2.5
Jeugland Old Age Home	32.7	26.2	1.9	7.9	0.4	28.2		2.4	**28.2**	1	2.4
Herfsoord Huis Old Age Home	31.7	24.9	1.8	7.8	0.4	27.9		2.2	**27.9**	1	2.2
Huis Prinscilla	29.4	25.0	1.8	7.7	0.4	26.6		2.1	**26.6**	1	2.1
Laerskool Emfulenipark	36.7	32.5	2.1	8.4	0.4	40.2		3.3	**40.2**	7	3.3
Nw University_Vaal Campus	35.4	31.8	2.1	8.2	0.4	49.1		4.6	**49.1**	**28**	4.6
Emfuleni Primary School	29.9	22.1	1.7	7.3	0.3	23.2		1.9	23.2		1.9
Mediclinic Vereeniging	32.2	24.4	2.0	7.6	0.4	37.0		3.5	**37.0**	10	3.5
Kopanong Provincial Hospital (Duncanville)	33.9	24.1	2.1	7.5	0.4	20.3		1.7	20.3		1.7
Avondrus Eventide Old Age Home	33.9	24.5	2.1	7.7	0.4	21.0		1.8	21.0		1.8
Riviera On Vaal Resort	33.2	27.6	2.1	7.7	0.4	43.1		4.1	**43.1**	**17**	4.1
Sedibeng Tvet College	33.2	27.2	2.1	7.7	0.4	46.8		4.3	**46.8**	**20**	4.3

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
General Smuts High School	32.2	29.3	2.0	7.8	0.4	36.2		3.5	**36.2**	9	3.5
Eureuka School & Selbourne Primary	32.0	28.2	2.0	7.6	0.4	36.6		3.2	**36.6**	4	3.2
Midvaal Private Hospital (Three Rivers)	40.3	30.8	2.4	8.8	0.5	45.7		3.7	**45.7**	**20**	3.7
Three Rivers Retirement Village	41.2	28.7	2.4	9.1	0.5	36.1		2.9	**36.1**	7	2.9
Drie Riviere Aftreeoord Old Age Home	41.5	27.4	2.4	9.3	0.5	30.2		2.5	**30.2**	1	2.5
Riverside High School	59.2	32.4	2.7	13.8	0.6	53.6		3.6	**53.6**	**17**	3.6
Risiville Primary School	45.7	29.3	2.4	9.9	0.5	28.2		2.4	**28.2**	1	2.4
Sebokeng Hospital	27.6	18.7	1.7	7.6	0.3	16.5		1.3	16.5		1.3
Clinix-Naledzi Private Hospital	27.2	18.2	1.7	7.5	0.3	15.8		1.4	15.8		1.4
Mohloli Secondary School	31.5	28.9	2.0	7.4	0.4	35.9		3.1	**35.9**	5	3.1
Tshirela Primary School (Boipatong)	29.0	22.8	1.8	7.5	0.4	22.1		2.0	22.1		2.0
Tsoaranang Primary School (Thepiso)	29.4	23.2	1.9	7.4	0.4	27.9		2.5	**27.9**	1	2.5
Thepiso Primary School	29.6	21.6	1.8	7.5	0.4	26.7		2.1	**26.7**	1	2.1
Emmanuel Primary School	29.7	24.2	1.9	7.3	0.4	30.8		2.8	**30.8**	1	2.8
Rust Ter Vaal Combined School	29.2	19.1	1.8	7.8	0.4	14.4		1.3	14.4		1.3
Roshnee Primary School	28.5	19.5	1.8	7.7	0.3	12.5		1.1	12.5		1.1
Roshnee High School	28.9	19.5	1.8	7.7	0.4	13.8		1.2	13.8		1.2
Hoerskool Dr Malan	39.0	21.0	2.1	9.0	0.4	15.8		1.4	15.8		1.4
Laerskool Voorwaarts	49.6	23.4	2.5	11.8	0.5	19.8		1.7	19.8		1.7
Meyerton Secondary School	39.5	22.7	2.1	8.9	0.4	15.4		1.5	15.4		1.5
Ratasetjhaba Primary School	32.2	18.5	1.9	8.4	0.4	12.7		1.2	12.7		1.2
Meyerton Primary School	36.4	19.6	2.0	8.9	0.4	15.3		1.3	15.3		1.3
Oprah Leadership Academy	39.3	18.9	2.1	9.4	0.4	16.2		1.3	16.2		1.3
Henley River Retirement Village	39.2	19.2	2.2	9.2	0.4	14.3		1.3	14.3		1.3
Henley High & Preparatory School	36.6	17.3	2.1	9.0	0.4	13.8		1.2	13.8		1.2
Randvaal Clinic	33.7	17.0	2.0	9.0	0.4	13.1		1.2	13.1		1.2
Laerskool Japie Greyling	32.8	15.9	2.0	8.5	0.4	11.6		1.1	11.6		1.1
Thomas Nhlapo Primary	35.2	16.3	2.0	8.9	0.4	12.9		1.2	12.9		1.2

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Randvaal Old Age Home	31.9	15.7	1.9	8.8	0.4	11.2		1.1	11.2		1.1
Laerskool Ag Visser	31.4	15.4	2.3	7.6	0.4	9.8		1.2	9.8		1.2
Lethaba Siyangobe	31.8	15.5	2.3	7.9	0.4	9.9		1.2	9.9		1.2
Shalimar Ridge Primary School	31.1	15.4	2.3	7.7	0.4	10.1		1.2	10.1		1.2
Jw Luckoff High School	32.2	14.9	2.4	8.2	0.5	10.2		1.2	10.2		1.2
Heidelberg Hospital	30.7	15.6	2.3	7.8	0.4	10.0		1.2	10.0		1.2
Thulatsatsi Operation (Rensburg)	31.4	15.2	2.3	7.6	0.4	9.9		1.2	9.9		1.2
Silwer Akker Tehuis	30.9	15.3	2.3	7.6	0.4	10.2		1.2	10.2		1.2
Riversands Retirement Village	30.8	15.6	2.3	8.0	0.4	10.0		1.2	10.0		1.2
Qhaqholla Primary School	33.7	15.9	2.3	7.9	0.4	10.3		1.2	10.3		1.2
Ratanda Primary School	35.1	15.4	2.4	8.3	0.5	10.6		1.2	10.6		1.2
Boneha Primary School	33.6	15.8	2.4	8.0	0.4	10.1		1.2	10.1		1.2
Sithokomele Primary School	33.8	15.8	2.4	8.1	0.4	10.1		1.2	10.1		1.2
Ratanda Bertha Gxowa Primary School	32.4	15.6	2.4	8.1	0.5	10.0		1.2	10.0		1.2
Khanya Lesedi Secondary School	35.0	15.7	2.4	8.2	0.4	10.3		1.2	10.3		1.2
Ratanda Secondary School	34.7	15.7	2.4	8.2	0.4	10.2		1.2	10.2		1.2
New Ratanda Secondary School	32.1	15.6	2.3	7.9	0.4	9.9		1.2	9.9		1.2
Kgoro Ya Thuto Secondary School	32.1	15.6	2.3	7.9	0.4	9.9		1.2	9.9		1.2
Ekurhuleni School For The Deaf	28.8	15.6	1.9	8.2	0.4	9.3		1.0	9.3		1.0
Pholosong Hospital	27.3	14.8	2.1	8.7	0.4	10.9		1.1	10.9		1.1
Tsakane Home For Aged	27.9	14.8	2.1	8.6	0.4	10.7		1.1	10.7		1.1
Mmuso Primary School	28.9	15.4	2.2	8.6	0.5	10.9		1.2	10.9		1.2
Michael Zulu Primary School	27.8	14.9	2.1	8.8	0.4	10.8		1.2	10.8		1.2
Nkabinde Primary School (Thembilisha)	26.5	13.8	2.0	8.7	0.4	11.1		1.2	11.1		1.2
Nigel Clinic	27.7	15.8	2.2	7.8	0.4	11.1		1.3	11.1		1.3
Tehuis Vir Bejaardes	27.6	15.6	2.2	7.7	0.4	11.3		1.3	11.3		1.3
Hoerskool John Vorster	27.7	15.8	2.2	7.8	0.4	11.2		1.3	11.2		1.3
Laerskool Hannes Visagie	27.8	15.6	2.2	7.8	0.4	11.5		1.3	11.5		1.3

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Nigel Secondary School	28.5	15.8	2.3	8.2	0.4	11.9		1.3	11.9		1.3
Laerskool Dunnottar	27.7	15.1	2.1	8.5	0.4	11.1		1.2	11.1		1.2
Springs Retirement Village	25.3	12.8	2.0	8.6	0.4	11.8		1.3	11.8		1.3
Life Springs Parkland Hospital	25.7	13.1	2.0	8.8	0.4	11.6		1.2	11.6		1.2
Netcare N17 Hospital (Springs)	25.8	13.3	2.0	8.8	0.4	11.6		1.2	11.6		1.2
Springs Boys High School	26.5	13.5	2.1	8.8	0.4	11.4		1.2	11.4		1.2
Laerskool Selectionpark	26.1	13.4	2.0	8.6	0.4	11.6		1.2	11.6		1.2
Kwasa College Pre&Primary School	26.4	13.7	2.1	8.5	0.4	12.0		1.3	12.0		1.3
Edelweis Medical Centre	26.3	13.6	2.0	8.5	0.4	11.8		1.3	11.8		1.3
Laerskool Christiaan Beyers	25.7	13.1	2.0	8.3	0.4	11.9		1.3	11.9		1.3
Hoerskool Hugenote	24.8	13.1	2.0	8.8	0.4	11.6		1.3	11.6		1.3
Brakpan Primary School	25.1	13.7	2.0	9.0	0.4	10.8		1.1	10.8		1.1
Parkrand Primary School	26.4	14.7	1.9	9.0	0.4	9.5		1.0	9.5		1.0
Thabo Memorial Hospital	26.2	14.6	1.9	9.0	0.4	9.1		1.0	9.1		1.0
Sunward Park Hospital	26.5	14.6	1.9	8.8	0.4	9.4		1.0	9.4		1.0
Alberton High School	27.0	14.8	1.8	9.1	0.4	8.7		0.9	8.7		0.9
Netcare Clinton Hospital	26.8	14.9	1.8	9.0	0.4	8.7		0.9	8.7		0.9
Alberton Tuiste Vir Bejaardes	26.9	14.9	1.8	9.2	0.4	8.7		0.9	8.7		0.9
Bertha Gxowa Hospital	26.8	14.8	1.9	10.0	0.5	8.9		0.9	8.9		0.9
Linmed Hospital	25.7	14.0	1.9	9.7	0.5	10.3		1.1	10.3		1.1
Hoerskool Brandwag (Airfield)	25.6	14.0	1.9	9.6	0.5	10.1		1.0	10.1		1.0
Thepiso Noto Intermediate School	25.9	13.9	1.9	10.3	0.5	13.4		1.5	13.4		1.5
Laerskool Bredell	23.6	13.9	1.8	8.5	0.4	10.0		1.0	10.0		1.0
Sibonelo Primary School (Daveyton)	24.7	13.8	1.9	9.2	0.4	12.1		1.3	12.1		1.3
Petit High School (Kempton Park Nu)	25.4	13.8	1.9	10.1	0.5	11.1		1.1	11.1		1.1
Arwyp Medical Centre	24.6	14.8	1.8	8.9	0.4	9.6		0.9	9.6		0.9
Hoerskool Birchleigh	24.4	14.7	1.7	8.2	0.4	9.6		0.9	9.6		0.9
Curro Serengeti Acadamy	23.2	14.5	1.7	7.8	0.4	9.7		1.0	9.7		1.0

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
South Rand Hospital	28.8	15.9	1.9	11.7	0.5	8.5		0.8	8.5		0.8
Chris Hani Baragwanath Hospital	24.5	14.3	1.6	8.7	0.4	7.7		0.7	7.7		0.7
Thulani Primary School	22.6	14.1	1.4	7.6	0.3	7.4		0.6	7.4		0.6
University of Witwatersrand	28.9	15.9	1.8	11.2	0.5	8.2		0.8	8.2		0.8
Milpark Hospital	27.7	15.2	1.7	10.2	0.4	8.2		0.8	8.2		0.8
Charlotte Maxixe Academic Hospital	28.5	15.2	1.8	10.7	0.5	8.3		0.8	8.3		0.8
Thembisa West Secondary School (Thembisa)	22.7	13.7	1.6	6.6	0.3	9.1		0.8	9.1		0.8
Lenmed Zamokuhle Private Hospital (Thembisa)	23.0	13.8	1.6	6.9	0.3	9.3		0.9	9.3		0.9
Ikusasa Comprehensive School	23.2	13.9	1.6	7.3	0.3	9.5		0.9	9.5		0.9
Gem Village Old Age Home	21.3	14.7	1.4	6.2	0.3	9.2		0.8	9.2		0.8
Rustoord Old Age Home	20.8	13.7	1.4	6.4	0.3	8.8		0.8	8.8		0.8
Cornwell Hill College (Irene)	21.3	14.5	1.4	6.5	0.3	9.3		0.8	9.3		0.8
Kleinfontein Sorg Sentrum Old Age Home (Donkerhoek)	22.2	14.9	1.5	8.2	0.3	11.4		1.0	11.4		1.0
Valtaki AH (Rayton)	23.8	15.6	1.5	8.7	0.3	12.3		1.1	12.3		1.1
Laerskool Rayton (Rayton)	21.0	13.9	1.4	6.6	0.3	10.5		0.9	10.5		0.9
Tierkop AH	24.0	15.5	1.7	8.8	0.4	11.7		1.2	11.7		1.2
Redford House The Hills Private School (Mooikloof Glen)	23.5	15.4	1.6	8.2	0.4	11.1		1.0	11.1		1.0
Rietvlei View Country Estate	23.5	15.7	1.6	8.2	0.4	11.3		1.1	11.3		1.1
Hazeldean Curro School (Tyger Valley)	20.7	13.9	1.3	6.5	0.3	9.2		0.8	9.2		0.8
Tyger Valley College	21.1	15.0	1.4	6.9	0.3	9.5		0.8	9.5		0.8
Pretoria East Hospital (Moreletapark)	21.8	14.8	1.4	7.2	0.3	9.6		0.9	9.6		0.9
Groenkloof Old Age Home	19.9	14.5	1.3	6.5	0.3	8.4		0.7	8.4		0.7
Steve Biko Academic Hospital	19.4	14.1	1.2	5.6	0.2	7.8		0.6	7.8		0.6
Willow Ridge High School (Wilgers)	20.4	14.6	1.3	6.1	0.2	8.9		0.7	8.9		0.7

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Hoerskool Waterkloof	21.7	14.7	1.4	7.4	0.3	9.6		0.8	9.6		0.8
Hoerskool Garsfontein	21.2	15.0	1.4	7.0	0.3	9.4		0.8	9.4		0.8
Afrikaanse Hoer Seunskool	19.9	14.5	1.3	6.4	0.3	8.1		0.7	8.1		0.7
Huis Silversig SAVF Old Age Home (Silverton)	19.9	13.7	1.2	5.5	0.2	8.4		0.7	8.4		0.7
Laersekool Meyerspark (Meyerspark)	20.0	13.8	1.2	5.6	0.2	8.6		0.7	8.6		0.7
Curro Academy Mamelodi	19.0	12.2	1.2	4.9	0.2	8.3		0.7	8.3		0.7
Impendulo Primary School	19.9	12.8	1.2	5.5	0.2	8.7		0.7	8.7		0.7
Nellmapius Ext 6 Primary School	20.2	12.6	1.2	5.4	0.2	8.6		0.7	8.6		0.7
Mamelodi Home For Aged	19.5	12.4	1.2	5.0	0.2	8.4		0.7	8.4		0.7

Predicted concentrations in µg/m³ at the sensitive receptors for Scenario D (MES), together with the limit value of the NAAQS and number of exceedances (NoE)

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Elsie Ballot Memorial Hospital	37.5	16.0	2.7	35.9	1.6	11.4		1.9	11.4		1.9
Laerskool Amersfoort	35.7	14.4	2.6	34.0	1.6	11.1		1.9	11.1		1.9
Embuzane Primary School	74.2	25.2	4.6	79.0	3.9	30.3		4.9	**30.3**	1	4.9
Sangqotho Primary School	25.4	10.9	2.4	16.5	1.3	12.9		2.1	12.9		2.1
Amersfoort Combined School	34.4	16.2	2.6	32.6	1.6	10.8		1.9	10.8		1.9
Injubuko Primary School	23.2	10.2	2.3	16.8	1.2	9.4		1.6	9.4		1.6
Daggakraal Primary School	35.6	13.4	3.2	36.6	2.3	13.5		2.1	13.5		2.1
Sizenzele Primary School	44.3	14.3	3.5	44.1	2.6	20.4		2.7	20.4		2.7
Seme Secondary School	33.1	13.1	3.2	32.8	2.2	15.8		2.3	15.8		2.3
Louwra Primary School	25.9	11.8	2.0	20.8	1.1	13.3		1.9	13.3		1.9
Perdekop Agricultural School	23.7	11.8	2.0	17.1	1.0	21.0		2.9	21.0		2.9
Vukuzenzele Combined School	24.7	12.1	2.0	18.1	1.1	20.4		2.9	20.4		2.9
Gunwana Primary School	23.7	11.4	1.9	18.5	1.0	10.9		1.8	10.9		1.8
Amajuba Memorial Hospital	20.6	9.9	1.7	15.2	0.8	9.9		1.5	9.9		1.5
Volksrust High School	20.5	10.6	1.6	14.5	0.8	10.1		1.4	10.1		1.4
Volksrust Municipal Clinic	20.1	9.7	1.6	14.4	0.8	9.1		1.4	9.1		1.4
C V O Skool Amajuba	20.2	10.2	1.6	14.7	0.8	9.7		1.4	9.7		1.4
Qhubulwazi Combined School	20.1	9.8	1.6	14.2	0.8	9.5		1.4	9.5		1.4
Volksrust Primary School	21.2	10.3	1.7	16.2	0.9	10.8		1.6	10.8		1.6
New Ermelo	17.7	8.6	2.0	9.5	0.8	7.1		1.1	7.1		1.1
Ermelo Christian School	18.3	8.8	2.0	10.1	0.8	7.3		1.2	7.3		1.2
SAVF Home For Aged	18.2	8.8	2.0	10.0	0.8	7.3		1.1	7.3		1.1
Ermelo Hospital	18.2	8.9	2.0	9.9	0.8	7.4		1.1	7.4		1.1
Mediclinic Ermelo	18.3	8.7	2.0	10.1	0.8	7.4		1.2	7.4		1.2
Hoerskool Ermelo	18.3	8.8	2.0	10.0	0.8	7.4		1.1	7.4		1.1
Ermelo Indian Combined School	18.2	8.6	2.0	9.8	0.8	7.4		1.1	7.4		1.1
Lungelo Combined School (Outside Town)	18.4	8.6	2.0	10.3	0.8	8.0		1.3	8.0		1.3
New Ermelo Primary School	18.1	8.6	2.0	9.7	0.8	7.2		1.1	7.2		1.1

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	350	125	50	200	40	75	12	40	40	12	20
Kwashashe (Outside Town)	18.8	8.9	2.1	10.3	0.8	7.2		1.1	7.2		1.1
Hts Ligbron	18.2	8.8	2.0	10.1	0.8	7.3		1.2	7.3		1.2
Laerskool Ermelo	18.3	8.7	2.0	9.9	0.8	7.3		1.1	7.3		1.1
JJ Vd Merwe Pre-Primary School	18.3	8.8	2.0	10.2	0.8	7.5		1.2	7.5		1.2
Lindile Secondary School	18.1	8.6	2.0	9.7	0.8	7.4		1.1	7.4		1.1
Emthonjeni Clinic	18.4	8.6	2.0	9.9	0.8	7.3		1.1	7.3		1.1
Reggie Masuku Secondary School	18.7	8.8	2.0	10.0	0.8	7.1		1.1	7.1		1.1
Cebisa Secondary School	18.6	8.5	2.0	9.9	0.8	7.3		1.1	7.3		1.1
Camden	16.8	8.8	1.9	8.9	0.7	7.0		1.1	7.0		1.1
Camden Combined School	16.6	9.0	1.9	8.7	0.7	7.0		1.1	7.0		1.1
Camden School	16.8	8.8	1.9	9.0	0.8	7.1		1.1	7.1		1.1
Umzimvelo Secondary School (Rural Area)	15.2	8.2	1.9	8.1	0.7	6.5		1.1	6.5		1.1
Bhekimfundo Primary School (Rural Area)	18.8	9.0	2.1	10.4	0.9	7.6		1.2	7.6		1.2
Eshwileni Primary School (Rural Area)	18.9	8.6	2.2	10.9	1.0	8.1		1.4	8.1		1.4
Davel Combined School	21.5	9.7	2.2	12.4	0.9	8.8		1.3	8.8		1.3
Morgenzon Landbou Akademie	22.5	10.0	2.4	14.7	1.2	14.1		1.9	14.1		1.9
Nqobangolwazi Secondary School	22.3	9.9	2.3	14.6	1.1	13.8		1.9	13.8		1.9
Siqondekhaya Pre Primary School	22.6	9.7	2.3	14.7	1.1	15.6		1.9	15.6		1.9
Sizakhele Primary School	22.6	9.7	2.3	14.6	1.1	15.3		1.9	15.3		1.9
Phezukwentaba Primary School (South of Morgenzon)	21.9	9.1	2.4	14.6	1.2	14.7		2.1	14.7		2.1
Kwaggalaagte Primary School (North of Morgenzon)	22.7	9.7	2.1	13.2	0.9	9.6		1.5	9.6		1.5
Sizakhele Clinic/Hospital	22.6	9.7	2.3	14.8	1.1	15.0		1.9	15.0		1.9
Grootvlei	14.6	7.8	1.3	8.9	0.6	7.3		1.0	7.3		1.0
Olive Grove Country Lodge	14.6	7.9	1.3	9.2	0.6	7.4		1.0	7.4		1.0
Grootvlei Town (South of Power Station)	14.6	7.9	1.3	8.8	0.6	7.0		1.0	7.0		1.0
Laerskool Grootvlei	14.8	7.9	1.3	8.9	0.6	7.1		1.0	7.1		1.0
Tokoloho Primary School	14.6	7.9	1.3	8.7	0.6	7.1		1.0	7.1		1.0
Tshepeha Combined School	14.6	7.9	1.3	8.8	0.6	7.1		1.0	7.1		1.0
Warembo Lodge	14.2	8.6	1.3	8.4	0.6	7.1		1.0	7.1		1.0

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Balfour	15.6	9.3	1.3	8.8	0.5	8.1		1.1	8.1		1.1
Siyathemba	16.3	9.8	1.4	9.2	0.6	8.2		1.1	8.2		1.1
Bonukukhanya Primary (Siyathemba)	16.2	9.7	1.4	9.2	0.6	8.1		1.1	8.1		1.1
Qalabocha Primary School (Siyathemba)	16.3	9.7	1.4	9.1	0.6	8.2		1.1	8.2		1.1
Vusumuzi Primary School	16.5	10.0	1.4	9.3	0.6	8.2		1.1	8.2		1.1
Gekombineerde Skool Balfour	15.3	9.2	1.3	8.7	0.6	7.8		1.1	7.8		1.1
Im Manchu Secondary School	15.3	9.0	1.3	8.6	0.5	7.8		1.1	7.8		1.1
Isifisosethu Secondary School (Siyathemba)	16.5	10.1	1.4	9.5	0.6	8.2		1.1	8.2		1.1
Setsheng Secondary School (Siyathemba)	16.5	9.9	1.4	9.2	0.6	8.3		1.1	8.3		1.1
Dr Nieuwoudt And Dr Kok	15.3	9.2	1.3	8.7	0.6	7.7		1.1	7.7		1.1
Balfour Clinic	15.4	9.0	1.3	8.6	0.5	7.8		1.0	7.8		1.0
Siyathemba Clinic	15.8	9.4	1.3	8.9	0.5	8.1		1.1	8.1		1.1
Mondoro Lodge	15.5	8.0	1.3	9.0	0.5	7.5		1.0	7.5		1.0
Wegelegen Manor	16.0	9.5	1.3	8.7	0.5	8.3		1.1	8.3		1.1
The Stone Cellar	14.1	7.4	1.1	7.6	0.4	7.3		0.9	7.3		0.9
Greylingstad	17.1	9.7	1.5	9.3	0.6	8.7		1.2	8.7		1.2
Nthorwane	16.7	9.2	1.4	8.9	0.6	8.4		1.2	8.4		1.2
Laerskool Greylingstad	17.6	9.7	1.5	9.7	0.6	8.7		1.2	8.7		1.2
Nthoroane Secondary School	16.7	9.2	1.4	8.8	0.6	8.5		1.2	8.5		1.2
Badgarleur Bush Lodge	15.3	8.1	1.4	8.6	0.6	7.5		1.1	7.5		1.1
Matla Village	48.2	15.6	2.8	32.4	1.5	26.8		3.3	**26.8**	1	3.3
Sifundise Primary School	48.2	15.3	2.8	32.4	1.5	26.1		3.3	**26.1**	1	3.3
Matla Coal Health Centre	48.8	16.3	2.9	32.5	1.5	25.4		3.3	**25.4**	1	3.3
Gweda Primary School	36.5	12.8	2.4	22.5	1.1	16.3		2.2	16.3		2.2
Zithobe Primary School	36.4	14.2	2.2	23.9	1.1	35.7		4.6	**35.7**	12	4.6
Kwanala Primary School	41.1	15.1	3.0	26.9	1.5	20.4		2.5	20.4		2.5
Reedstream Park	43.1	14.2	3.4	29.3	1.9	21.2		2.5	21.2		2.5
Rietspruit Clinic	40.9	13.5	3.4	27.4	1.9	19.3		2.3	19.3		2.3
Lehlaka Combined School	41.2	13.6	3.4	27.7	1.9	19.6		2.4	19.6		2.4
Mbali Coal/Blesboklaagte Housing	49.3	15.5	3.8	35.5	2.3	24.2		2.8	24.2		2.8
Kinross	29.5	10.7	2.0	17.9	0.9	18.1		2.5	18.1		2.5

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Kinross Settlement	27.4	11.6	2.0	16.5	0.9	20.2		2.8	20.2		2.8
Kinross Municipal Clinic	28.7	10.6	2.0	17.4	0.9	17.2		2.5	17.2		2.5
Kriel	36.6	13.5	2.7	22.9	1.4	15.7		2.1	15.7		2.1
Eagles Nest Guest House	35.8	13.4	2.7	22.1	1.3	15.5		2.0	15.5		2.0
Merlin Park Primary School	35.2	12.1	2.8	22.6	1.4	14.7		2.0	14.7		2.0
Kriel Medical Centre	35.3	12.4	2.8	22.3	1.4	14.8		2.0	14.8		2.0
Laerskool Krielpark	36.3	13.1	2.8	22.8	1.4	15.0		2.0	15.0		2.0
Laerskool Onverwacht	35.3	12.3	2.8	22.9	1.4	14.7		2.0	14.7		2.0
Silwer Fleur Aftree Oord (Old Age Home)	36.2	12.6	2.8	22.9	1.4	15.0		2.0	15.0		2.0
Thubelihle	34.4	11.9	2.9	21.1	1.5	14.5		1.9	14.5		1.9
Sibongamandla Secondary School	33.4	12.0	2.9	20.6	1.5	14.4		1.8	14.4		1.8
Ga-Nala Clinic	36.6	12.7	2.8	23.5	1.4	14.3		2.0	14.3		2.0
Impilo Primary School	31.3	11.5	2.8	19.2	1.4	12.4		1.6	12.4		1.6
Bonginhlanhla Primary School	33.5	12.0	2.8	20.4	1.5	14.3		1.8	14.3		1.8
Sibongamandla Secondary School	33.4	12.0	2.9	20.6	1.5	14.4		1.8	14.4		1.8
Leandra	26.6	12.9	1.9	15.6	0.8	21.1		3.1	21.1		3.1
Eendracht	26.3	13.4	1.8	16.1	0.8	19.5		2.8	19.5		2.8
Sidingulwazi Primary School	26.1	12.7	1.8	15.5	0.8	19.3		2.9	19.3		2.9
Ss Mshayisa Primary School	26.1	12.5	1.8	15.4	0.8	19.4		2.9	19.4		2.9
Chief Ampie Mayisa Secondary School	25.7	12.2	1.8	15.2	0.8	19.2		2.9	19.2		2.9
Lebogang Clinic	26.1	12.5	1.8	15.6	0.8	20.2		2.9	20.2		2.9
Kleuterskool Haas Das	19.5	8.9	1.7	12.4	0.7	13.6		2.0	13.6		2.0
Standerton Primary School	19.5	9.0	1.7	12.4	0.7	14.1		2.0	14.1		2.0
Laerskool Jeugkrag	19.8	9.4	1.7	12.6	0.7	15.2		2.1	15.2		2.1
Laerskool Standerton	19.5	8.9	1.7	12.5	0.7	13.5		2.0	13.5		2.0
Laerskool Kalie De Haas	19.6	9.1	1.7	12.9	0.7	12.8		1.9	12.8		1.9
Hoerskool Standerton	19.5	9.0	1.7	12.4	0.7	14.1		2.0	14.1		2.0
Standerton Provincial Government Hospital	19.5	8.9	1.7	12.3	0.7	13.8		2.0	13.8		2.0
Mar-Peh Medicare Private Hospital	19.2	8.8	1.7	12.5	0.7	13.1		1.9	13.1		1.9
Standerton Retirement Home	19.3	8.8	1.7	12.5	0.7	12.9		1.9	12.9		1.9
Standerton Ouetehuis/Old Age Home	19.4	8.8	1.7	12.7	0.7	13.5		1.9	13.5		1.9

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Holmdene Secondary School	17.9	9.5	1.6	10.4	0.6	10.1		1.7	10.1		1.7
Cathuza Primary School (SE of Town)	21.2	9.7	1.9	14.6	0.9	15.6		2.2	15.6		2.2
Sizanani Pre Primary School	18.9	8.8	1.7	11.9	0.7	12.8		1.9	12.8		1.9
Hlobisa Primary School	18.7	8.9	1.6	11.6	0.7	11.9		1.8	11.9		1.8
Shukuma Primary School	18.4	8.7	1.6	11.5	0.7	10.9		1.8	10.9		1.8
Retsebile Primary School	18.8	8.9	1.6	11.8	0.7	13.5		1.9	13.5		1.9
Thuto-Thebe Secondary School	19.4	9.0	1.7	12.3	0.7	14.2		2.0	14.2		2.0
Jandrell Secondary School	18.7	9.0	1.6	11.7	0.7	12.7		1.9	12.7		1.9
Thobelani Secondary School	18.9	8.8	1.7	11.9	0.7	13.0		1.9	13.0		1.9
Standerton Tb Hospital	19.0	8.8	1.6	11.8	0.7	11.3		1.8	11.3		1.8
Thuthukani Pre Primary School	22.4	13.5	1.9	14.0	0.9	29.6		3.7	**29.6**	1	3.7
Ulwazi Primary School	22.1	12.9	1.9	14.1	0.9	27.6		3.6	**27.6**	1	3.6
Zikhetheleni Secondary School	22.4	13.2	1.9	14.4	0.9	28.8		3.6	**28.8**	1	3.6
Joubertsvlei Primary School (North of Tutuka)	25.5	9.1	2.0	16.1	0.9	11.8		1.9	11.8		1.9
Amalumgelo Primary School (NE of Tutuka)	34.7	12.9	2.7	26.4	1.5	38.5		3.8	**38.5**	8	3.8
Grootdraaidam Primary School	21.5	9.5	1.8	13.8	0.8	17.9		2.4	17.9		2.4
Laerskool Secunda	25.8	9.0	1.9	15.5	0.8	14.1		2.0	14.1		2.0
Laerskool Kruinpark	26.1	8.9	2.0	15.7	0.9	13.3		1.9	13.3		1.9
Laerskool Oranjegloed Primary	25.4	8.9	1.9	15.0	0.8	13.4		1.9	13.4		1.9
Curro Castle Combined School	25.2	9.0	1.9	15.0	0.8	13.7		1.9	13.7		1.9
Hoërskool Oosterland	26.4	9.1	2.0	15.7	0.9	13.8		1.9	13.8		1.9
Mediclinic Secunda (Hospital)	25.6	9.0	1.9	15.5	0.8	14.3		2.0	14.3		2.0
Mediclinic Highveld (Hospital_Trichardt, Secunda)	27.8	9.5	2.1	17.1	0.9	13.6		2.0	13.6		2.0
Daviescourt/Davieshof Old Age Home	25.9	9.0	1.9	15.4	0.8	14.1		1.9	14.1		1.9
Highveld Park High School	26.4	9.2	2.0	15.7	0.8	14.0		1.9	14.0		1.9
Hoerskool Secunda	25.5	8.9	1.9	15.4	0.8	14.1		1.9	14.1		1.9
Basizeni Special School	22.5	9.8	1.7	12.5	0.7	13.4		2.0	13.4		2.0
Maphala-Gulube Primary School	22.0	9.4	1.7	11.8	0.7	12.1		1.9	12.1		1.9
Shapeve Primary School	22.6	9.8	1.7	12.7	0.7	13.6		2.0	13.6		2.0

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Thomas Nhlabathi Secondary School	22.0	9.7	1.7	11.6	0.7	13.3		1.9	13.3		1.9
Embalenhle Hospital / Clinic	22.2	9.6	1.7	11.6	0.7	12.7		1.9	12.7		1.9
Vukuzithathe Primary School	22.1	9.4	1.7	11.6	0.7	12.6		1.9	12.6		1.9
K I Twala Secondary	21.7	9.5	1.7	11.6	0.7	12.6		1.9	12.6		1.9
Allan Makunga Primary School	22.2	9.8	1.7	12.5	0.7	13.3		2.0	13.3		2.0
Evander Hospital Arv Clinic	26.3	9.9	1.9	15.9	0.8	15.5		2.2	15.5		2.2
Laerskool Hoeveld	25.9	10.0	1.9	15.6	0.8	15.9		2.2	15.9		2.2
Hoerskool Evander	25.0	10.2	1.8	14.9	0.8	16.2		2.2	16.2		2.2
Bernice Samuel Hospital	23.1	11.3	1.4	13.0	0.6	17.8		2.2	17.8		2.2
Hoerskool Delmas	23.2	11.4	1.4	13.0	0.6	17.7		2.3	17.7		2.3
Laerskool Delmas	24.3	11.8	1.4	13.6	0.6	18.0		2.4	18.0		2.4
Kangela Primary School (North of Delpark)	25.5	12.2	1.4	14.7	0.6	18.8		2.6	18.8		2.6
Savf Ons Eie Ouetehuis / Old Age Home	24.3	11.8	1.4	13.6	0.6	18.0		2.4	18.0		2.4
Laerskool Eloff	20.2	10.3	1.3	11.5	0.5	15.1		1.9	15.1		1.9
Rietkol Primary School	20.4	10.0	1.3	11.4	0.5	14.9		1.9	14.9		1.9
Bazani Primary School	25.8	11.9	1.4	14.5	0.6	18.5		2.8	18.5		2.8
Phaphamani Secondary School	25.2	11.3	1.4	13.9	0.6	17.9		2.7	17.9		2.7
Vezimfundo Primary School	24.9	12.2	1.4	14.5	0.6	18.7		2.8	18.7		2.8
Arbor Primary School	57.9	21.5	2.6	37.9	1.4	59.4		10.2	**59.4**	**98**	10.2
Ogies Combined School	59.3	19.0	4.1	42.3	2.5	32.2		3.2	**32.2**	1	3.2
Ogies Tb Clinic	63.0	19.9	4.1	44.5	2.5	33.6		3.3	**33.6**	2	3.3
Ogies Police Station	63.0	19.9	4.1	44.5	2.5	33.6		3.3	**33.6**	2	3.3
Hlangu Phala Primary School	70.5	23.5	4.2	49.2	2.6	29.8		3.3	**29.8**	1	3.3
Sukumani Primary School	69.2	22.1	4.2	48.5	2.6	29.7		3.3	**29.7**	1	3.3
Thuthukani Primary School	67.7	22.0	4.2	47.4	2.6	29.4		3.2	**29.4**	1	3.2
Mehlwana Secondary School	69.8	20.4	4.3	48.5	2.6	32.7		3.3	**32.7**	1	3.3
Makause Combined School	69.1	20.1	4.3	47.4	2.6	30.7		3.2	**30.7**	1	3.2
Sibongindawo Primary School	105.2	29.4	5.4	75.0	3.5	59.9		5.8	**59.9**	**34**	5.8
Laerskool Balmoral	80.9	31.8	3.1	55.1	1.7	25.2		2.3	**25.2**	1	2.3
Clewer Primary School	44.5	15.3	2.8	28.8	1.5	13.9		1.4	13.9		1.4
Witbank High School	33.3	12.3	2.2	19.7	1.1	12.0		1.2	12.0		1.2

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Eden Park Retirement Village	33.9	13.1	2.3	20.4	1.1	12.0		1.2	12.0		1.2
Savf House Immergroen Old Age Home	33.6	12.8	2.2	19.5	1.0	12.1		1.2	12.1		1.2
Mthimkulu Housing For The Aged	35.8	13.4	2.3	21.3	1.1	12.1		1.2	12.1		1.2
Emalahleni Private Hospital	33.4	12.6	2.2	19.2	1.0	11.8		1.1	11.8		1.1
Life Cosmos Hospital	32.7	12.2	2.2	19.3	1.0	11.8		1.1	11.8		1.1
Duvha Primary School	35.6	13.7	2.5	22.5	1.2	10.8		1.2	10.8		1.2
Laerskool Taalfees	33.0	12.4	2.2	19.4	1.0	12.1		1.2	12.1		1.2
Witbank Provincial Hospital	32.6	12.5	2.2	18.9	1.0	11.7		1.1	11.7		1.1
Nancy Shiba Primary School (Vosman)	41.8	16.7	2.3	25.8	1.2	12.1		1.2	12.1		1.2
Wh De Klerk Skool	30.6	12.1	2.0	17.3	0.9	10.4		1.0	10.4		1.0
Laerskool Panorama	30.4	11.9	2.0	16.6	0.9	10.4		1.0	10.4		1.0
Laerskool Duvhapark	33.8	12.4	2.4	21.2	1.2	10.5		1.2	10.5		1.2
Laerskool Klipfontein	33.8	12.9	2.3	20.4	1.1	11.8		1.2	11.8		1.2
Cambridge Academy	32.0	12.8	2.2	18.8	1.0	11.3		1.1	11.3		1.1
Besilindile Primary School	41.1	17.0	2.2	24.9	1.1	11.7		1.2	11.7		1.2
Reynopark High School	33.6	13.0	2.4	20.2	1.2	11.4		1.2	11.4		1.2
Bakenveld Golf Estate	29.2	11.5	2.1	17.1	1.0	8.9		1.0	8.9		1.0
Allendale Secondary School	27.1	11.1	2.3	16.9	1.1	9.4		1.1	9.4		1.1
Khayalethu Primary School	35.8	13.4	2.2	21.1	1.1	11.8		1.2	11.8		1.2
Illanga Secondary School	28.4	11.0	2.3	17.3	1.1	9.6		1.1	9.6		1.1
Joy Creche (Duvha)	29.6	11.5	2.3	18.3	1.1	9.8		1.1	9.8		1.1
Linderus Old Age Home	21.0	10.5	1.5	9.3	0.5	7.1		0.7	7.1		0.7
Vergeet My Nie Old Age Home	21.1	10.6	1.5	9.4	0.5	7.2		0.7	7.2		0.7
Middleburg Frail Care Unit And Home For Elderly	20.3	10.7	1.4	8.9	0.5	6.8		0.7	6.8		0.7
Life Midmed Hospital	20.4	10.7	1.4	9.0	0.5	6.8		0.7	6.8		0.7
Middelburg Hospital	20.9	10.6	1.5	9.3	0.5	7.1		0.7	7.1		0.7
Makhathini Primary School	20.9	10.8	1.4	9.2	0.5	6.9		0.7	6.9		0.7
Laerskool Dennesig	20.3	10.8	1.4	8.7	0.5	6.8		0.7	6.8		0.7
Hoerskool Kanonkop	20.3	10.6	1.4	8.7	0.5	6.8		0.7	6.8		0.7
Laerskool Kanonkop	20.3	10.6	1.4	8.9	0.5	6.7		0.7	6.7		0.7

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Steelcrest High School	20.1	10.5	1.4	8.9	0.5	6.8		0.7	6.8		0.7
Middelburg Primary	20.9	10.5	1.5	9.3	0.5	7.1		0.7	7.1		0.7
Middleburg Ext 6 Clinic	22.4	10.8	1.5	10.5	0.6	7.5		0.8	7.5		0.8
Sofunda Secondary School	21.8	10.8	1.5	9.9	0.5	7.2		0.7	7.2		0.7
Mhluzi Primary School	21.3	10.8	1.5	9.5	0.5	7.0		0.7	7.0		0.7
Highlands Primary School	21.0	10.6	1.5	9.4	0.5	7.2		0.7	7.2		0.7
Blinkpan Primary School	24.0	10.0	2.3	14.0	1.1	9.2		1.1	9.2		1.1
Laerskool Koornfontein	23.6	9.8	2.3	13.7	1.1	9.3		1.1	9.3		1.1
Blinkpan	24.3	10.1	2.3	14.3	1.1	9.3		1.2	9.3		1.2
Laerskool Kragveld	19.6	9.9	1.9	10.3	0.7	7.6		0.9	7.6		0.9
Pullens Hope	19.7	9.9	1.9	10.1	0.7	7.6		0.9	7.6		0.9
Arnot Colliery Primary School	16.4	9.0	1.6	7.7	0.5	6.4		0.8	6.4		0.8
Laerskool Rietkuil	16.3	8.8	1.6	7.5	0.5	6.5		0.8	6.5		0.8
Beestepan Agricultural School	16.4	8.6	1.4	7.0	0.5	6.5		0.7	6.5		0.7
Gekombineerde Skool Hendrina	18.3	8.5	2.0	9.5	0.8	7.2		1.0	7.2		1.0
Hendrina Primary School	18.2	8.3	1.9	9.4	0.7	7.1		1.0	7.1		1.0
Kwazamokuhle Secondary School	18.0	8.5	1.9	9.3	0.7	7.1		1.0	7.1		1.0
Ubuhle Bolwai Secondary School	13.7	7.4	1.7	6.8	0.6	6.2		0.9	6.2		0.9
Lothair Primary School	13.8	7.4	1.7	6.8	0.6	6.3		0.9	6.3		0.9
Warburton Combined School	13.9	8.4	1.6	7.0	0.5	6.0		0.8	6.0		0.8
Warburton Town	14.2	8.1	1.6	7.0	0.5	6.0		0.8	6.0		0.8
Kwachibikhulu Clinic	15.0	8.6	1.7	7.5	0.6	6.3		0.9	6.3		0.9
Kwachibikhulu Primary School	15.1	8.7	1.7	7.5	0.6	6.3		0.9	6.3		0.9
Carolina Hospital	14.3	8.1	1.6	6.8	0.5	6.3		0.8	6.3		0.8
Zinikeleni Secondary School (Silobela)	14.2	8.1	1.6	6.7	0.5	6.3		0.8	6.3		0.8
Volkskool Carolina	14.4	7.9	1.6	6.8	0.5	6.2		0.8	6.2		0.8
Sobuza Primary School	14.2	8.1	1.6	6.8	0.5	6.4		0.8	6.4		0.8
Ons Eie Ouetehuis (Old Age Home)	14.5	7.9	1.6	6.9	0.5	6.2		0.8	6.2		0.8
Laerskool Breyten	17.7	8.6	2.0	9.6	0.8	6.4		1.0	6.4		1.0
Siyazi Primary School (Kwazanele)	18.1	8.7	2.0	10.1	0.8	6.5		1.0	6.5		1.0
Masizakhe Secondary School (Kwazanele)	18.0	8.9	2.0	10.0	0.8	6.5		1.0	6.5		1.0

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Belfast Rusoord (Old Age Home)	14.0	8.2	1.2	6.8	0.4	5.2		0.6	5.2		0.6
Belfast Hospital	14.4	8.3	1.2	7.1	0.4	5.2		0.6	5.2		0.6
Platorand School	14.8	8.4	1.2	7.5	0.4	5.3		0.6	5.3		0.6
Belfast Primary School (Siyathuthuka)	14.0	8.4	1.2	6.6	0.4	5.1		0.6	5.1		0.6
Siyathuthuka Clinic	14.0	8.4	1.2	6.7	0.4	5.1		0.6	5.1		0.6
Life Bethal Hospital	24.9	11.3	2.2	14.1	1.0	10.3		1.5	10.3		1.5
Hoerskool Hoogenhout	24.8	11.4	2.2	14.3	1.0	10.0		1.5	10.0		1.5
Jim Van Tonderskool	26.0	12.1	2.3	15.1	1.0	10.6		1.5	10.6		1.5
Bethal Independent Primary School	25.8	12.0	2.3	14.7	1.0	10.4		1.5	10.4		1.5
Laerskool Marietjie Van Niekerk	25.0	10.9	2.3	14.4	1.0	10.1		1.5	10.1		1.5
Laerskool Hm Swart	24.7	11.4	2.2	14.2	1.0	10.2		1.5	10.2		1.5
Sakhisizwe Primary School (Emzinoni)	25.4	10.7	2.1	14.1	0.9	10.4		1.6	10.4		1.6
Alpheus D Nkosi Secondary School (Emzinoni)	24.4	10.7	2.2	13.8	0.9	9.9		1.5	9.9		1.5
Silwerjare Old Age Home	24.7	11.3	2.2	14.1	1.0	10.2		1.5	10.2		1.5
Residentia Palm Oord	24.9	11.4	2.2	14.1	1.0	10.4		1.5	10.4		1.5
Bronkhorspruit Hospital	24.9	13.0	1.1	12.4	0.4	14.5		1.3	14.5		1.3
Cultura High School	29.0	16.5	1.3	15.2	0.5	18.7		1.7	18.7		1.7
Bronkhorspruit Primary School	26.2	14.0	1.1	13.0	0.4	15.2		1.4	15.2		1.4
Bronkhorspruit Dam	30.6	16.4	1.4	16.5	0.6	19.9		2.2	19.9		2.2
Hoerskool Erasmus	26.7	14.0	1.2	13.8	0.5	16.2		1.5	16.2		1.5
Althea Independent School	26.4	14.8	1.2	13.2	0.5	15.6		1.4	15.6		1.4
Kgoro Primary School (Zithobeni)	23.8	14.1	1.1	10.8	0.4	12.8		1.2	12.8		1.2
Zithobeni Secondary School (Zithobeni)	22.9	13.7	1.1	10.0	0.4	12.6		1.2	12.6		1.2
Vaal Power AH	21.4	10.4	1.2	16.4	0.7	58.2		7.7	**58.2**	**86**	7.7
Sasolburg Provincial Hospital	16.7	11.2	1.0	9.8	0.4	24.4		2.1	24.4		2.1
Moredou Old Age Home	16.1	10.7	0.9	8.4	0.4	21.2		1.9	21.2		1.9
Ons Gryse Jeug Old Age Home	16.1	10.5	0.9	9.0	0.4	22.8		2.0	22.8		2.0
Noord Primere Skool	16.2	10.5	0.9	9.1	0.4	23.6		2.1	23.6		2.1
Sasolburg High School	16.1	10.7	0.9	9.2	0.4	22.5		1.9	22.5		1.9
Sakhubusa Secondary School	16.2	10.6	0.9	9.0	0.4	30.4		2.5	**30.4**	1	2.5

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Bekezela Primary School	16.6	10.6	0.9	8.9	0.4	37.0		3.0	**37.0**	11	3.0
Isaac Mhlambi Primary	16.8	11.1	1.0	9.4	0.5	35.7		2.6	**35.7**	2	2.6
Refenkgotso Primary School	21.5	8.7	1.3	18.2	0.7	29.5		3.0	**29.5**	1	3.0
Deneysville Primary School	21.2	9.1	1.3	18.2	0.8	22.5		2.6	22.5		2.6
Netcare Vaalpark Hospital	17.0	11.8	1.0	9.1	0.5	36.2		3.2	**36.2**	11	3.2
Vaalpark Articon Secondary School	16.8	12.2	1.0	9.4	0.5	39.8		3.6	**39.8**	**19**	3.6
Mediclinic Emfuleni	15.0	8.5	0.9	7.8	0.4	29.0		2.3	**29.0**	1	2.3
Jeugland Old Age Home	15.0	9.0	0.9	7.9	0.4	25.4		2.2	**25.4**	1	2.2
Herfsoord Huis Old Age Home	15.0	8.1	0.9	7.8	0.4	25.0		2.0	**25.0**	1	2.0
Huis Prinscilla	14.7	8.4	0.9	7.7	0.4	23.8		1.9	23.8		1.9
Laerskool Emfulenipark	16.1	11.0	0.9	8.4	0.4	37.0		3.1	**37.0**	7	3.1
Nw University_Vaal Campus	15.6	10.7	0.9	8.2	0.4	46.3		4.3	**46.3**	**28**	4.3
Emfuleni Primary School	14.2	8.4	0.8	7.3	0.3	20.1		1.7	20.1		1.7
Mediclinic Vereeniging	14.6	9.1	0.9	7.6	0.4	34.4		3.2	**34.4**	10	3.2
Kopanong Provincial Hospital (Duncanville)	14.7	8.7	0.9	7.5	0.4	17.8		1.5	17.8		1.5
Avondrus Eventide Old Age Home	14.7	9.2	0.9	7.7	0.4	18.5		1.6	18.5		1.6
Riviera On Vaal Resort	14.9	9.9	0.9	7.7	0.4	40.5		3.9	**40.5**	**17**	3.9
Sedibeng Tvet College	14.9	9.9	0.9	7.7	0.4	44.2		4.0	**44.2**	**20**	4.0
General Smuts High School	14.7	10.6	0.9	7.8	0.4	33.6		3.3	**33.6**	9	3.3
Eureuka School & Selbourne Primary	14.6	10.4	0.9	7.6	0.4	34.0		3.0	**34.0**	4	3.0
Midvaal Private Hospital (Three Rivers)	16.5	10.5	1.0	8.8	0.5	43.3		3.5	**43.3**	**20**	3.5
Three Rivers Retirement Village	16.5	10.0	1.0	9.1	0.5	33.4		2.6	**33.4**	7	2.6
Drie Riviere Aftreeoord Old Age Home	16.5	9.8	1.0	9.3	0.5	27.6		2.2	**27.6**	1	2.2
Riverside High School	20.2	10.3	1.1	13.8	0.6	51.2		3.3	**51.2**	**17**	3.3
Risiville Primary School	17.2	10.2	1.0	9.9	0.5	25.7		2.2	**25.7**	1	2.2
Sebokeng Hospital	13.8	8.0	0.8	7.6	0.3	13.5		1.1	13.5		1.1
Clinix-Naledzi Private Hospital	14.0	7.8	0.8	7.5	0.3	13.1		1.2	13.1		1.2
Mohloli Secondary School	14.5	9.5	0.9	7.4	0.4	33.4		2.9	**33.4**	5	2.9
Tshirela Primary School (Boipatong)	14.6	8.5	0.9	7.5	0.4	19.4		1.8	19.4		1.8
Tsoaranang Primary School (Thepiso)	14.0	9.1	0.9	7.4	0.4	25.3		2.3	**25.3**	1	2.3
Thepiso Primary School	14.2	8.5	0.9	7.5	0.4	24.1		1.9	24.1		1.9

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Emmanuel Primary School	14.2	9.4	0.9	7.3	0.4	28.1		2.5	**28.1**	1	2.5
Rust Ter Vaal Combined School	14.6	8.0	0.9	7.8	0.4	11.8		1.1	11.8		1.1
Roshnee Primary School	14.4	7.6	0.9	7.7	0.3	10.0		0.9	10.0		0.9
Roshnee High School	14.6	7.8	0.9	7.7	0.4	11.2		1.0	11.2		1.0
Hoerskool Dr Malan	15.5	8.4	1.0	9.0	0.4	13.5		1.2	13.5		1.2
Laerskool Voorwaarts	17.8	9.4	1.1	11.8	0.5	17.2		1.5	17.2		1.5
Meyerton Secondary School	15.6	8.8	1.0	8.9	0.4	13.0		1.3	13.0		1.3
Ratasetjhaba Primary School	15.0	8.4	0.9	8.4	0.4	10.3		1.0	10.3		1.0
Meyerton Primary School	15.3	8.2	0.9	8.9	0.4	12.9		1.1	12.9		1.1
Oprah Leadership Academy	15.7	7.8	1.0	9.4	0.4	13.9		1.1	13.9		1.1
Henley River Retirement Village	15.8	7.9	1.0	9.2	0.4	12.0		1.1	12.0		1.1
Henley High & Preparatory School	15.4	7.9	1.0	9.0	0.4	11.3		1.0	11.3		1.0
Randvaal Clinic	15.4	8.3	0.9	9.0	0.4	10.6		1.0	10.6		1.0
Laerskool Japie Greyling	15.0	8.1	0.9	8.5	0.4	9.1		0.9	9.1		0.9
Thomas Nhlapo Primary	15.1	8.0	1.0	8.9	0.4	10.3		0.9	10.3		0.9
Randvaal Old Age Home	15.2	8.1	0.9	8.8	0.4	8.8		0.9	8.8		0.9
Laerskool Ag Visser	14.2	7.8	1.1	7.6	0.4	7.4		0.9	7.4		0.9
Lethaba Siyangobe	14.2	8.1	1.1	7.9	0.4	7.5		0.9	7.5		0.9
Shalimar Ridge Primary School	14.1	8.0	1.1	7.7	0.4	7.8		0.9	7.8		0.9
Jw Luckoff High School	14.5	7.6	1.1	8.2	0.5	7.7		0.9	7.7		0.9
Heidelberg Hospital	14.1	8.2	1.1	7.8	0.4	7.6		0.9	7.6		0.9
Thulatsatsi Operation (Rensburg)	14.1	7.8	1.1	7.6	0.4	7.5		0.9	7.5		0.9
Silwer Akker Tehuis	14.0	8.0	1.1	7.6	0.4	7.8		0.9	7.8		0.9
Riversands Retirement Village	14.2	8.3	1.1	8.0	0.4	7.6		0.9	7.6		0.9
Qhaqholla Primary School	14.0	7.6	1.1	7.9	0.4	7.8		0.9	7.8		0.9
Ratanda Primary School	14.3	7.6	1.1	8.3	0.5	8.0		0.9	8.0		0.9
Boneha Primary School	14.0	7.6	1.1	8.0	0.4	7.6		0.9	7.6		0.9
Sithokomele Primary School	14.1	7.7	1.1	8.1	0.4	7.6		0.9	7.6		0.9
Ratanda Bertha Gxowa Primary School	14.5	8.2	1.1	8.1	0.5	7.6		0.9	7.6		0.9
Khanya Lesedi Secondary School	13.9	7.6	1.1	8.2	0.4	7.8		0.9	7.8		0.9
Ratanda Secondary School	13.9	7.6	1.1	8.2	0.4	7.7		0.9	7.7		0.9

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
New Ratanda Secondary School	14.3	8.0	1.1	7.9	0.4	7.5		0.9	7.5		0.9
Kgoro Ya Thuto Secondary School	14.3	8.0	1.1	7.9	0.4	7.5		0.9	7.5		0.9
Ekurhuleni School For The Deaf	14.9	8.3	1.0	8.2	0.4	6.5		0.8	6.5		0.8
Pholosong Hospital	16.1	8.7	1.1	8.7	0.4	7.3		0.9	7.3		0.9
Tsakane Home For Aged	15.7	8.2	1.1	8.6	0.4	7.2		0.9	7.2		0.9
Mmuso Primary School	15.8	8.2	1.1	8.6	0.5	7.6		1.0	7.6		1.0
Michael Zulu Primary School	16.3	8.4	1.1	8.8	0.4	7.3		0.9	7.3		0.9
Nkabinde Primary School (Thembilisha)	16.4	9.2	1.1	8.7	0.4	7.7		0.9	7.7		0.9
Nigel Clinic	14.8	8.3	1.1	7.8	0.4	8.2		1.0	8.2		1.0
Tehuis Vir Bejaardes	14.9	8.1	1.1	7.7	0.4	8.4		1.0	8.4		1.0
Hoerskool John Vorster	14.7	8.3	1.1	7.8	0.4	8.4		1.0	8.4		1.0
Laerskool Hannes Visagie	15.0	7.9	1.1	7.8	0.4	8.6		1.0	8.6		1.0
Nigel Secondary School	15.3	7.8	1.2	8.2	0.4	9.0		1.1	9.0		1.1
Laerskool Dunnottar	15.7	8.3	1.1	8.5	0.4	7.8		1.0	7.8		1.0
Springs Retirement Village	16.6	8.8	1.1	8.6	0.4	8.5		1.0	8.5		1.0
Life Springs Parkland Hospital	16.3	9.0	1.1	8.8	0.4	8.3		1.0	8.3		1.0
Netcare N17 Hospital (Springs)	16.4	9.1	1.1	8.8	0.4	8.2		1.0	8.2		1.0
Springs Boys High School	16.4	8.7	1.1	8.8	0.4	8.1		1.0	8.1		1.0
Laerskool Selectionpark	16.3	8.8	1.1	8.6	0.4	8.3		1.0	8.3		1.0
Kwasa College Pre&Primary School	16.0	8.6	1.1	8.5	0.4	9.0		1.1	9.0		1.1
Edelweis Medical Centre	16.4	8.5	1.1	8.5	0.4	8.6		1.1	8.6		1.1
Laerskool Christiaan Beyers	16.3	8.5	1.1	8.3	0.4	8.7		1.1	8.7		1.1
Hoerskool Hugenote	16.4	8.9	1.1	8.8	0.4	8.4		1.0	8.4		1.0
Brakpan Primary School	16.9	9.8	1.1	9.0	0.4	7.8		0.9	7.8		0.9
Parkrand Primary School	16.3	9.2	1.1	9.0	0.4	6.7		0.8	6.7		0.8
Thabo Memorial Hospital	16.1	8.9	1.0	9.0	0.4	6.3		0.8	6.3		0.8
Sunward Park Hospital	16.1	9.1	1.1	8.8	0.4	6.5		0.8	6.5		0.8
Alberton High School	15.9	8.5	1.0	9.1	0.4	5.9		0.7	5.9		0.7
Netcare Clinton Hospital	15.9	8.5	1.0	9.0	0.4	5.9		0.7	5.9		0.7
Alberton Tuiste Vir Bejaardes	16.0	8.7	1.0	9.2	0.4	5.9		0.7	5.9		0.7
Bertha Gxowa Hospital	17.1	9.6	1.1	10.0	0.5	6.0		0.7	6.0		0.7

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Linmed Hospital	17.2	10.6	1.1	9.7	0.5	7.2		0.9	7.2		0.9
Hoerskool Brandwag (Airfield)	17.2	9.5	1.1	9.6	0.5	7.1		0.8	7.1		0.8
Thepiso Noto Intermediate School	18.8	11.1	1.2	10.3	0.5	10.6		1.3	10.6		1.3
Laerskool Bredell	15.8	9.1	1.0	8.5	0.4	7.1		0.8	7.1		0.8
Sibonelo Primary School (Daveyton)	17.7	10.1	1.1	9.2	0.4	9.3		1.1	9.3		1.1
Petit High School (Kempton Park Nu)	18.4	10.4	1.1	10.1	0.5	8.1		0.9	8.1		0.9
Arwyp Medical Centre	16.2	9.7	1.0	8.9	0.4	6.4		0.7	6.4		0.7
Hoerskool Birchleigh	15.5	9.5	1.0	8.2	0.4	6.7		0.7	6.7		0.7
Curro Serengeti Acadamy	15.6	9.8	1.0	7.8	0.4	7.0		0.8	7.0		0.8
South Rand Hospital	19.1	10.9	1.1	11.7	0.5	6.0		0.7	6.0		0.7
Chris Hani Baragwanath Hospital	15.7	9.5	0.9	8.7	0.4	5.7		0.6	5.7		0.6
Thulani Primary School	14.0	9.0	0.8	7.6	0.3	5.5		0.5	5.5		0.5
University of Witwatersrand	18.9	11.6	1.1	11.2	0.5	6.0		0.6	6.0		0.6
Milpark Hospital	17.6	11.3	1.0	10.2	0.4	6.0		0.6	6.0		0.6
Charlotte Maxixe Academic Hospital	18.0	11.3	1.1	10.7	0.5	6.0		0.6	6.0		0.6
Thembisa West Secondary School (Thembisa)	14.2	9.1	0.9	6.6	0.3	6.3		0.6	6.3		0.6
Lenmed Zamokuhle Private Hospital (Thembisa)	15.2	9.9	0.9	6.9	0.3	6.7		0.7	6.7		0.7
Ikusasa Comprehensive School	15.0	9.7	0.9	7.3	0.3	6.7		0.7	6.7		0.7
Gem Village Old Age Home	14.9	8.6	0.8	6.2	0.3	6.9		0.7	6.9		0.7
Rustoord Old Age Home	14.6	8.7	0.8	6.4	0.3	6.6		0.6	6.6		0.6
Cornwell Hill College (Irene)	14.7	8.9	0.8	6.5	0.3	7.1		0.7	7.1		0.7
Kleinfontein Sorg Sentrum Old Age Home (Donkerhoek)	17.4	10.5	0.9	8.2	0.3	8.8		0.9	8.8		0.9
Valtaki AH (Rayton)	19.7	11.7	1.0	8.7	0.3	10.0		1.0	10.0		1.0
Laerskool Rayton (Rayton)	16.7	9.7	0.8	6.6	0.3	8.3		0.7	8.3		0.7
Tierkop AH	18.6	11.2	1.0	8.8	0.4	9.3		1.0	9.3		1.0
Redford House The Hills Private School (Mooikloof Glen)	17.9	11.3	1.0	8.2	0.4	8.6		0.9	8.6		0.9
Rietvlei View Country Estate	17.9	11.1	1.0	8.2	0.4	8.8		0.9	8.8		0.9

	SO_2			NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Hazeldean Curro School (Tyger Valley)	15.4	9.2	0.8	6.5	0.3	6.7		0.6	6.7		0.6
Tyger Valley College	15.5	9.3	0.8	6.9	0.3	6.9		0.7	6.9		0.7
Pretoria East Hospital (Moreletapark)	16.2	9.7	0.9	7.2	0.3	7.2		0.7	7.2		0.7
Groenkloof Old Age Home	14.6	8.8	0.8	6.5	0.3	6.3		0.6	6.3		0.6
Steve Biko Academic Hospital	13.8	9.3	0.7	5.6	0.2	5.8		0.5	5.8		0.5
Willow Ridge High School (Wilgers)	14.6	8.7	0.8	6.1	0.2	6.4		0.6	6.4		0.6
Hoerskool Waterkloof	16.1	9.9	0.9	7.4	0.3	7.3		0.7	7.3		0.7
Hoerskool Garsfontein	15.4	9.4	0.8	7.0	0.3	6.9		0.7	6.9		0.7
Afrikaanse Hoer Seunskool	14.4	8.9	0.8	6.4	0.3	6.1		0.5	6.1		0.5
Huis Silversig SAVF Old Age Home (Silverton)	14.0	8.7	0.7	5.5	0.2	6.0		0.5	6.0		0.5
Laersekool Meyerspark (Meyerspark)	14.2	8.7	0.7	5.6	0.2	6.2		0.5	6.2		0.5
Curro Academy Mamelodi	13.8	8.4	0.7	4.9	0.2	5.9		0.5	5.9		0.5
Impendulo Primary School	14.7	9.3	0.7	5.5	0.2	6.3		0.6	6.3		0.6
Nellmapius Ext 6 Primary School	14.4	8.3	0.7	5.4	0.2	6.2		0.5	6.2		0.5
Mamelodi Home For Aged	14.3	8.8	0.7	5.0	0.2	5.9		0.5	5.9		0.5

ANNEXURE 3: NEMA REGULATION – APPENDIX 6

Specialist Reports as per the NEMA EIA Regulations, 2014 (as amended), must contain the information outlined in According to Appendix 6 (1) of the Regulations. Table A1 indicates where this information is included in the AIR.

Table A1: Prescribed contents of the Specialist Reports (Appendix 6 of the EIA Regulations, 2014)

Relevant section in GNR. 982	Requirement description	Relevant section in this report
(a) details of—	(i) the specialist who prepared the report; and	Section 2.7
	(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Section 2.7 & Annexure 2
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Section 12
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section 1, 2.1 & 3.2
(cA)	an indication of the quality and age of base data used for the specialist report;	Section 5 & 6
(cB)	a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 6.1
(d)	the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Site investigation not applicable
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 5 & 6.2
(f)	details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 6.3 & 6.4
(g)	an identification of any areas to be avoided, including buffers;	None identified
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 6.3.2
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge; Note: Uncertainties should be qualified within the report – there will always be uncertainties due to gaps in knowledge should also be qualified – a gap is to record that not all knowledge can be obtained for a study.	Section 2.9
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 6.4
(k)	any mitigation measures for inclusion in the EMPr;	Section 9

Relevant section in GNR. 982	Requirement description	Relevant section in this report
	Note: We need to include whether these mitigation measures (excluding ongoing monitoring) can be practically implemented prior to commencement or not.	
(l)	any conditions for inclusion in the environmental authorisation;	Section 9
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 9
(n) a reasoned opinion—	(i) whether the proposed activity, activities or portions thereof should be authorised;	Section 10
	(iA) regarding the acceptability of the proposed activity or activities; and	Section 10
	(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan; Note: We need to include whether these mitigation measures (excluding ongoing monitoring) can be practically implemented prior to commencement or not.	Section 10
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 1
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Addressed in April 2021 AIR
(q)	any other information requested by the competent authority.	Addressed in April 2021 AIR
(2)	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Section 1 & 6.2.1

ANNEXURE 4: CURRICULUM VITAE

MARK ZUNCKEL

Firm	:	uMoya-NILU (Pty) Ltd
Profession	:	Air quality consultant
Specialization	:	Air quality assessment, air quality management planning, air dispersion modelling, boundary layer meteorology, project management
Position in Firm	:	Managing director and senior consultant
Years with Firm	:	Since 1 August 2007
Nationality	:	South African
Year of Birth	:	1959
Language Proficiency	:	English and Afrikaans

EDUCATION AND PROFESSIONAL STATUS

Qualification	Institution	Year
National Diploma (Meteorology)	Technikon Pretoria	1980
BSc (Meteorology)	Univ. of Pretoria	1984
BSc Hons (Meteorology)	Univ. of Pretoria	1988
MSc	Univ. of Natal	1992
PhD	Univ. Witwatersrand	1999

Registered Natural Scientist: South African Society for Natural Scientific Professionals
Ex-Council Member: National Association for Clean Air
Member: National Association for Clean Air

EMPLOYMENT AND EXPERIENCE RECORD

Period	**Organisation details and responsibilities/roles**
1976 – May 1992	South African Weather Bureau : Observer, junior forecaster, senior forecast, researcher, assistant director
June 1992 – July 2007	CSIR: Consultant and researcher, Research group Leader: Atmospheric Impacts
August 2007 to present	uMoya-NILU Consulting: Managing Director and senior air quality consultant

Key and Recent Project Experience:

1996	Project leader & Principal researcher: Atmospheric impact assessment for the proposed Mozal aluminium smelter in Maputo, Mozambique.

1996	Project leader & Principal researcher: Dry sulphur deposition during the Ben MacDhui High Altitude Trace Gas and Transport Experiment (BATTEX) in the Eastern Cape.
1997	Project leader & Principal researcher: Atmospheric impact assessment of the proposed capacity expansion project for Alusaf in Richards Bay.
1997	Project leader & Principal researcher: The Uruguayan ambient air quality project with LATU.
1997	Principal researcher on the Air quality specialist study for the Strategic Environmental Assessment on the industrial and urban hinterland of Richards Bay.
1997	Project leader & Principal researcher: Feasibility study for the implementation of a fog detection system in the Cape Metropolitan area: Meteorological aspects.
2001	Project leader & Principal researcher: Air quality specialist study for the Environmental Impact Assessment for the proposed expansion of the Hillside Aluminium Smelter, Richards Bay.
2001-03	Researcher: The Cross Border air Pollution Impact (CAPIA) project. A 3-year modelling and impacts study in the SADC region.
2002	Project leader & Principal researcher: Air quality assessment specialist study for the proposed Pechiney Smelter at Coega.
2002	Project leader & Principal researcher: Air quality assessment specialist study for the proposed N2 Wild Coast Toll Road.
2002-05	Project leader on the NRF project – development of a dynamic air pollution prediction system
2004	Project leader on the specialist study for expansion at the Natal Portland Cement plant at Simuma, KwaZulu-Natal.
2004-05	Researcher: National Air Quality Management Plan implementation project for Department Environmental Affairs and Tourism.
2005	Researcher in the assessment of air quality impacts associated with the expansion of the Natal Portland Cement plant at Port Shepstone.
2006-07	Project team leader of a multi-national team to develop the National Framework for Air Quality Management for the Department of Environment Affairs and Tourism
2007	Air quality assessment for Mutla Early Production System in Uganda for ERM Southern Africa on behalf of Tullow Oil.
2007-10	Lead consultant on the development of a dust mitigation strategy fro the Bulk Terminal Saldanha and an ambient guideline for Fe_2O_3 dust for Transnet Projects and on-going monitoring.
2008	Lead consultant on the Air quality status quo assessment and scoping for the EIA for the Sonangol Refinery
2008-09	Lead consultant on the development of the air quality management plan for the Western Cape Provincial. Department of Environmental Affairs and Development Planning.
2008-10	Lead consultant on the development of the Highveld Priority Area air quality management plan for the Department of Environmental Affairs and Tourism.
2008	Lead consultant in the development of an odour management and implementation strategy for eThekwini, focussing on Wastewater Treatment Works and odourous industrial sources

2008&10	Lead consultant on the Air Quality Specialist Study for the EIA for the proposed Kalagadi Manganese Smelter at Coega
2008	Lead consultant on the Air Quality Assessment for the Proposed Construction and Operation of a Second Cement Mill at NPC-Cimpor, Simuma near Port Shepstone.
2008	Lead consultant on the Air Quality Specialist Study Report for the New Multi-Purpose Pipeline Project (NMPP) for Transnet Pipelines.
2008	Lead consultant on the Air quality assessment for the proposed UTE Power Plant and RMDZ coal mine at Moatize, Mozambique for Vale.
2008-09	Lead consultant on the Dust source apportionment study for the Coedmore region in Durban for NPC-Cimpor.
2009	Consultant on the Air quality specialist study for the upgrade of the Kwadukuza Landfill, KwaZulu-Natal
2009-10	Lead consultant on the Audit of ambient air quality monitoring programme and air quality training for air quality personnel at PetroSA
2010	Lead consultant on the Qualitative assessment of impact of dust on solar power station at Saldanha Bay
2010	Lead consultant on the Air quality specialist study for the EIA for the Kalagadi Manganese Smelter at Coega
2009-10	Lead consultant on the Air quality specialist study for the Environmental Management Framework for the Port of Richards Bay
2010	Lead consultant on the Air quality status quo assessment and abatement planning at Idwala Carbonates, Port Shepstone
2010	Lead consultant on the Air quality status quo assessment and abatement planning at Sappi Tugela, Mandeni
2010–11	Air quality status quo assessment and revision of the Air Quality Management Plan for City of Johannesburg
2010	Lead consultant on the Air quality status quo assessment and abatement planning at First Quantum Mining’s Bwana Mkubwa and Kansanshi mines, Zambia
2010–11	Lead consultant on the Air quality specialist study for the EIA for the Alternative Fuel and Resources Project at Simuma, Port Shepstone
2010–11	Lead consultant on the Air quality specialist study for the EIA for the Coke Oven re-commissioning at ArcelorMittal Newcastle
2010	Qualitative air quality assessment for the EIA for the Mozpel sugar to ethanol project , Mozambique
2011	Development of the South African Air Quality Information System – Phase II The National Emission Inventory
2011	Ambient baseline monitoring for Riversdale’s Zambezi Coal Project in Tete, Mozambique
2010-11	Ambient quality baseline assessment for the Ncondeze Coal Project, Tete Mozambique
2011-12	Air quality assessment for the mining and processing facilities at Longmin Platinum in Marikana
2012	Air quality assessment for the proposed LNG and OLNG power stations in Mozambique
2012	Modelling study in Abu Dhabi for the transport and deposition of radio nuclides
2012	Air quality assessment for the proposed manganese ore terminal at the Ngqura Port

2012-13	Air quality management plan development for Stellenbosch Municipality
2012-12	Air quality management plan development for the Eastern Cape Province
2013	Air quality specialist for Tullow Oil Waraga-D and Kinsinsi environmental audit in Uganda
2013	Air quality specialist study for the EIA for the Thabametsi IPP station
2013	Air quality management plan for the Ugu District Municipality
2013-14	Air quality specialist study for the application for postponement of the minimum emission standards for 9 Eskom power stations
2014	Air quality specialist study for the application for postponement applications of the minimum emission standards for the Engen Refinery in Merebank, Durban
2014-15	Baseline assessment and AQMP development for the uThungulu District Municipality
2013-15	Baseline assessment, AQMP and Threat Assessment for the Waterberg-Bojanala Priority Area
2014-15	Review of the 2007 AQMP for eThekwini Municipality, including metropolitan emission inventory development for all sectors, i.e. industrial, transport, waste management, biomass burning, residential fuel burning, dispersion modelling and strategy development
2014-14	Dispersion modelling study for Richards Bay Minerals
2015	Air quality assessment for Rainbow Chickens at Hammersdale
2015	Air quality status quo assessment and planning for TNPA ports in South Africa
2016- 7	Lead author of the National State of Air Report for 2005 to 2015, including national emission inventory development for all sectors, i.e. industrial, transport, waste management, biomass burning, residential fuel burning
2016	Air quality assessment for Kanshansi Mine, Solwesi, Zambia
2016	Assessment of air quality impacts associated with activities at the Venetia Mine, Limpopo Province
2016	Assessment of air quality impacts associated with activities at the Komati Anthracite Mine, Mpumalanga Province
2016	Air quality assessment for the proposed Powership Project at the Port of Nacala, Mozambique
2016	Air quality assessment for the proposed Richards Bay Gas to Power Project
2017	Baseline assessment and review of the 2009 AQMP for Gauteng Province, including emission inventory development for all sectors, i.e. industrial, transport, waste management, biomass burning, residential fuel burning, and dispersion modelling
2017	Baseline assessment and air quality management plan for Northern Cape Province
2017	Air quality assessment for the EIA for the Thabametsi Power Station in Limpopo Province
2017	Air quality assessment for the EIA for the proposed Tshivasho Power Station in Limpopo Province
2018	Air quality assessment for the EIA for the proposed Bellmall Thermal Plant in Ekurhuleni
2018	Air quality assessment for the EIA for the proposed Simba Oil mini Refinery in Tororo, Uganda
2018-19	Air dispersion modelling for input to the Atmospheric Reports for the postponement application for 14 Eskom power stations

2019	Air quality impact assessment for the proposed NamPower expansion project in Walvis Bay
2019	Air quality assessment for the mine expansion project at the Akanani Mine
2019	Air quality impact assessment for the proposed power plant at Nacala, Mozambique
2020	AIR for the KarpowershipSA proposal in the Ports of Ngqura, Richards Bay and Saldanha Bay
2020	AIR for the Coega Development Corporation gas-to-power project at 4 sites in the CDC
2020	AIRs for 10 Eskom coal-fired power power stations on the Highveld to support their postponement application
2020	AIR for the proposed Azure Power gas-to-power project in the Western Cape
2021	Air quality assessment for the proposed optimisation project at Beeshoek Iron Ore Mine, Postmasburg, Northern Cape
2021	AIR for the proposed Frontier Power Gas-to-Power project at Saldanha Bay, Western Cape
2021	AIR for the 2021 shutdown and start-up at Engen Refinery in Merebank
2021	AIR for the proposed expansion of the Swartkops Ore handling facility in Port Elizabeth, Eastern Cape
2016-21	AEL compliance monitoring for Joseph Grieveson, Durban, including dust fallout monitoring and reporting
2018-21	Dust fallout and HF monitoring and reporting for Hulamin, Richards Bay
2018-21	Dust fallout and H_2S monitoring and reporting for at KwaDukuza Landfill for Dolphin Coast Landfill Management (DCLM)
2019-21	AEL compliance monitoring for Umgeni Iron and Steel Foundry, including dust fallout monitoring and reporting

PUBLICATIONS

Author and co-author of 34 articles in scientific journals, chapters in books and conference proceedings. Author and co-author of more than 300 technical reports and presented 47 papers at local and international conferences.

ATHAM RAGHUNANDAN

uMOYA-NILU

Firm	:	uMoya-NILU Consulting (Pty) Ltd
Profession	:	Air Quality Consultant
Specialization	:	Meteorological and Atmospheric Dispersion Modelling, Air Quality Specialist Studies, Project Management, Data Processing, Emission Inventories
Position in Firm	:	Senior Air Quality Consultant
Years with Firm	:	14 years (appointed in 2008)
Nationality	:	South African

Year of Birth	:	1977
Language Proficiency	:	English (mother tongue), Afrikaans (fair)

EDUCATION AND PROFESSIONAL STATUS

Qualification	**Institution**	**Year**
M.A. (Atmospheric Sciences)	University of Natal, Durban	2003
B.A. Hons. (Environmental Sciences)	University of Durban–Westville	2001
B.Paed. (Education)	University of Durban–Westville	2000

Memberships:

- National Association for Clean Air (NACA)
- South African Society for Atmospheric Sciences (SASAS)
- South African Council of Educators (SACE)

EMPLOYMENT AND EXPERIENCE RECORD

Period	Organisation details and responsibilities/roles
Jan 2003 – Oct 2008	CSIR: Consultant/Researcher in Air Quality Group, Research Group Leader – Air Quality Research Group
Nov 2008 – present	uMoya-NILU: Senior Air Quality Consultant

Key and Recent Project Experience:

2003	Baseline air dispersion modelling study for Natal Portland Cement (Pty) Ltd – Simuma Plant, Port Shepstone – Modelling and Reporting
2004	Air Quality Screening Study for MOZAL 3 – Modelling and Reporting
2005	Air Quality Specialist Study for the Proposed Kudu Combined Cycle Gas Turbine Power Station at Oranjemund, Namibia (Site D) – Modelling and Reporting
2005	Air Quality Specialist Study for the Proposed Kudu Combined Cycle Gas Turbine Power Plant at Uubvlei, Namibia – Modelling and Reporting
2005	Air Quality Specialist Study for a Proposed Cement Milling, Storage and Packaging Facility and a Second Clinker Kiln at Natal Portland Cement (Pty) Ltd – Simuma Plant, Port Shepstone – Modelling and Reporting
2005	Technology Review: Air quality specialist study for the Coega Aluminium Smelter at Coega, Port Elizabeth – Modelling and Reporting
2005	Assessment of Development Scenarios for Hillside Aluminium using Sulphur Dioxide (SO_2) as an Ambient Air Quality Indicator – Modelling and Reporting
2005	Air Quality Scoping Study for Eskom's Proposed Open Cycle Gas Turbine Power Station at Atlantis – Modelling and Reporting

2005	Air Quality Specialist Study for Eskom's Proposed Open Cycle Gas Turbine Power Station at Atlantis, Western Cape – Modelling and Reporting
2005	Air Quality Specialist Study for the Proposed Tata Steel Ferrochrome Project at Richards Bay – Alton North Site – Modelling and Reporting
2005	Air Quality Audit for the Amathole District Municipality - Compilation of detailed emissions inventory
2006	A Regional Scale Air Dispersion Modelling Study for Northeastern Uruguay – Modelling and Reporting
2006	Air Dispersion Modelling Study for Natal Portland Cement (Pty) Ltd for the Proposed AFR Programme at the Simuma Plant, Port Shepstone – Modelling and Reporting
2007	Development of an air quality management strategy for particulate matter at the Bulk Terminal Saldanha - Project Leader and Reporting
2007	Air Quality and Human Health Specialist Study for the Proposed Coega Integrated LNG to Power Project (CIP) within the Coega Industrial Zone, Port Elizabeth, South Africa - Project Leader, Modelling and Reporting
2008	Dispersion Modelling for the Proposed Coega Aluminium Smelter (CAL) at Port Elizabeth - Project Leader, Modelling and Reporting
2008	Modelled and Measured Vertical Ozone Profiles over Southern Africa (as part of the Young Researcher Establishment Fund (2005-2008)) - Project Leader
2008	Air Quality Specialist Study for the Proposed N2 Wild Coast Toll Highway - Project Leader, Modelling and Reporting
2008	Initial Air Quality Impact Assessment for the Proposed Illovo Ethanol Plant in Mali, West Africa - Project Leader, Modelling and Reporting
2008	Modelling Mercury Stack Emissions from South African Coal-fired Power Power stations – Modelling and Reporting
2009	Air Quality Management Plan for the Western Cape Province – Baseline Assessment – Modelling
2009	Proposed Exxaro AlloyStream™ Manganese Project in the Coega Industrial Development Zone: Air Quality Impact Assessment – Modelling and Reporting
2009	Air Quality Specialist Study for the Kalagadi Manganese Smelter at Coega, Eastern Cape – Modelling and Reporting
2009	Qualitative Air Quality Impact Assessment for the Wearne Platkop Quarry – Modelling and Reporting
2009	Specialist Air Quality Study for the Vopak Terminal Durban Efficiency Project – Modelling
2009	Qualitative Air Quality Impact Assessment for the Proposed ETA STAR Coal Mine at Moatize, Mozambique – Modelling and Reporting
2009	Specialist Air Quality Study for the Kwadukuza Landfill Upgrade Project – Modelling and Reporting
2010	Ambient dust assessment at Saldanha Bay for the period October 2006 to September 2009 for Transnet Bulk Terminal Saldanha – Reporting
2010	Dust Impact Assessment for the Proposed Saldanha Bay Pilot PV plant – Reporting
2010	Modelling Particulate Emission Concentration Scenarios for Eskom's Kriel Power Station – Modelling and Reporting
2010	Air Quality Dispersion Modelling for MOZAL, Mozambique – Modelling and Reporting

2010	Air Quality Management Plan for the Highveld Priority Area – Air Quality Baseline Assessment for the Highveld Priority Area – Modelling
2010	Ambient Air Quality Modelling and Monitoring at Sappi, Mandeni – Modelling and Reporting
2010	Dust Impact Study at Idwala Carbonates – Modelling and Reporting
2010	Air quality specialist study for the EIA for the proposed re-commissioning of an existing coke oven battery at ArcelorMittal South Africa, Newcastle Works – Modelling
2010	Air quality specialist study for the proposed storage and utilisation of alternative fuels and resources at NPC-Cimpor's Simuma facility, Port Shepstone, KwaZulu-Natal – Modelling and Reporting
2010	Air quality status quo assessment and abatement planning at First Quantum Mining's Bwana Mkubwa and Kansanshi mines, Zambia – Modelling
2010	Air quality specialist study for the proposed briquetting plant at the Mafube Colliery – Modelling and Reporting
2011	Air quality modelling study for the Copeland reactor at Sappi Stanger – Modelling and Reporting
2011	Air quality modelling study for the Copeland reactor at Sappi Tugela – Modelling and Reporting
2011	Air quality monitoring and modelling study for the Copeland reactor at Mpact Paper, Piet Retief – Modelling and Reporting
2011	Air Quality Study for the Basic Environmental Assessment for the Proposed Biomass Co-Firing Facility at the Arnot Power Station – Modelling and Reporting
2011	Assessment of Scenarios for Developing and Implementing a Sulphur Dioxide Emissions Licensing Strategy for Hillside Aluminum – Modelling and Reporting
2011-12	Air quality assessment for the mining and processing facilities at Lonmin Platinum in Marikana – Modelling and Reporting
2012	Development of an Air Quality Management Plan for Anglo's Mafube Colliery in Mpumalanga – Modelling and Reporting
2012	Air quality assessment for the proposed manganese ore terminal at the Ngqura Port – Modelling and Reporting
2012	Air Quality Impact Assessment for NPC Cimpor – Modelling and Reporting
2013	Air Quality Impact Assessment for Proposed AfriSam Plant in Coega – Modelling
2013	Air quality assessment for the Orion Engineered Carbons Co-Gen Plant – Modelling
2013	Air quality assessment for the Orion Engineered Carbons - Main Boiler – Modelling
2013	Air quality assessment for the EIA for the Sekoko Coal Mine – Modelling and Reporting
2013	Air quality specialist study for the EIA for the Thabametsi IPP station – Modelling and Reporting
2013	Air quality specialist study for the EIA for the Mamathwane Common User facility – Modelling and Reporting
2013-14	Air quality specialist study for the application for postponement of the minimum emission standards for 16 Eskom power stations: Acacia, Arnot, Camden, Duvha, Grootvlei, Hendrina, Kendal, Komati, Kriel, Lethabo,

	Majuba, Matimba, Matla, Madupi, Tutuka, Port Rex – Modelling and Reporting
2014	Air quality specialist study for the application for postponement of the minimum emission standards for the Engen Refinery in Merebank, Durban – Modelling and Reporting
2013-14	Baseline assessment and air quality management plan for the Waterberg-Bojanala Priority Area – Modelling
2013	Air Quality Specialist Study for the EIA for the Pandora Platinum Mine Joint Venture – Modelling and Reporting
2013	Air Quality Specialist Study for the EIA for the Proposed New Tailings Storage Facility (TD8) and Associated Infrastructure at Lonmin's Western Platinum Mine and Eastern Platinum Mine – Modelling and Reporting
2015	Waterberg-Bojanala Priority Area Air Quality Management Plan and Threat Assessment – Modelling
2015	Air Quality Management Plan for eThekwini Municipality – Modelling and Reporting
2015	Air Quality Management Plan for the uThungulu District Municipality – Modelling and Reporting
2015	Dispersion Modelling for Richards Bay Minerals – Modelling and Reporting
2015	Atmospheric Impact Report in support of Sancryl Chemicals's application for a verification to the existing AEL as a result of the introduction of Ethyl Acrylate and Vinyl Acetate, Prospecton – Modelling and Reporting
2016	Dispersion Modelling Study for the City of Johannesburg – Modelling and Reporting
2016	Air Quality Specialist Study for the Department of Energy's Emergency Power IPP Project at Richards Bay and Saldanha Bay – Modelling and Reporting
2016	Atmospheric Impact Report in support of the EIA for the Proposed Gas to Power Plant in Zone 1F of the Richards Bay IDZ – Modelling and Reporting
2016	Atmospheric Impact Report for the EIA for the proposed Tshivhaso Coal-fired Power Plant, Lephalale – Modelling and Reporting
2016	TNPA Air Quality Study – Dispersion Modelling for 8 Ports in South Africa: Port of Richards Bay, Durban, East London, Ngqura, Port Elizabeth, Mossel Bay, Cape Town and Saldanha Bay – Modelling and Reporting
2016	Atmospheric Impact Report for Durran's Calcination Plant – Modelling and Reporting
2016	Air Quality Assessment for the EIA for the Floating Power Plant in Nacala, Mozambique – Modelling and Reporting
2016	Ambient Air Quality Assessment for 2016 for Kansanshi Mining Plc – Modelling and Reporting
2016	Air Quality Impact Assessment for the EIA for the Proposed Hilli FLNG Project in Cameroon – Modelling and Reporting
2016	Kansanshi Smelter and TSF1 Modelling Scenarios for Kansanshi Mining Plc – Modelling and Reporting
2016	Air Quality Assessment the Proposed Accommodation Facility at the Venetia Mine in Limpopo – Modelling and Reporting
2016	Atmospheric Impact Report in support of the EIA for the Proposed Optimisation of the Process Plant at Nkomati Anthracite Mine – Modelling and Reporting

2017	Atmospheric Impact Report in support of the DRDAR Atmospheric Emission License (AEL) application for the proposed replacement and use of an incinerator at their State Veterinary Laboratories located in Grahamstown, Middelburg and Queesntown in the Eastern Cape – Modelling and Reporting
2017	Baseline Assessment and Review of the 2009 AQMP for Gauteng Province, including emission inventory development for all sectors, i.e. industrial, transport, waste management, biomass burning, residential fuel burning, and dispersion modelling – Modelling and Reporting
2017	Baseline Assessment and Air Quality Management Plan for Northern Cape Province – Modelling and Reporting
2017	Atmospheric Impact Report in support of Maloka Machaba Surfacing's application for an Atmospheric Emission License (AEL) for a proposed asphalt plant located in Polokwane – Modelling and Reporting
2017	Assessment of modelling scenarios involving an increase in the open area of the cone on the Common Stack for the pretreater, reformer and CHD furnaces at Engen Refinery – Modelling and Reporting
2017	Atmospheric Impact Report in support of the Atmospheric Emission License (AEL) application and stack-height assessment for the proposed Thabametsi Power Plant near Lephalale, Limpopo – Modelling and Reporting
2017	Dispersion Modelling Study for the Beeshoek Mine, near Postmasburg, Northern Cape – Modelling and Reporting
2018	Air quality assessment for the EIA for the proposed Bellmall Thermal Plant in Ekurhuleni – Modelling and Reporting
2018	Air quality assessment for the EIA for the proposed Simba Oil mini Refinery in Tororo, Uganda – Modelling and Reporting
2018-19	Air dispersion modelling for input to the Atmospheric Reports for the postponement application for 14 Eskom power stations – Modelling and Reporting
2019	Air quality impact assessment for the proposed NamPower expansion project in Walvis Bay – Modelling and Reporting
2019	Air quality assessment for the mine expansion project at the Akanani Mine – Modelling and Reporting
2019	Air quality impact assessment for the proposed power plant at Nacala, Mozambique – Modelling and Reporting
2019	Atmospheric Impact Report in Support of the Atmospheric Emission License (AEL) Amendment Application and Basic Assessment for Dow Southern Africa - New Germany – Modelling and Reporting
2019	Atmospheric Impact Report in support of Tau-Pele Construction's application for an Atmospheric Emission License (AEL) for a proposed emulsion and asphalt plant located in Indwe, Eastern Cape – Modelling and Reporting
2019	Atmospheric Impact Report in Support of the EIA for the Proposed Material Source and Processing Sites Along the N3 Between Durban and Hilton, KwaZulu-Natal: RCL1, RCL9 and Harrison's Quarry – Modelling and Reporting
2019	Atmospheric Impact Report in Support of the Atmospheric Emission License (AEL) Amendment Application and Basic Assessment for the Vopak Efficiency (Growth 4) Expansion Project, Durban, South Africa – Modelling and Reporting

2020	AIR for the KarpowershipSA proposal in the Ports of Ngqura, Richards Bay and Saldanha Bay – Modelling and Reporting
2020	AIR for the Coega Development Corporation gas-to-power project at 4 sites in the CDC – Modelling and Reporting
2020	AIRs for 10 Eskom coal-fired power power stations on the Highveld to support their postponement application – Modelling and Reporting
2020	AIR for the proposed Azura Power gas-to-power project in the Western Cape – Modelling and Reporting
2020	Atmospheric Impact Report for the proposed 315 MW LPG Power Plant at Saldanha Bay – Modelling and Reporting
2021	Air quality assessment for the proposed optimisation project at Beeshoek Iron Ore Mine, Postmasburg, Northern Cape – Modelling and Reporting
2021	Air quality assessment for the proposed expansion at Akanani Mine in Limpopo – Modelling and Reporting
2021	AIR for the proposed Frontier Power Gas-to-Power project at Saldanha Bay, Western Cape
2021	AIR for the 2021 shutdown and start-up at Engen Refinery in Merebank – Modelling and Reporting
2021	AIR for the proposed expansion of the Swartkops Ore handling facility in Port Elizabeth, Eastern Cape – Modelling and Reporting
2021	Atmospheric Impact Report in support of the Proposed 200 MW Engie CB Hybrid Power Project in the Coega Special Economic Zone (SEZ) – Modelling and Reporting
2021	Air Quality Impact Assessment for the proposed Mining of TSF-1 at the Stibium Mopani Mine near Gravelotte, Limpopo Province – Modelling and Reporting
2021	Addendum to the Atmospheric Impact Report in support of the proposed Mulilo-Total 200 MW Gas-fired Power Station, Coega Special Development Zone, Eastern Cape – Reporting
2021	Air Quality Assessment for the EIA for the Tete 1 400 MW Coal-Fired Power Plant, Tete Province, Mozambique – Modelling and Reporting
2021	Atmospheric Impact Report in support of Tugela Asphalt's application for an Atmospheric Emission License (AEL) for a proposed asphalt plant located in Mandini, KwaZulu-Natal – Modelling
2021	Atmospheric Impact Report for Nkomati Mine – Modelling and Reporting
2022	Emission Inventory for Lanxess for 2021 – Reporting
2022	Annual Report for Puregas: Atmospheric Emission License - Submission to the City of Ekurhuleni in compliance with the Atmospheric Emission Licence of the facility for the Reporting Period Year 2021 – Reporting
2022	Emission Inventory for Puregas for 2021 – Reporting
2022	Emission Inventory for Dow Advanced Materials for 2020 – Reporting
2022	Atmospheric Impact Report for the Engen Cape Town Terminal – Modelling and Reporting

PUBLICATIONS

Author and co-author of 5 articles in scientific journals and conference proceedings. Author and co-author of more than 200 technical reports for external contract clients. Presented 4 papers at local conferences. A full list of publications, conference papers and contract reports is available on request.

NOPASIKA XULU

Firm	:	uMoya-NILU (Pty) Ltd
Profession	:	Senior Air Quality Consultant
Specialization	:	Air Quality Assessment, Air Dispersion Modelling; Project Management; Data Analysis; Report Writing and Reviews
Position in Firm	:	Senior Air Quality Consultant
Years with Firm	:	Since 27 March 2023
Nationality	:	South African
Year of Birth	:	1985
Language Proficiency	:	English and IsiZulu (read, write. Speak)

EDUCATION AND PROFESSIONAL STATUS

Qualification	Institution	Year
BSc. Environmental Studies	Univ. of Witwatersrand	2011
BSc Hons (Env. Studies)	Univ. of Witwatersrand	2012
BSc MSc (Env Sciences)	NWU Potchefstroom	2017

EMPLOYMENT AND EXPERIENCE RECORD

Period	Organisation details and responsibilities/roles
Oct 2016 – Dec 2018	Gondwana Environmental Solutions (Pty) Ltd: Air Quality Management Plans; Report Writing; Business Development and Marketing, Researcher,
July 2019 – March 2023	Rayten Engineering Solutions (Pty) Ltd: Air Quality Consultant, Project Management; Report Writing and Review; Data Analysis; Dispersion Modelling and Air Quality Impact Assessment; Research; Compiling Atmospheric Emission License (AEL) Applications; Populating National Atmospheric Emissions Inventory System; AEL Compliance Auditing; Dust Emission Reduction Plans; Greenhouse Gas Emissions Inventory Reporting; Facilitating/ Attending meetings; Liaising with Clients and Suppliers.

March 2023 – Present: uMoya – Nilu Consulting (Pty) Ltd Senior Air Quality Consultant, Dispersion Modelling and Air Quality Impact Assessments; Project Management

Key Project Experience:

2019 – 2023: Project Leader: Air Quality Impact Assessment projects (Harmony Moab Khotsong; EzeeTile Bloemfontein, EzeeTile Mokopane; Transvaal Galvanizers; Duho Drying; Lingaro Drying; Nama Copper Pty Ltd) Project Leader: AEL Applications and Reporting (Harmony Kopanang Operations;

Harmony Mponeng Operations; Sibanye Gold Mines; Sibanye Platinum Mines; TotalEnergies Marketing; Matt Cast Supplies CC; Independent Crematorium SA; City of Tshwane Crematorium; Buffalo City Municipality Crematorium; Wahl Industries; Transvaal Galvanizers)

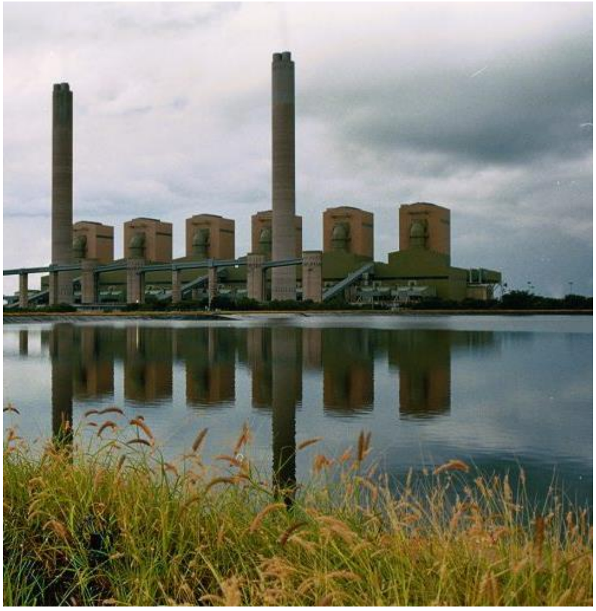
2014 – 2017: Researcher: Air Quality Assessment in low-income residential areas in the Highveld

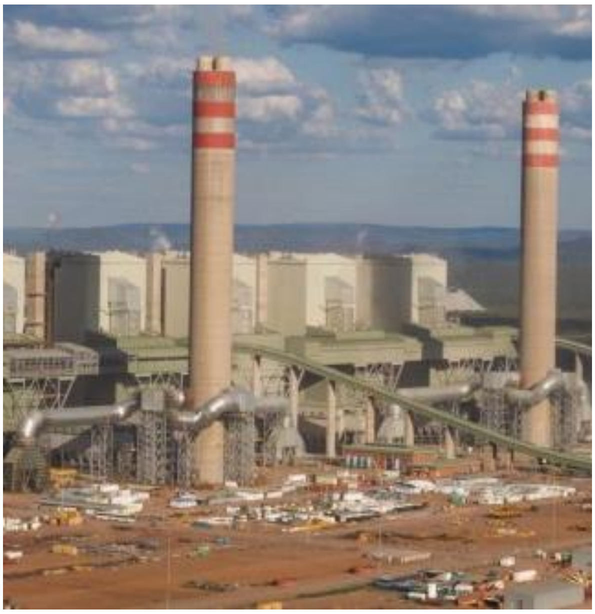
Publications: Author: Xulu, N.A., Piketh, S.J. Feig,G.T., Lack, D.A and Garland,R.M., (2020).Characterizing Light Absorbing Aerosols in a Low –Income Settlement in South Africa. Aerosol Air Quality Aerosol Air Quality Research. https://doi.org/10.4209/aaqr.2019.09.004

CONTACT INFORMATION:

Email: nopasika@umoya-nilu.co.za
Phone: +27 63 1289 447

ATMOSPHERIC IMPACT REPORT IN SUPPORT OF THE APPLICATION FOR EXEMPTION FROM THE MINIMUM EMISSION STANDARDS FOR ESKOM'S COAL-FIRED POWER STATIONS IN THE WATERBERG (A CUMULATIVE ASSESSMENT)





Final
4 November 2024

uMOYA-NILU

Report issued by:

uMoya-NILU Consulting (Pty) Ltd
P O Box 20622
Durban North, 4016
South Africa

Report issued to:

WSP Group Africa (Pty) Ltd
Building 1, Maxwell Office Park
Magwa Crescent West, Waterfall City
Midrand, 1685
South Africa

Report Details

Client:	WSP Group Africa (Pty) Ltd
Report title:	Atmospheric Impact Report in Support of the Application for Exemption from the Minimum Emission Standards for Eskom's Coal-Fired Power Stations in the Waterberg (A Cumulative Assessment)
Project:	uMN920-24
Report number:	uMN219-24
Version:	Final 4 November 2024
Prepared by:	uMoya-NILU Consulting (Pty) Ltd, P O Box 20622, Durban North 4016, South Africa
Authors:	Mark Zunckel, Atham Raghunandan and Nopasika Xulu

When used in a reference this document should be cited as follows:
uMoya-NILU (2024): Atmospheric Impact Report in Support of the Application for Exemption from the Minimum Emission Standards for Eskom's Coal-Fired Power Stations in the Waterberg (A Cumulative Assessment), Report No.: uMN219-24, November 2024.

Front page picture credit: https://www.eskom.co.za/eskom-divisions/gx/coal-fired-power-stations/

EXECUTIVE SUMMARY

Eskom operates a fleet of 14 coal-fired power stations, collectively generating more than 39 000 MW of electricity. The combustion of coal to generate steam for the generation of electricity is a Listed Activity in terms of the National Environmental Management: Air Quality Act (Act No. 39 of 2004). As such, Eskom holds Atmospheric Emission Licenses (AEL) for the respective power stations and is obligated to operate these power stations according to conditions specified in the respective AELs. Minimum Emission Standards (MES) for Listed Activities were published in 2010 (DEA, 2010) including compliance timeframes for existing and new plants had to comply with the MES for new plants by 30 April 2020.

Between 2018 and 2020, Eskom submitted applications to the Department of Forestry, Fisheries and the Environment (DFFE) based on an internally approved Emission Reduction Plan, which defined which power stations would have emission reduction technology installed and when. The National Air Quality Officer (NAQO) made decisions on these applications in 2019, which were not in favour of Eskom. Eskom appealed the NAQO's decision, and the Minister established the National Environmental Consultative and Advisory (NECA) Forum to advise her on the issue. The Minister ruled on the Eskom appeals on 22 May 2024 and granted the suspension of the Minimum Emission Standards (MES) at five (5) power stations on the Highveld up to 31 March 2030, namely Arnot, Camden, Grootvlei, Hendrina and Kriel. She further directed Eskom to submit an application in terms of Section 59 of the National Environmental Management: Air Quality Act for the exemption of the MES for eight (8) power stations that will continue to operate post 2030. These are Duvha, Kendal, Lethabo, Majuba, Matla and Tutuka on the Highveld and Medupi and Matimba in the Waterberg.

In terms the Minister's ruling Eskom Holdings SOC Ltd appointed WSP Group Africa (Pty) Ltd to prepare the necessary applications. WSP sub-contracted uMoya-NILU Consulting (Pty) Ltd to prepare the associated Atmospheric Impact Reports (AIRs) to support the applications. In response, AIRs have been prepared to support the exemption applications for the individual power stations. This AIR collectively assesses the two power stations in the Waterberg-Bojanala Priority Area, i.e. Medupi and Matimba, to provide further supporting information for the exemption applications. They are relatively close together in the Lephalale Local Municipality, just west of the town of Lephalale.

Eskom intends to systematically reduce emissions resulting from the fleet of coal-burning power stations. Three emission reduction trajectories from Eskom's financial ERP models are described here and illustrated in Figure E1 for NO_X, SO_2 and PM.

> **ERP 2024 A**: Eskom continue as planned, which includes all PM and NOx abatement projects and FGD at Kusile – This is why ERP 2024 A = B = C for NOx & PM (only security of supply differs) – by the time Grootvlei, Kriel, Arnot, Hendrina, Camden, Duvha and Matla are shutdown, Eskom will be fully compliant with NO_X and PM MES through the fleet.
>
> **ERP 2024 B**: 2024 A as above, but also FGD at Medupi, DSI at Majuba, and FGD at Kendal, hence the improvement from 2036 in SO_2 for ERP 2024 B. This is Eskom's middle-ground scenario; doing more than 2024 A, but not doing 2024 C.

ERP 2024 C: All of 2024 A and 2024 B above, but also FGD at Lethabo and Tutuka. Although this shows big improvement in SO_2 vs ERP 2024 B, this is a combination of Lethabo & Tutuka FGD, and actually probably more from shutdown of Duvha & Matla – station shutdowns have bigger impact on SO_2 reduction than FGD. When you look at the modelling results, ERP 2024 B already well within NAAQS (this is our model Scenario C), so enforcing ERP 2024 C not really justifiable, especially considering all the other negative impacts of FGD (age of Tutuka & Lethabo, costs, waste, water etc.).

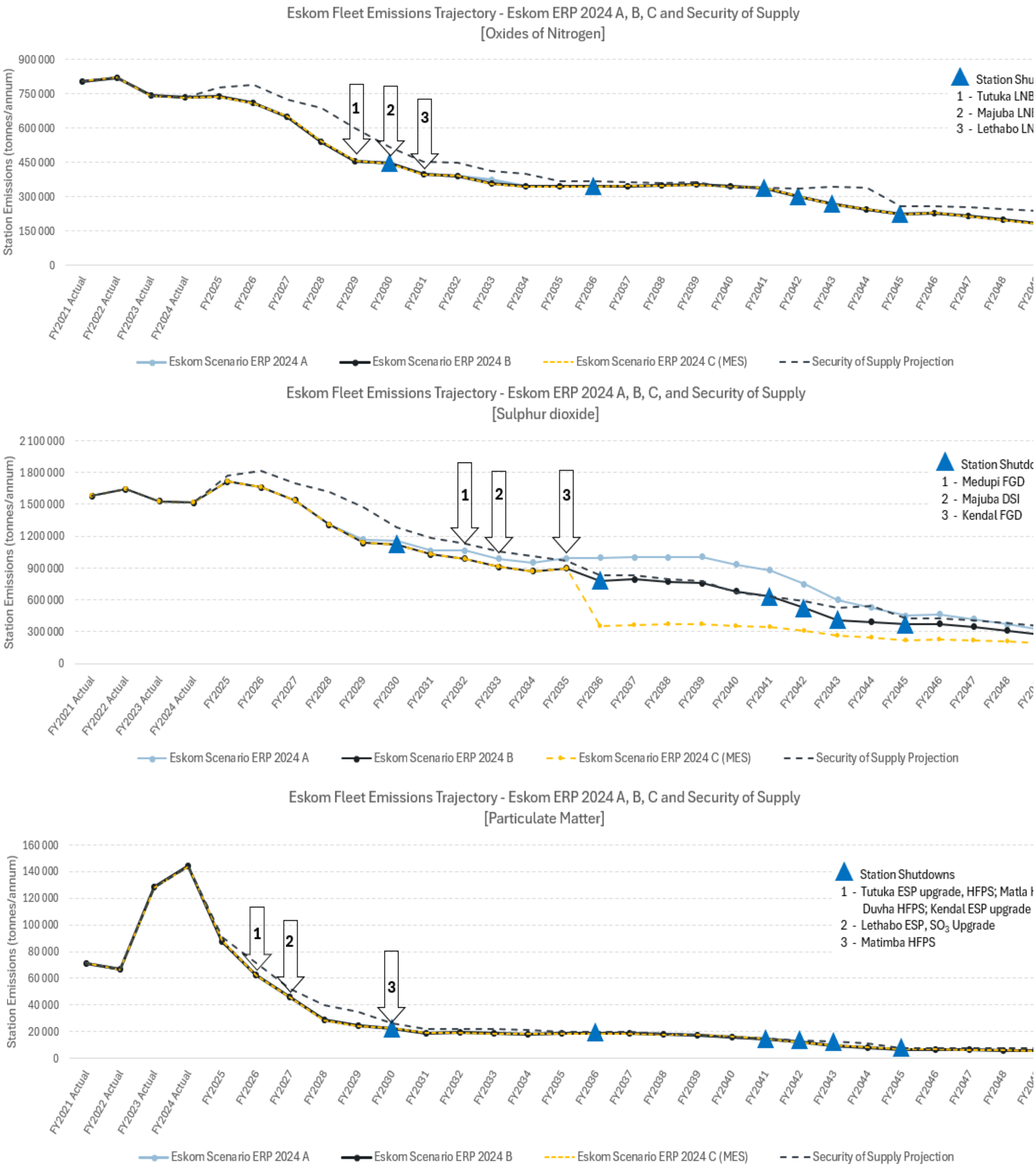
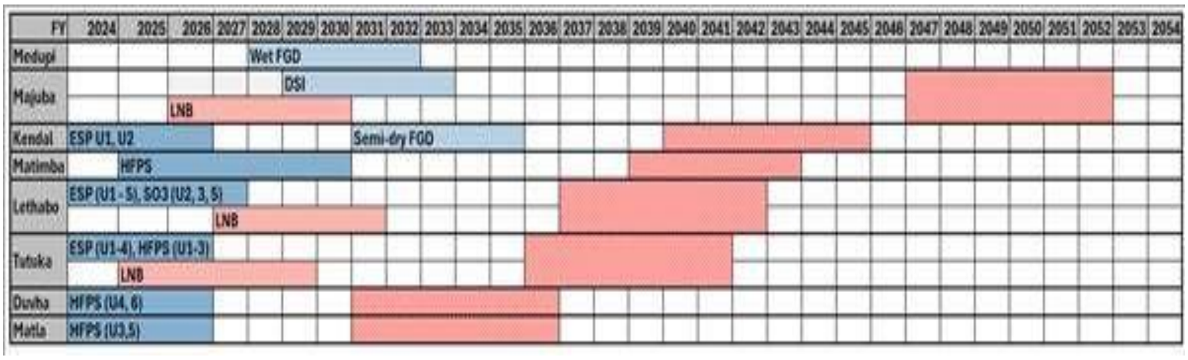


Figure E-1: Eskom's fleet emission trajectory NO_X (top), SO_2 (middle) and PM (bottom)

The proposed schedule for the installation of NO_X, PM and SO_2 emission reduction technologies and the shutdown schedule for power stations is shown in Figure E-2.



FGD: flue gas desulphurisation
DSI: Dry Sorbent Injection
LNB: low NO_X Burner
HFPS: high frequency power supply
ESP: Electrostatic precipitator
DHP: Dust Handling Plant
Station Shutdown

Figure E-2: Emission reduction installation schedule and the planned shutdown of power stations

This AIR for the Waterberg power stations collectively assesses Medupi and Matimba to provide supporting information for the exemption applications for the two individual power stations. In so do doing, 5 emission scenarios are assessed for the two power stations. These are:

Scenario 1 (Current): The baseline scenario using actual monthly stack emissions for 2021-2023 and fugitive emissions from the coal stockyards and the ash dumps (No FGD installed).
Scenario A (2025): Eskom's planned 2025 stack emissions, representing anticipated station performance between 2025 – 2030, including fugitive emissions from the coal stockyards and the ash dumps (No FGD installed).
Scenario B (2031): Eskom's planned 2031 stack emissions, representing anticipated station performance between 2031 – 2035, including fugitive emissions from the coal stockyards and the ash dumps (No FGD installed but load reduction).
Scenario C (2036): Eskom's planned 2036 stack emissions, representing anticipated station performance from 2036 onwards, including fugitive emissions from the coal stockyards and the ash dumps (FGD installed at Medupi).
Scenario D (MES): Full compliance with the MES, including fugitive emissions from the coal stockyards and the ash dumps (FGD installed at Medupi and Matimba).

The annual average SO_2, NO_X and PM emission rates in tonnes per annum and the equivalent emission concentrations in mg/Nm^3 for Medupi and Matimba for the five scenarios are presented in Table E-1.

Table E-1: Annual emissions from the Matimba and Medupi Power Stations and the corresponding emission concentrations

Scenario	Stack	Emission rate (tonnes/annum)			Emission concentration @ 10% O_2 and average load (mg/Nm^3)		
		NO_X	SO_2	PM	NO_x	SO_2	PM
		Medupi Power Station					
1[a]	Stack 1	25 577	123 502	1 314	257	1 343	13
	Stack 2	25 577	123 502	1 314	257	1 343	13
A	Stack 1	34 716	134 340	1 663	522	2 020	25
	Stack 2	34 716	134 340	1 663	522	2 020	25
B	Stack 1	20 770	80 374	1 273	522	2 020	32
	Stack 2	20 770	80 374	1 273	522	2 020	32
C	Stack 1	23 447	31 263	1 438	375	500	23
	Stack 2	23 447	31 263	1 438	375	500	23
D	Stack 1	23 447	31 263	1 438	375	500	23
	Stack 2	23 447	31 263	1 438	375	500	23
		Matimba Power Station					
1[a]	Stack 1	28 921	150 457	2 648	291	1 514	27
	Stack 2	28 921	150 457	2 648	291	1 514	27
A	Stack 1	28 346	150 830	1 820	545	2 900	35
	Stack 2	28 346	150 830	1 820	545	2 900	35
B	Stack 1	18 118	103 026	1 243	510	2 900	35
	Stack 2	18 118	103 026	1 243	510	2 900	35
C	Stack 1	20 872	112 752	1 432	510	2 755	35
	Stack 2	20 872	112 752	1 432	510	2 755	35
D	Stack 1	20 872	33 825	1 432	510	827	35
	Stack 2	20 872	33 825	1 432	510	827	35
MES					**750**	**1000**	**50**

(a): Average from actual monthly emissions

Fugitive emissions of particulates result from coal storage and handling, and from ashing activities at the power stations. The estimated annual PM_{10} emission rates are shown in Table E-2. These are assumed to be the same for all five scenarios.

Table E-2: Fugitive sources of PM_{10} at the Medupi and Matimba Power Stations

Power station	Source name	Emission (tonnes/year)
		PM_{10}
Medupi	Coal Yard	86.6
	Excess Coal Yard	30.4
	Ash Dump	1 951
Matimba	Coal Yard	22.7
	Ash Dump	6 066

The CALPUFF dispersion model is used to predict ambient concentrations of SO_2, NO_2, PM_{10} and $PM_{2.5}$ resulting from Medupi and Matimba operating together. The dispersion modelling simulates the stack emissions (PM, SO_2, NO_X) and fugitive emissions (PM) from the coal stock yard and the ash dump for the five scenarios. While the focus of the assessment is on the stack emissions, the inclusion of fugitive PM emissions provides a holistic understanding of the contribution of the two power stations to ambient PM_{10} and $PM_{2.5}$

concentrations. Modelling is done according to the modelling regulations and 3-years of hourly surface and upper air meteorological data is used.

The PM emissions from the stacks and fugitive sources are not speciated into PM_{10} and $PM_{2.5}$. Rather all PM emitted is assumed to be firstly PM_{10} in the modelling and assesses against the National Ambient Air Quality Standards (NAAQS) for PM_{10}. Secondly, all PM emitted is assumed to be $PM_{2.5}$ in the modelling and assesses against the NAAQS for $PM_{2.5}$. The predicted PM_{10} and $PM_{2.5}$ concentrations also include the formation of secondary particulates from SO_2 and NO_2 stack emissions. Together, this represents a worse-case environmental scenario for PM_{10} and $PM_{2.5}$. The stack emissions generally have an effect some distance from the source as they are released well above ground level and are buoyant. Fugitive emissions are released close to ground level and without any buoyancy they have an effect close to the source.

In the body of the report the predicted ambient SO_2, NO_2, PM_{10} and $PM_{2.5}$ concentrations are presented as isopleth maps over the modelling domain. The predicted concentrations at 51 identified receptor points in the study area are included Appendix 2 of this report. In this executive summary the maximum predicted annual SO_2, NO_2, PM_{10} and $PM_{2.5}$ concentrations and the 99th percentile concentration of the 24-hour and 1-hour predicted concentrations in the modelling domain are discussed below.

For SO_2, the predicted concentrations are attributed only to the stack emissions. The maximum predicted annual average concentrations for the 5 scenarios are low relative to the limit values of the respective NAAQS. The predicted the 99th percentile of the 24-hour SO_2 concentrations and the predicted 1-hour concentrations exceeded the limit value of the NAAQS in Scenario A (2025) Scenario B, (2031) and in Scenario C (2036). The predicted maximum SO_2 concentration occur within 15 km to the southwest of the two power stations. Noteworthy is the compliance with actual emissions in Scenario 1 (Current) and Scenario D (MES) which assumes that the MES are attained.

For NO_2, the predicted concentrations are attributed only to the stack emissions. The predicted maximum annual concentration and predicted 99th percentile of the 24-hour concentrations are low relative to the limit values of the respective NAAQS for the 5 scenarios. The predicted maximum NO_2 concentration also occur within 15 km to the southwest of the two power stations.

For PM_{10} and $PM_{2.5}$, the maximum predicted annual average concentrations exceed the limit values of the respective NAAQS in all scenarios. Similarly, the predicted 99th percentile of the 24-hour PM_{10} and $PM_{2.5}$ concentrations exceeds the limit value of the NAAQS. The predicted maximum PM_{10} and $PM_{2.5}$ concentrations occur within 10 km southwest of the two power stations.

The predicted ambient concentrations of SO_2 and NO_2 resulting from power station stack emissions are lower than the concentrations measured at the respective AQMS in the Waterberg. This is to be expected since AQMS are exposed to all sources of SO_2 and NO_2 while the model includes only the power station stack emissions. At the monitoring stations, the predicted and monitored SO_2 and NO_2 concentrations comply with the respective NAAQS.

For PM_{10} and $PM_{2.5}$ the predicted ambient concentrations result from the power station stack emissions and the fugitive low-level sources, i.e. the coal stock yard and the ash dumps at each power station. At the Marapong and Lephalale AQMS the modelled concentrations are considerably lower than the monitored concentrations. This is to be expected since AQMS are exposed to all sources of PM_{10} and $PM_{2.5}$. The difference between the predicted concentrations and the measured concentrations provides an indication of the contribution of other emission sources at the respective AQMS.

At the Medupi AQMS however the modelled PM_{10} and $PM_{2.5}$ concentrations are generally higher than the monitored concentrations, contrary to expectation as the AQMS is exposed to more sources. Noteworthy is the poor data recovery at the Medupi AQMS, especially in 2022 and 2023. In these years for PM_{10} it was only 56% and 62%, and for $PM_{2.5}$ it was 35% and 28%. Data is deemed acceptable if recovery is 90% or more. In this data of 50% or more was used, so the results need to be viewed with caution, otherwise that data was not used in averaging.

The predicted SO_2 and NO_2 concentrations are below the respective limit values of the NAAQS for all averaging period in all 5 emission scenarios at all sensitive receptors. Similarly, the predicted annual average PM_{10} and $PM_{2.5}$ concentrations are below the limit values of the NAAQS at all sensitive receptor points in all five scenarios.

Exceedance of the 24-hour limit value of the NAAQS for PM_{10} and $PM_{2.5}$ are predicted in all five scenarios at several of sensitive receptor points. For Scenario A (2025) the exceedances of the limit value for PM_{10} occur at most sensitive receptor points. For $PM_{2.5}$, the limit value of the NAAQS changes from 40 $\mu g/m^3$ to 25 $\mu g/m^3$ in 2030, resulting in an increase in the number of receptor points where the limit value is exceeded. The reader is reminded that PM is assumed to be $PM_{2.5}$ is compared to the stringent NAAQS for $PM_{2.5}$.

Noteworthy findings from the modelling results may be summarised as:

i) Ambient SO_2 and NO_2 concentrations are attributed to the stack emissions only, while ambient PM_{10} and $PM_{2.5}$ concentrations are attributed to the stack emissions and the low-level fugitive sources. The stack emissions generally have an effect some distance from the source, while low-level emissions have an effect close to the source.

ii) The predicted ambient concentrations are lower than the monitored concentrations for all pollutants at all AQMS, except at the Medupi AQMS where predicted and measured are higher in general. It is expected that measured concentrations will be higher than modelled since AQMS are exposed to all sources of the pollutants while the modelled concentrations result from power station emission only.

    The difference between the modelled concentrations and the measured concentrations are indicative of the contribution of other sources at the respective AQMS.

    The PM_{10} and $PM_{2.5}$ data recovery rate at the Medupi AQMS in 2022 and 2023 was poor so it is likely that the reported averages are unreliable.

iii) For Scenario 1 (Current):

    a. Predicted SO_2 and NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.

b. Predicted PM_{10} and $PM_{2.5}$ concentrations comply with the NAAQS, except close to the power stations where the limit value of the 24-hour NAAQS are exceeded as a result of the fugitive sources. Exceedances of the limit value for PM_{10} are predicted once at 2 sensitive receptor points respectively and thereof compliant with the NAAQS. For $PM_{2.5}$ exceedances of the limit value were predicted at 17 sensitive receptor points, at 10 of which the limit value was exceeded more than 12 times, hence non-compliant with the NAAQS.

iv) For Scenario A (2025):

a. Predicted annual and 1-hour SO_2 concentrations comply with the NAAQS throughout the modelling domain, but exceedances of the 24-hour limit value are predicted at 10 sensitive receptor points.

b. Predicted NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.

c. Predicted PM_{10} and $PM_{2.5}$ concentrations comply with the NAAQS, except close to the power stations where the limit value of the 24-hour NAAQS are exceeded as a result of the fugitive sources. Exceedances of the limit value for PM_{10} are predicted once at 5 sensitive receptor points respectively and thereof compliant with the NAAQS. For $PM_{2.5}$ exceedances of the limit value were predicted at 17 sensitive receptor points, at 10 of which the limit value was exceeded more than 12 times, hence non-compliant with the NAAQS.

v) For Scenario B (2031):

a. Predicted annual and 1-hour SO_2 concentrations comply with the NAAQS throughout the modelling domain, but exceedances of the 24-hour limit value are predicted at 10 sensitive receptor points.

b. Predicted NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.

c. Predicted PM_{10} and $PM_{2.5}$ concentrations comply with the NAAQS, except close to the power stations where the limit value of the 24-hour NAAQS are exceeded as a result of the fugitive sources. The number of predicted exceedances for PM_{10} decrease to 2, while the number of exceedances for $PM_{2.5}$ increase to 27 sensitive receptor points. The increase corresponds to the more stringent $PM_{2.5}$ limit value of 25 μg/m^3 which is implemented in 2030. At 14 of these points limit value was exceeded more than 12 times, hence non-compliant with the NAAQS.

vi) For Scenario C: (2036):

a. Predicted annual and 1-hour SO_2 concentrations comply with the NAAQS throughout the modelling domain, but exceedances of the 24-hour limit value are predicted at 9 sensitive receptor points.

b. Predicted NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.

c. Predicted PM_{10} and $PM_{2.5}$ concentrations comply with the NAAQS, except close to the power stations where the 24-hour limit value of the NAAQS for $PM_{2.5}$ are exceeded as a result of the fugitive sources. Exceedances of the limit value for $PM_{2.5}$ are predicted at 25 sensitive receptor points. At 14 of these points limit value was exceeded more than 12 times, hence non-compliant with the NAAQS.

vii) For Scenario D:

a. Predicted SO_2 and NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.

b. Predicted PM_{10} and $PM_{2.5}$ concentrations comply with the NAAQS, except close to the power stations where the 24-hour limit value of the NAAQS for $PM_{2.5}$ are exceeded as a result of the fugitive sources. Exceedances of the limit value for $PM_{2.5}$ are predicted at 25 sensitive receptor points. At 14 of these points limit value was exceeded more than 12 times, hence non-compliant with the NAAQS.

Given the conservative approach to the fugitive emission source simulations, and that this has provided an absolute worst-case emission scenario, and based on recommendations received from uMoya-Nilu, Eskom will be undertaking an additional modelling scenario, assessing only PM, SO_2, and NO_X stack emissions. NO_X and SO_2 emissions will be included in this scenario to ensure secondary particulate formation is accounted for. This will provide improved insight to impacts directly related to stack emissions, which are the focus of this exemption application.

ACKNOWLEDGEMENT

Jared Lodder, Yakeen Kowlas and Lehlohonolo Sello from WSP Group Africa (Pty) Ltd are acknowledged for processing the ambient air quality and wind data for the baseline assessment.

GLOSSARY OF TERMS AND ACRONYMS

AEL	Atmospheric Emission Licence
AIR	Atmospheric Impact Report
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
EIA	Environmental Impact Assessment
FGD	Flue-gas desulfurisation
g/s	Grams per second
kPa	Kilo Pascal
MES	Minimum Emission Standards
mg/Nm^3	Milligrams per normal cubic meter refers to emission concentration, i.e. mass per volume at normal temperature and pressure, defined as air at 20^{o}C (293.15 K) and 1 atm (101.325 kPa)
NAAQS	National Ambient Air Quality Standards
NAQO	National Air Quality Officer
NECA	National Environmental Consultative and Advisory
NEM-AQA	National Environment Management: Air Quality Act, 2004 (Act No. 39 of 2004)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
USEPA	United States Environmental Protection Agency
µm	Micro meter (1 µm = 10^{-6} m)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

Eskom operates a fleet of 14 coal-fired power stations in South Africa, collectively generating more than 39 000 MW of electricity. The combustion of coal to generate steam for the generation of electricity is a Listed Activity in terms of the National Environmental Management: Air Quality Act (Act No. 39 of 2004). Eskom holds Atmospheric Emission Licenses (AEL) for the respective power stations and is obligated to operate these power stations according to conditions specified in the respective AELs. Minimum Emission Standards (MES) for Listed Activities were published in 2010 (DEA, 2010) including compliance timeframes for existing and new plants. Existing activities had to comply with the MES for new plant by 30 April 2020.

Between 2018 and 2020, Eskom submitted applications to the Department of Forestry, Fisheries and the Environment (DFFE) based on an internally approved Emission Reduction Plan, which defined which power stations would have emission reduction technology installed and when. The National Air Quality Officer (NAQO) made decisions on these applications in 2019, which were not in favour of Eskom. Eskom appealed the NAQO's decision, and the Minister established the National Environmental Consultative and Advisory (NECA) Forum to advise her on the issue. The Minister ruled on the Eskom appeals on 22 May 2024 and granted the suspension of the Minimum Emission Standards (MES) at five (5) power stations on the Highveld up to 31 March 2030, namely Arnot, Camden, Grootvlei, Hendrina and Kriel. The Minister further directed Eskom to submit an application in terms of Section 59 of the National Environmental Management: Air Quality Act for the exemption of the MES for eight (8) power stations that will continue to operate post 2030. These are Duvha, Kendal, Lethabo, Majuba, Matla and Tutuka on the Highveld and Medupi and Matimba in the Waterberg.

In terms the Minister's ruling Eskom Holdings SOC Ltd appointed WSP Group Africa (Pty) Ltd to prepare the necessary applications. WSP Group Africa (Pty) Ltd sub-contracted uMoya-NILU Consulting (Pty) Ltd to prepare the associated Atmospheric Impact Reports (AIRs) (DEA, 2013a) to support the applications. While AIRs have been prepared to support the respective suspension and exemption applications for the individual power stations, this AIR collectively assesses the two coal-fired power stations in the in the Waterberg-Bojanala Priority Area, i.e. Medupi and Matimba. The intention of this cumulative AIR is to provide further supporting information for the exemption applications for the two individual power stations. Both Medupi and Matimba with valid AEL's (Table 1-1) with information regarding their respective AELs and proposed shutdown dates.

Table 1-1: AEL information

Power Station	Installed capacity	AEL	Dates	Shutdown date
Medupi	4 760 MW	H16/1/13-AEL/M1/R1	Expire: 01 Dec 2025	2071
Matimba	3 990MW	H16/1/13-WDM05	Expire: 27 Sept 2027	2043

2. ENTERPRISE DETAILS

2.1 Enterprise Details

Eskom enterprise details are summarised in Table 2-1.

Table 2-1: Enterprise information

Entity Name:	Eskom Holdings SOC Limited
Type of Enterprise, e.g. Company/Close Corporation/Trust, etc.:	State Owned Company
Company Registration Number:	2002/015527/30
Registered Address:	Megawatt Park, Maxwell Drive, Sunninghill, Sandton
Postal Address:	P. O. Box 1091, Johannesburg, 2000
Telephone Number (General):	+27 11 800 3861
Fax Number (General):	
Company Website:	www.eskom.co.za
Industry Type/Nature of Trade:	Electricity Generation
Land Use Zoning as per Town Planning Scheme:	Agricultural/Heavy industry
Land Use Rights if outside Town Planning Scheme:	Not applicable

2.2 Location and extent of the power stations

Medupi and Matimba are located in the Waterberg-Bojanala Priority Area, in the Waterberg District Municipality and are about 6 km apart, west-southwest and west and of the town of Lephalale respectively. Medupi is on the Farm Naauwontkomen about 16 km from Lephalale. Matimba is on the Farm Grootestryd about 13 km from Lephalale. Their relative location is illustrated in Figure 2-1.

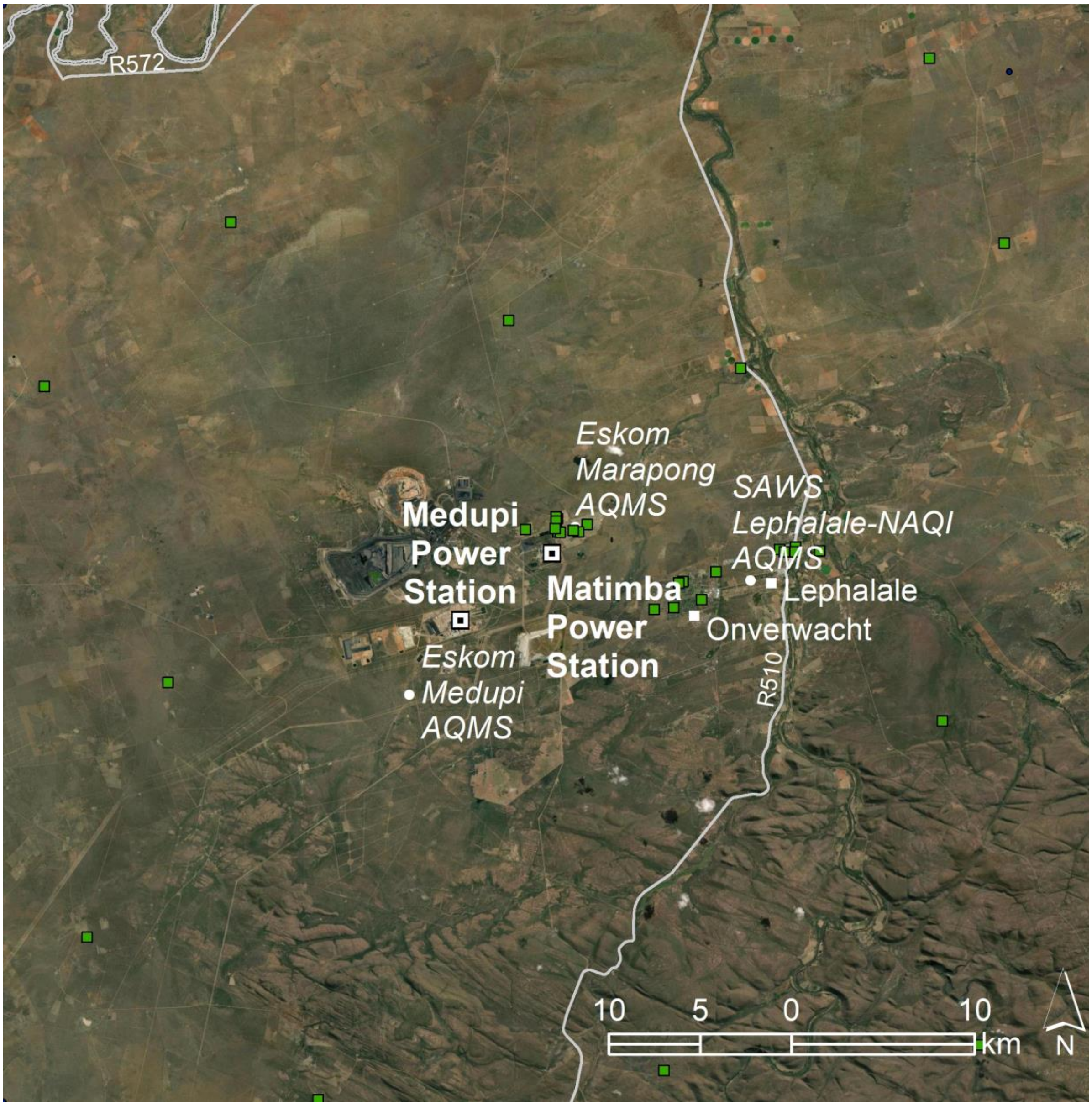


Figure 2-1: Relative location of the Medupi and Matimba coal-fired Power Stations in the modelling domain shown by white squares, with sensitive receptors shown by green squares

2.3 Description of surrounding land use

The Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa (DEA, 2014a) recommends the Land Use Procedure as sufficient for determining the urban/rural status of a modelling domain. The classification of the study area as urban or rural is based on the Auer method (Auer, 1978), as specified in the USEPA guideline on air dispersion models (USEPA, 2005). From the Auer's method, areas typically defined as rural include residences with grass lawns and trees, large estates, metropolitan parks and golf courses, agricultural areas, undeveloped land and water surfaces. An area is defined as urban if it has less than 35% vegetation coverage or it falls into one of the use types in Table 2-2.

Table 2-2: Land types, use and structures and vegetation cover

Type	Use and Structures	Vegetation
I1	Heavy industrial	Less than 5 %
I2	Light/moderate industrial	Less than 5 %
C1	Commercial	Less than 15 %
R2	Dense single / multi-family	Less than 30 %
R3	Multi-family, two-story	Less than 35 %

Generally the individual power stations are located in rural areas where the surrounding land use is primarily agriculture and includes coal mining. The surrounding land-use includes amongst others, urban areas with residential, commercial and recreational areas, industrial areas, agriculture, mining, forestry, undeveloped areas and conservation areas.

The US Environmental Protection Agency (USEPA, 2024) recognise Sensitive Receptors as areas which include, but are not limited to, hospitals, schools, daycare facilities, elderly housing and convalescent facilities or specialised healthcare facilities. These are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides and other pollutants. The California Air Resources Board (CARB, 2024) identify Sensitive Receptors as children, elderly, asthmatics and others who are at a heightened risk of negative health outcomes due to exposure to air pollution.

The locations where these sensitive receptors congregate are considered sensitive receptor locations and therefore include hospitals, schools and day care centres, and other such locations. Three ambient air quality monitoring stations (AQMS) and 51 sensitive receptor points were identified within 30 km of Medupi and Matimba (Table 2-3).

Table 2-3: Sensitive receptors in the Waterberg

Receptor	UTMx	UTMy
Eskom Marapong AQMS - Monitoring Station	564.044	7383.715
Eskom Medupi AQMS - Monitoring Station	554.985	7374.552
SAWS Lephalale-NAQI AQMS - Monitoring Station	573.617	7380.786
Phegelelo Senior Secondary	563.060	7384.177
Contractors Village	561.293	7383.583
Ditheku Primary School	562.976	7384.275
Ditheko Primary School	564.691	7383.858
Marapong Training Centre	563.087	7383.465
Marapong Clinic	564.193	7383.463
Tielelo Secondary School	562.969	7384.035
Grootegeluk Medical Centre - Community Center	563.210	7383.420
Lephalale College	569.911	7380.730
Nelsonskop Primary School	563.913	7383.542
Hansie en Grietjie Pre-Primary School	569.673	7380.666
Sedibeng Special School for the Deaf and Disabilities	570.930	7379.738
Kings College	568.333	7379.207
Bosveld Primary School	569.400	7379.308
Lephalale Medical Hospital	562.938	7383.633
Ellisras Hospital	571.713	7381.272
Laerskool Ellisras Primary School	576.067	7382.619

Receptor	UTMx	UTMy
Hoerskool Ellisras Secondary School	575.189	7382.497
Marlothii Learning Academy	575.455	7382.359
Hardekool Akademie vir C.V.O	577.372	7382.411
Lephalale Clinic	576.044	7382.374
Ons Hoop	573.075	7392.408
Woudend	573.771	7422.152
Ramabara's	584.098	7373.114
Ga-Shongoane	608.321	7391.282
Bulge River	570.571	7332.998
Kaingo Mountain Lodge	582.064	7338.855
Community	557.518	7338.134
Kiesel	517.256	7348.639
Kremetartpan	537.357	7361.299
Mbala Private Camp	549.972	7352.418
Steenbokpan	541.767	7375.229
Receptor	535.001	7391.410
Sandbult	528.616	7377.834
Hardekraaltjie	526.176	7399.999
Receptor	560.399	7395.005
Receptor	545.208	7400.388
Receptor	559.690	7413.300
Receptor	583.382	7409.353
Receptor	587.468	7399.237
Ditaung	605.602	7401.960
Letlora	592.779	7416.528
Receptor	526.899	7365.394
Glenover	516.500	7360.781
Oxford Safaris	510.472	7376.086
Receptor	518.190	7387.978
Tholo Bush Estate	586.073	7355.406
Receptor	568.868	7354.021
Receptor	599.331	7360.083
Cheetah Safaris	537.952	7340.196
Rhinoland Safaris	607.228	7376.566

2.4 Atmospheric Emission License (AEL) and Other Authorisations

Medupi and Matimba have valid Atmospheric Emissions Licence (AEL) issued by the Waterberg District Municipality. The AEL numbers, issue dates and expiry dates are listed in Table 2-4. Both AELs concern three Listed Activities.

Table 2-4: Current authorisations related to air quality

<table>
<tr><th rowspan="2">Power Station</th><th rowspan="2">Atmospheric Emission License</th><th rowspan="2">Expiry Date</th><th colspan="2">Listed Activity</th><th rowspan="2">Listed Activity Process Description</th></tr>
<tr><th>Category</th><th>Sub-category</th></tr>
<tr><td>Medupi</td><td>H16/1/13-AEL/M1/R1</td><td>01 Dec 2025</td><td>1</td><td>1.1</td><td>Solid Fuel Combustion Installations</td></tr>
<tr><td rowspan="2">Matimba</td><td rowspan="2">H16/1/13-WDM05</td><td rowspan="2">27 Sep 2027</td><td>2</td><td>2.4</td><td>Storage and Handling of Petroleum Products</td></tr>
<tr><td>5</td><td>5.1</td><td>Storage and Handling of Ore and Coal</td></tr>
</table>

2.5 Modelling contractor

The dispersion modelling for this AIR is conducted by:

Company: uMoya-NILU Consulting (Pty) Ltd
Modellers: Dr Mark Zunckel, Atham Raghunandan, Nopasika Xulu
Contact details: Tel: 031 262 3265
Cell: 083 690 2728
email: mark@umoya-nilu.co.za
atham@umoya-nilu.co.za
nopasika@umoya-nilu.co.za

See Annexure 2 for abridged CV's

2.6 Terms of Reference

The terms of reference for this AIR are to assesses the cumulative effect of the two coal-fired power in the Waterberg (Medupi and Matimba) to provide support for the applications for the individual power stations. In so do doing, 5 emission scenarios are assessed for the two power stations. These scenarios are:

Scenario 1 (Current): The baseline scenario using actual monthly stack emissions for 2021-2023 and fugitive emissions from the coal stockyards and the ash dumps (No FGD installed).
Scenario A (2025): Eskom's planned 2025 stack emissions, representing anticipated station performance between 2025 – 2030, including fugitive emissions from the coal stockyards and the ash dumps (No FGD installed).
Scenario B (2031): Eskom's planned 2031 stack emissions, representing anticipated station performance between 2031 – 2035, including fugitive emissions from the coal stockyards and the ash dumps (No FGD installed but load reduction).
Scenario C (2036): Eskom's planned 2036 stack emissions, representing anticipated station performance from 2036 onwards, including fugitive emissions from the coal stockyards and the ash dumps (FGD installed at Medupi).
Scenario D (MES): Full compliance with the MES, including fugitive emissions from the coal stockyards and the ash dumps (FGD installed at Medupi and Matimba).

2.7 Assumptions

The following assumptions are relevant to this AIR:

a) No ambient monitoring is done in this assessment, rather available ambient air quality data is used.
b) The assessment of potential human health impacts is based on predicted (modelled) ambient concentrations of SO_2, NO_2, PM_{10} and $PM_{2.5}$ and the health-based National Ambient Air Quality Standards (NAAQS).
c) Emissions data used in this AIR have been provided by Eskom and are deemed to be accurate and representative of operating conditions in the respective scenarios.
d) The PM emissions are not speciated into PM_{10} and $PM_{2.5}$, rather all PM emitted is assumed to be PM_{10}, and all PM emitted is assumed to be $PM_{2.5}$. This represents a worse-case emission scenario for PM_{10} and $PM_{2.5}$.
e) Assumptions regarding emissions from the coal yards and ash dumps are included in Section 4.4

3. NATURE OF THE PROCESS

3.1 Listed Activity or Activities

As a measure to reduce emissions from industrial sources and to improve ambient air quality, Listed Activities and associated Minimum Emission Standards (MES) were initially published in 2010 in Government Notice 248 (DEA, 2010) with the most recent revision applicable in 2020 (Government Notice 421, DEA, 2020).

The Listed Activities relevant to all the coal-fired power stations are listed in Table 3-1.

Table 3-1: Details of the Listed Activity for coal-fired power stations according to GN 248 (DEA, 2010) and its revisions (DEA, 2013b, 2019 2020)

Category of Listed Activities	Sub-category of Listed Activity	Description of Listed Activity	Description and Application of the Listed Activity
1: Combustion Installations	1.1: Solid Fuel Combustion Installations	Solid fuels combustion installations used primarily for steam raising or electricity generation.	All installations with design capacity equal to or greater than 50 MW heat input per unit, based on the lower calorific value of the fuel used.
2: Petroleum Industry, the production of gaseous and liquid fuels as well as petrochemicals from crude oil, coal, gas or biomass	2.4: Storage and handling of petroleum products	Petroleum products storage tanks and product transfer facilities.	All permanent immobile liquid storage facilities at a single site with a combined storage capacity of greater than 1 000 cubic metres.
5: Mineral Processing, Storage and Handling	5.1: Storage and Handling of Ore and Coal	Storage and handling of ore and coal not situated on the premises of a mine or works as defined in the Mines Health and Safety Act 29/1996.	Locations designed to hold more than 100 000 tons.

3.2 Process Description

Eskom Holdings SOC Limited is a South African utility that generates, transmits and distributes electricity. The bulk of that electricity is generated by large coal-fired power stations that are situated close to the sources of coal. Medupi and Matimba are such power stations with a base load generation capacity of 4 584 MW and 3 990 MW, respectively.

The generic process is that coal is received at the power station's coal stockyard from nearby mines It is milled to pulverised fuel and fed to the boilers. Combustion of the coal in the boilers heats water to superheated steam, which drives the turbines. In turn, the turbines drive the generators which generate electricity. Medupi and Matimba each have six generation units.

Typical process units at a coal-fired power station are listed in Table 3-2.

Table 3-2: Unit processes at a coal-fired power station

Unit Process	Function of Unit Process	Batch or Continuous Process
Boiler Unit 1	Generation of electricity from coal	Continuous
Boiler Unit 2	Generation of electricity from coal	Continuous
Boiler Unit 3	Generation of electricity from coal	Continuous
Boiler Unit 4	Generation of electricity from coal	Continuous
Boiler Unit 5	Generation of electricity from coal	Continuous
Boiler Unit 6	Generation of electricity from coal	Continuous
Coal stockyard	Storage of coal	Continuous
Fuel oil storage tanks	Storage of fuel oil	Continuous
Ashing facility	Storage of ash	Continuous

3.3 Air pollutants resulting from the process

3.3.1 Air pollutants

Atmospheric emissions depend on the fuel composition and rate of consumption, boiler design and operation, and the efficacy of pollution control devices. Emissions from the boilers are emitted via two stacks and include sulphur dioxide (SO_2), oxides of nitrogen ($NO + NO_2 = NO_X$) and Particulate Matter (PM).

SO_2 is produced from the combustion of sulphur bound in coal. The stoichiometric ratio of SO_2 to sulphur dictates that 2 kg of SO_2 are produced from every kilogram of sulphur combusted. The coal used by the Matimba Power Station has a sulphur content (wt %) of less than 1 %. NO_X is produced from thermal fixation of atmospheric nitrogen in the combustion flame and from oxidation of nitrogen bound in the coal. The quantity of NO_X produced is directly proportional to the temperature of the flame.

The non-combustible portion of the fuel remains as solid waste. The coarser, heavier waste is called 'bottom ash' and is extracted from the boiler, and the lighter, finer portion is 'fly ash' and is usually suspended in the flue gas, and in the absence of any emission control would be emitted as PM through the stack. The coal used at Matimba has an ash content of between 30 and 40%.

3.3.2 National Ambient Air Quality Standards

National Ambient Air Quality Standards (NAAQS) (DEA, 2009, 2012) apply to the pollutants emitted by Medupi and Matimba. The NAAQS consists of a 'limit' value and a permitted frequency of exceedance. The limit value is the fixed concentration level aimed at reducing the harmful effects of a pollutant. The permitted frequency of exceedance represents the acceptable number of exceedances of the limit value expressed as the 99th percentile. Compliance with the ambient standard implies that the frequency of exceedance of the limit value does not exceed the permitted tolerance. The NAAQS for SO_2, NO_2, PM_{10} and $PM_{2.5}$ are presented in Table 3-3.

Table 3-3: NAAQS for pollutants relevant to Medupi and Matimba

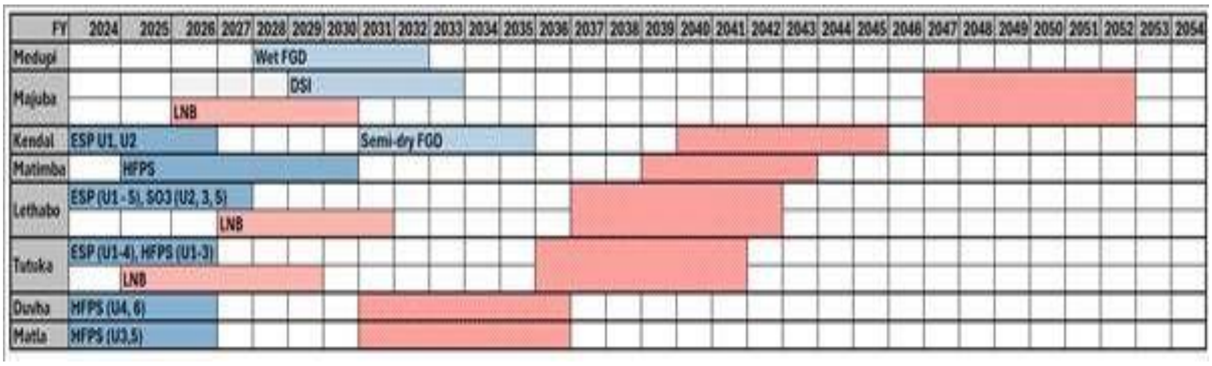
Pollutant	Averaging period	Limit value (µg/m^3)	Tolerance
SO_2	1 hour	350	88
	24 hour	125	4
	1 year	50	0
NO_2	1 hour	200	88
	1 year	40	0
PM_{10}	24 hour	75	4
	1 year	40	0
$PM_{2.5}$	24 hour	40 (25[a])	4
	1 year	20 (15 [a])	0

[(a)]: Applicable from 01 January 2030

4. ATMOSPHERIC EMISSIONS

4.1 Point Source Emission Rates (Emission scenarios)

Eskom intends to systematically reduce emissions resulting from the fleet of coal-burning power stations. This includes the systematic introduction of emission reduction technologies, and the shutdown of power stations by 2045. The proposed schedule to 2050 for the installation of NO_X, PM and SO_2 emission reduction technologies and the shutdown schedule for power stations is shown in Figure 4-1. The key planned intervention for Medupi is the installation of wet-FGD.



FGD: flue gas desulphurisation

DSI: Dry Sorbent Injection

LNB: low NO_X Burner

HFPS: high frequency power supply

ESP: Electrostatic precipitator

DHP: Dust Handling Plant

Station Shutdown

Figure 4-1: Emission reduction installation schedule and the planned shutdown of power stations

Shutdown of Matimba is planned from 2039 to 2043, while Medupi will remain operational until at least 2071. The total NO_X, SO_2 and PM emission resulting from operational coal-fired power stations at selected milestones from current emissions to 2050 are compared in Table 4-1.

Table 4-1: Total NO_X, SO_2 and PM emissions in tonnes from all operational fleet of coal-fired power stations at selected milestones

Years	NO_X	SO_2	PM
2025	108 743	570 139	6 924
2031	77 663	355 778	4 916
2036	89 267	289 280	5 650
2045	61 177	80 949	3 671
2050	61 889	83 753	3 714

Three emission reduction trajectories from Eskom's financial ERP models are described here and illustrated in Figure 4-2 to Figure 4-4 for NOx, SO_2 and PM:

ERP 2024 A: Eskom continue as planned, which includes all PM and NOx abatement projects and FGD at Kusile – This is why ERP 2024 A = B = C for NOx & PM (only security of supply differs) – by the time Grootvlei, Kriel, Arnot, Hendrina, Camden, Duvha and Matla are shutdown, Eskom will be fully compliant with NO_X and PM MES through the fleet.

ERP 2024 B: 2024 A as above, but also FGD at Medupi, DSI at Majuba, and FGD at Kendal, hence the improvement from 2036 in SO_2 for ERP 2024 B. This is Eskom's middle-ground scenario; doing more than 2024 A, but not doing 2024 C.

ERP 2024 C: All of 2024 A and 2024 B above, but also FGD at Lethabo and Tutuka. Although this shows big improvement in SO_2 vs ERP 2024 B, this is a combination of Lethabo & Tutuka FGD, and actually probably more from shutdown of Duvha & Matla – station shutdowns have bigger impact on SO_2 reduction than FGD. When you look at the modelling results, ERP 2024 B already well within NAAQS (this is our model Scenario C), so enforcing ERP 2024 C not really justifiable, especially considering all the other negative impacts of FGD (age of Tutuka & Lethabo, costs, waste, water etc.).

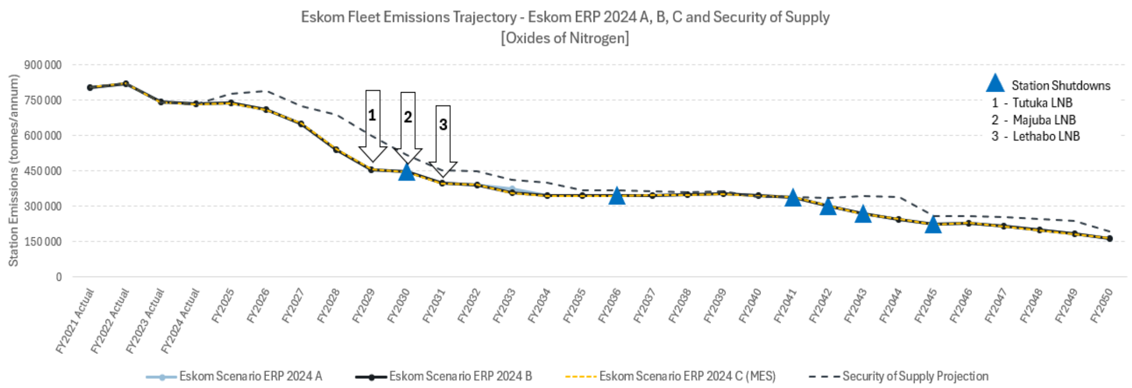


Figure 4-2: Eskom's fleet emission trajectory for NO_X

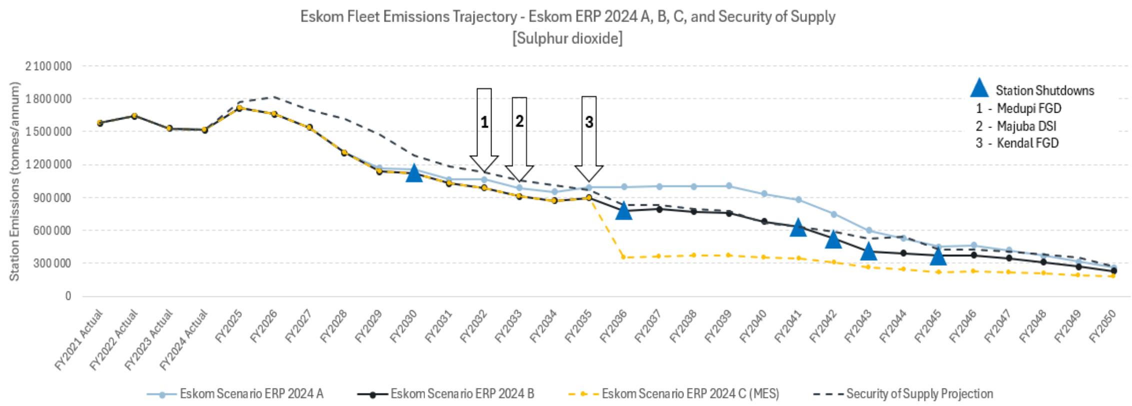


Figure 4-3: Eskom's fleet emission trajectory for SO_2

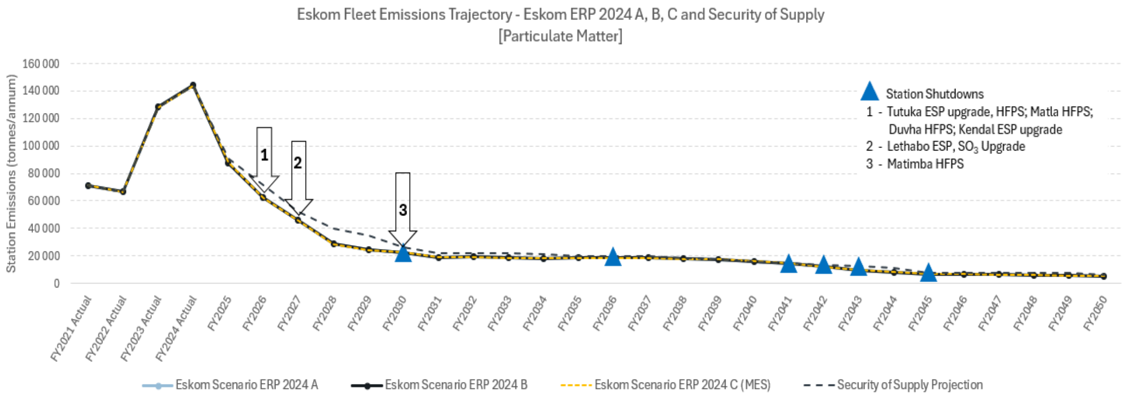


Figure 4-4: Eskom's fleet emission trajectory for PM

4.2 Point Source Parameters

Stack parameters for the individual power stations are not provided here, but are included in the respective AIRs (uMoya-NILU, 2024a, uMoya-NILU, 2024b).

The estimated emission rates and equivalent emission concentrations that are used in the dispersion modelling for the two stacks are shown in Table 4-2. The maximum anticipated emissions during each period are used for simulation in the model. The boiler units are assumed to operate continuously, i.e. 24 hours a day. Since each future scenario is a snapshot of period of operation (e.g. Scenario A = 2025 to 2030), the maximum anticipated emissions during that period, in a single year was selected for simulation in the model.

Table 4-2: Annual emissions from the Matimba and Medupi Power Stations and the corresponding emission concentrations

Scenario	Stack	Emission rate (tonnes/annum)			Emission concentration @ 10% O_2 and average load (mg/Nm^3)		
		NO_X	SO_2	PM	NO_x	SO_2	PM
		Medupi Power Station					
1[a]	Stack 1	25 577	123 502	1 314	257	1 343	13
	Stack 2	25 577	123 502	1 314	257	1 343	13
A	Stack 1	34 716	134 340	1 663	522	2 020	25
	Stack 2	34 716	134 340	1 663	522	2 020	25
B	Stack 1	20 770	80 374	1 273	522	2 020	32
	Stack 2	20 770	80 374	1 273	522	2 020	32
C	Stack 1	23 447	31 263	1 438	375	500	23
	Stack 2	23 447	31 263	1 438	375	500	23
D	Stack 1	23 447	31 263	1 438	375	500	23
	Stack 2	23 447	31 263	1 438	375	500	23
		Matimba Power Station					
1[a]	Stack 1	28 921	150 457	2 648	291	1 514	27
	Stack 2	28 921	150 457	2 648	291	1 514	27
A	Stack 1	28 346	150 830	1 820	545	2 900	35
	Stack 2	28 346	150 830	1 820	545	2 900	35
B	Stack 1	18 118	103 026	1 243	510	2 900	35
	Stack 2	18 118	103 026	1 243	510	2 900	35
C	Stack 1	20 872	112 752	1 432	510	2 755	35
	Stack 2	20 872	112 752	1 432	510	2 755	35
D	Stack 1	20 872	33 825	1 432	510	827	35
	Stack 2	20 872	33 825	1 432	510	827	35
MES					**750**	**1000**	**50**

(a): Average from actual monthly emissions

4.3 Point Source Maximum Emission Rates (Start Up, Shut-Down, Upset and Maintenance Conditions)

All power stations are required to conduct continuous emission measurements. Emissions include maximum emissions during start-up, shut-down, maintenance or upset conditions are accounted for in the actual monthly emissions used in Scenario 1 (Current) in this assessment.

4.4 Fugitive Emissions

The methodology to estimate emission rates of particulates from the coal stockyard and ash dumping activities for the power stations is described in this section.

A general equation for emission estimation is: E = A x EF x (1-ER/100)

where: E = emissions;
A = activity rate;
EF = emission factor; and
ER = overall emission reduction efficiency (%)

An emission factor is a representative value that relates the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of the pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kg of particulate emitted per tonne of coal crushed). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality and are generally assumed to be representative of long-term averages for all facilities in the source category (USEPA, 2024b).

The emission factors used for the calculation of particulates in this study are the most recent factors published in the United States Environmental Protection Agency (US EPA), AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13: Section 13.2.4 Aggregate Handling and Storage Piles; Section 13.2.5 Industrial Wind Erosion; (USEPA, 2024b).

Wind entrainment of dust and PM_{10} from the coal stockpile and ash dump is a function of the physical size of the facility and the nature of the exposed surface, i.e. the moisture content, silt content, amount of vegetation cover, size of the particles on the surface and wind speed. Characteristics of the coal stockpile and ash dump at the power station is shown in Table 4-3.

As a mitigation measure, water is sprayed onto the coal stockpiles occasionally to reduce dust generation. In this assessment, the coal stockpile is assessed under worst case conditions (e.g. drought conditions), where it is assumed that no water will be sprayed onto the coal stockpile and 100% of the area is exposed to wind erosion.

The ash dump, by nature, is generally in a damp state depending on rainfall conditions, and if the ash is pumped onto the ash dump in a fluid state or trucked in. Rising green walls will provide vegetation cover on the sides and it is expected that most of the ash dump area exposed at the top will include a wet beach area. These initiatives, together with occasional wetting will reduce the amount of dust entrainment from the ash dump.

In this assessment, the ash dumps are modelled under worst case conditions (e.g. drought conditions), where it is assumed that it is mostly dry and 80% of the surface area is exposed to wind erosion, providing a worst-case (environmentally conservative) scenario. The annual emission rates for the coal stockpiles and ash dumps are shown in Table 4-4.

Table 4-3: Characteristics of the coal stockpile and ash dumps at the Medupi and Matimba Power Stations

	Medupi Power Station			Matimba Power Station	
Parameter	**Coal stockpile**	**Excess Coal stockpile**	**Ash dump**	**Coal stockpile**	**Ash dump**
Quantity of material stored (tonnes/year)	2 814 200	14 420 972	19 290 207	1 999 239	3 966 084
Moisture content (%)	4.5	4.5	27	4.5	27
Silt content (%)	2.2	2.2	80	2.2	80
Exposed surface area (m^2)	379 867	1 042 153	698 447	283 538	2 172 869
Height (m)	20	30.7	46.44	18	64
Dry area (%)	100	100	80	100	80
Dust abatement method	Wetting - Water	Wetting - Water	Spraying of dust using water during operation, top soil and vegetation coverage at incremental heights	Wetting - Water	Spraying of dust using water during operation, top soil and vegetation coverage at incremental heights
Material transfer method and ashing system	Conveyors (front end loaders in case of emergency)	Conveyors (front end loaders in case of emergency)	Dry (delivered by truck)	Conveyors (front end loaders in case of emergency)	Dry (delivered by trucks)

Table 4-4: Fugitive sources of PM_{10} at the Medupi and Matimba Power Stations

Power station	Source name	Emission (tonnes/year)
		PM_{10}
Medupi	Coal Yard	86.6
	Excess Coal Yard	30.4
	Ash Dump	1 951
Matimba	Coal Yard	22.7
	Ash Dump	6 066

5. BASELINE CONDITIONS

The description of the baseline conditions of the area provides an understanding on the receiving atmospheric environment so that changes as a result of the application for exemption of the MES can be assessed. The baseline description therefore includes an overview of the climatology and meteorology of the area, and an assessment of ambient air quality over the last three years measured at monitoring stations in the area. Other sources of air pollution in the area are also discussed.

5.1 Climate and meteorology

5.1.1 Temperature and rainfall

The climate of a given location is affected by its latitude, terrain and altitude, as well as nearby water bodies and their currents. Climates are classified according to the average and the typical ranges of different variables, most commonly temperature and precipitation.

The Waterberg experiences a hot semi-arid (BSh) climate according to the Köppen Climate Classification. Summer days are generally hot with maximum temperatures often exceeding 31 °C, and summer nights are mild. Winter days are mild and nights are cold. The average daily temperatures at Lephalale are illustrated in Figure 5-1. The area receives an average of 383 mm of rainfall annually, with nearly 90% of the rainfall occurring in the summer months between October and March (Figure 5-1). Rainfall seldom occurs in winter.

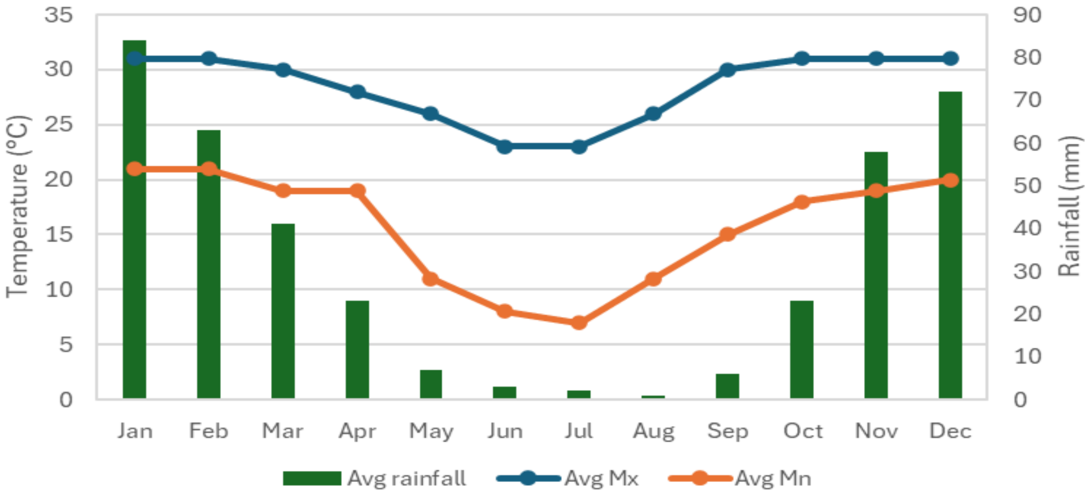


Figure 5-1: Average monthly maximum and minimum temperatures and average monthly rainfall at Lephalale (https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/lephalale_south-africa_7730334)

5.1.2 Wind

Windroses illustrate the frequency of hourly wind from the 16 cardinal wind directions, with wind indicated from the direction it blows, i.e. easterly winds blow from the east. It also illustrates the frequency of average hourly wind speed in six wind speed classes.

The annual windrose at Marapong is presented in Figure 5-2 for the 3-year period, 2021 to 2023. At Medupi the wind is generally light with wind speeds seldom reaching more than 6 m/s (Figure 5-2). The wind is almost exclusively from the sector northeast to easterly, except in the winter when they tend to the east-southeast (Figure 5-3). A high frequency of calm winds occur (nearly 24 %).

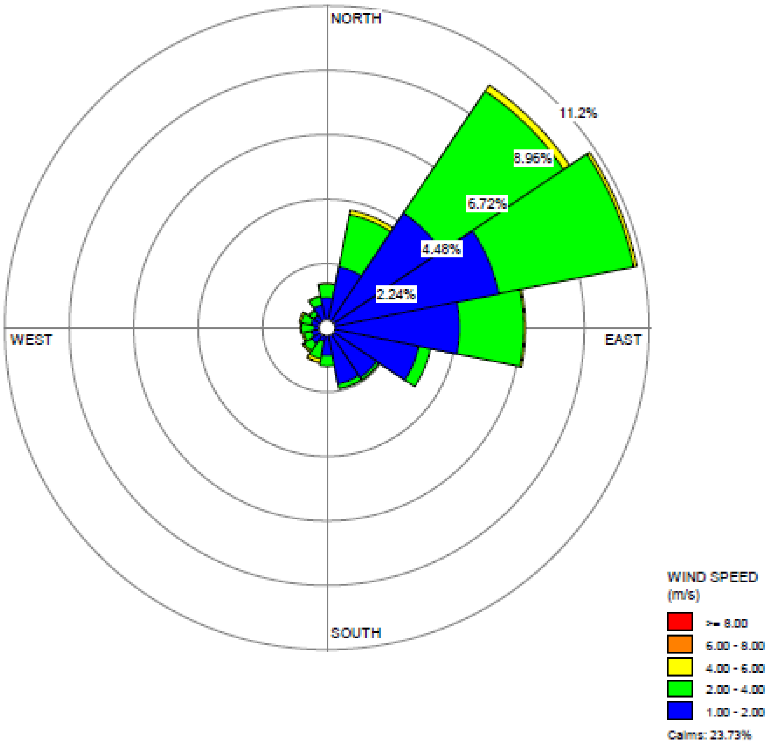


Figure 5-2: Annual windrose at the Marapong AQMS

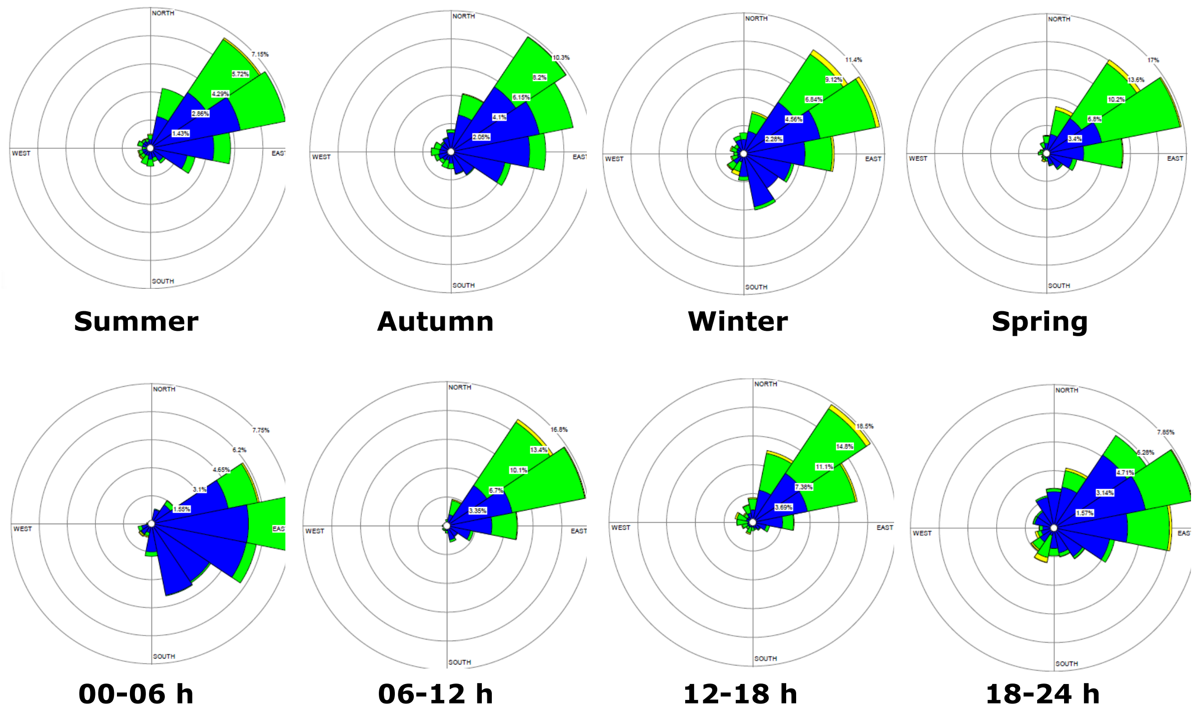


Figure 5-3: Seasonal (top) and diurnal (bottom) windroses at the Marapong AQMS

5.1.3 Air Pollution Dispersion Potential

The air pollution dispersion of an area refers to the ability of atmospheric processes, or meteorological mechanisms, to disperse and remove pollutants from the atmosphere. Dispersion comprises both vertical and horizontal components of motion. The vertical component is defined by the stability of the atmosphere and the depth of the surface mixing layer. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field and atmospheric stability. The wind speed determines the rate of downwind transport and wind direction and the variability in wind direction determines the general path of the pollutant. Atmospheric stability, or instability, determines the ability of the atmosphere to mix and dilute pollutants. Stability is a function of solar radiation (thermal turbulence) and wind speed and surface roughness, which induce mechanical turbulence. The dispersion potential of an area therefore experiences diurnal and seasonal changes.

By day, with strong insolation (in-coming solar radiation) and stronger winds, the dispersion potential is generally efficient through vertical dilution and horizontal dispersion. The dispersion potential is generally better on summer days than winter days. At night, as the surface temperature inversion develops, the lowest layer of the atmosphere becomes more stable, reaching a maximum at sunrise. As a result, the dispersion potential typically becomes less efficient during the night and the poorest conditions generally occur at sunrise. Thermal turbulence disappears when the sun sets, and mechanical turbulence decreases as the wind speeds drops at night. Pollutants tend to accumulate near the point of release under these conditions, particularly if these are released close to ground level. The dispersion potential is generally poorer on winter nights than summer nights.

In the Matimba study area the dispersion potential is expected to be relatively good during the day in summer and winter as a result of daytime temperatures and a relatively high frequency of moderate winds. Summer rainfall is an important removal mechanism for air pollutants. Night-time surface temperature inversions are prevalent in winter and tend to trap pollutants that are released at or near ground level. Generally, there is better air pollution dispersion in summer when air pollutants disperse easily, compared with winter when pollutants can accumulate in stable night-time conditions. The tall power station stacks together with hot buoyant emissions ensure that pollutants are released above the surface inversion.

5.2 Ambient air quality

Agricultural and mining activities, as well as residential areas, are the key land use activities surrounding Medupi and Matimba. There are three relatively large residential areas, namely Marapong, Onverwacht and Lephalale. Marapong arcs from the north-northeast to the east-northeast and is less than 1 km from Matimba Power Station and 8 km northeast of Medupi. Lephalale is 18 km to the east of Medupi and between them is the Onverwacht residential area, 13 km from Medupi. The Matimba Power Station (industry) is 6 km northeast of Medupi and the Grootegeluk Coal Mine (mining) is 4 km north-northwest of Medupi.

Three ambient air quality monitoring stations (AQMS) are located relatively close to Medupi and Matimba. These are the Eskom Marapong AQMS (Maragpong AQMS) which is 2.2 km northeast of Medupi, Eskom Medupi AQMS (Medupi AQMS) which is 10.6 km southwest of Medupi, and the South African Weather Service (SAWS) Lephalale AQMS (Lephalale AQMS) which is 11.3 km east-southeast of Medupi.

Ambient air quality at the three AQMS will be influenced by local (nearby) sources, but ambient concentrations measured at these AQMS will also be influenced by emissions from the two power stations. Local sources of air pollution near the three AQMS include agricultural activities, domestic fuel and waste burning, vehicle emissions, mining and power generation. The Exxarro Grootegeluk Mine and Afrimat Kuipesbult Quarry are significant mining activities.

Pollutant concentrations measured at the three AQMS for 2021 to 2023 are presented here and are referenced against the respective NAAQS (Table 3-3).

5.2.1 Data recovery

Data recovery for the Marapong AQMS was relatively low for all pollutants for all years and below the minimum requirement of 90% as stipulated by the SANAS TR 07-03 (SANAS, 2012). Data recovery for SO_2 (2021), NO_2 (2021 and 2022), PM_{10} (2021) and $PM_{2.5}$ (2021 and 2022) was between 50% and 89.9%. These data are included in this discussion but must be viewed with caution.

Data recovery for the Medupi AQMS was above 90% for SO_2 (2021), NO_2 (2022), PM_{10} (2021) and $PM_{2.5}$ (2021), meeting the minimum requirement of 90% (SANAS, 2012). Data recovery for SO_2 (2022 and 2023), NO_2 (2021 and 2023) and PM_{10} (2022 and 2023) was between 50% and 89.9%, which is below the minimum requirement. These data are included in this discussion but must be viewed with caution.

Data recovery for the Lephalale AQMS was above 90% for SO_2 (2021), however data recovery for SO_2 (2022 and 2023), NO_2 (2021 to 2023), PM_{10} (2021 and 2023) and $PM_{2.5}$ (2023) was between 50% and 89.9%. These data are included in this discussion but must be viewed with caution.

Pollutants with a data recovery below 50% in a single year were not considered in this baseline discussion. These are highlighted in bold in Table 5-1.

Table 5-1: Data recovery at the Marapong, Medupi and Lephalale AQMSs from 2021 to 2023

Year	Data recovery (%)			
	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Marapong AQMS				
2021	59.5	50.4	71.9	67.6
2022	**38.9**	59.4	**43.9**	59.8
2023	**0**	**0**	**0**	**0**
Medupi AQMS				
2021	97.9	86.6	93.2	96.5
2022	75.2	90.4	56.5	**35.4**
2023	71.5	80.1	62.1	**27.8**
Lephalale AQMS				
2021	96.1	64.1	51.4	**48.9**
2022	73.2	71.0	**34.2**	**29.0**
2023	58.0	74.9	59.6	57.7
Note:	Data recovery for the Marapong and Medupi AQMSs are based on 10-minute average data, while the Lephalale AQMS is based on 1-hour average data.			

5.2.2 Sulphur Dioxide (SO_2)

Marapong AQMS

- The 10-min average (Figure 5-4) SO_2 concentrations exceeded the 10-min (500 µg/m³) NAAQS in 2021 (23 times), however remaining compliant as 526 exceedances of 10-min NAAQS are permitted per calendar year.
- The 1-hour average (Figure 5-5) SO_2 concentrations exceeded the 1-hour (350 µg/m³) NAAQS in 2021 (sixteen times), thus compliant with the respective NAAQS as 88 exceedances of the 1-hour NAAQS are permitted per calendar year.
- The 24-hour average (Figure 5-6) SO_2 concentrations exceeded the 24-hour (125 µg/m³) NAAQS in 2021 (one time), thus compliant with the respective NAAQS as four exceedances of the 24-hour NAAQS are permitted per calendar year.
- The annual average SO_2 concentrations for 2021 (13.9 µg/m³) remained below the annual average NAAQS (50 µg/m³), thus compliant with the respective NAAQS.

Medupi AQMS

- The 10-min average (Figure 5-4) SO_2 concentrations exceeded the 10-min (500 µg/m³) NAAQS in 2021 (34 times), 2022 (75 times) and 2023 (53 times), thus compliant with the respective NAAQS as 526 exceedances of 10-min NAAQS are permitted per calendar year.
- The 1-hour average Figure 5-5) SO_2 concentrations exceeded the 1-hour (350 µg/m³) NAAQS in 2021 (eighteen times), 2022 (27 times) and 2023 (21 times), thus compliant

with the respective NAAQS as 88 exceedances of the 1-hour NAAQS are permitted per calendar year.

- The 24-hour average (Figure 5-6) SO_2 concentrations exceeded the 24-hour (125 µg/m³) NAAQS in 2021 (one time), 2022 (one time) and 2023 (one time), thus compliant with the respective NAAQS as four exceedances of the 24-hour NAAQS are permitted per calendar year.
- The annual average SO_2 concentrations for 2021 (16.2 µg/m³), 2022 (27.0 µg/m³) and 2023 (34.6 µg/m³) remained below the annual average NAAQS (50 µg/m³), thus compliant with the respective NAAQS.

Lephalale AQMS

- The 1-hour average (Figure 5-5) SO_2 concentrations exceeded the 1-hour (350 µg/m³) NAAQS in 2023 (two times), thus compliant with the respective NAAQS as 88 exceedances of the 1-hour NAAQS are permitted per calendar year. The 1-hour average SO_2 concentrations remained below the 1-hour (350 µg/m³) NAAQS in 2021 and 2022, with no exceedances recorded, thus compliant with the respective NAAQS.
- The 24-hour average (Figure 5-6) SO_2 concentrations remained below the 24-hour (125 µg/m³) NAAQS between 2021 and 2023, with no exceedances recorded, thus compliant with the respective NAAQS.
- The annual average SO_2 concentrations for 2021 (5.4 µg/m³), 2022 (5.0 µg/m³) and 2023 (7.1 µg/m³) remained below the annual average NAAQS (50 µg/m³), thus compliant with the respective NAAQS.

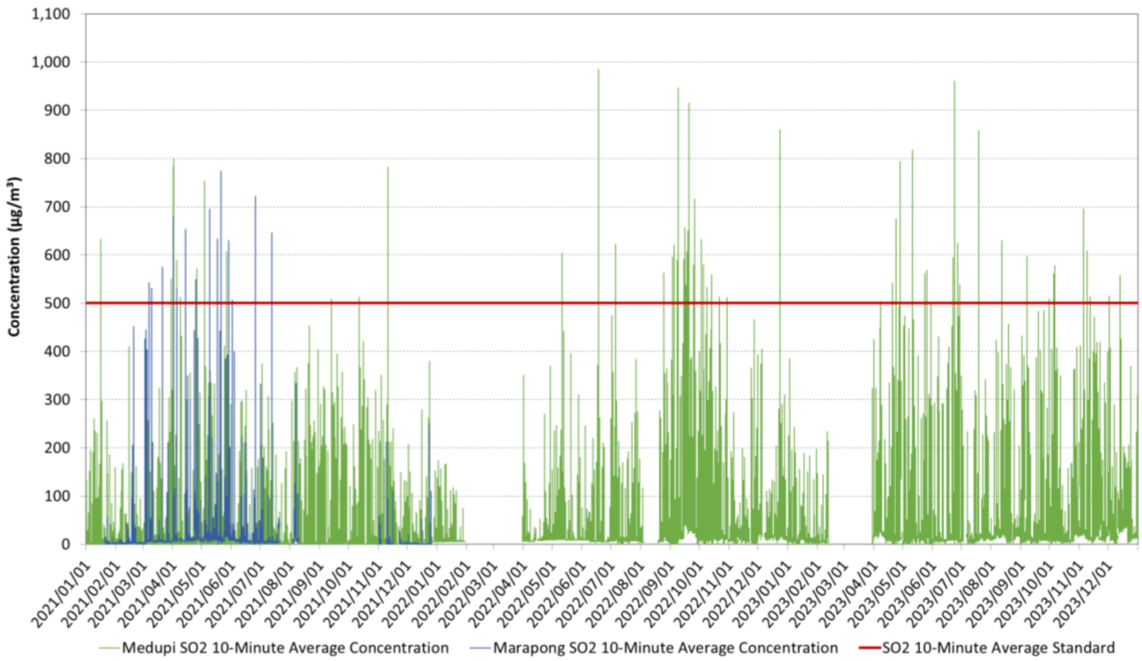


Figure 5-4: 10-minute average SO_2 concentrations at Marapong, Medupi and Lephalale AQMS for 2021 to 2023

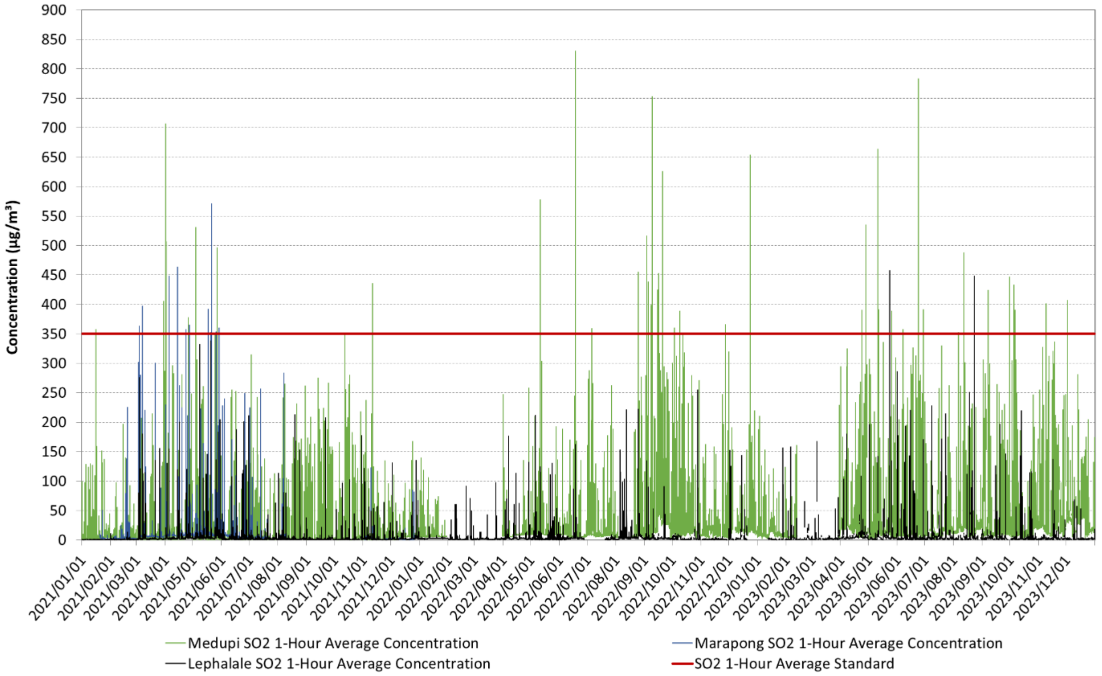


Figure 5-5: 1-hour average SO_2 concentrations at Marapong, Medupi and Lephalale AQMS for 2021 to 2023

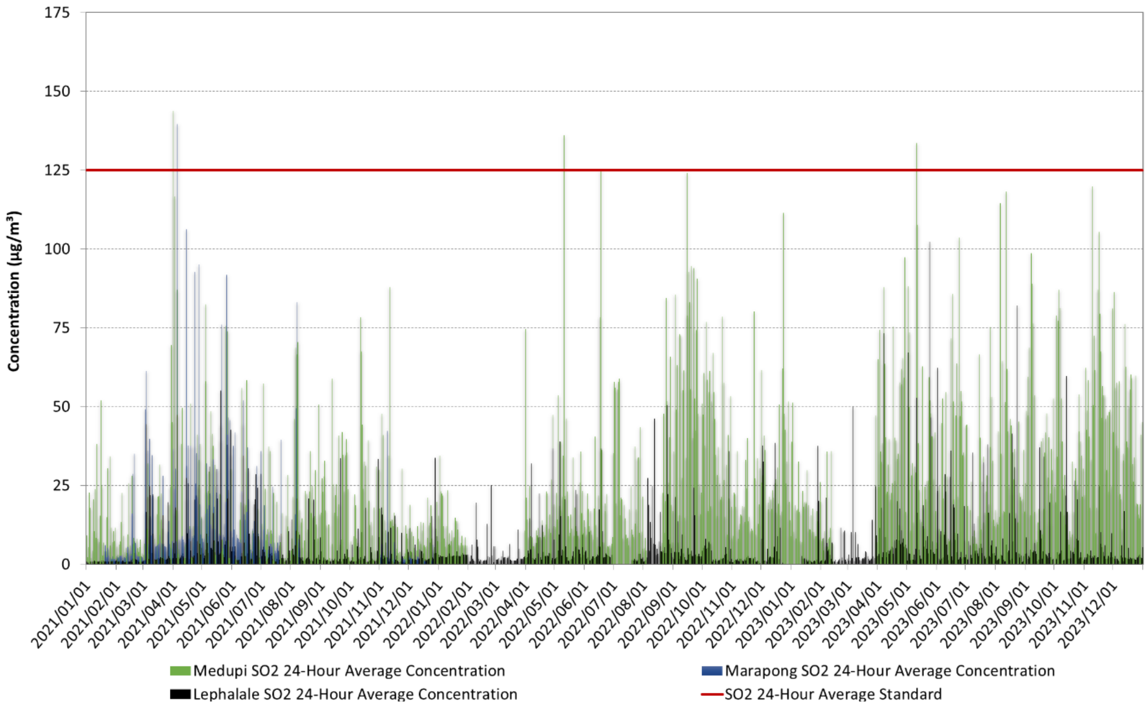


Figure 5-6: 24-hour average SO_2 concentrations at Marapong, Medupi and Lephalale AQMS for 2021 to 2023

5.2.3 Nitrogen Dioxide (NO_2)

Marapong AQMS

- The 1-hour average (Figure 5-7) NO_2 concentrations remained below the 1-hour NAAQS (200 µg/m³) for 2021 and 2022, with no exceedances recorded, thus compliant with the respective NAAQS.
- The annual average NO_2 concentrations for 2021 (16.4 µg/m³) and 2022 (17.3 µg/m³) remained below the annual average NAAQS (40 µg/m³), thus compliant with the respective NAAQS.

Medupi AQMS

- The 1-hour average (Figure 5-7) NO_2 concentrations remained below the 1-hour NAAQS (200 µg/m³) between 2021 and 2023, with no exceedances recorded, thus compliant with the respective NAAQS.
- The annual average NO_2 concentrations for 2021 (5.5 µg/m³), 2022 (10.4 µg/m³) and 2023 (11.3 µg/m³) remained below the annual average NAAQS (40 µg/m³), thus compliant with the respective NAAQS.

Lephalale AQMS

- The 1-hour average Figure 5-7) NO_2 concentrations remained below the 1-hour NAAQS (200 µg/m³) between 2021 and 2023, with no exceedances recorded, thus compliant with the respective NAAQS.
- The annual average NO_2 concentrations for 2021 (10.8 µg/m³), 2022 (12.8 µg/m³) and 2023 (15.7 µg/m³) remained below the annual average NAAQS (40 µg/m³), thus compliant with the respective NAAQS.

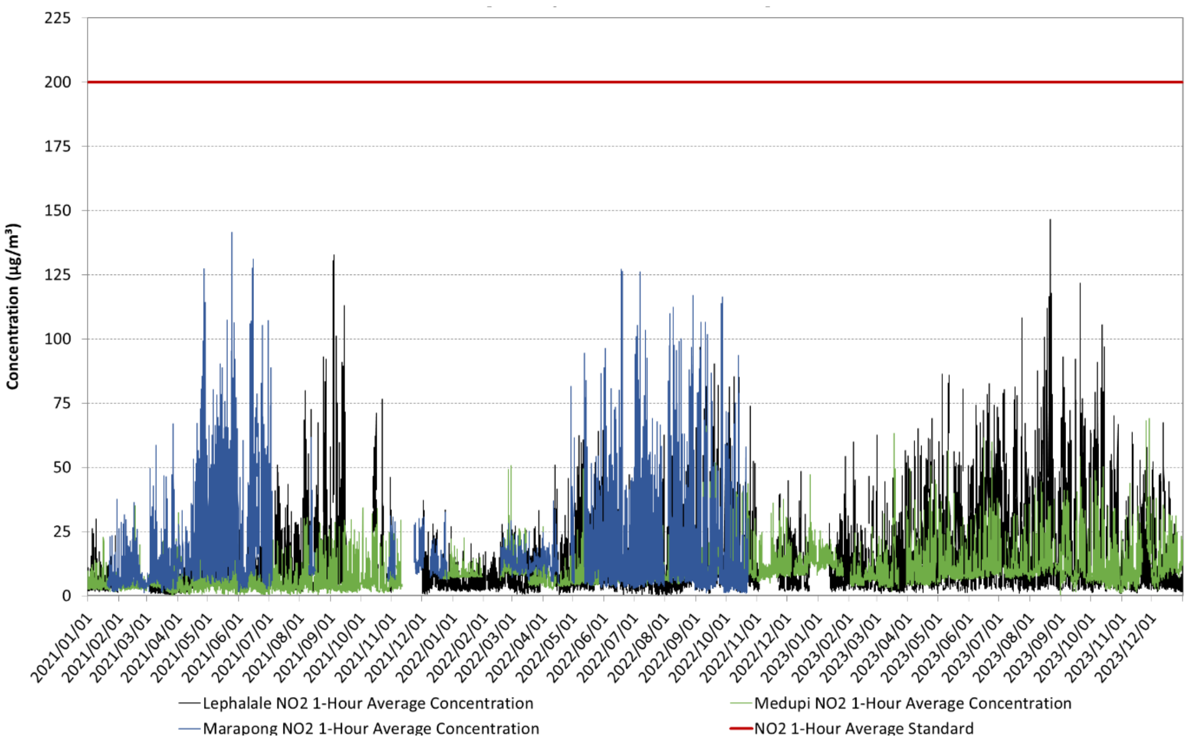


Figure 5-7: 1-hour average NO_2 concentrations at Marapong, Medupi and Lephalale AQMS for 2021 to 2023

5.2.4 Particulates (PM_{10} and $PM_{2.5}$)

Marapong AQMS

- The 24-hour average (Figure 5-8) PM_{10} concentrations exceeded the 24-hour average NAAQS (75 µg/m³) in 2021 (47 times), thus is non-compliant with the respective NAAQS as four exceedances per year are permitted.
- The annual average PM_{10} concentrations for 2021 (47.0 µg/m³) exceeded the annual average NAAQS (40 µg/m³), thus is non-compliant with the respective NAAQS.
- The 24-hour average (Figure 5-9) $PM_{2.5}$ concentrations exceeded the 24-hour average NAAQS (40 µg/m³) in 2021 (43 times) and 2022 (41 times), thus are non-compliant with the respective NAAQS as four exceedances per year are permitted.
- The annual average $PM_{2.5}$ concentrations for 2021 (25.8 µg/m³) and 2022 (30.2 µg/m³) exceeded the annual average NAAQS (20 µg/m³), thus are non-compliant with the respective NAAQS.

Medupi AQMS

- The 24-hour average (Figure 5-8) PM_{10} concentrations exceeded the 24-hour average NAAQS (75 µg/m³) in 2021 (12 times), 2022 (seven times) and 2023 (22 times), thus are non-compliant with the respective NAAQS as four exceedances per year are permitted.
- The annual average PM_{10} concentrations for 2021 (28.9 µg/m³), 2022 (28.4 µg/m³) and 2023 (37.5 µg/m³) remained below the annual average NAAQS (40 µg/m³), thus compliant with the respective NAAQS.
- The 24-hour average (Figure 5-9) $PM_{2.5}$ concentrations exceeded the 24-hour average NAAQS (40 µg/m³) in 2021 (eight times), thus is non-compliant with the respective NAAQS as four exceedances per year are permitted.
- The annual average $PM_{2.5}$ concentrations for 2021 (15.2 µg/m³) below the annual average NAAQS (20 µg/m³), thus compliant with the respective NAAQS.

Lephalale AQMS

- The 24-hour average (Figure 5-8) PM_{10} concentrations exceeded the 24-hour average NAAQS of 75 µg/m³ once in 2021, with no exceedances in 2023, , thus compliant with the respective NAAQS as four exceedances per year are permitted.
- The annual average PM_{10} concentrations for 2021 (37.3 µg/m³) and 2023 (17.4 µg/m³) remained below annual average NAAQS (40 µg/m³), thus compliant with the respective NAAQS.
- The 24-hour average (Figure 5-9) $PM_{2.5}$ concentrations in 2023 remained below the 24-hour average NAAQS (40 µg/m³) with no exceedances recorded, thus compliant with the respective NAAQS.
- The annual average $PM_{2.5}$ concentrations for 2023 (15.2 µg/m³) remained below the annual average NAAQS (20 µg/m³), thus compliant with the respective NAAQS.

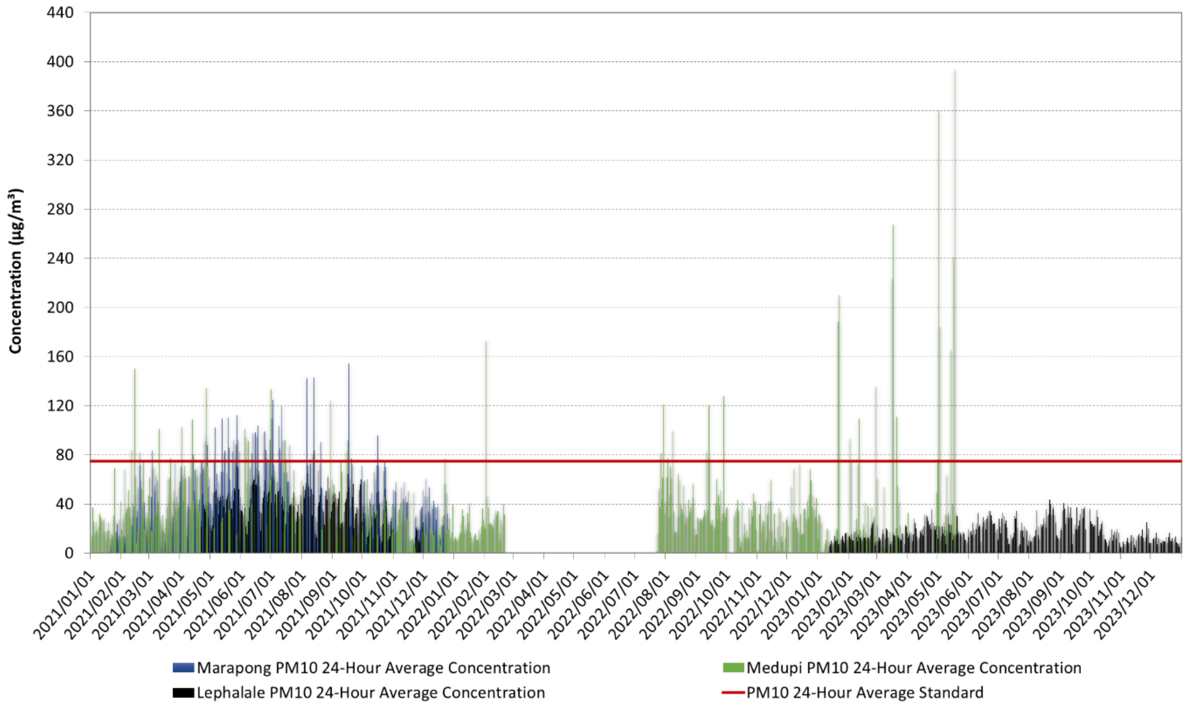


Figure 5-8: 24-hour average PM_{10} concentrations at Marapong, Medupi and Lephalale AQMS for 2021 to 2023

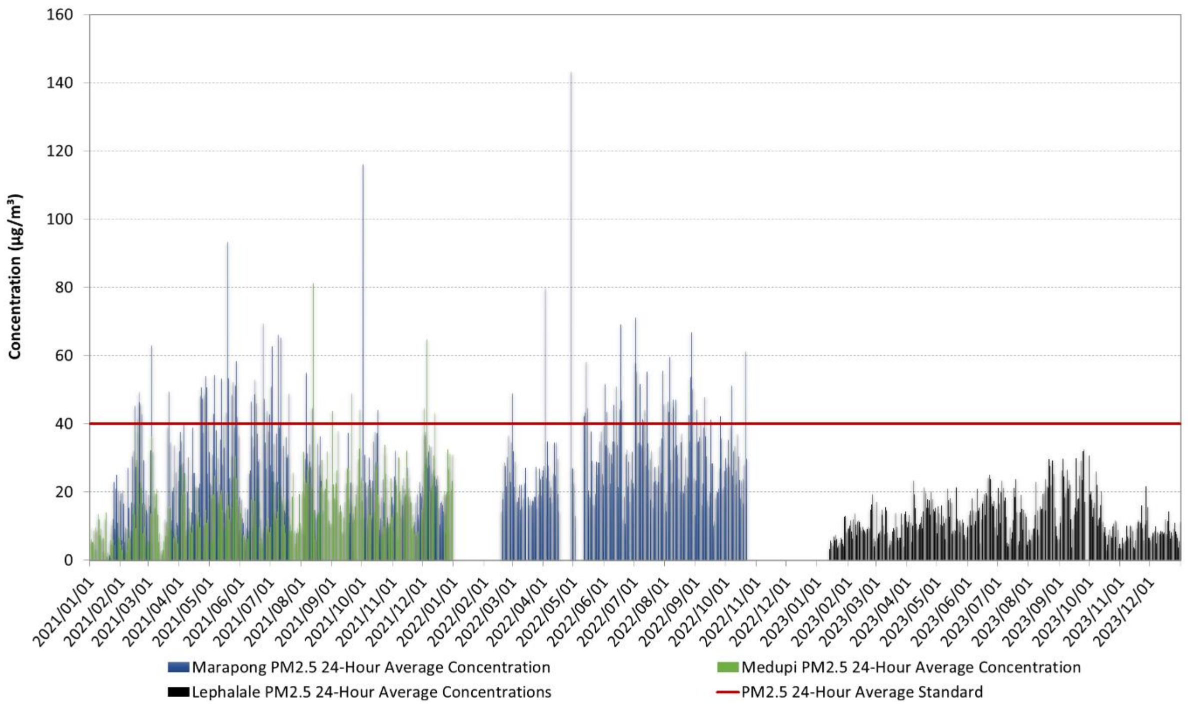


Figure 5-9: 24-hour average $PM_{2.5}$ concentrations at Marapong, Medupi and Lephalale AQMS for 2021 to 2023

5.2.5 Ambient pollutant summary

A summary of exceedances of the limit value of the NAAQS for all pollutants is presented in (Table 5-2).

Despite the proximity of several sources of SO_2 and NO_2 to the three monitoring sites, including Medupi and Matimba Power Station, no exceedances of the NAAQS for SO_2 and NO_2 were recorded during the period 2021 to 2023.

The key pollutants of concern however, are PM_{10} and $PM_{2.5}$. During the period 2021 to 2023 numerous exceedances of the NAAQS limit value for both the 24-hour and annual average for PM_{10} and $PM_{2.5}$ were recorded at the Marapong and Medupi AQMS. The exceedances are attributed to the proximity of sources of particulates to these monitoring sites, such as domestic fuel burning, wind and vehicle entrainment of dust, and mining.

Table 5-2: Pollutant exceedance summary at the Marapong, Medupi and Lephalale AQMS from 2021 to 2023

Pollutant	Averaging Period	Concentration	Permitted Number of Exceedances	2021	2022	2023
Marapong AQMS						
SO_2	10-min	500 µg/m³	526	23	- (1)	- (1)
	1-hour	350 µg/m³	88	16	- (1)	- (1)
	24-hour	125 µg/m³	4	1	- (1)	- (1)
	1-year	50 µg/m³	0	0	- (1)	- (1)
NO_2	1-hour	200 µg/m³	88	0	0	- (1)
	1-year	40 µg/m³	0	0	0	- (1)
PM_{10}	24-hour	75 µg/m³	4	47	- (1)	- (1)
	1-year	40 µg/m³	0	1	- (1)	- (1)
$PM_{2.5}$	24-hour	40 µg/m³	4	43	41	- (1)
	1-year	20 µg/m³	0	1	1	- (1)
Medupi AQMS						
SO_2	10-min	500 µg/m³	526	34	75	53
	1-hour	350 µg/m³	88	18	27	21
	24-hour	125 µg/m³	4	1	1	1
	1-year	50 µg/m³	0	0	0	0
NO_2	1-hour	200 µg/m³	88	0	0	0
	1-year	40 µg/m³	0	0	0	0
PM_{10}	24-hour	75 µg/m³	4	12	7	22
	1-year	40 µg/m³	0	0	0	0
$PM_{2.5}$	24-hour	40 µg/m³	4	8	- (1)	- (1)
	1-year	20 µg/m³	0	0	- (1)	- (1)
Lephalale AQMS						
SO_2	10-min	500 µg/m³	526	- (2)	- (2)	- (2)
	1-hour	350 µg/m³	88	0	0	2
	24-hour	125 µg/m³	4	0	0	0
	1-year	50 µg/m³	0	0	0	0
NO_2	1-hour	200 µg/m³	88	0	0	0
	1-year	40 µg/m³	0	0	0	0
PM_{10}	24-hour	75 µg/m³	4	1	- (1)	0
	1-year	40 µg/m³	0	0	- (1)	0
$PM_{2.5}$	24-hour	40 µg/m³	4	- (1)	- (1)	0
	1-year	20 µg/m³	0	- (1)	- (1)	0
Notes:	(1) Data recovery below 50%; thus, exceedances are not presented. (2) The Lephalale AQMS does not measure data in 10-minute intervals. Values in red indicate non-compliance against the respective standard.					

6. IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT

6.1 Dispersion Modelling

6.1.1 Models used

A Level 3 air quality assessment must be conducted in situations where the purpose of the assessment requires a detailed understanding of the air quality impacts (time and space variation of the concentrations) and when it is important to account for causality effects, calms, non-linear plume trajectories, spatial variations in turbulent mixing, multiple source types and chemical transformations (DEA, 2014b). A Level 3 assessment may be used in situations where there is a need to evaluate air quality consequences under a permitting or environmental assessment process for large industrial developments that have considerable social, economic and potential environmental consequences. Under these circumstances, the assessment for Matimba and Medupi clearly demonstrates the need for a Level 3 assessment.

The CALPUFF suite of models are approved by the US EPA (http://www.src.com/calpuff/calpuff1.htm) and by the DEA for Level 3 assessments (DEA, 2014b). It consists of a meteorological pre-processor, CALMET, the dispersion model, CALPUFF, and the post-processor, CALPOST. It is an appropriate air dispersion model for the purpose of this assessment as it is well suited to simulate dispersion from several sources. It also has capability to simulate dispersion in the atmosphere's complex land-sea interface. More information about the model can be found in the User's Guide for the CALPUFF Dispersion Model (US EPA, 1995).

The Air Pollution Model (TAPM) (Hurley, 2000; Hurley et al., 2001; Hurley et al., 2002) is used to model surface and upper air metrological data for the study domain. TAPM uses global gridded synoptic-scale meteorological data with observed surface data to simulate surface and upper air meteorology at given locations in the domain, taking the underlying topography and land cover into account. The global gridded data sets that are used are developed from surface and upper air data that are submitted routinely by all meteorological observing stations to the Global Telecommunication System of the World Meteorological Organisation. TAPM has been used successfully in Australia where it was developed (Hurley, 2000; Hurley et al., 2001; Hurley et al., 2002). It is an ideal tool for modelling applications where meteorological data does not adequately meet requirements for dispersion modelling. TAPM modelled output data is therefore used to augment the site-specific surface meteorological data for input to CALPUFF.

6.1.2 TAPM and CALPUFF parameterisation

The TAPM diagnostic meteorological model is used to generate a 3-dimensional temporally and spatially continuous meteorological field for 2021, 2022 and 2023 in hourly increments for the modelling domain.

TAPM is set-up in a nested configuration of two domains, centred between Medupi and Matimba. The outer domain is 480 km by 480 km at a 12 km grid resolution and the inner domain is 120 km by 120 km at a 3 km grid resolution (Figure 6-1). The nesting configuration ensures that topographical effects on meteorology are captured and that meteorology is well resolved and characterised across the boundaries of the inner domain. Twenty-seven vertical levels are modelled in each nest from 10 m to 5 000 m, with a finer resolution in the lowest 1 000 m. The subset of the entire TAPM model output in the form of pre-processed gridded surface meteorological data fields is input into the dispersion model.

The 3-dimensional TAPM meteorological output on the inner grid includes hourly wind speed and direction, temperature, relative humidity, total solar radiation, net radiation, sensible heat flux, evaporative heat flux, convective velocity scale, precipitation, mixing height, friction velocity and Obukhov length. The spatially and temporally resolved TAPM surface and upper air meteorological data is used as input to the CALPUFF meteorological pre-processor, CALMET.

The CALPUFF modelling domain covers an area of 11 664 km^2, where the domain extends 108 km (west-east) by 108 km (north-south). It consists of a uniformly spaced receptor grid with 1 km spacing, giving 11 664 grid cells (108 x 108 grid cells).

The topographical and land use for the respective modelling domains is obtained from the dataset accompanying the Commonwealth Scientific and Industrial Research Organisation (CSIRO) The Air Pollution Model (TAPM) modelling package (CSIRO, 2008). This dataset includes global terrain elevation and land use classification data on a longitude/latitude grid at 30-second grid spacing from the US Geological Survey, Earth Resources Observation Systems (EROS) Data Center.

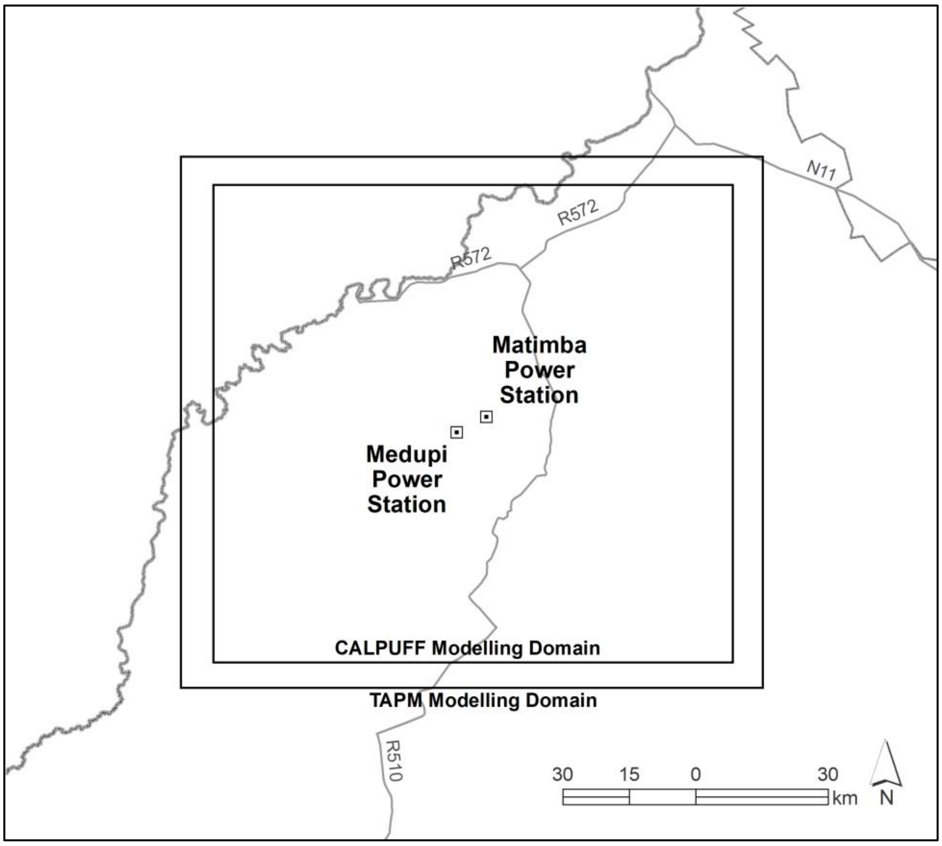


Figure 6-1: TAPM and CALPUFF modelling domains centred on Matimba

The parameterisation of key variables that will apply in CALMET and CALPUFF are indicated in Table 6-1 and Table 6-2 respectively.

Table 6-1: Parameterisation of key variables for CALMET

Parameter	Model value
12 vertical cell face heights (m)	0, 20, 40, 80, 160, 320, 640, 1000, 1500, 2000, 2500, 3000, 4000
Coriolis parameter (per second)	0.0001
Empirical constants for mixing height equation	Neutral, mechanical: 1.41 Convective: 0.15 Stable: 2400 Overwater, mechanical: 0.12
Minimum potential temperature lapse rate (K/m)	0.001
Depth of layer above convective mixing height through which lapse rate is computed (m)	200
Wind field model	Diagnostic wind module
Surface wind extrapolation	Similarity theory
Restrictions on extrapolation of surface data	No extrapolation as modelled upper air data field is applied
Radius of influence of terrain features (km)	5
Radius of influence of surface stations (km)	Not used as continuous surface data field is applied

Table 6-2: Parameterisation of key variables for CALPUFF

Parameter	Model value
Chemical transformation	Default NO_2 conversion factor is applied
Wind speed profile	Rural
Calm conditions	Wind speed < 0.5 m/s
Plume rise	Transitional plume rise, stack tip downwash, and partial plume penetration is modelled
Dispersion	CALPUFF used in PUFF mode
Dispersion option	Pasquill-Gifford coefficients are used for rural and McElroy-Pooler coefficients are used for urban
Terrain adjustment method	Partial plume path adjustment

6.1.3 Model accuracy

Air quality models attempt to predict ambient concentrations based on "known" or measured parameters, such as wind speed, temperature profiles, solar radiation and emissions. There are however, variations in the parameters that are not measured, the so-called "unknown" parameters as well as unresolved details of atmospheric turbulent flow. Variations in these "unknown" parameters can result in deviations of the predicted concentrations of the same event, even though the "known" parameters are fixed.

There are also "reducible" uncertainties that result from inaccuracies in the model, errors in input values and errors in the measured concentrations. These might include poor quality or unrepresentative meteorological, geophysical and source emission data, errors in the measured concentrations that are used to compare with model predictions and inadequate model physics and formulation used to predict the concentrations. "Reducible" uncertainties can be controlled or minimised. This is done by using accurate input data, preparing the input files correctly, checking and re-checking for errors, correcting for odd model behaviour, ensuring that the errors in the measured data are minimised and applying appropriate model physics.

Models recommended in the DEA dispersion modelling guideline (DEA, 2014b) have been evaluated using a range of modelling test kits (http://www.epa.gov./scram001). CALPUFF is one of the models that have been evaluated and it is therefore not mandatory to perform any modelling evaluations. Rather the accuracy of the modelling in this assessment is enhanced by every effort to minimise the "reducible" uncertainties in input data and model parameterisation.

6.1.4 Assessment scenarios

Five emission scenarios are assessed for Medupi and Matimba. These scenarios are:

Scenario 1 (Current): The baseline scenario using actual monthly stack emissions for 2021-2023 and fugitive emissions from the coal stockyards and the ash dumps (No FGD installed).

Scenario A (2025): Eskom's planned 2025 stack emissions, representing anticipated station performance between 2025 – 2030, including fugitive emissions from the coal stockyards and the ash dumps (No FGD installed).

Scenario B (2031): Eskom's planned 2031 stack emissions, representing anticipated station performance between 2031 – 2035, including fugitive emissions from the coal stockyards and the ash dumps (No FGD installed but load reduction).

Scenario C (2036): Eskom's planned 2036 stack emissions, representing anticipated station performance from 2036 onwards, including fugitive emissions from the coal stockyards and the ash dumps (FGD installed at Medupi).

Scenario D (MES): Full compliance with the MES, including fugitive emissions from the coal stockyards and the ash dumps (FGD installed at Medupi and Matimba).

6.2 Dispersion Modelling Results

The dispersion modelling results are compared with the NAAQS for SO_2, NO_2, PM_{10} and $PM_{2.5}$ (Table 3-3). It is not possible to apportion the PM_{10} and $PM_{2.5}$ portion of the total PM, so the PM emission is conservatively modelled as PM_{10} and $PM_{2.5}$. The CALPUFF modelling suite provides for the chemical conversion of SO_2 and NO_X to secondary particulates, i.e. sulphate and nitrate in the modelling results. The predicted PM_{10} and $PM_{2.5}$ concentrations presented here include direct emissions of PM plus secondary particulates formed from the power station emissions.

The 99th percentile predicted ambient SO_2, NO_2, PM_{10} and $PM_{2.5}$ concentrations from the dispersion modelling for Medupi and Matimba for the five emission scenarios are presented as isopleth maps over the modelling domain. The DEA (2012c) recommend the 99th percentile concentrations for short-term assessment with the NAAQS since the highest predicted ground-level concentrations can be considered outliers due to complex variability of meteorological processes. In addition, the limit value in the NAAQS is the 99th percentile.

6.2.1 Maximum predicted ambient concentrations

The maximum predicted annual SO_2, NO_2, PM_{10} and $PM_{2.5}$ concentrations and the 99th percentile of the 24-hour and 1-hour predicted concentrations in the modelling domain are discussed here and are listed in Table 6-3 for the 5 scenarios. Exceedances of the limit value of the NAAQS are shown in red font. Exceedance of the limit value does not automatically indicate non-compliance with the NAAQS as the standards provide a tolerance in the form of a permitted number of exceedances. The frequency of exceedances is discussed in Section 6.2.2.

For SO_2, the predicted concentrations are attributed only to the stack emissions. The maximum predicted annual average concentrations for the 5 scenarios are low relative to the limit values of the respective NAAQS. The predicted the 99th percentile of the 24-hour SO_2 concentrations and the predicted 1-hour concentrations exceeded the limit value of the NAAQS in Scenario A (2025) Scenario B (2031) and in Scenario C (2036). The predicted maximum SO_2 concentration occurs between 10 and 15 km southwest of Medupi and Matimba. Noteworthy is the compliance with the NAAQS with actual emissions (Scenario 1 (Current)) and Scenario D (MES).

For NO_2, the predicted concentrations are attributed only to the stack emissions. The predicted maximum and 99th percentile concentrations comply the respective NAAQS for the 5 scenarios. The predicted maximum NO_2 concentration occurs between 10 and 15 km southwest of Medupi and Matimba.

For PM_{10} and $PM_{2.5}$, the predicted concentrations are attributed to stack emissions, the low-level fugitive sources (coal stockyard and ash dump) and the contribution from secondary particulate formation. The total PM emissions are not speciated into PM_{10} or $PM_{2.5}$, rather all PM emitted is assumed to be firstly PM_{10}, and then all PM emitted is assumed to be $PM_{2.5}$.

For PM_{10} and $PM_{2.5}$, the maximum predicted annual average concentrations exceed the limit values of the respective NAAQS in all scenarios. Similarly, the 99th percentile of the

24-hour PM_{10} and $PM_{2.5}$ concentrations exceeds the limit value of the NAAQS. The predicted maximum PM_{10} and $PM_{2.5}$ concentrations occur within 10 km of Medupi and Matimba to the southwest.

Table 6-3: Maximum predicted ambient annual SO_2, NO_2 PM_{10}, and $PM_{2.5}$ concentrations in µg/m³ and the predicted 99th percentile concentrations for 24-hour and 1-hour averaging periods, with the NAAQS

Scenario and Pollutant	Averaging time		
Predicted maximum SO_2	**Annual**	**24-hour**	**1-hour**
Scenario 1 (Current)	15.6	123.2	316.9
Scenario A (2025)	24.7	**223.9**	**598.9**
Scenario B (2031)	26.7	**221.6**	**575.8**
Scenario C (2035)	17.9	**211.2**	**451.0**
Scenario D (MES)	6.7	64.9	156.6
NAAQS	50	125	350
Predicted maximum NO_2	**Annual**		**1-hour**
Scenario 1 (Current)	2.0		46.9
Scenario A (2025)	3.9		103.0
Scenario B (2031)	4.3		100.1
Scenario C (2035)	3.2		82.4
Scenario D (MES)	3.2		82.4
NAAQS	40		200
Predicted maximum PM_{10}	**Annual**	**24-hour**	
Scenario 1 (Current)	**77.9**	**277.2**	
Scenario A (2025)	**78.3**	**278.3**	
Scenario B (2031)	**78.2**	**276.2**	
Scenario C (2035)	**77.9**	**272.6**	
Scenario D (MES)	**77.6**	**270.0**	
NAAQS	40	75	
Predicted maximum $PM_{2.5}$	**Annual**	**24-hour**	
Scenario 1 (Current)	**77.9**	**277.2**	
Scenario A (2025)	**78.3**	**278.3**	
Scenario B (2031)	**78.2**	**276.2**	
Scenario C (2035)	**77.9**	**272.6**	
Scenario D (MES)	**77.6**	**270.0**	
NAAQS	**20**	**40**	Up to 31 Dec 2029
NAAQS	**15**	**25**	From 01 Jan 2030

6.2.2 Predicted concentrations at AQMS and sensitive receptors

The predicted annual SO_2, NO_2, PM_{10} and $PM_{2.5}$ concentrations and the 99th percentile of the 24-hour and 1-hour predicted concentrations at AQMS in the Waterberg modelling area are presented in Table 6-4 to Table 6-7. The measured annual averages in 2021, 2022 and 2023 presented with the modelled annual average concentration for Scenario 1: (Current).

For SO_2 and NO_2 the predicted ambient concentrations result from the respective power station stack emissions only. At all the AQMS the modelled concentrations are lower than the monitored concentrations. This is to be expected since AQMS are exposed to all sources of SO_2 and NO_2. The difference between the predicted concentrations and the measured concentrations provides an indication of the contribution of the power station stack emissions at the respective AQMS.

For PM_{10} and $PM_{2.5}$ the predicted ambient concentrations result from the respective power station stack emissions and the fugitive low-level sources, i.e. the coal stockyard and the ash dumps at each power station. At the Marapong and Lephalale AQMS the modelled concentrations are considerably lower than the monitored concentrations. This is to be expected since AQMS are exposed to all sources of PM_{10} and $PM_{2.5}$. The difference between the predicted concentrations and the measured concentrations provides an indication of the contribution of the power station stack emissions at the respective AQMS.

At the Medupi AQMS however the modelled PM_{10} and $PM_{2.5}$ concentrations are generally higher than the monitored concentrations, contrary to expectation as the AQMS is exposed to more sources. Noteworthy is the poor data recover at the Medupi AQMS, especially in 2022 and 2023. In these years for PM_{10} it was only 56% and 62%, and for $PM_{2.5}$ it was 35% and 28%. Data is deemed acceptable if recovery is 90% or more. In this data of 50% or more was used, so the results need to be viewed with caution, otherwise that data was not used in averaging.

Table 6-4: Measured annual average SO_2 concentration at the Waterberg AQMS compared with predicted concentrations in µg/m³

Receptor	2021	2022	2023	Modelled
Marapong AQMS	13.9	-	-	6.2
Medupi AQMS	16.2	27.0	34.6	10.9
Lephalale AQMS	5.4	5.0	7.1	5.4

Table 6-5: Measured annual average NO_2 concentration at the Waterberg AQMS compared with predicted concentrations in µg/m³

Receptor	2021	2022	2023	Modelled
Marapong AQMS	16.4	17.3	-	0.7
Medupi AQMS	5.5	10.4	11.3	1.4
Lephalale AQMS	10.8	12.8	15.7	0.5

Table 6-6: Measured annual average PM_{10} concentration at the Waterberg AQMS compared with predicted concentrations in µg/m³

Receptor	2021	2022	2023	Modelled
Marapong AQMS	47.0	-	-	5.7
Medupi AQMS	28.8	28.4	37.5	36.2
Lephalale AQMS	37.3	-	17.4	2.1

Table 6-7: Measured annual average $PM_{2.5}$ concentration at the Waterberg AQMS compared with predicted concentrations in μg/m³

Receptor	2021	2022	2023	Modelled
Marapong AQMS	25.8	30.2	-	5.7
Medupi AQMS	15.2	-	-	36.2
Lephalale AQMS	-	-	12.2	2.1

In the Waterberg study area 51 sensitive receptors were identified (Table 2-3). The predicted ambient SO_2 NO_2, PM_{10} and $PM_{2.5}$ concentrations at the sensitive receptors for the five scenarios are presented in Annexure 1 with the limit value of the NAAQS. The predicted concentrations at the sensitive receptors are discussed here. The NAAQS provides for 4 exceedances of the 24-hour limit value per year, implying that 12 or fewer exceedances of the limit value in the 3-year modelling period comply with the NAAQS. The number of exceedances are included in the tables in Appendix 1.

For SO_2, the predicted concentrations result from SO_2 emissions from the power station stacks. At all identified sensitive receptors the predicted annual and 1-hour SO_2 concentrations are below the respective NAAQS for all averaging periods. The highest predicted concentrations occur in Scenario A (2025) when exceedances of the 24-hour limit value of the NAAQS at 10 sensitive receptors are predicted. Exceedances are also predicted at 10 sensitive receptors in Scenario B (2031) and at 9 in Scenario C (2036). Noteworthy is that no exceedances are predicted for Scenario D (MES).

For NO_2, the predicted concentrations result from NO_X emissions from the power station stacks. At all identified sensitive receptors the predicted NO_2 concentrations are low and below the respective NAAQS for all averaging periods. The highest predicted concentration occur for the proposed Scenario A (2025) emissions.

For PM_{10} and $PM_{2.5}$, it must be remembered that the predicted concentrations are attributed to stack emissions and the low-level fugitive sources (coal stockyard and ash dump). Furthermore, the total PM emission is not speciated into PM_{10} and $PM_{2.5}$, but rather all PM emitted is assumed to be PM_{10}, and all PM emitted is assumed to be $PM_{2.5}$. In addition, the predicted PM_{10} and $PM_{2.5}$ concentrations account for the formation of secondary particulates from SO_2 and NO_2 stack emissions. This is a very conservative approach.

For PM_{10} and $PM_{2.5}$, the predicted annual average concentrations are below the limit values of the NAAQS at all sensitive receptor points in all five scenarios. Exceedance of the 24-hour limit value of the NAAQS for PM_{10} and $PM_{2.5}$ are predicted in all five scenarios at several sensitive receptor points (Table 6-8). For $PM_{2.5}$, the limit value of the NAAQS drops from 40 μg/m³ to 25 μg/m³ in 2030 resulting in an increase in the number of receptor points where the limit value is exceeded.

Table 6-8: Number of sensitive receptors where the limit value of the 24-hour NAAQS is exceeded

Scenario	Number of sensitive receptors	
	PM_{10}	$PM_{2.5}$
Scenario 1 (Current)	2	17
Scenario A (2025)	5	17
Scenario B (2031)	2	27
Scenario C (3036)	0	25
Scenario D (MES)	0	24

6.2.3 Isopleth maps

Isopleth maps of predicted ambient SO_2, NO_2, PM_{10} and $PM_{2.5}$ concentrations are presented in the following sections. The predicted concentrations are shown as isopleths, lines of equal concentration, in µg/m^3 for the respective NAAQS averaging periods. The isopleths are depicted as coloured lines on the various maps, corresponding to a particular predicted ambient concentration. Areas within red isopleths indicate an area where exceedances of the respective NAAQS limit value are predicted to occur. Sensitive receptors are represented by green squares and AQMS are represented by white dots.

The South African NAAQS permits 4 exceedances of the 24-hour or daily limit value per annum, implying 12 permitted exceedances in a three-year modelling period. For the 24-hour or daily isopleth maps, areas within burgundy isopleths indicate areas where more than 12 exceedances of the limit value are predicted over a 3-year period. The predicted 24-hour concentrations in these areas do not comply with the NAAQS.

The South African NAAQS also permits 88 exceedances of the 1-hour or hourly limit value per annum, implying 264 permitted exceedances in a three-year modelling period. For the 1-hour or hourly isopleth maps, areas within burgundy isopleths indicate areas where more than 264 exceedances of the limit value are predicted over a 3-year period. The predicted 1-hour concentrations in these areas do not comply with the NAAQS.

6.2.3.1 Sulphur dioxide (SO_2)

The isopleth maps showing the predicted annual average SO_2 concentrations clearly demonstrate the effect of the predominant northeasterly winds, with dispersion generally to the southwest of the power plant. In all scenarios the highest predicted annual average concentrations occur between 10 and 20 km of the two power stations and to the southwest. The predicted annual ambient concentrations are relatively low and are below the NAAQS in all scenarios throughout the Waterberg modelling domain.

For the annual, 24-hour and 1-hour predictions, the effect of the increase in SO_2 emissions at Medupi from Scenario 1 (Current) to Scenario A (2025) is shown in the modelled results by an increase in the affected area, and with predicted exceedances of the limit value of the 24-hour and 1-hour NAAQS in an area to the southwest of Medupi and Matimba. There is marginal decrease observed in concentrations from Scenario A (2025) to Scenario B (2031) as the total emission tonnage decreases. The reduction in SO_2 emissions at Medupi in Scenario C (2036) is seen by a marked reduction in the affected area for this scenario. Noteworthy is compliance with the NAAQS in Scenario D (MES).

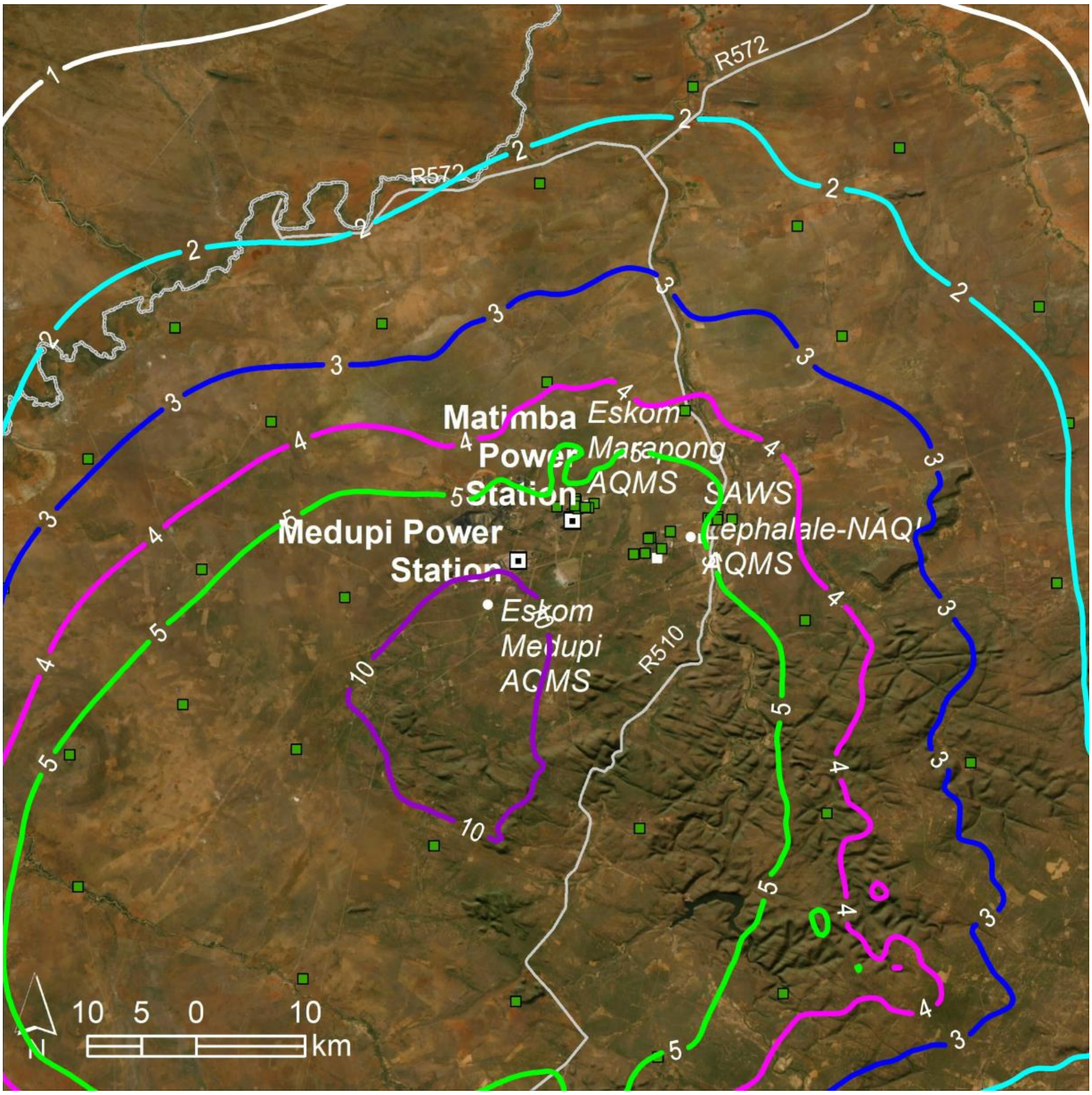


Figure 6-2: Predicted annual average SO_2 concentrations in µg/m³ for Scenario 1 (Current) (NAAQS Limit is 50 µg/m³)

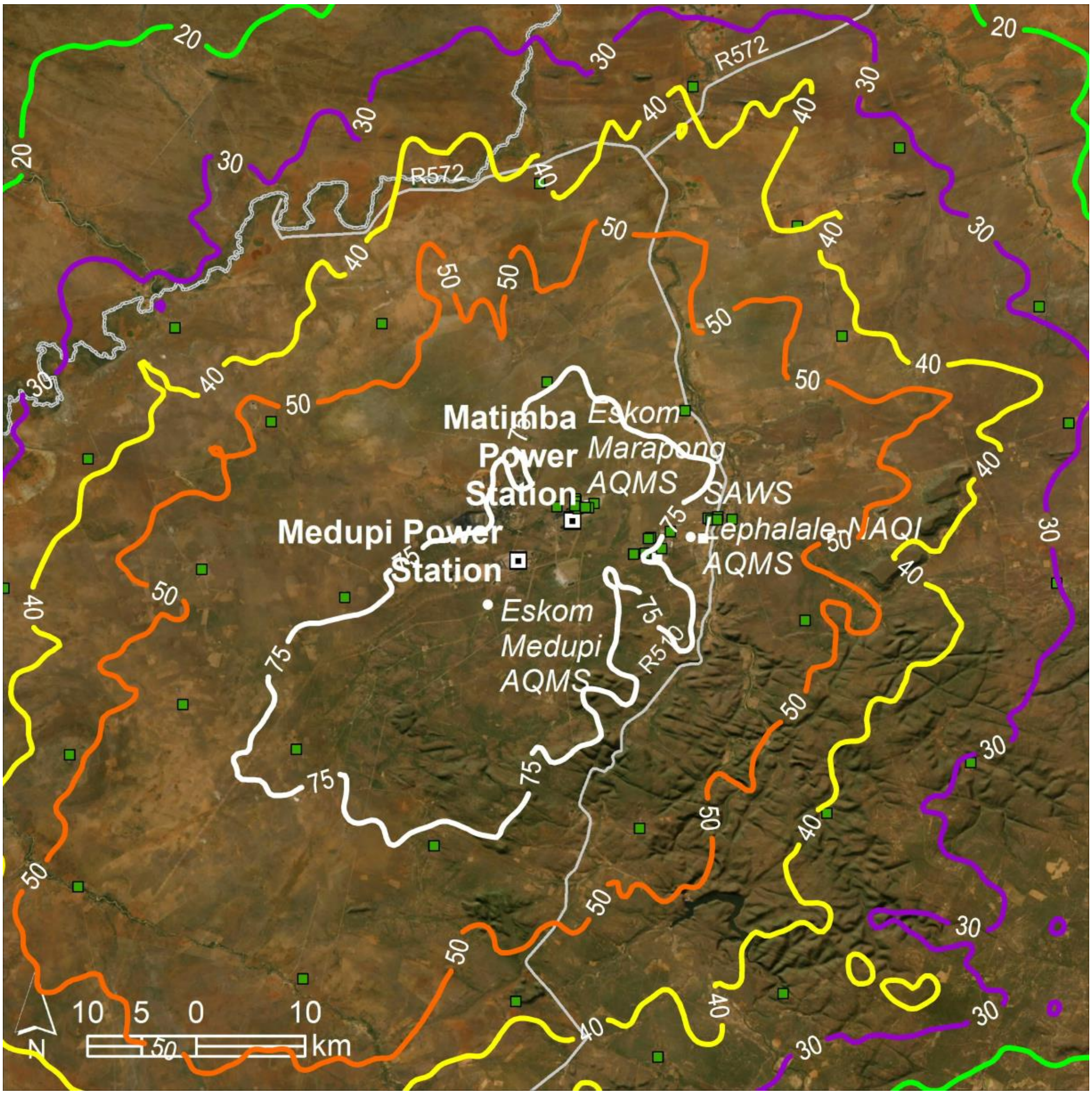


Figure 6-3: Predicted 99th percentile 24-hour SO_2 concentrations in µg/m^3 for Scenario 1 (Current) (NAAQS Limit is 125 µg/m^3)

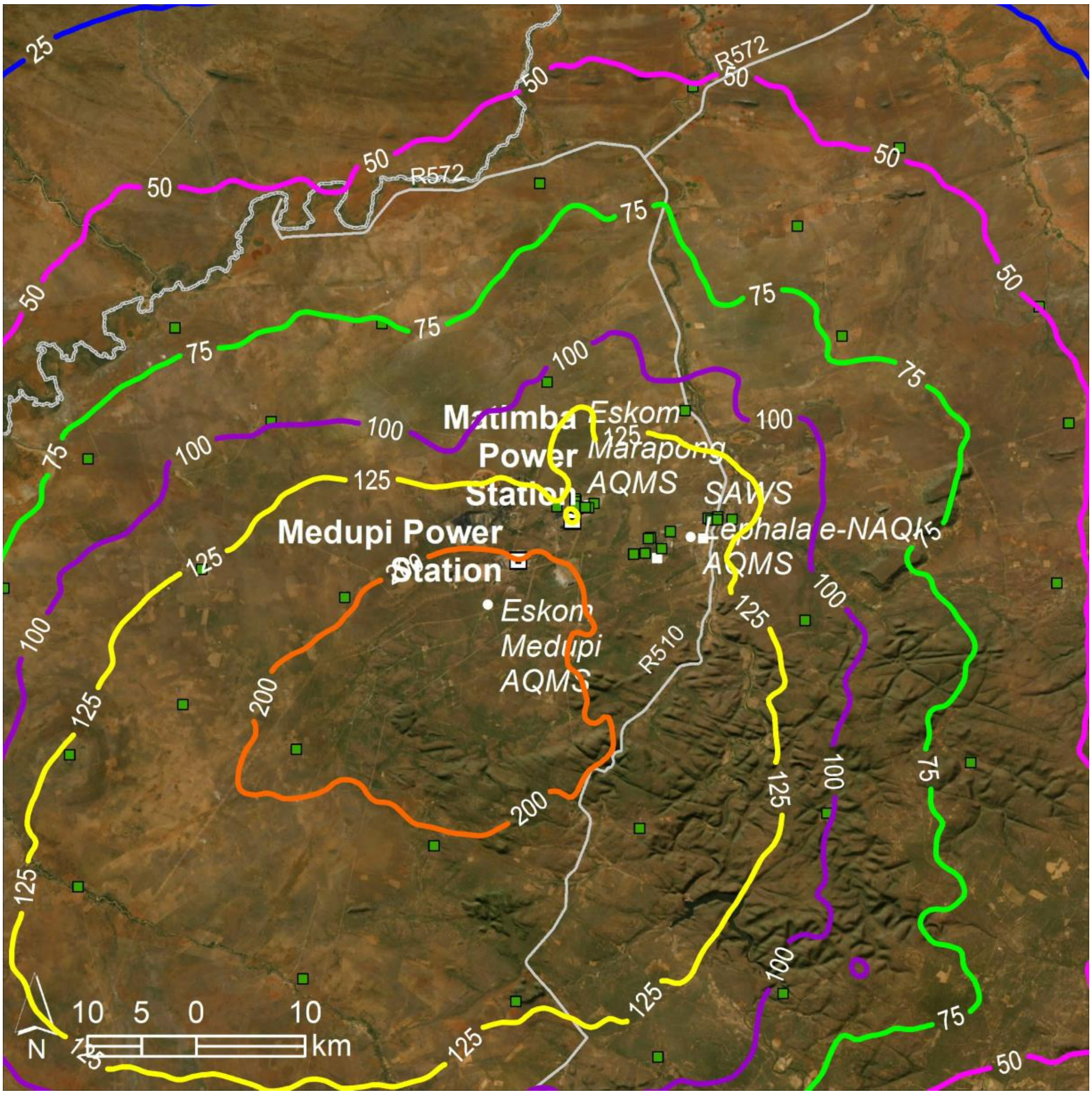


Figure 6-4: Predicted 99th percentile 1-hour SO_2 concentrations in $\mu g/m^3$ for Scenario 1 (Current) (NAAQS Limit is 350 $\mu g/m^3$)

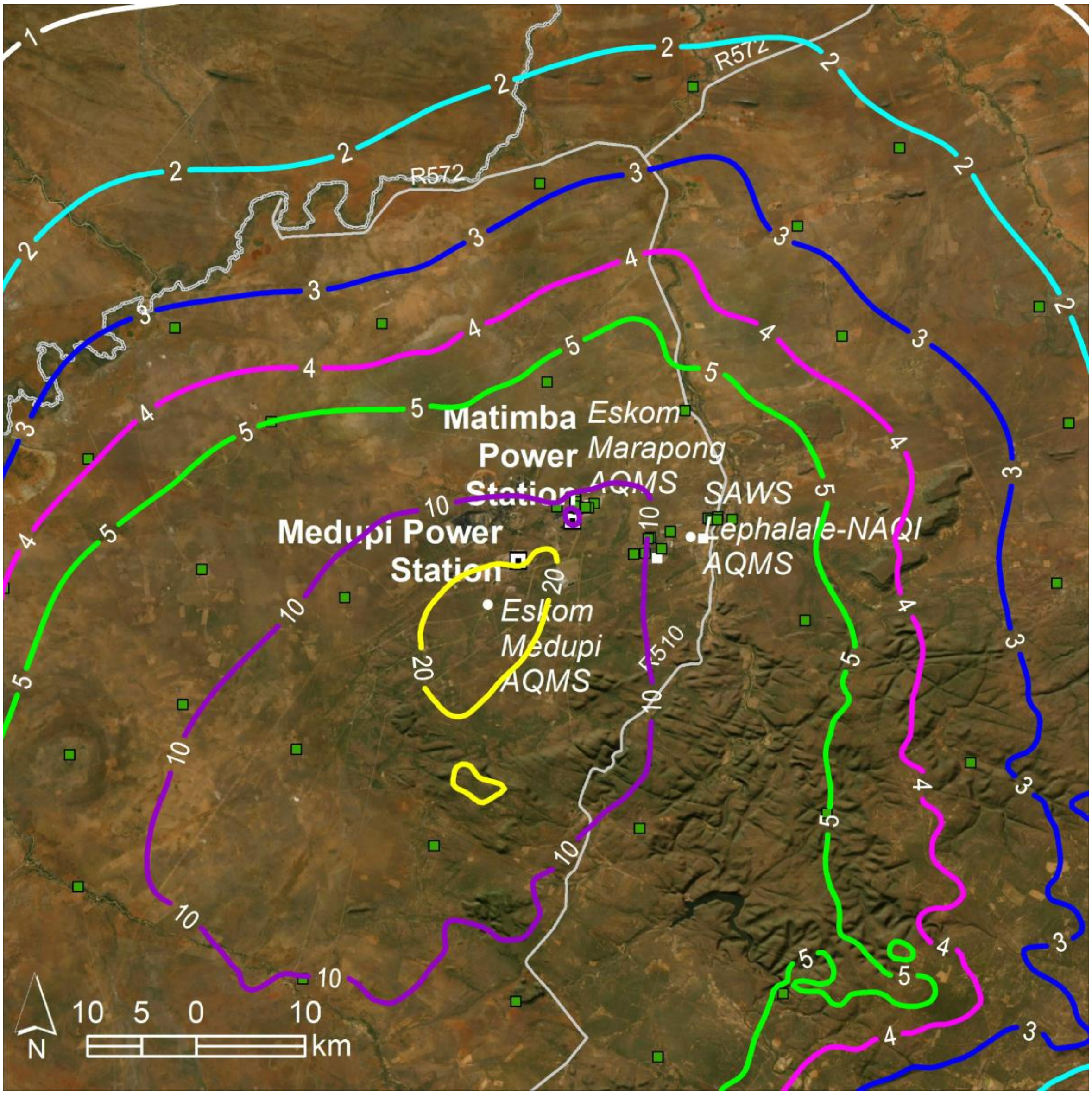


Figure 6-5: Predicted annual average SO_2 concentrations in µg/m³ for Scenario A (2025) (NAAQS Limit is 50 µg/m³)

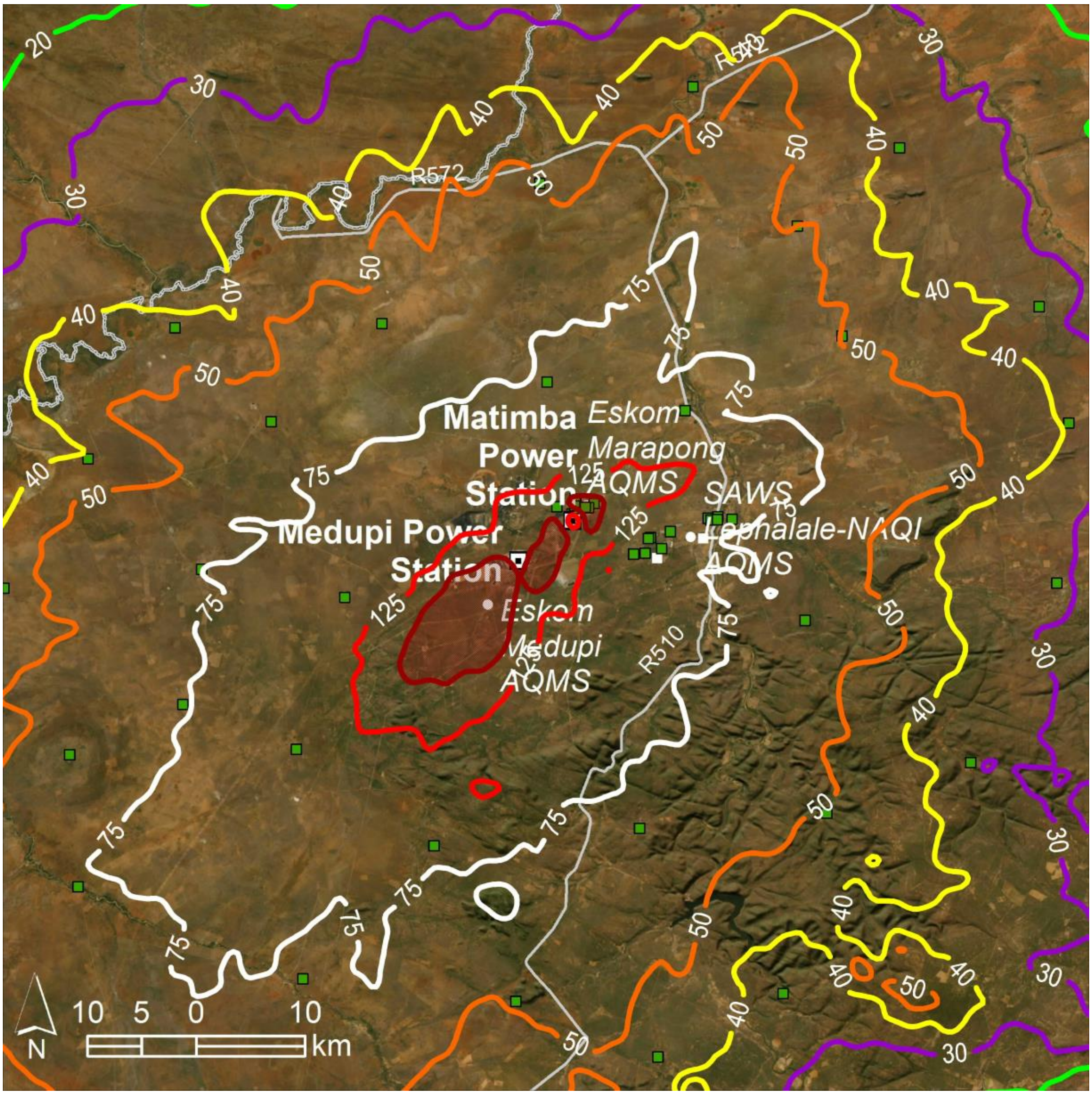


Figure 6-6: Predicted 99th percentile 24-hour SO_2 concentrations in μg/m^3 for Scenario A (2025) (NAAQS Limit is 125 μg/m^3)

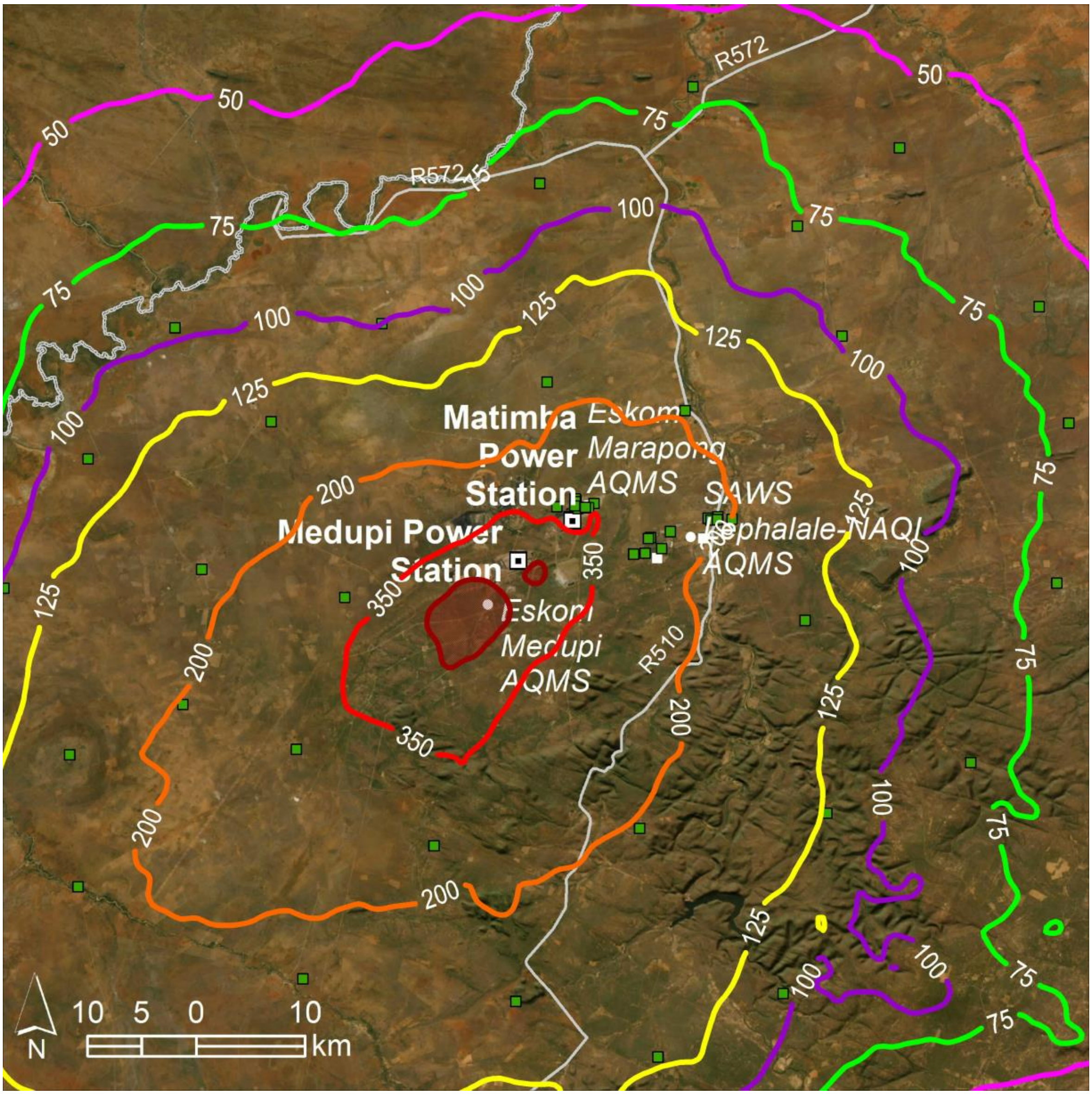


Figure 6-7: Predicted 99th percentile 1-hour SO_2 concentrations in μg/m³ for Scenario A (2025) (NAAQS Limit is 350 μg/m³)

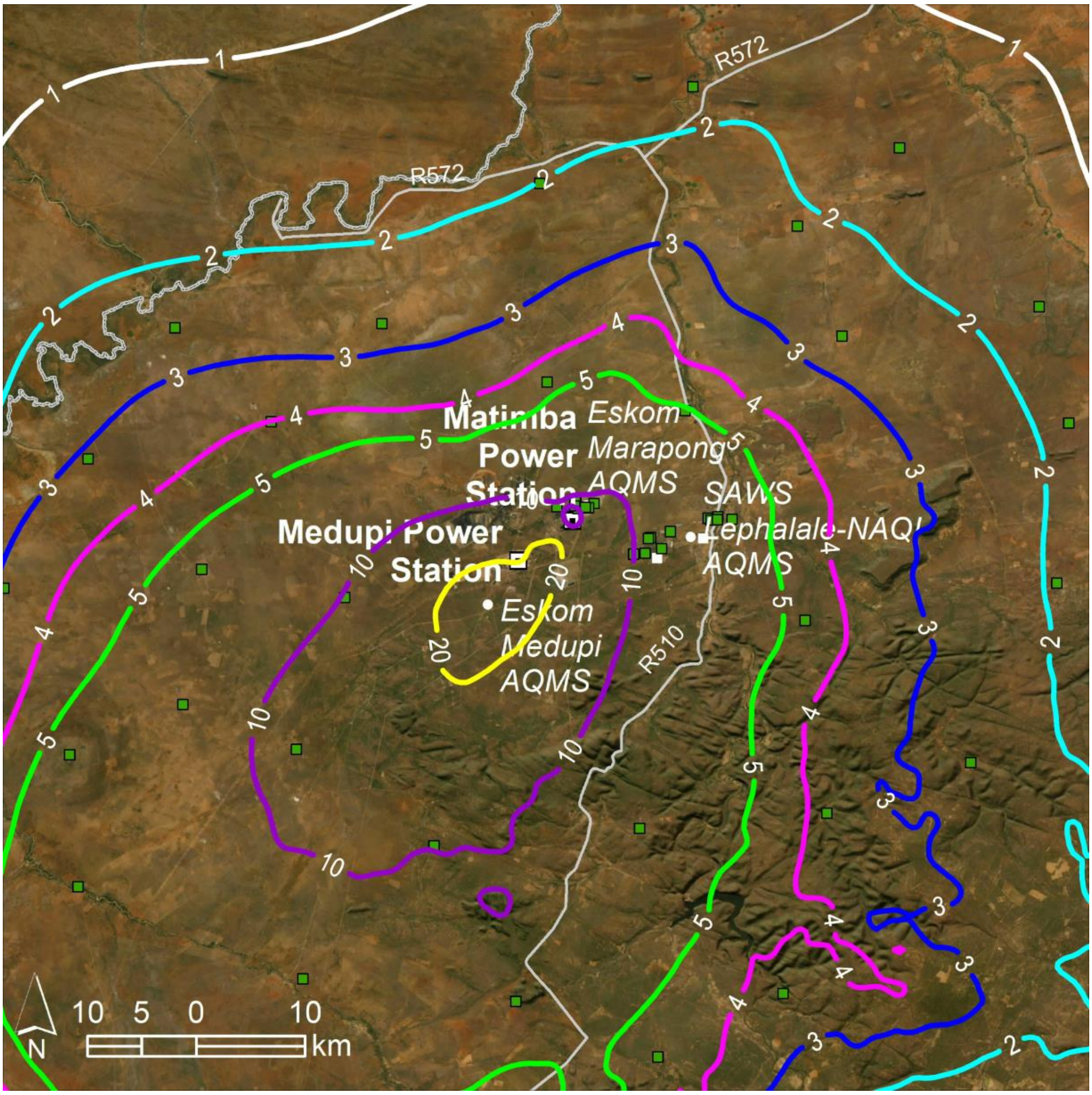


Figure 6-8: Predicted annual average SO_2 concentrations in µg/m³ for Scenario B (2031) (NAAQS Limit is 50 µg/m³)

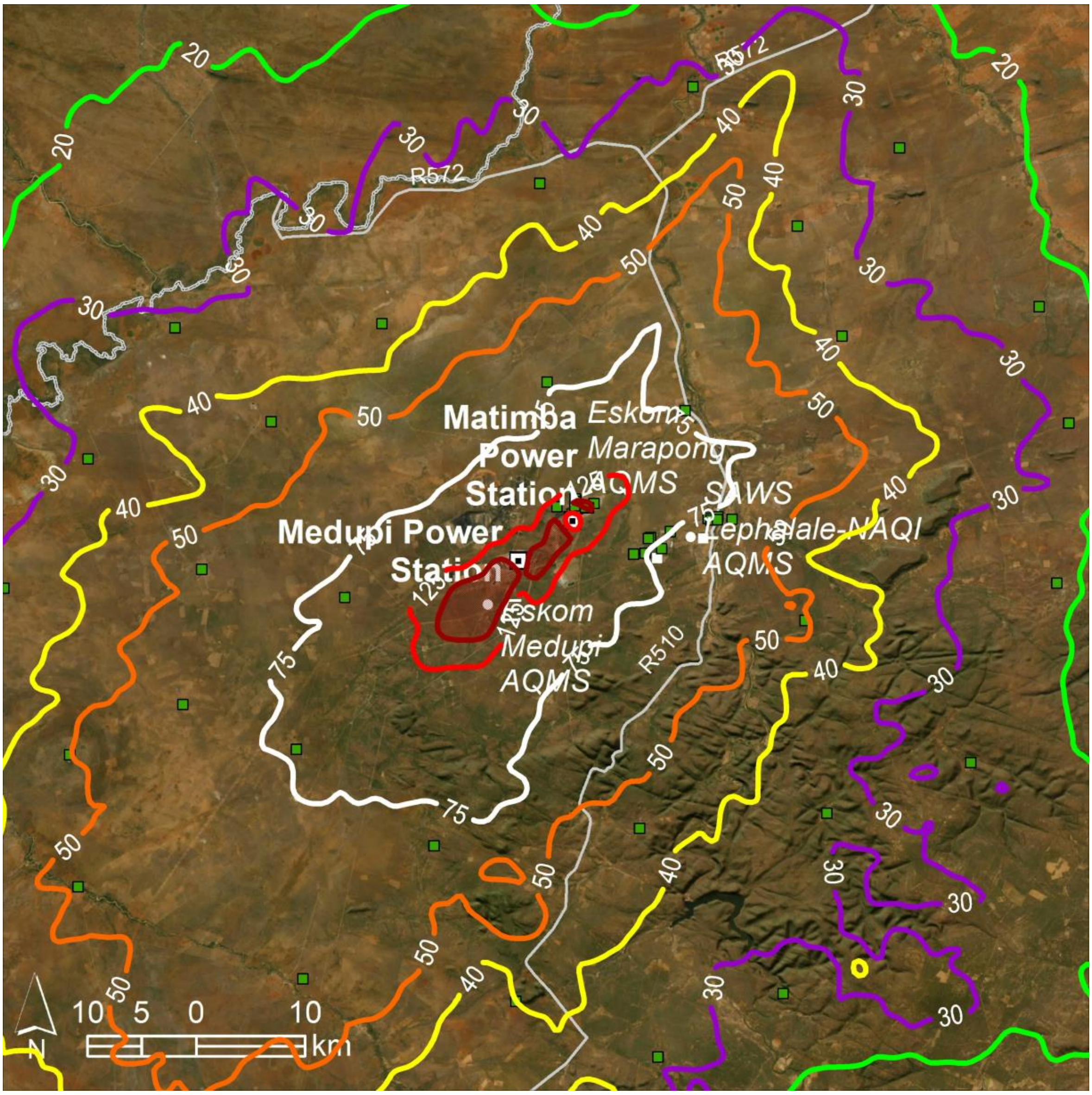


Figure 6-9: Predicted 99th percentile 24-hour SO_2 concentrations in µg/m^3 for Scenario B (2031) (NAAQS Limit is 125 µg/m^3)

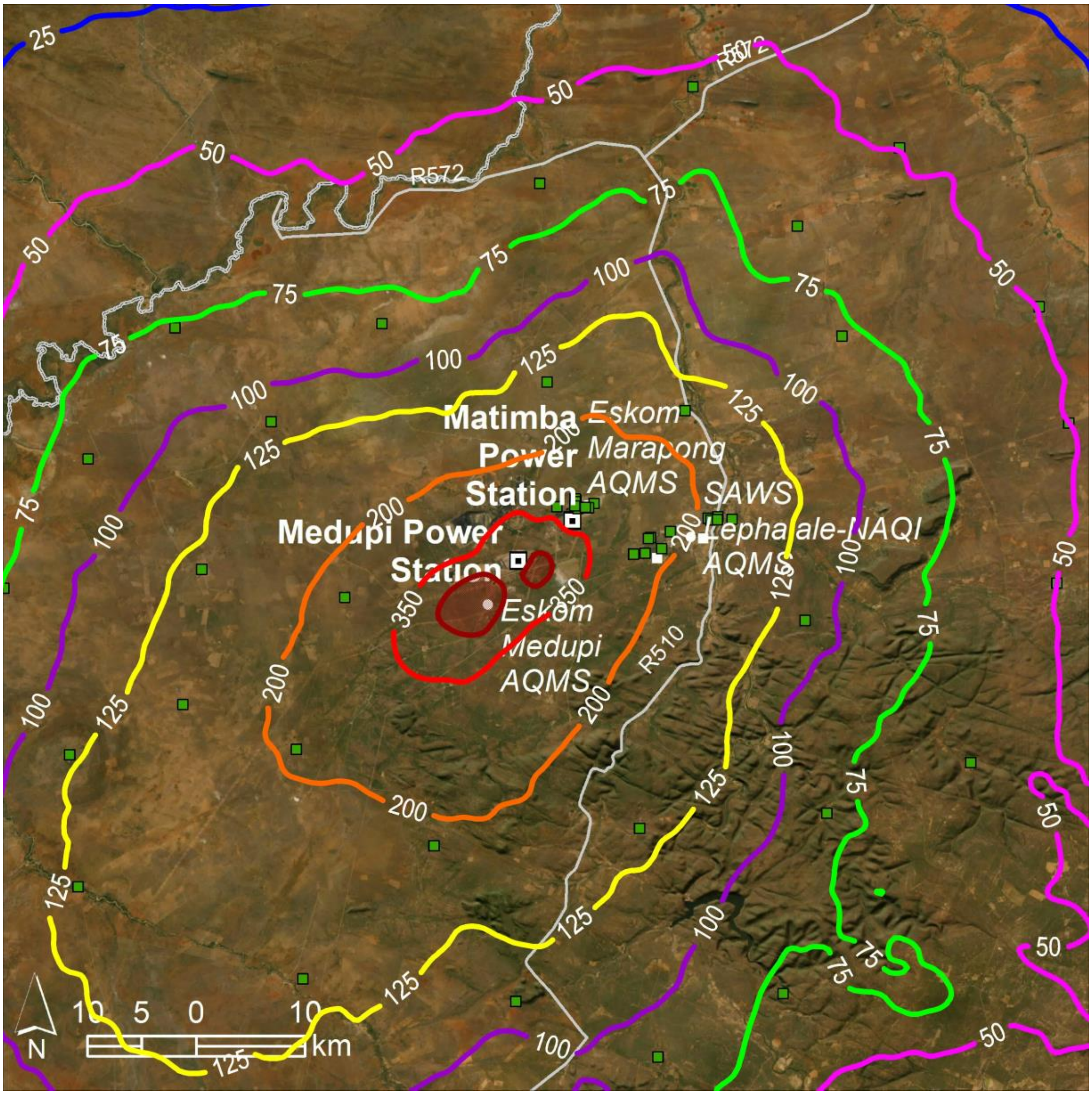


Figure 6-10: Predicted 99th percentile 1-hour SO_2 concentrations in µg/m³ for Scenario B (2031) (NAAQS Limit is 350 µg/m³)

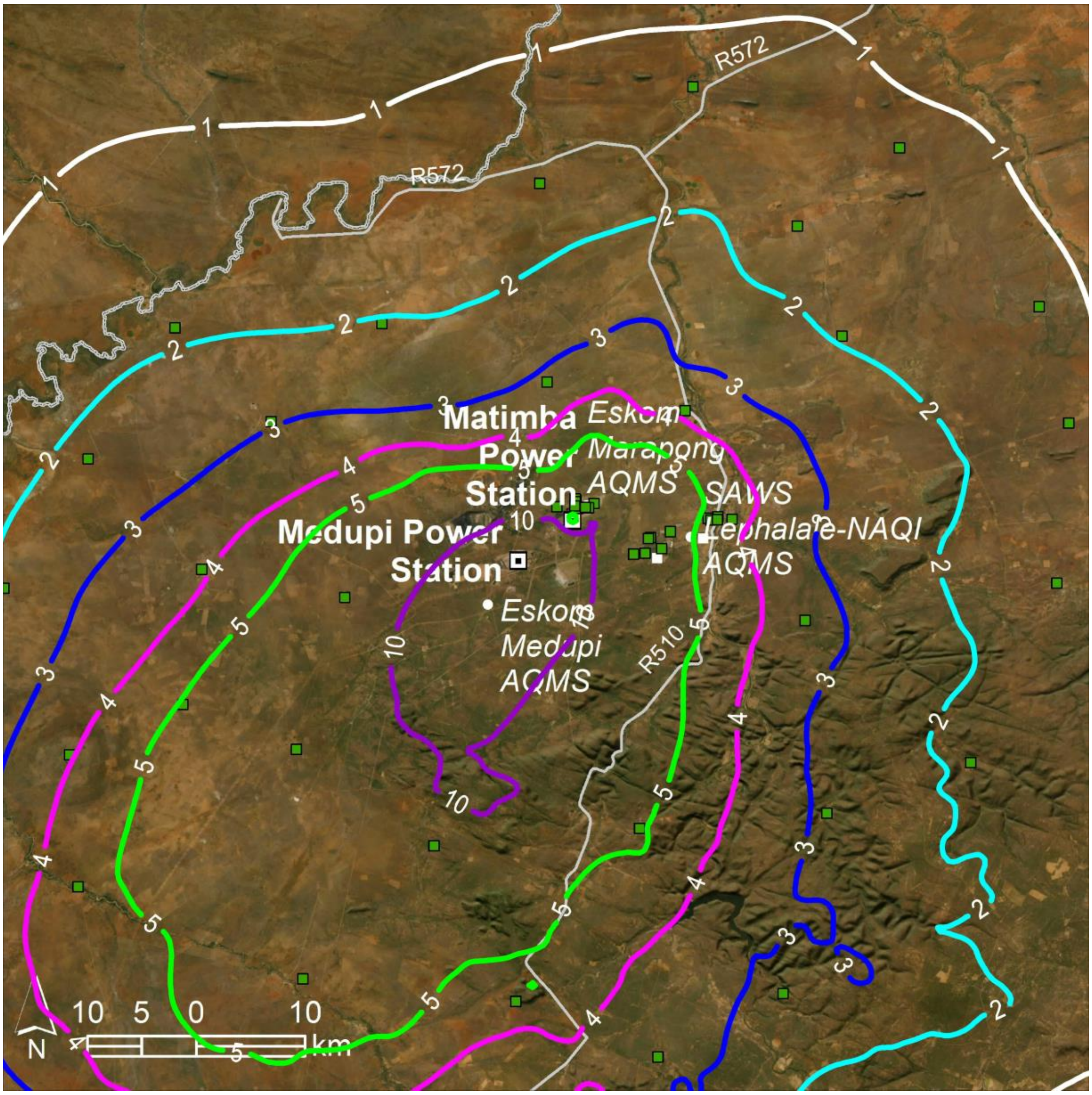


Figure 6-11: Predicted annual average SO_2 concentrations in µg/m³ for Scenario C (2036) (NAAQS Limit is 50 µg/m³)

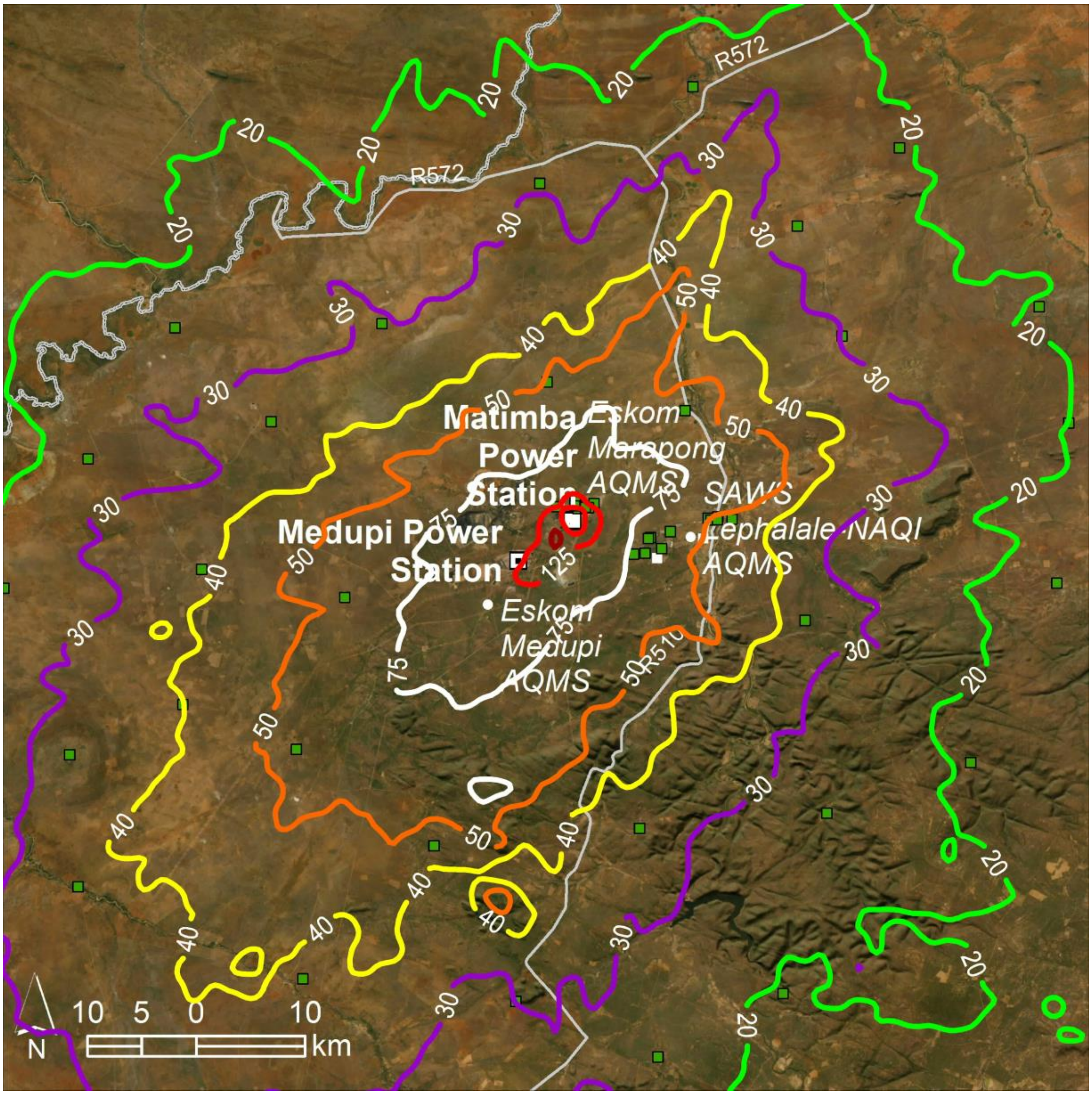


Figure 6-12: Predicted 99th percentile 24-hour SO_2 concentrations in µg/m^3 for Scenario C (2036) (NAAQS Limit is 125 µg/m^3)

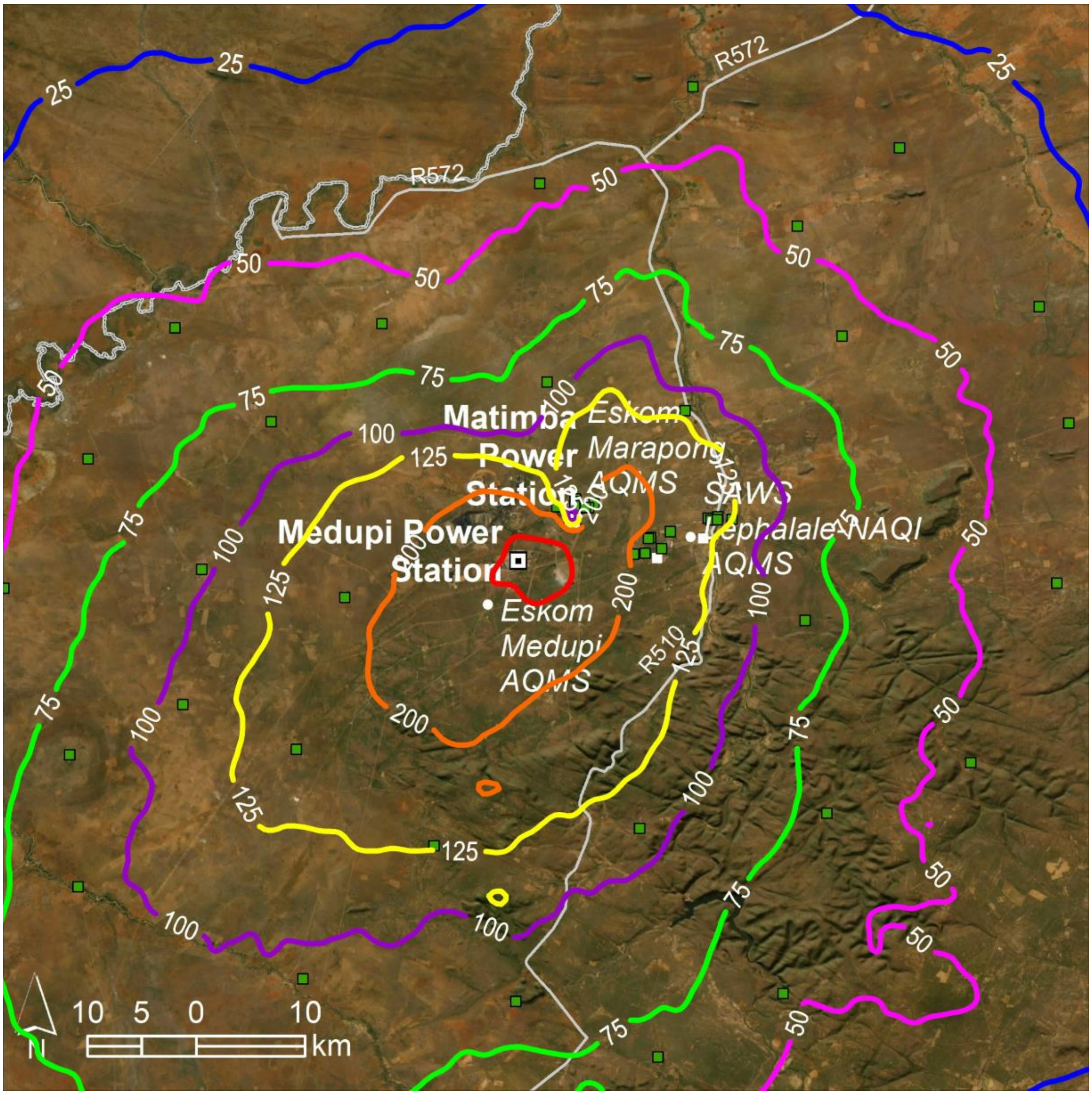


Figure 6-13: Predicted 99th percentile 1-hour SO_2 concentrations in μg/m^3 for Scenario C (2036) (NAAQS Limit is 350 μg/m^3)

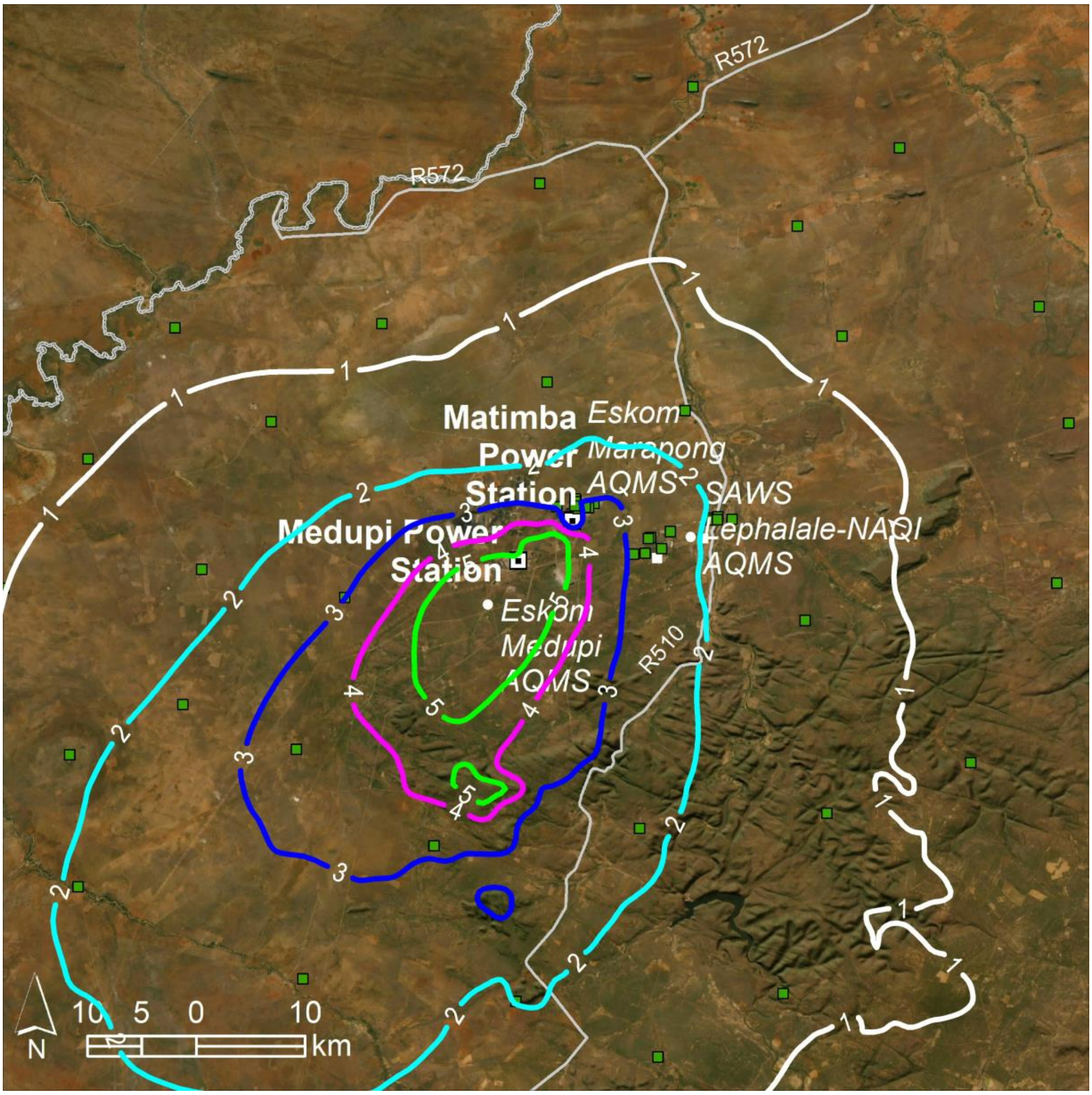


Figure 6-14: Predicted annual average SO_2 concentrations in µg/m^3 for Scenario D (MES) (NAAQS Limit is 50 µg/m^3)

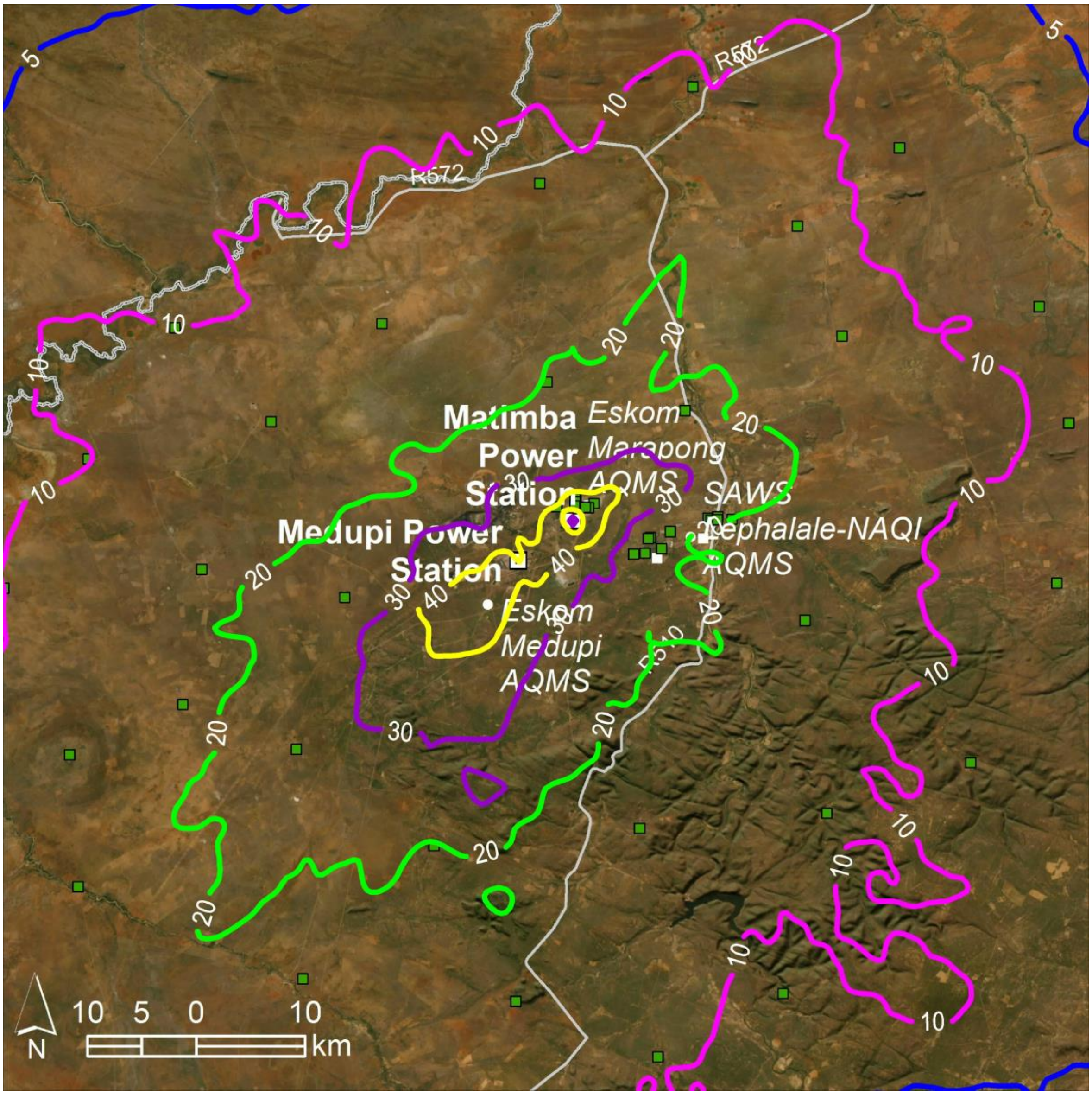


Figure 6-15: Predicted 99th percentile 24-hour SO_2 concentrations in µg/m³ for Scenario D (MES) (NAAQS Limit is 125 µg/m³)

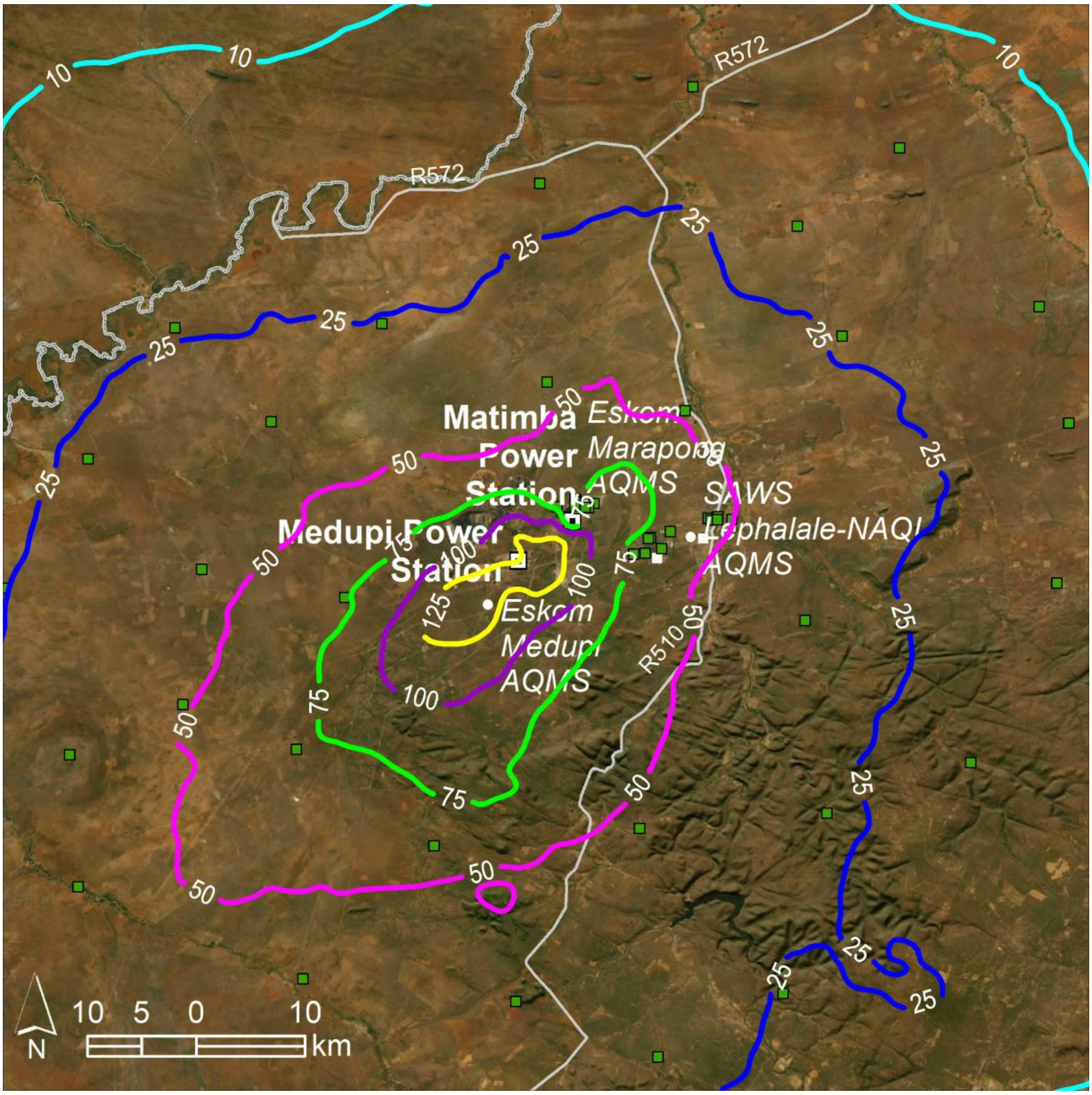


Figure 6-16: Predicted 99th percentile 1-hour SO_2 concentrations in µg/m³ for Scenario D (MES) (NAAQS Limit is 350 µg/m³)

6.2.3.2 Nitrogen dioxide (NO_2)

The isopleth maps showing the predicted annual average NO_2 concentrations clearly demonstrate the effect of the predominant northeasterly winds, with dispersion generally to the southwest of the power plant. In all scenarios the highest predicted annual average concentrations occur between 10 and 20 km to the southwest of the two power stations. The predicted ambient concentrations for all averaging periods are low and well below the NAAQS in all scenarios throughout the modelling domain.

For the annual 24-hour and 1-hour predictions, the effect of the increase in NO_2 emissions from Scenario 1 (Current) to Scenario A (2025) at Medupi is shown in the modelled results by an increase in the affected area. Similarly, the reduction in NO_2 emissions to Scenario B (2031) at both Medupi and Matimba is seen by a reduction in the affected area from the one scenario to the next. A small reduction in the affected is seen from Scenario B (2031) to Scenario C (2036). No further change is seen from Scenario C (2036) to Scenario D (MES).

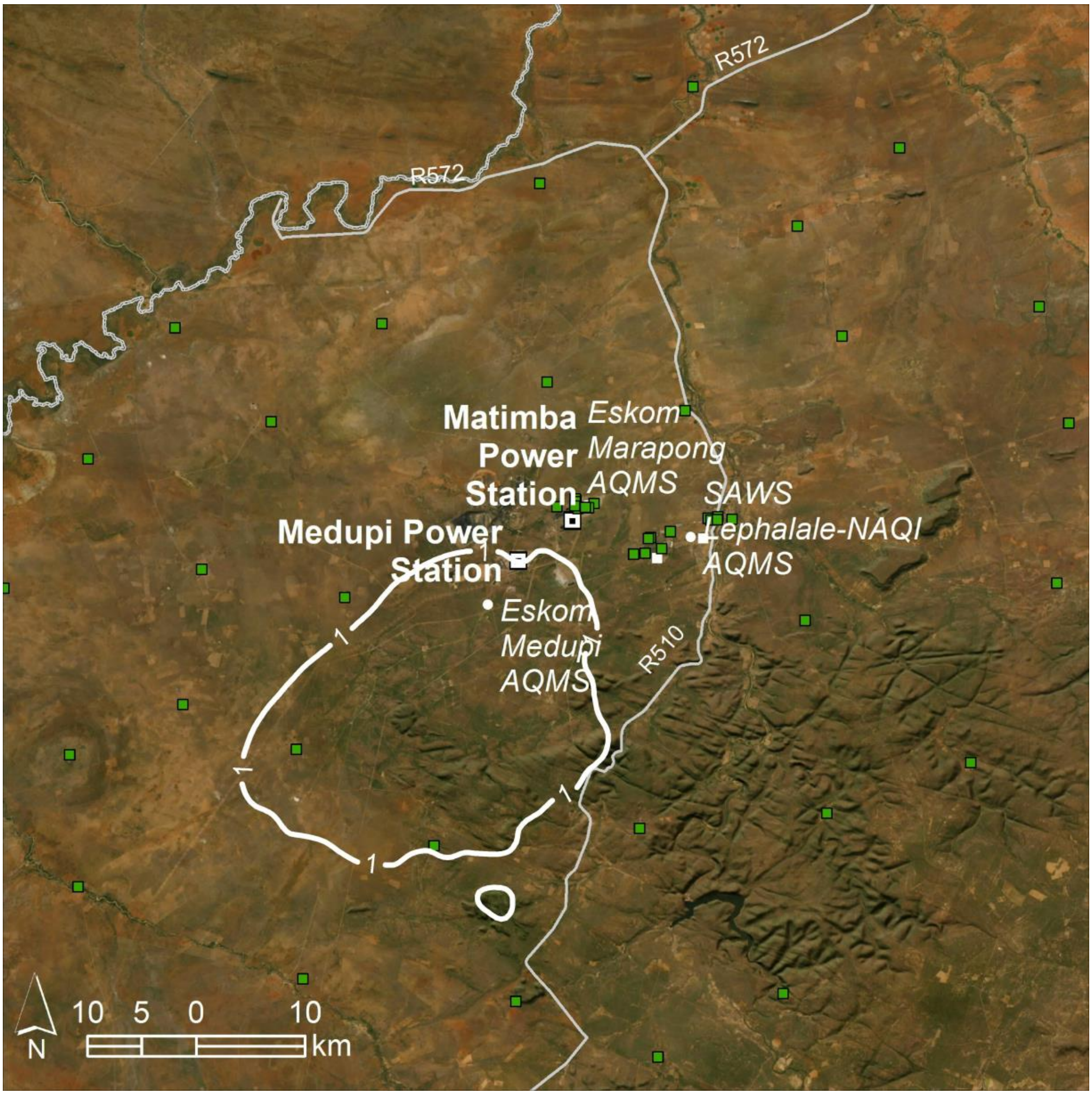


Figure 6-17: Predicted annual average NO_2 concentrations in μg/m^3 for Scenario 1 (Current) (NAAQS Limit is 40 μg/m^3)

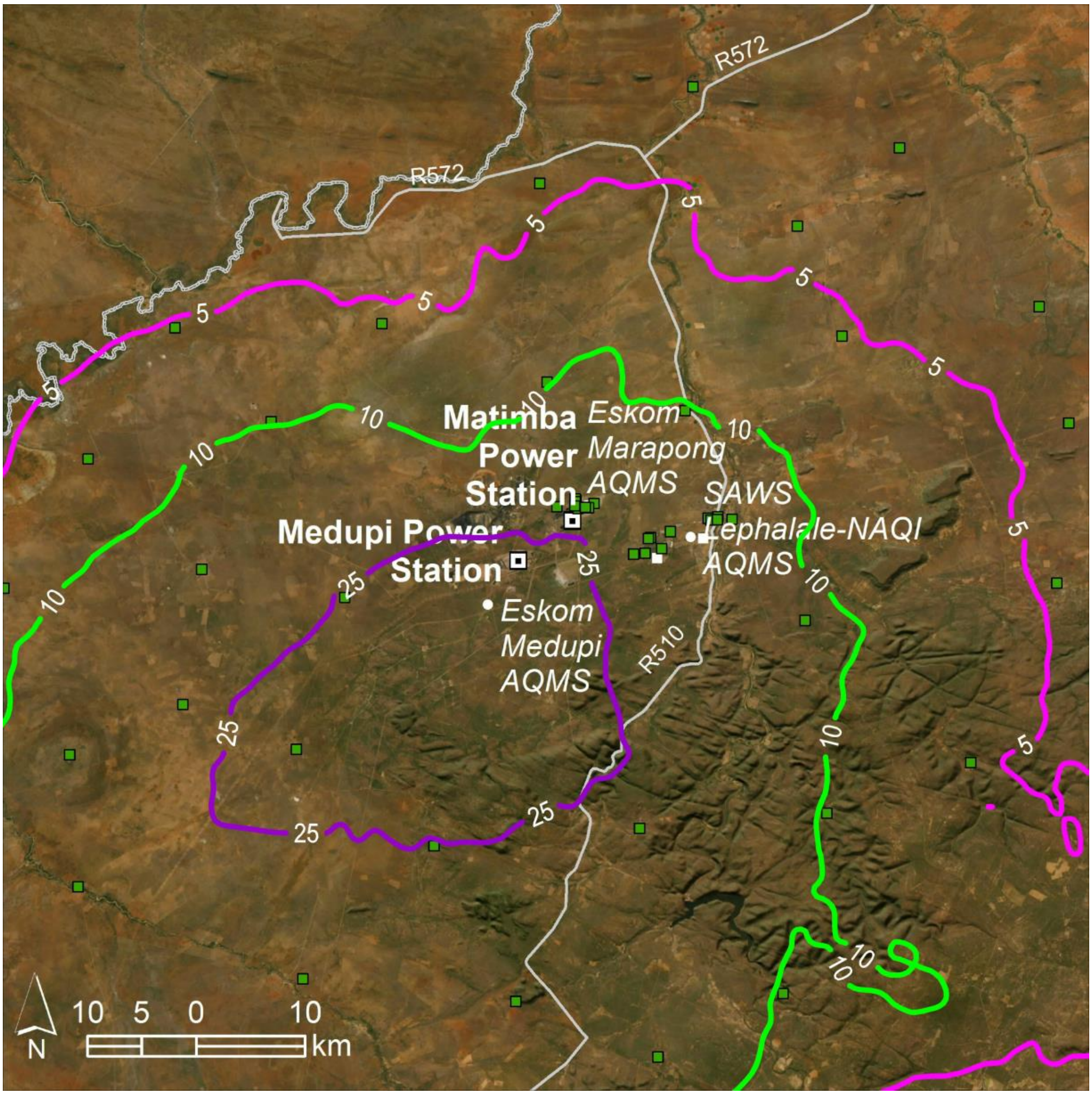


Figure 6-18: Predicted 99th percentile 1-hour NO_2 concentrations in µg/m^3 for Scenario 1 (Current) (NAAQS Limit is 200 µg/m^3)

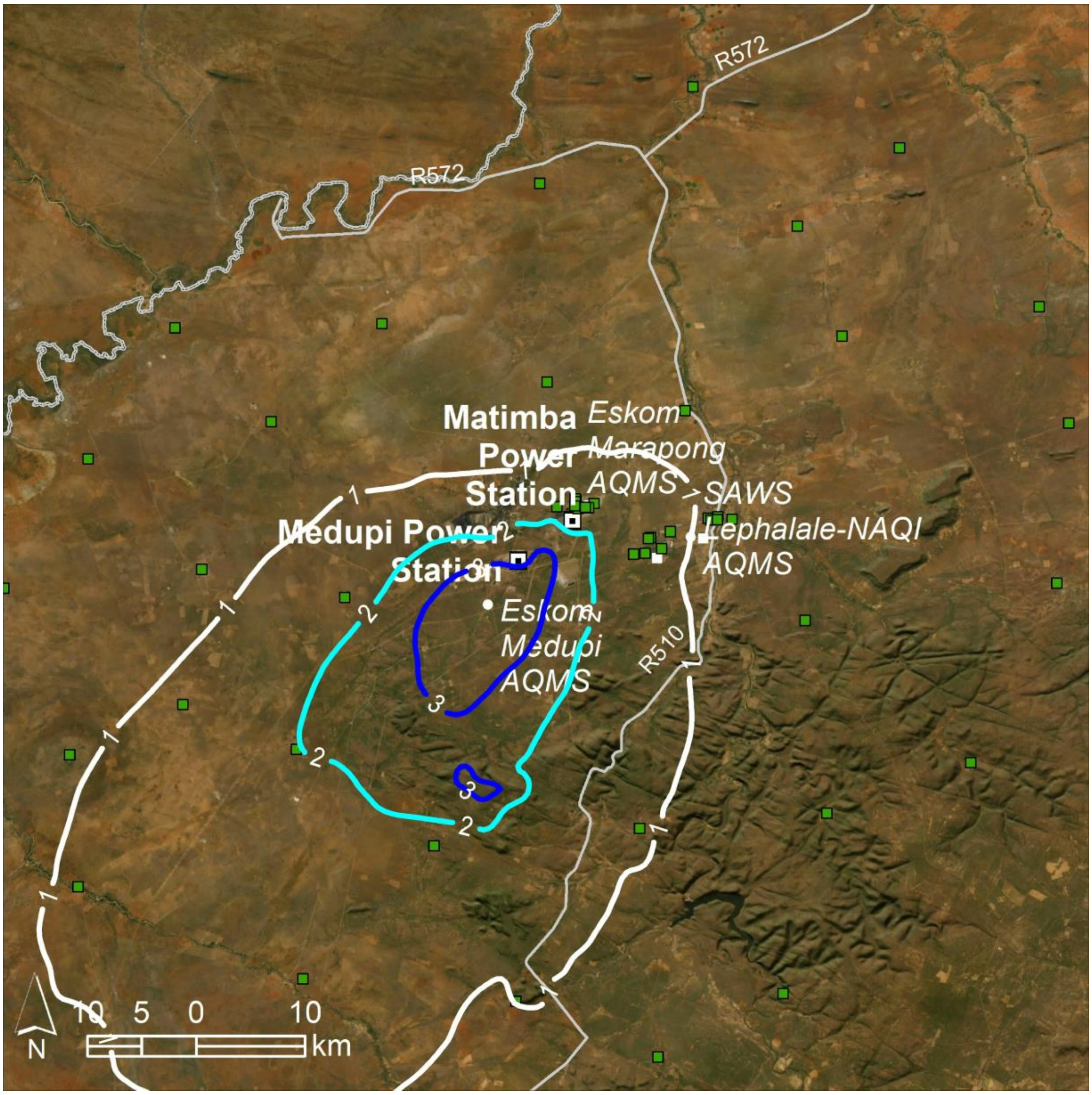


Figure 6-19: Predicted annual average NO_2 concentrations in µg/m³ for Scenario A (2025) (NAAQS Limit is 40 µg/m³)

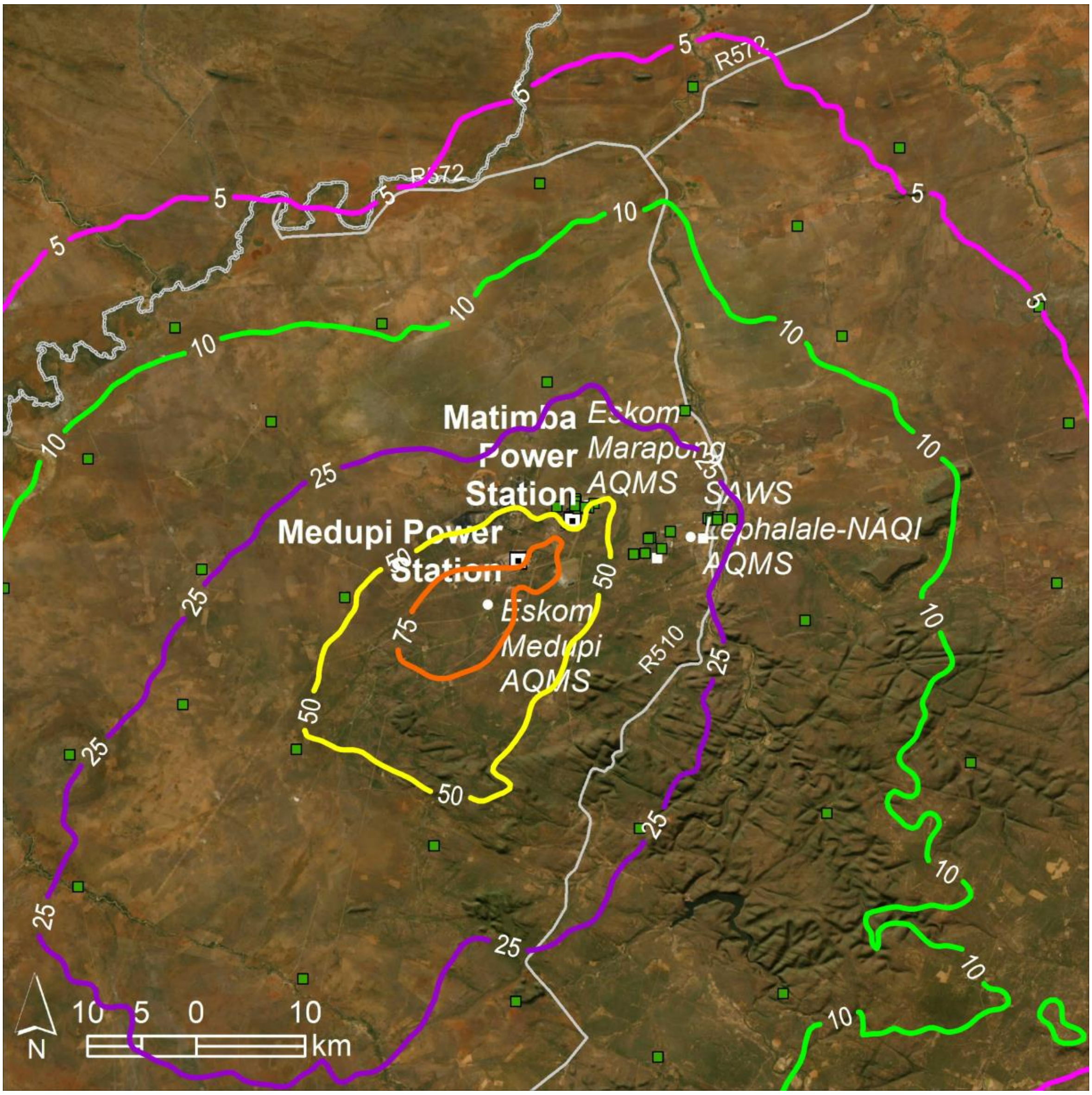


Figure 6-20: Predicted 99th percentile 1-hour NO_2 concentrations in µg/m³ for Scenario A (2025) (NAAQS Limit is 200 µg/m³)

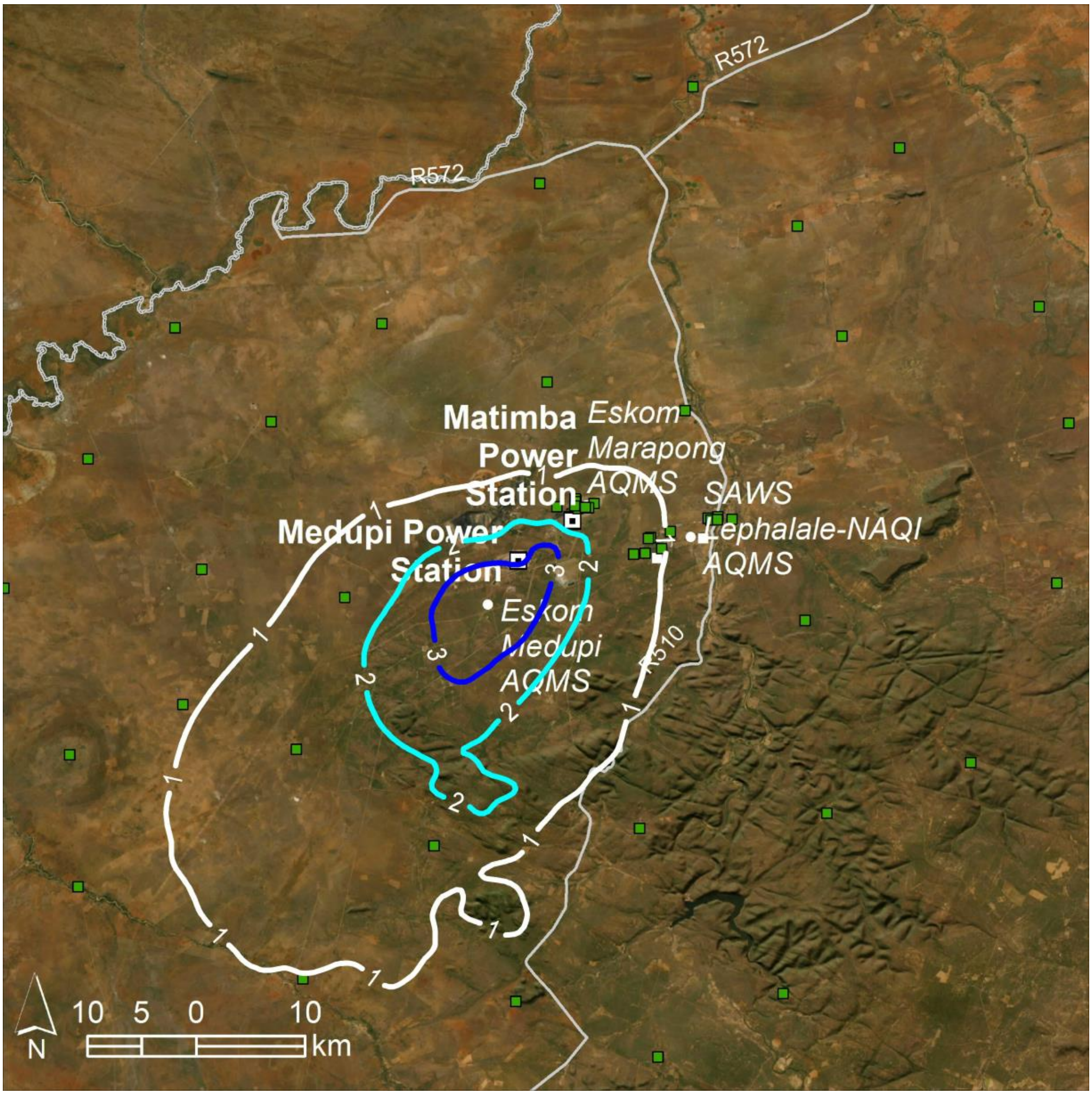


Figure 6-21: Predicted annual average NO_2 concentrations in µg/m³ for Scenario B (2031) (NAAQS Limit is 40 µg/m³)

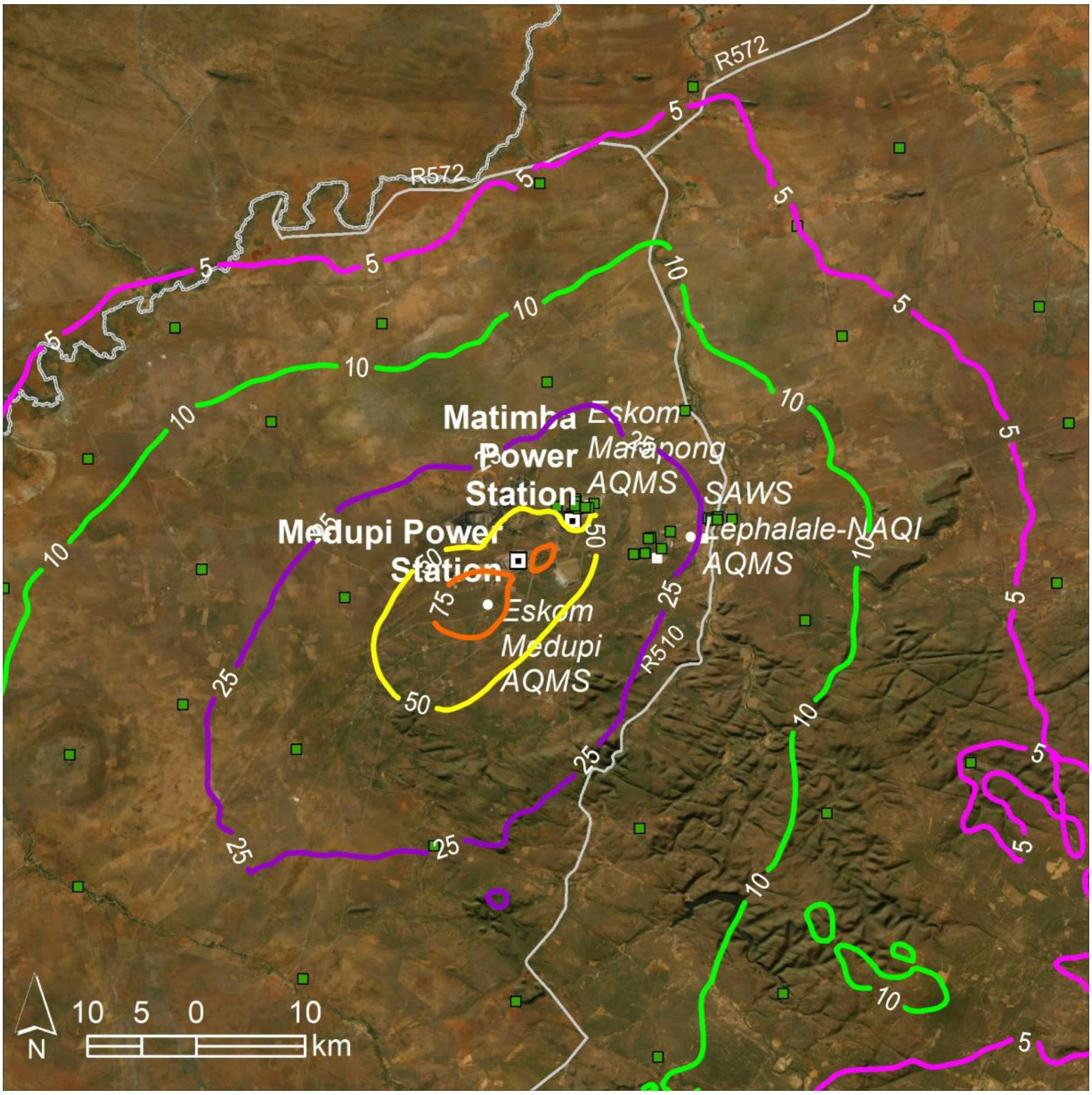


Figure 6-22: Predicted 99th percentile 1-hour NO_2 concentrations in µg/m³ for Scenario B (2031) (NAAQS Limit is 200 µg/m³)

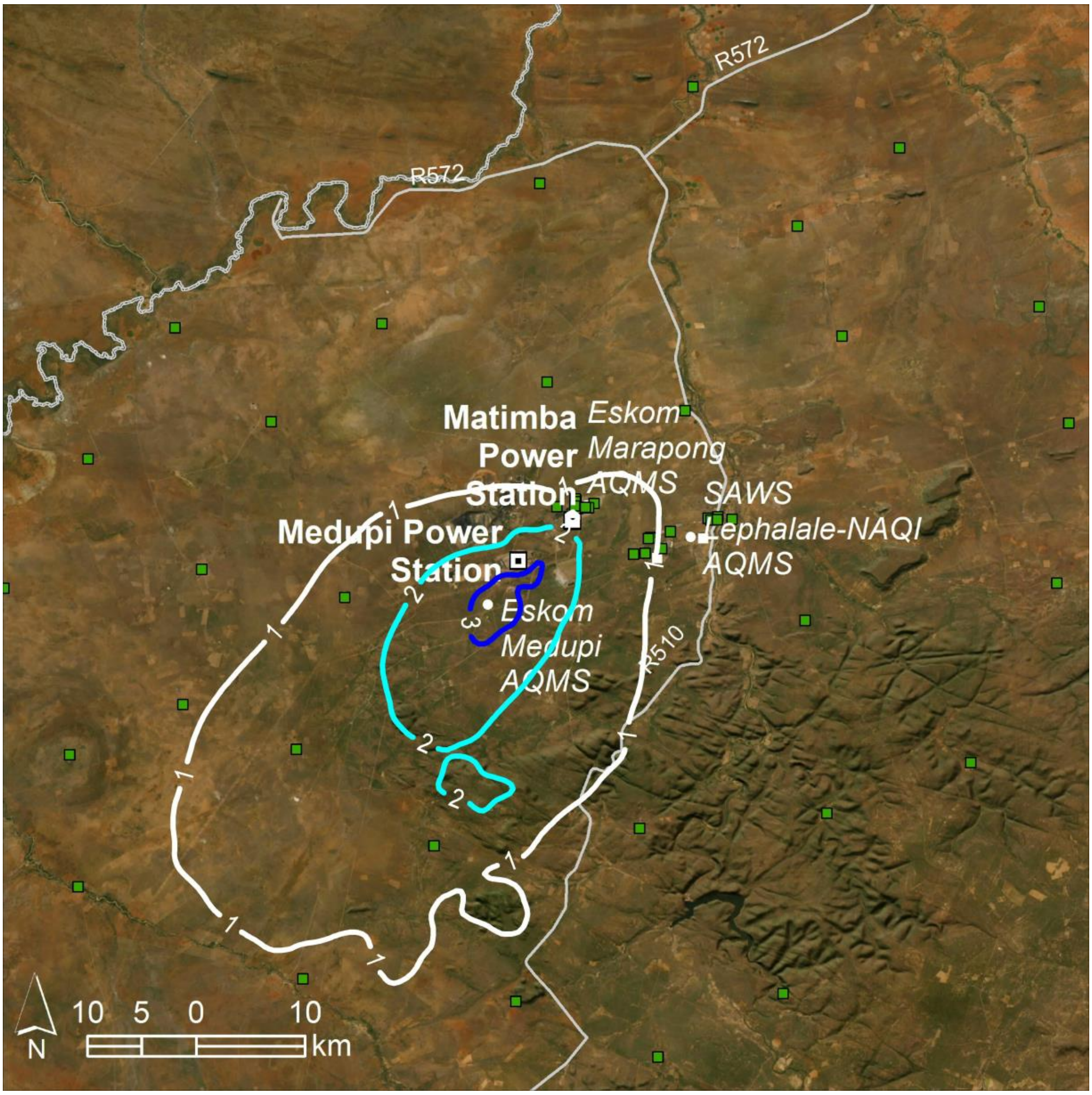


Figure 6-23: Predicted annual average NO_2 concentrations in μg/m³ for Scenario C (2036) (NAAQS Limit is 40 μg/m³)

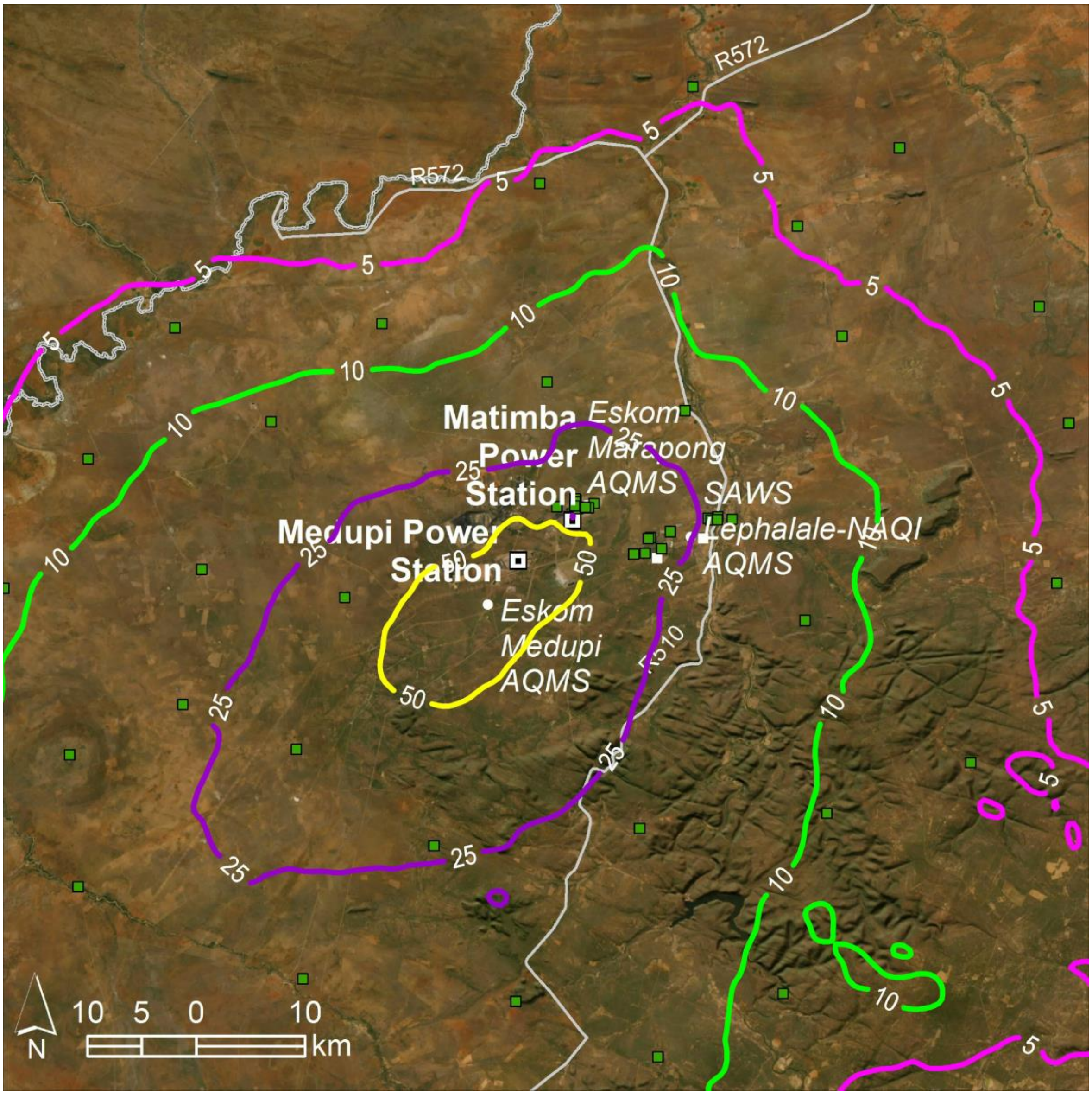


Figure 6-24: Predicted 99th percentile 1-hour NO_2 concentrations in µg/m³ for Scenario C (2036) (NAAQS Limit is 200 µg/m³)

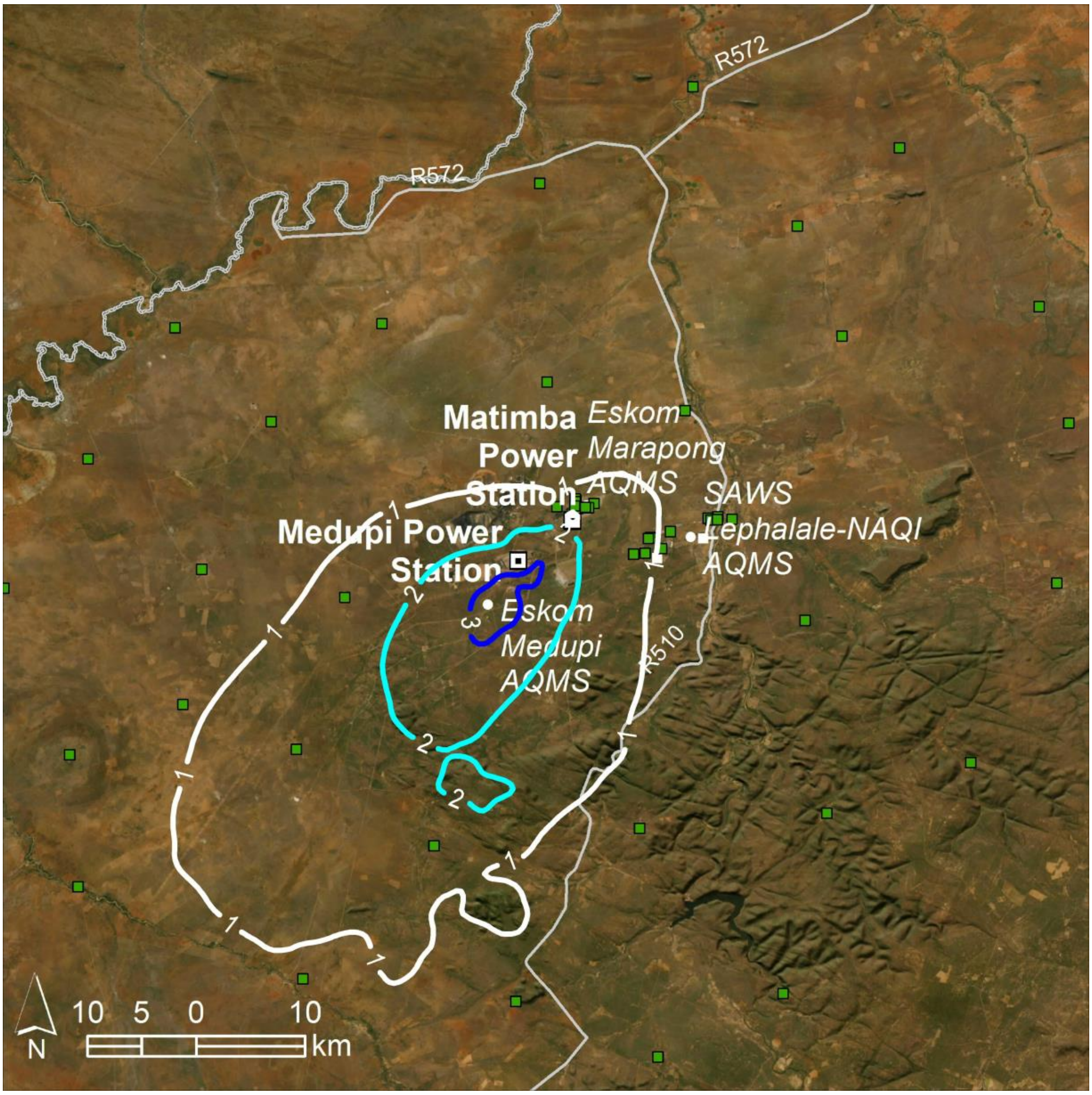


Figure 6-25: Predicted annual average NO_2 concentrations in μg/m³ for Scenario D (MES) (NAAQS Limit is 40 μg/m³)

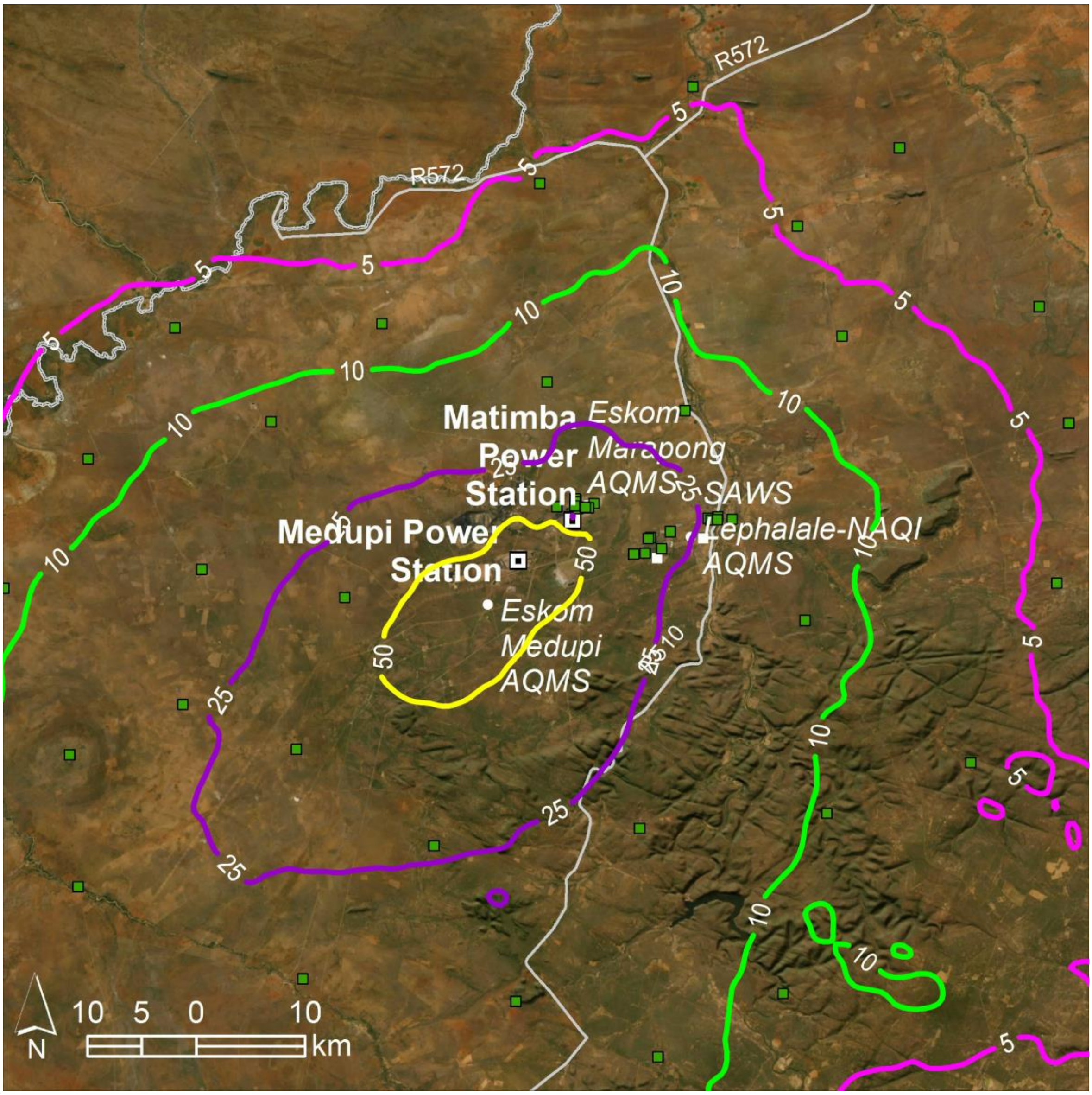


Figure 6-26: Predicted 99th percentile 1-hour NO_2 concentrations in µg/m³ for Scenario D (MES) (NAAQS Limit is 200 µg/m³)

6.2.3.3 Particulates (PM_{10})

The isopleth plots for PM_{10} are similar for all scenarios due to the significant contribution of the low-level fugitive sources to the ambient concentrations. The fugitive emission from the coal stockyard and the ash dump are the same for all scenarios, hence the similarity in the model results for the five scenarios. The effect on ambient PM_{10} concentrations of relatively small changes in the stack PM emissions is masked in the model output by the effect of the fugitive sources.

The predicted annual average concentrations exceed the NAAQS of 40 $\mu g/m^3$ in a small area immediately to the southwest of the two power stations. The area where the predicted 24-hour concentrations exceed the limit value of 75 $\mu g/m^3$ (shaded area) extends up to 10 km to the southwest of the two power station.

Exceedances of the 24-hour limit value of 75 $\mu g/m^3$ is exceeded once in the 3-year modelling period at 2 sensitive receptor points in Scenario 1 (Current) and Scenario B (2031), and once at 5 sensitive receptor points in Scenario A (2025). As 12 exceedances are permitted in the 3-year modelling period these predictions comply with the NAAQS.

It must be remembered that the predictions are conservative given the assumption that TPM = PM_{10} = $PM_{2.5}$. Remembering too that the fugitive emission have the greatest effect on ambient concentrations close to the source, while the effect of the stack emissions is generally further from the power station.

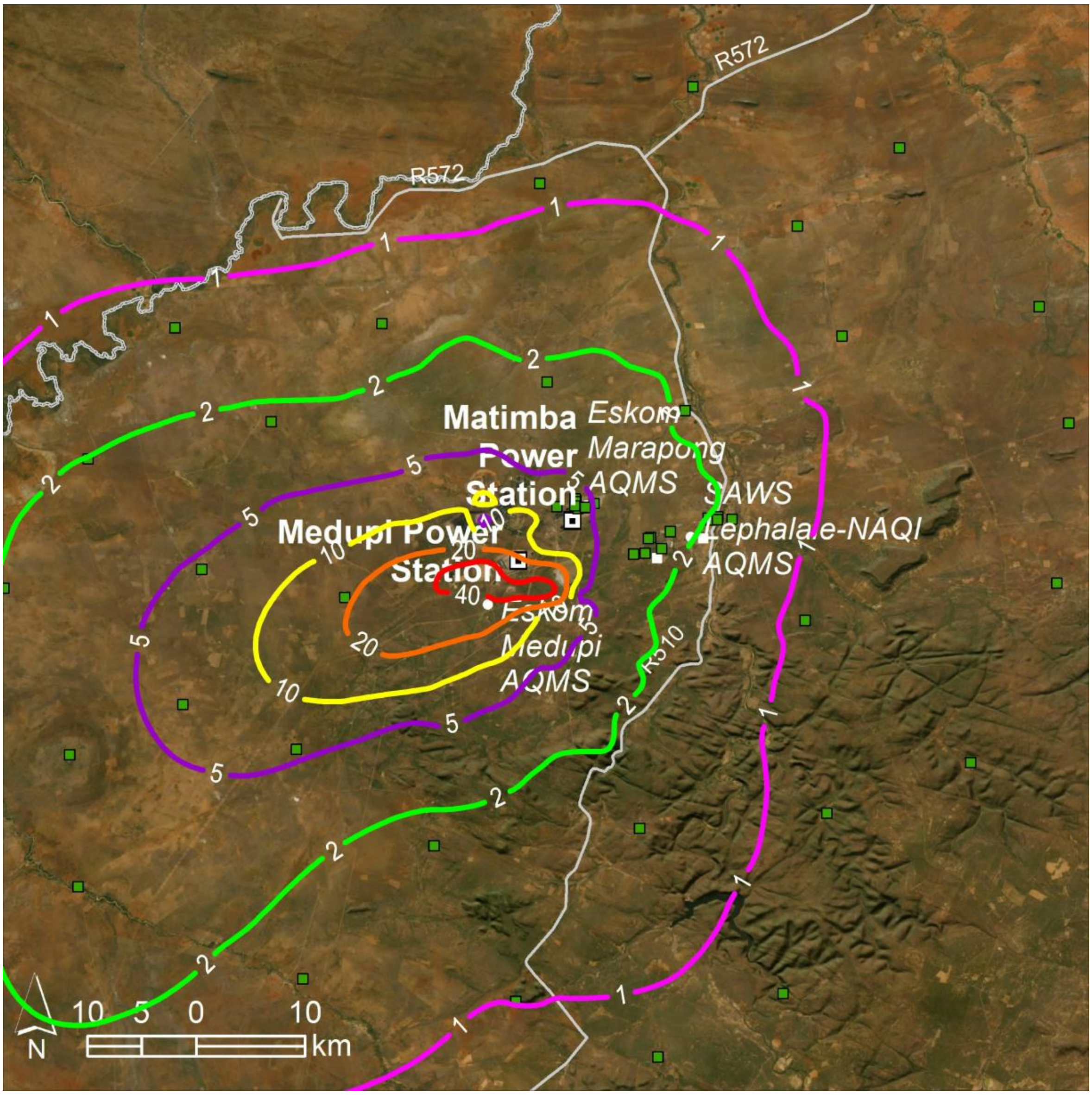


Figure 6-27: Predicted annual average PM_{10} concentrations in µg/m^3 for Scenario 1 (Current) (NAAQS Limit is 40 µg/m^3)

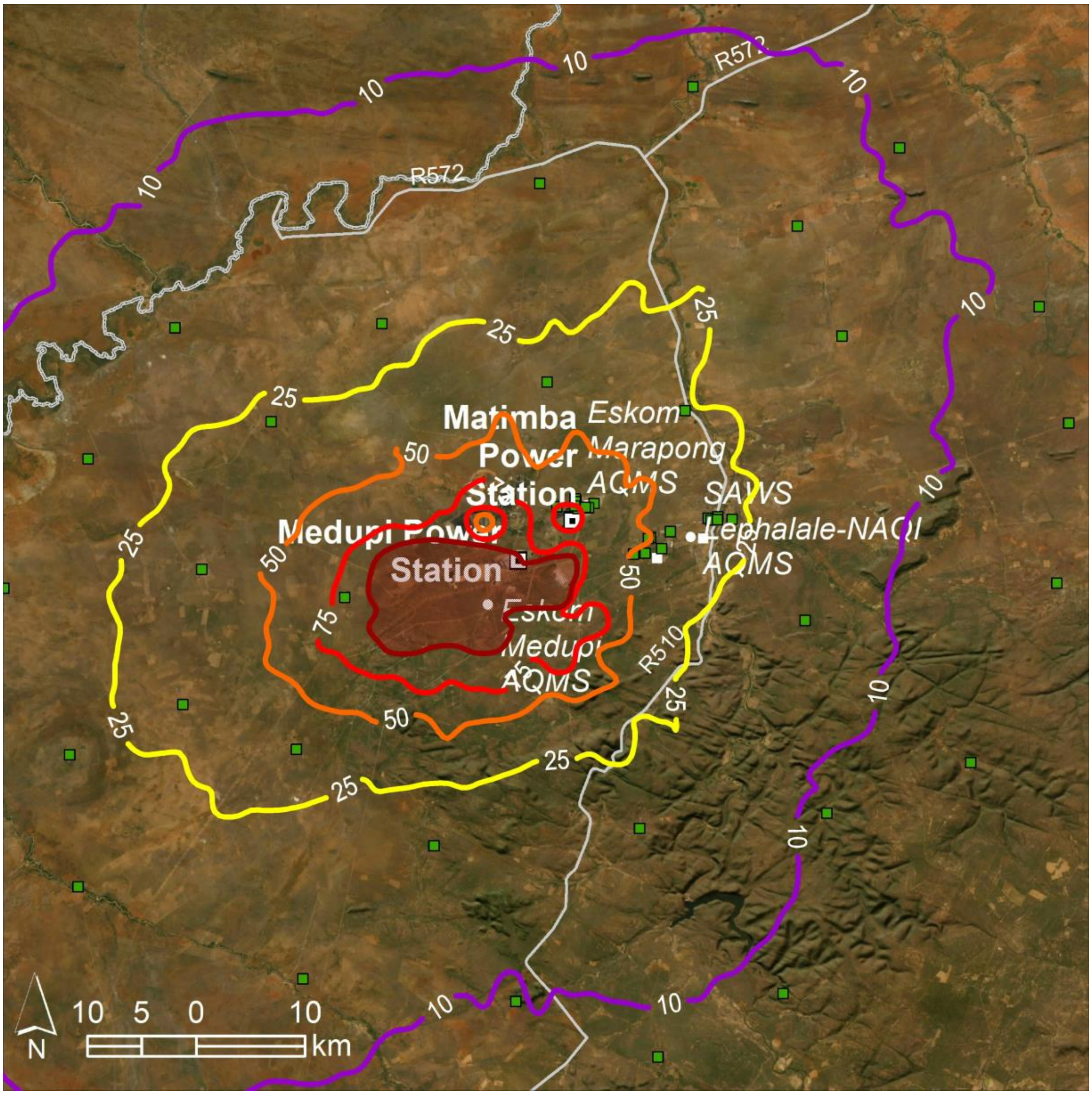


Figure 6-28: Predicted 99th percentile of the 24-hour PM_{10} concentrations in $\mu g/m^3$ for Scenario 1 (Current) (NAAQS Limit is 75 $\mu g/m^3$)

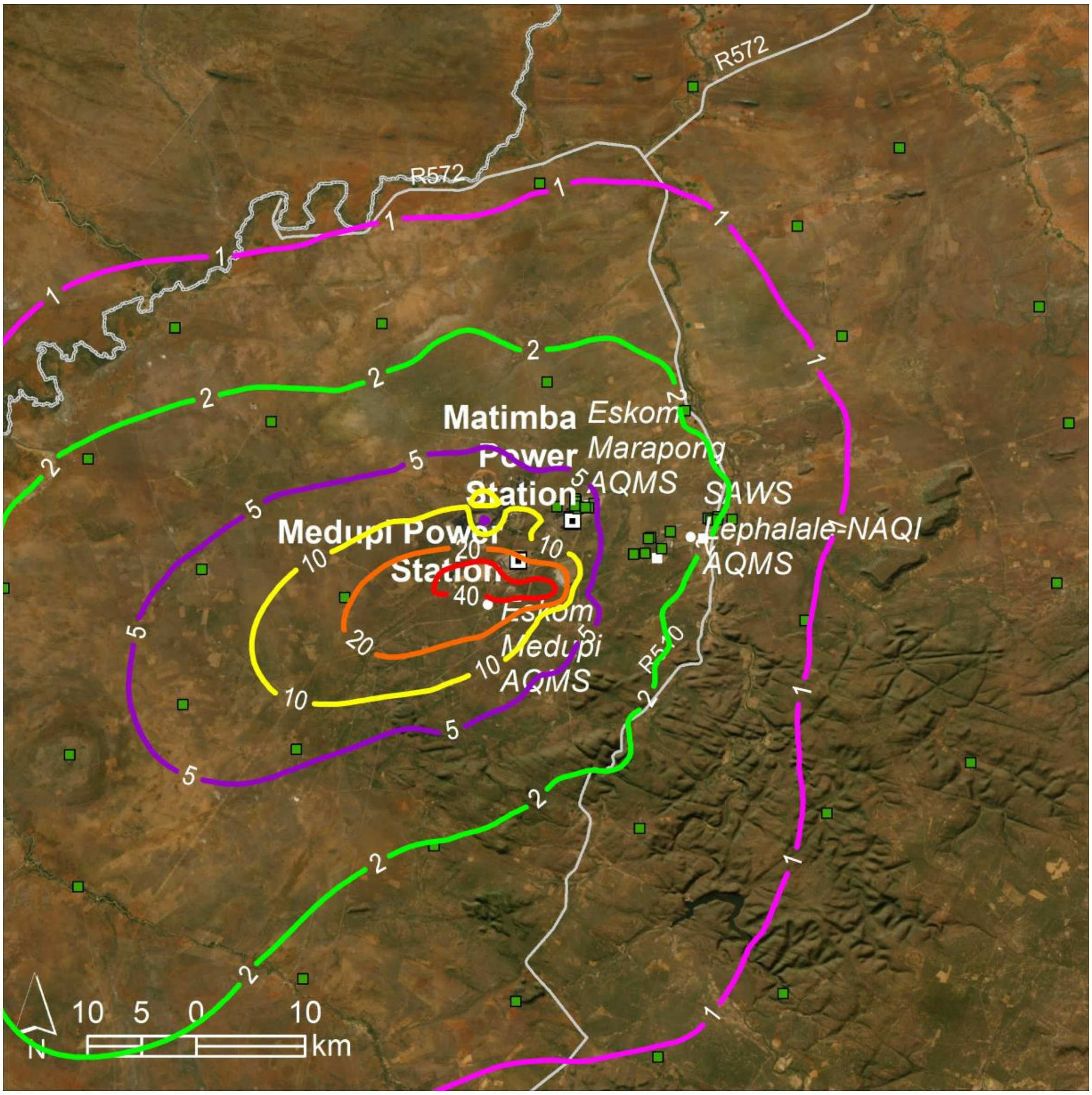


Figure 6-29: Predicted annual average PM_{10} concentrations in µg/m^3 for Scenario A (2025) (NAAQS Limit is 40 µg/m^3)

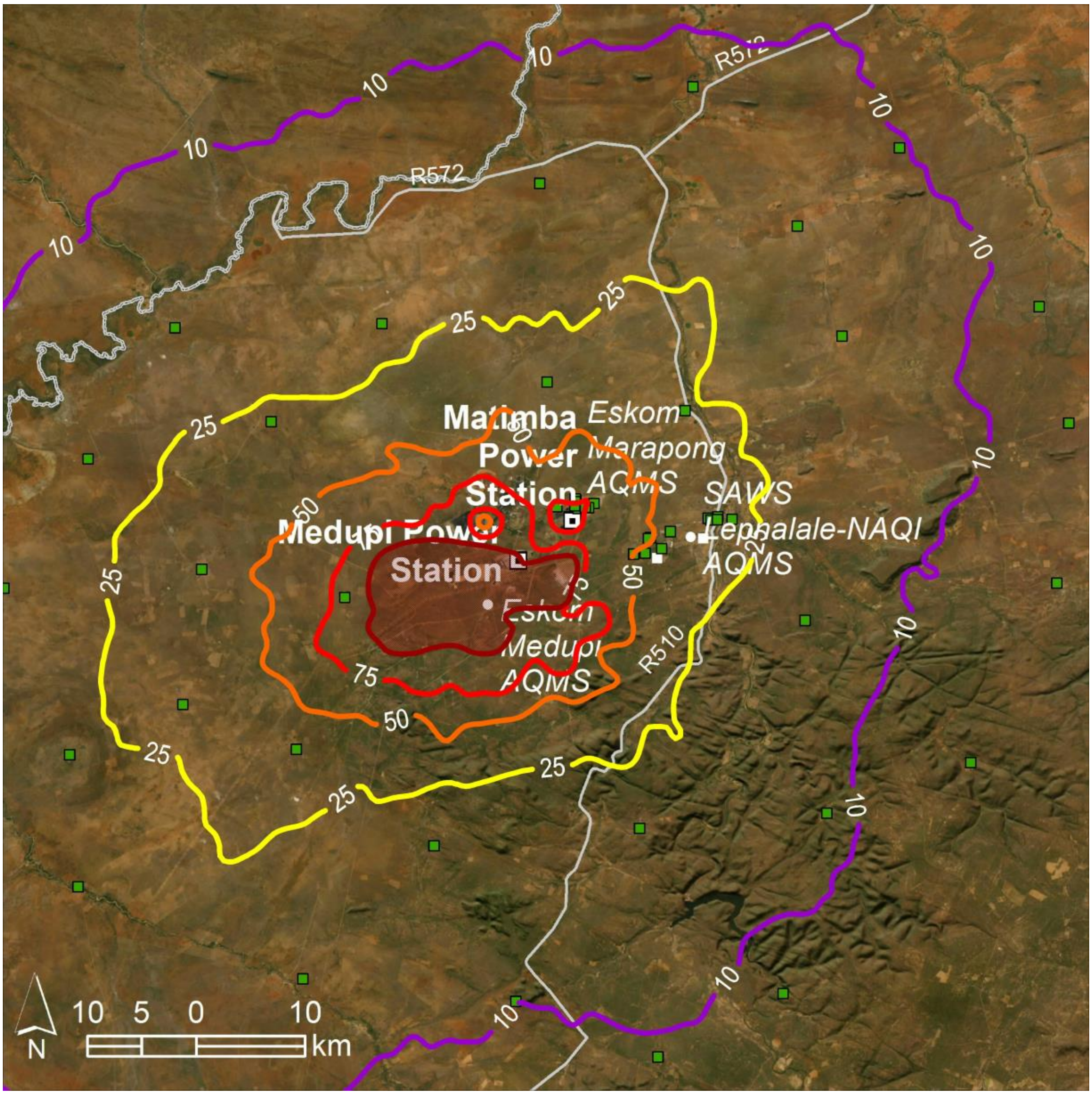


Figure 6-30: Predicted 99th percentile of the 24-hour PM_{10} concentrations in µg/m³ for Scenario A (2025) (NAAQS Limit is 75 µg/m³)

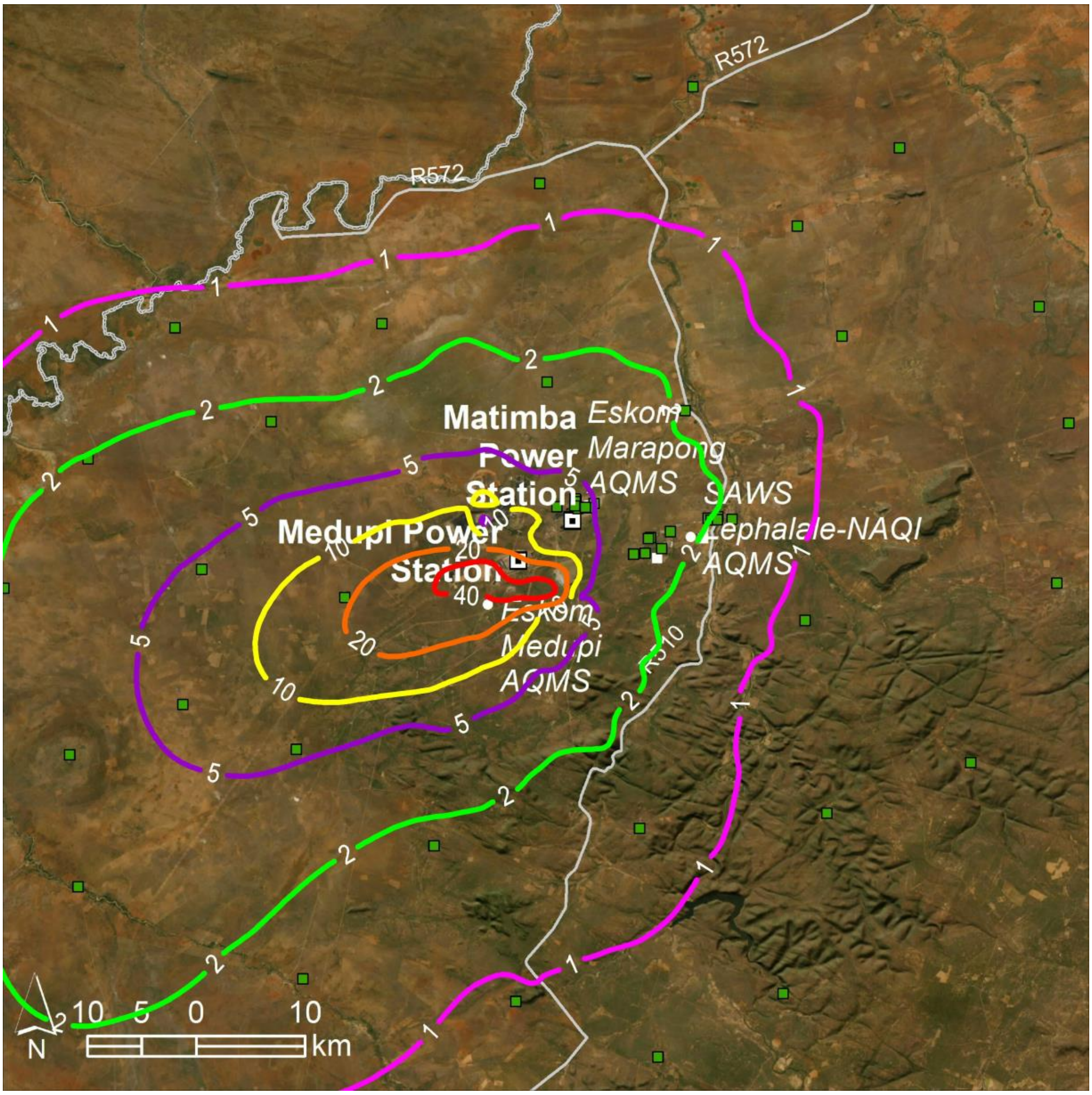


Figure 6-31: Predicted annual average PM_{10} concentrations in µg/m³ for Scenario B (2031) (NAAQS Limit is 40 µg/m³)

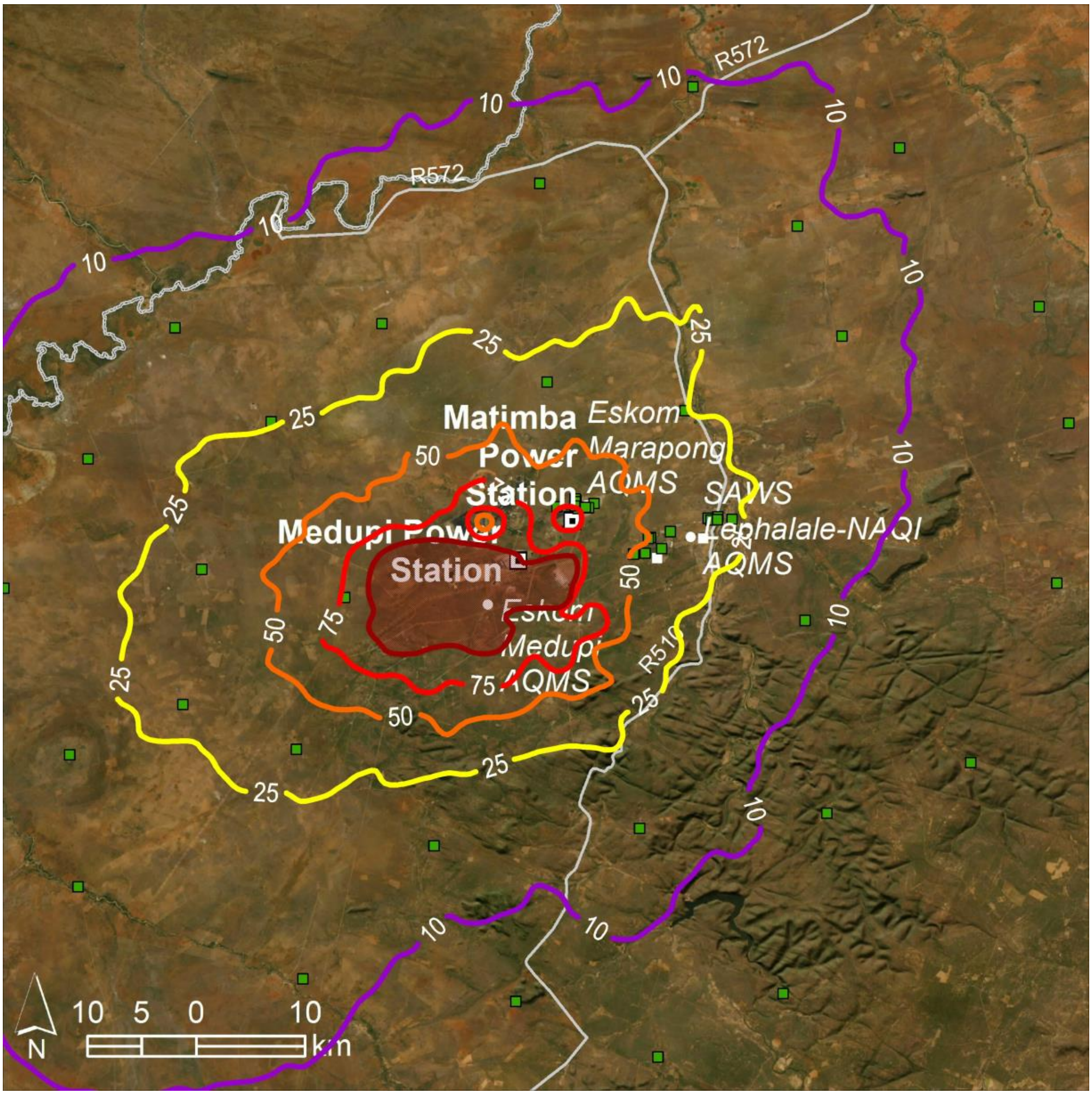


Figure 6-32: Predicted 99th percentile of the 24-hour PM_{10} concentrations in $\mu g/m^3$ for Scenario B (2031) (NAAQS Limit is 75 $\mu g/m^3$)

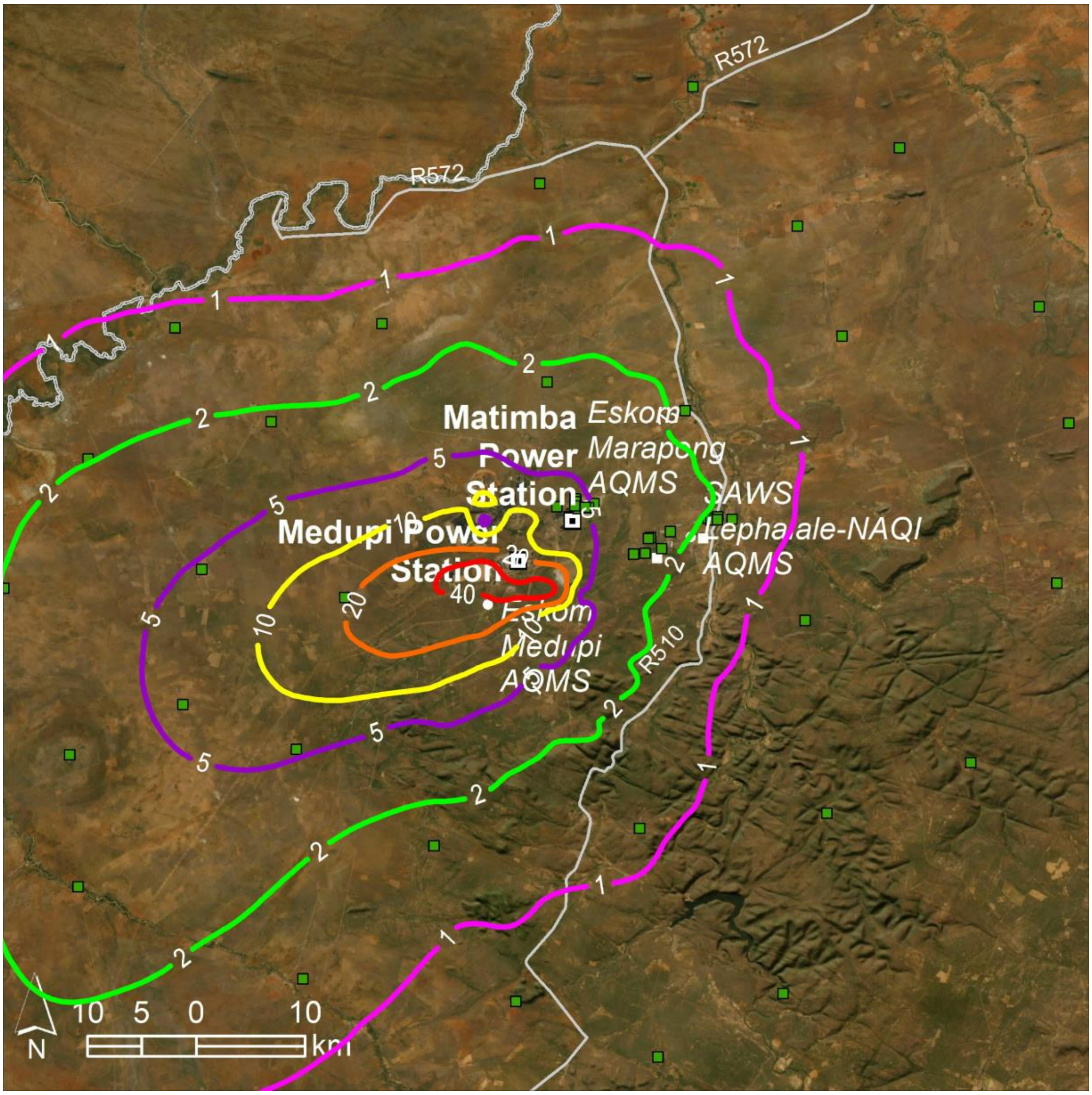


Figure 6-33: Predicted annual average PM_{10} concentrations in µg/m³ for Scenario C (2036) (NAAQS Limit is 40 µg/m³)

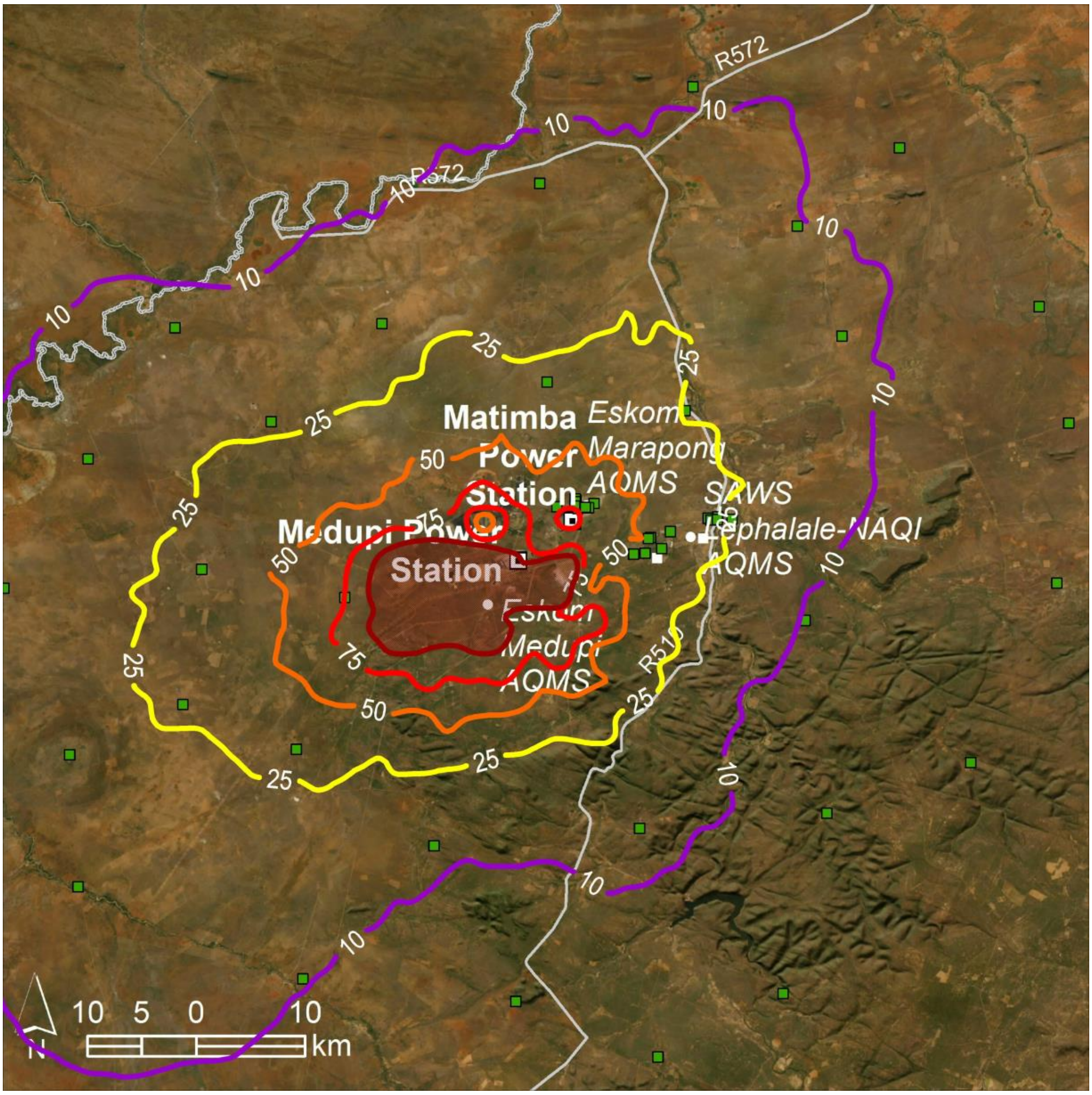


Figure 6-34: Predicted 99th percentile of the 24-hour PM_{10} concentrations in µg/m³ for Scenario C (2036) (NAAQS Limit is 75 µg/m³)

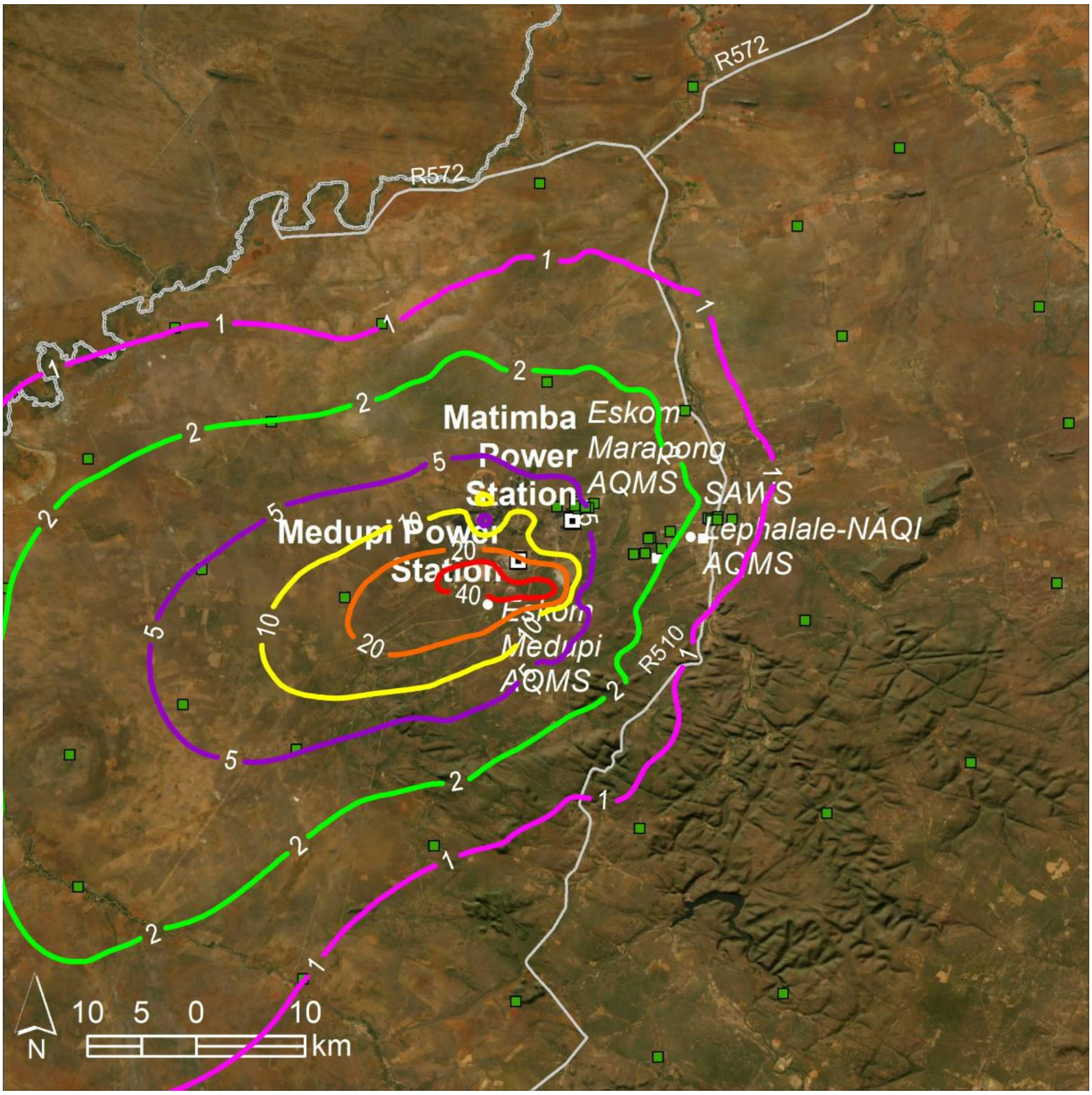


Figure 6-35: Predicted annual average PM_{10} concentrations in µg/m³ for Scenario D (MES) (NAAQS Limit is 40 µg/m³)

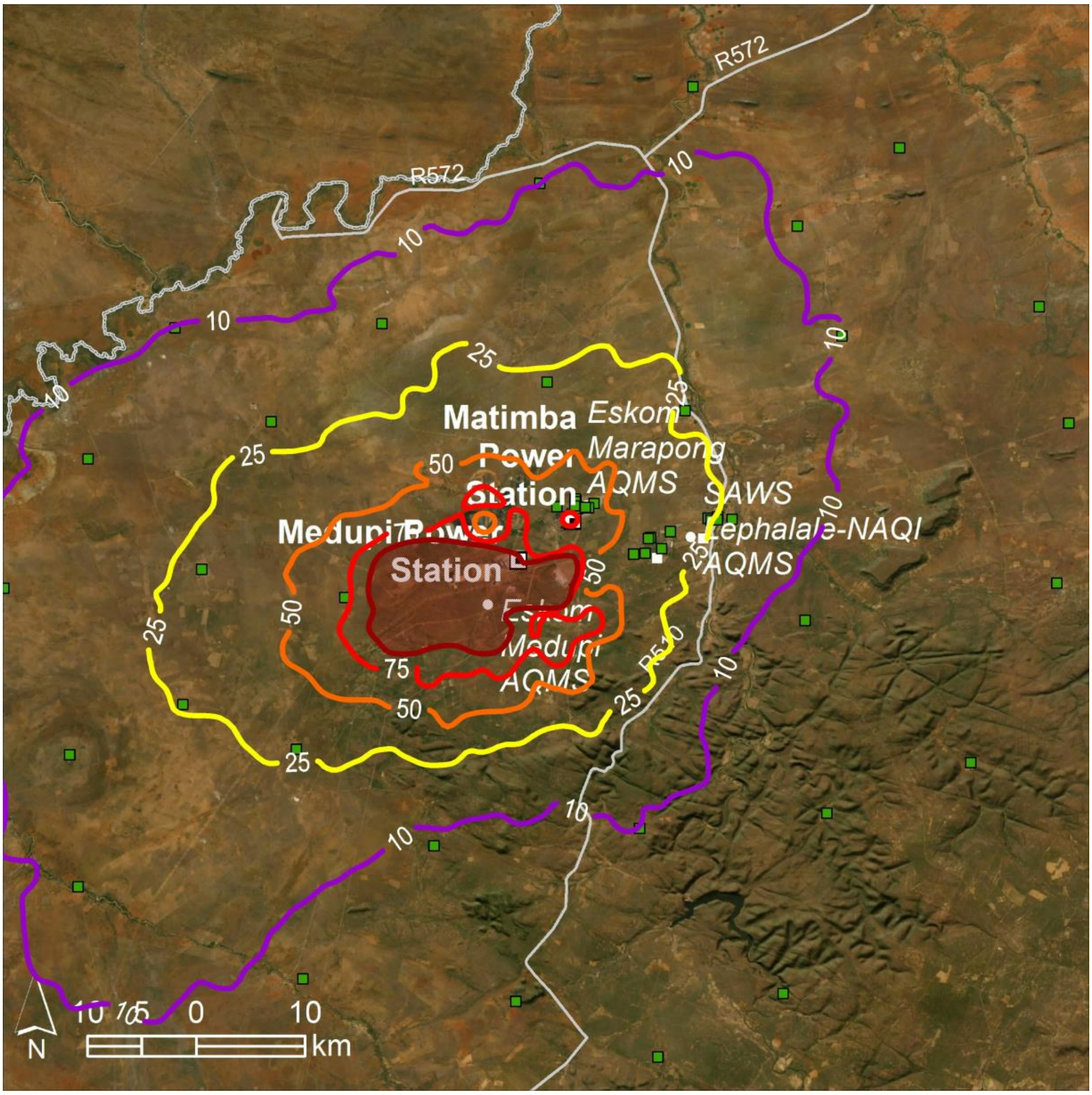


Figure 6-36: Predicted 99th percentile of the 24-hour PM_{10} concentrations in $\mu g/m^3$ for Scenario D (MES) (NAAQS Limit is 75 $\mu g/m^3$)

6.2.3.4 Particulates ($PM_{2.5}$)

The isopleth plots for $PM_{2.5}$ are similar for all scenarios due to the significant contribution of the low-level fugitive sources to the ambient concentrations close to the sources. The fugitive emission from the coal yards and the ash dumps at Medupi and Matimba are the same for all scenarios, hence the similarity in the model results for the five scenarios. The effect on ambient $PM_{2.5}$ concentrations of relatively small changes in the stack PM emissions is masked in the model output by the effect of the fugitive sources.

The area where the predicted annual average $PM_{2.5}$ concentrations exceed the NAAQS of 20 μg/m^3 extends approximately 10 km from the power station. The area is larger than for PM_{10} is due the more stringent NAAQS being applied for $PM_{2.5}$. The reader is reminded that the PM has been simulated as $PM_{2.5}$ and compared against the most stringent NAAQS for $PM_{2.5}$.

For Scenario 1 (Current) and Scenario A (2025) the limit value of the 24-hour NAAQS of 40 μg/m^3 is exceeded at 17 sensitive receptors. At 9 of these the limit value is exceeded more than 12 times and are therefore non-compliant with NAAQS. In Scenario B (2031), Scenario C (2036) and Scenario D (MES) the limit value of the NAAQS of 25 μg/m^3 applies, resulting in an increase in the number of receptor points where the limit value is exceeded to 25. At 14 of these the limit value is exceeded more than 12 times and are therefore non-compliant with NAAQS. (See Appendix 1).

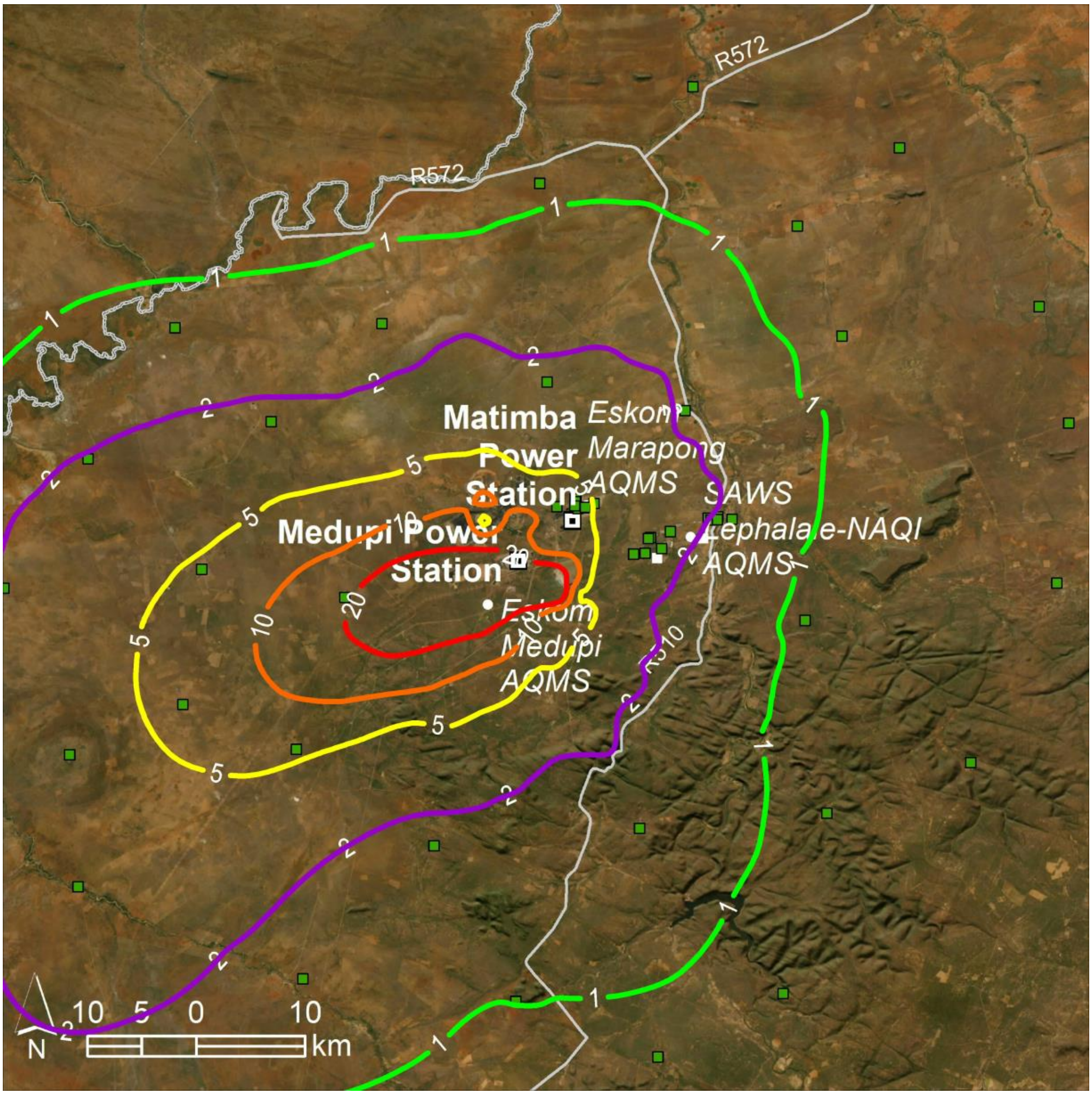


Figure 6-37: Predicted annual average $PM_{2.5}$ concentrations in µg/m³ for Scenario 1 (Current) (NAAQS Limit is 20 µg/m³)

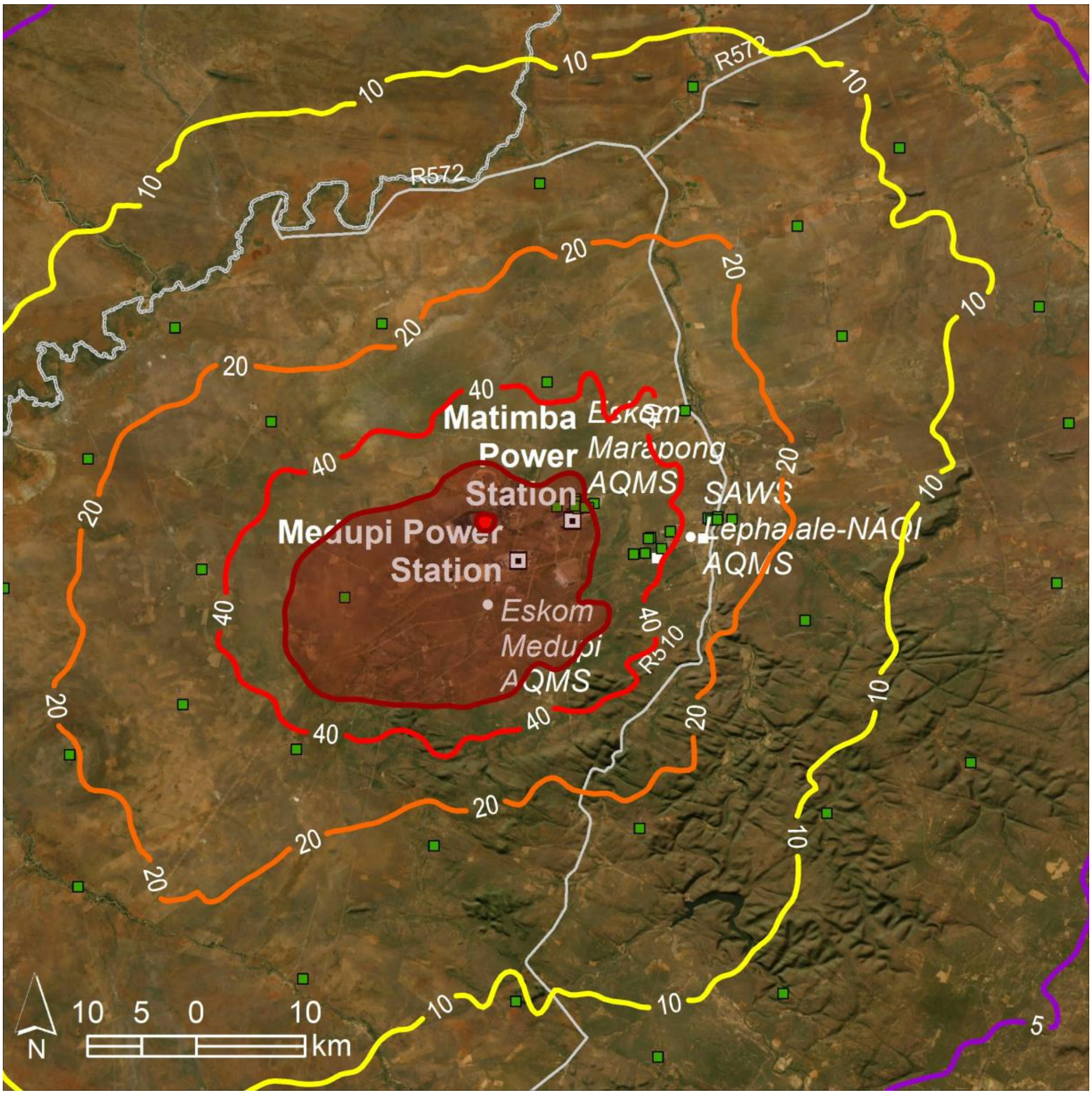


Figure 6-38: Predicted 99th percentile of the 24-hour $PM_{2.5}$ concentrations in µg/m³ for Scenario 1 (Current) (NAAQS Limit is 40 µg/m³)

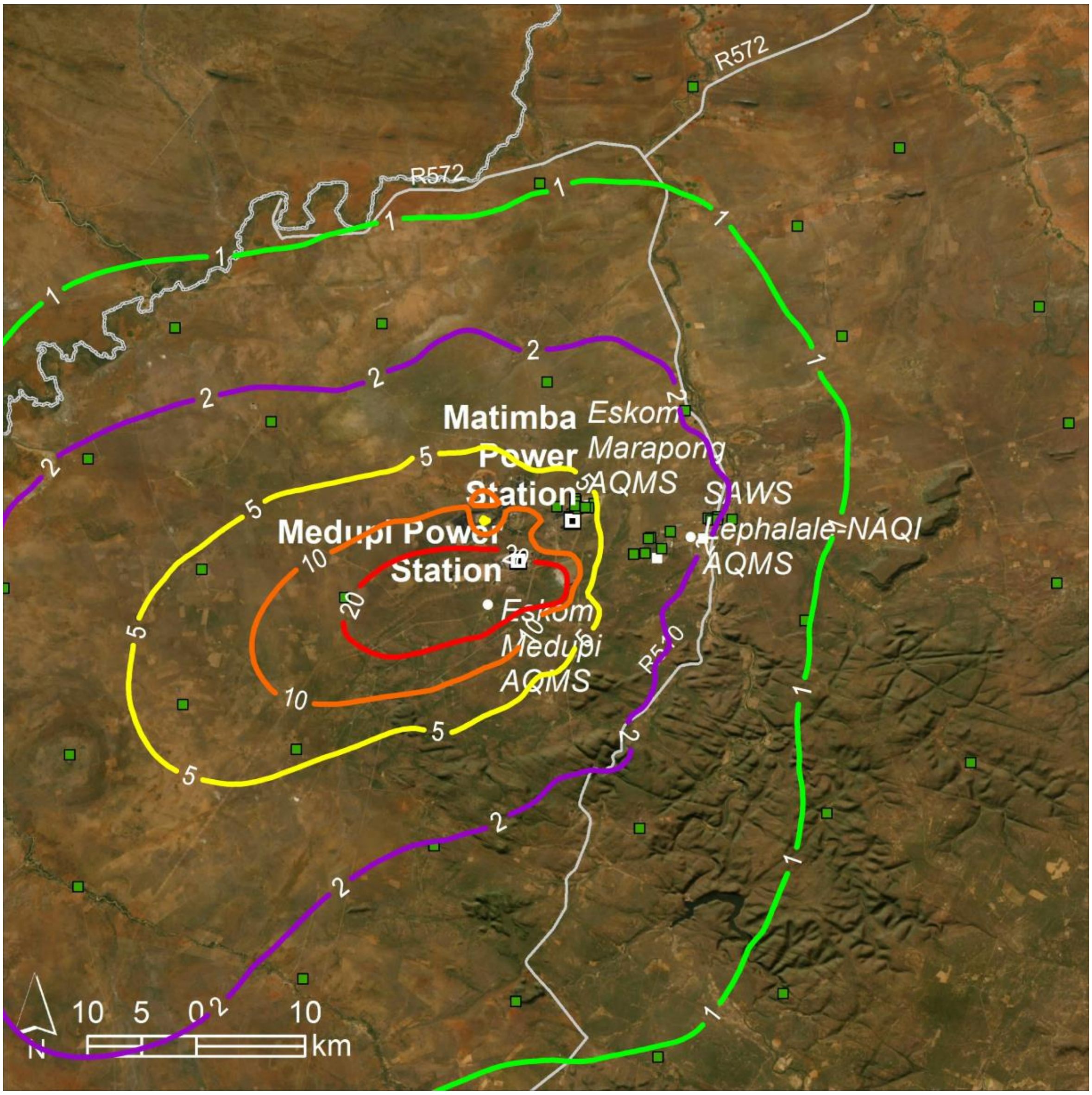


Figure 6-39: Predicted annual average $PM_{2.5}$ concentrations in µg/m³ for Scenario A (2025) (NAAQS Limit is 20 µg/m³)

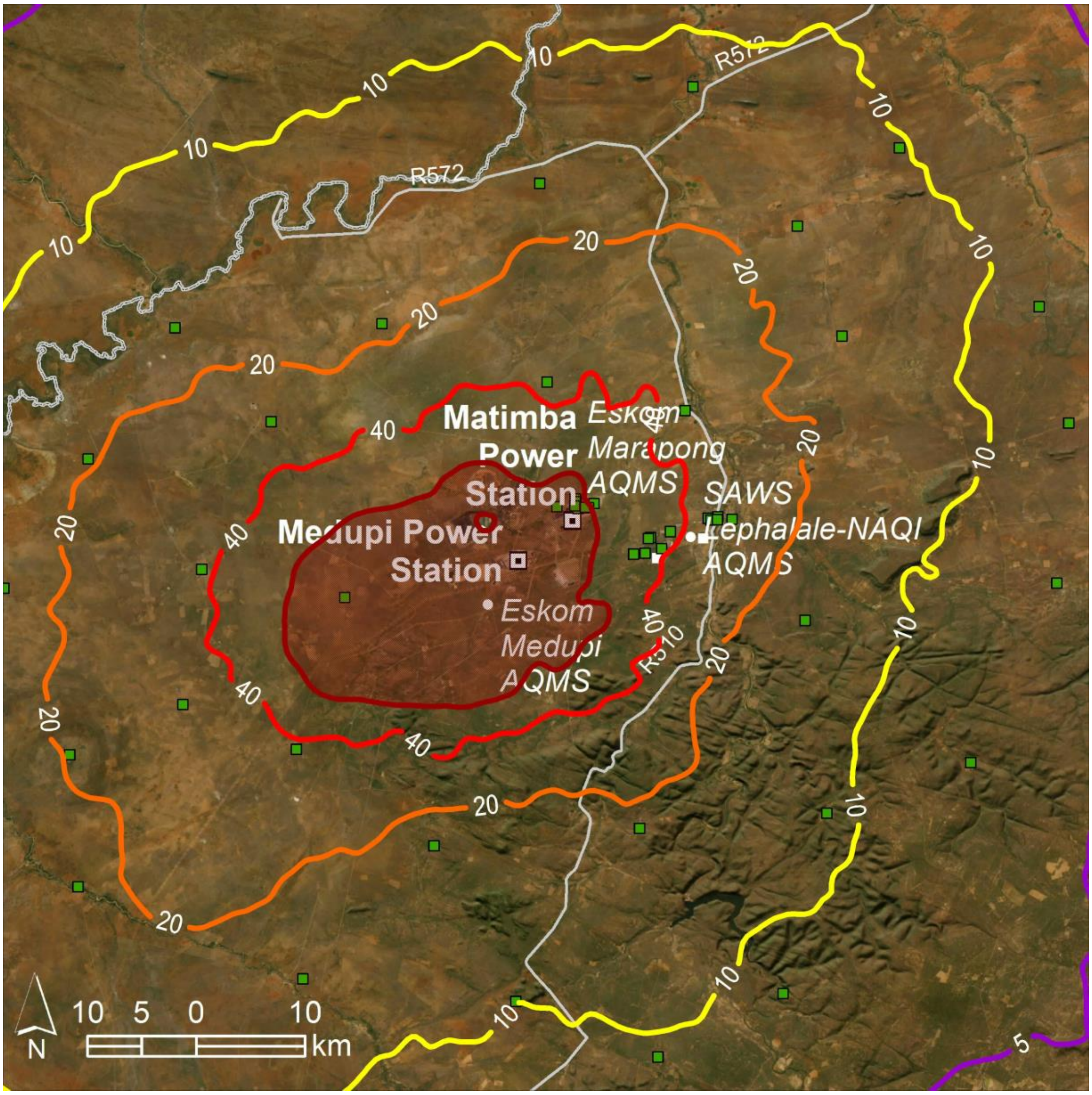


Figure 6-40: Predicted 99th percentile of the 24-hour $PM_{2.5}$ concentrations in μg/m³ for Scenario A (2025) (NAAQS Limit is 40 μg/m³)

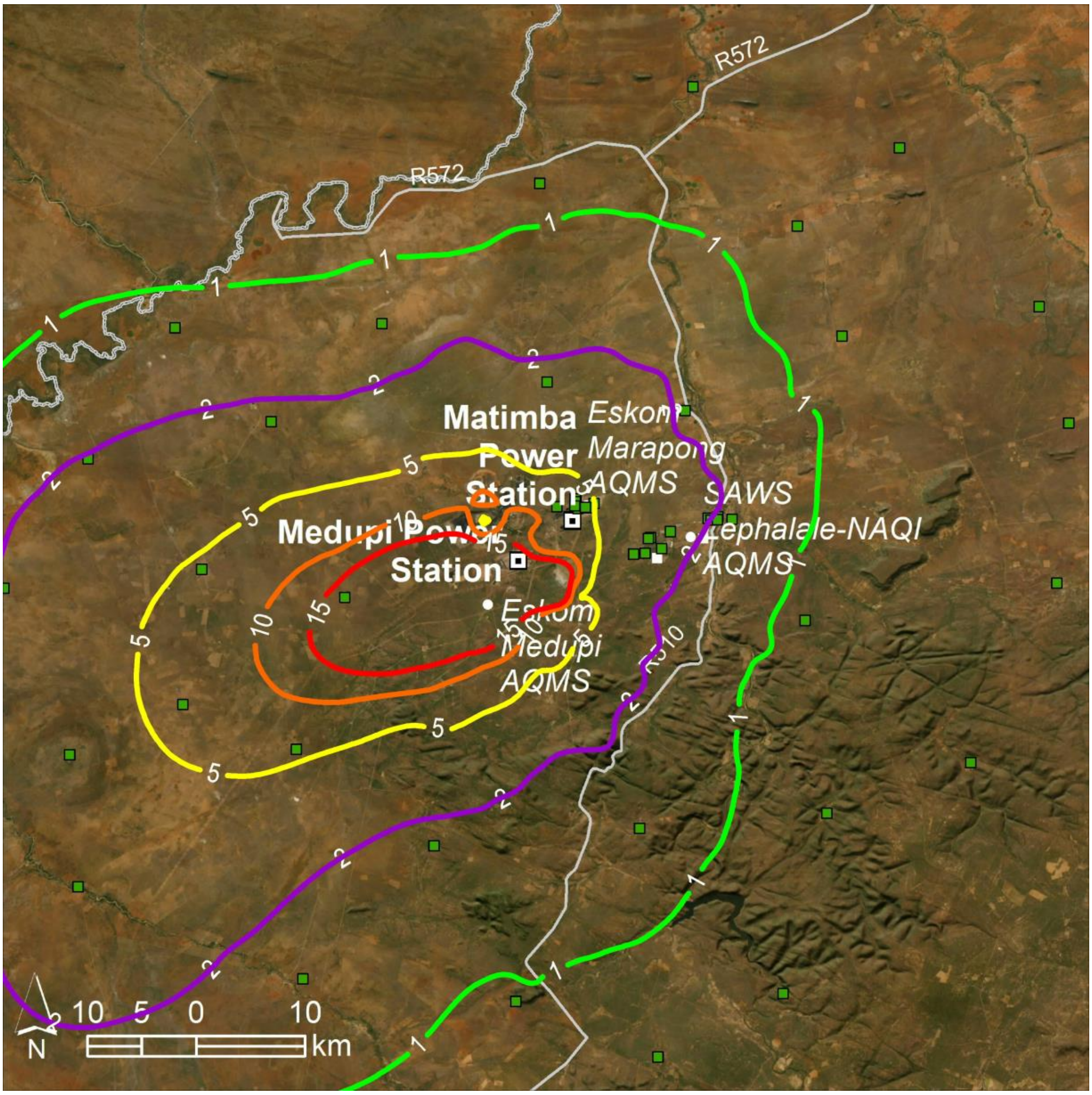


Figure 6-41: Predicted annual average $PM_{2.5}$ concentrations in µg/m³ for Scenario B (2031) (NAAQS Limit is 15 µg/m³)

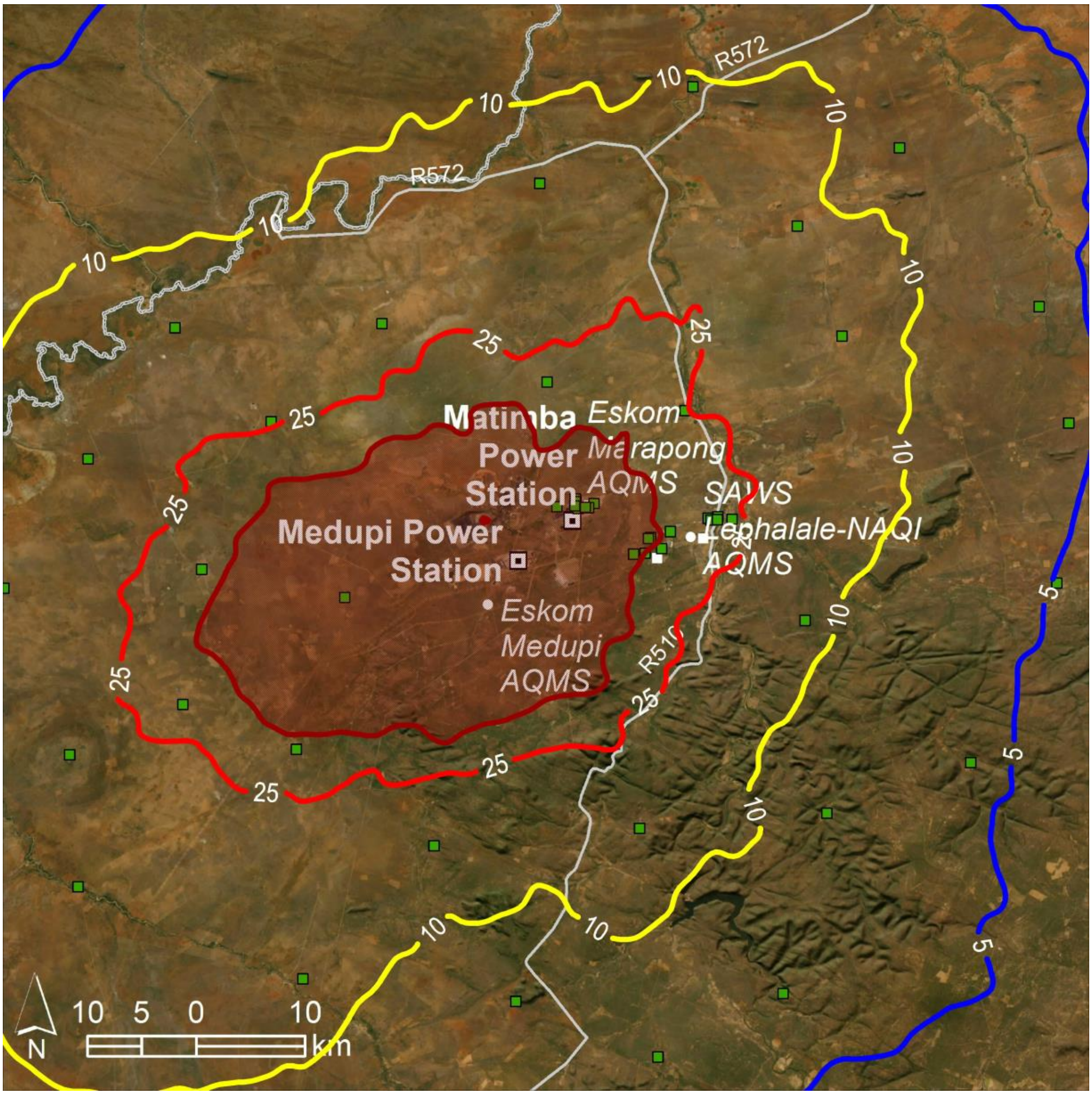


Figure 6-42: Predicted 99th percentile of the 24-hour $PM_{2.5}$ concentrations in $\mu g/m^3$ for Scenario B (2031) (NAAQS Limit is 25 $\mu g/m^3$)

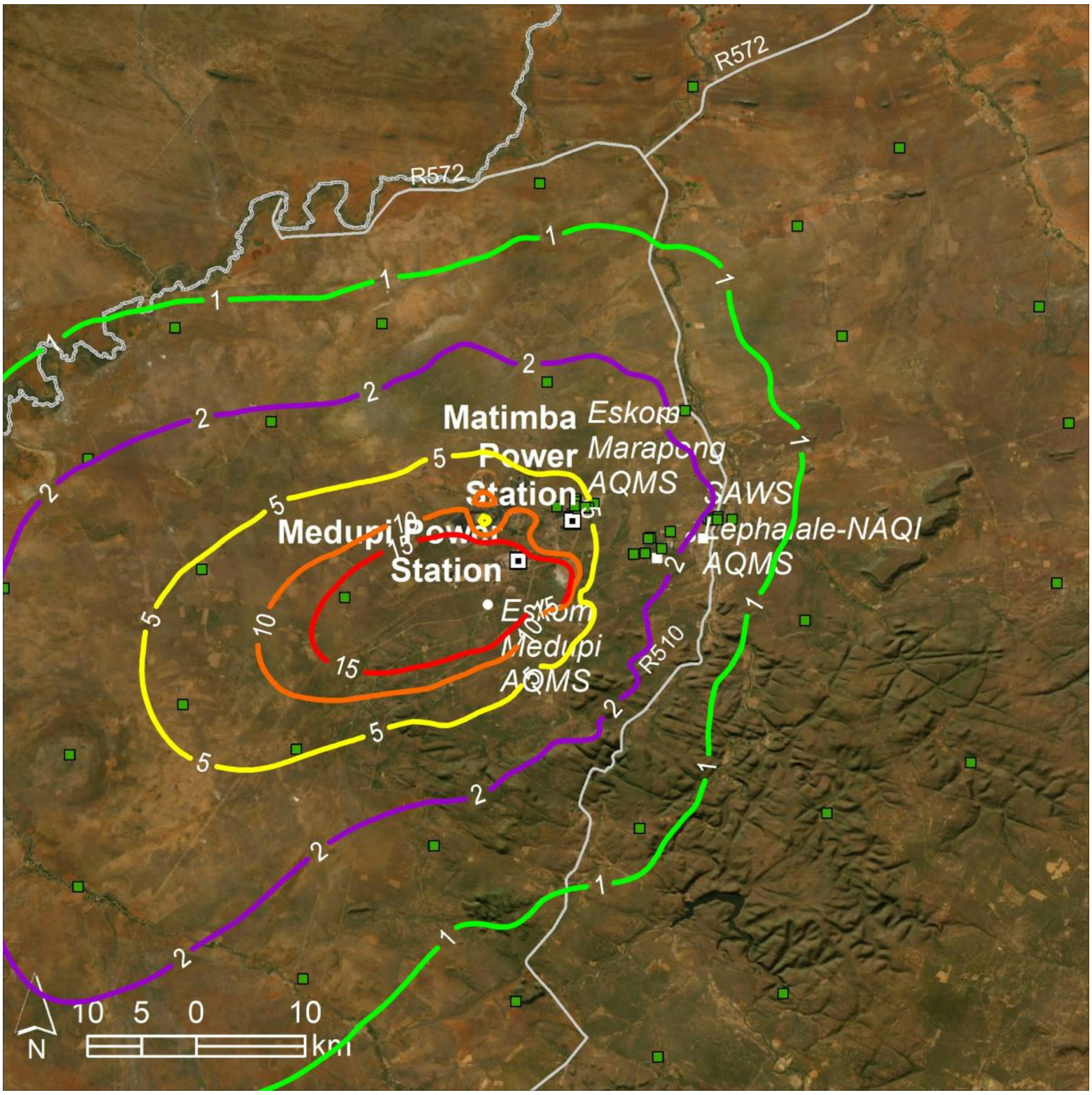


Figure 6-43: Predicted annual average $PM_{2.5}$ concentrations in µg/m³ for Scenario C (2036) (NAAQS Limit is 15 µg/m³)

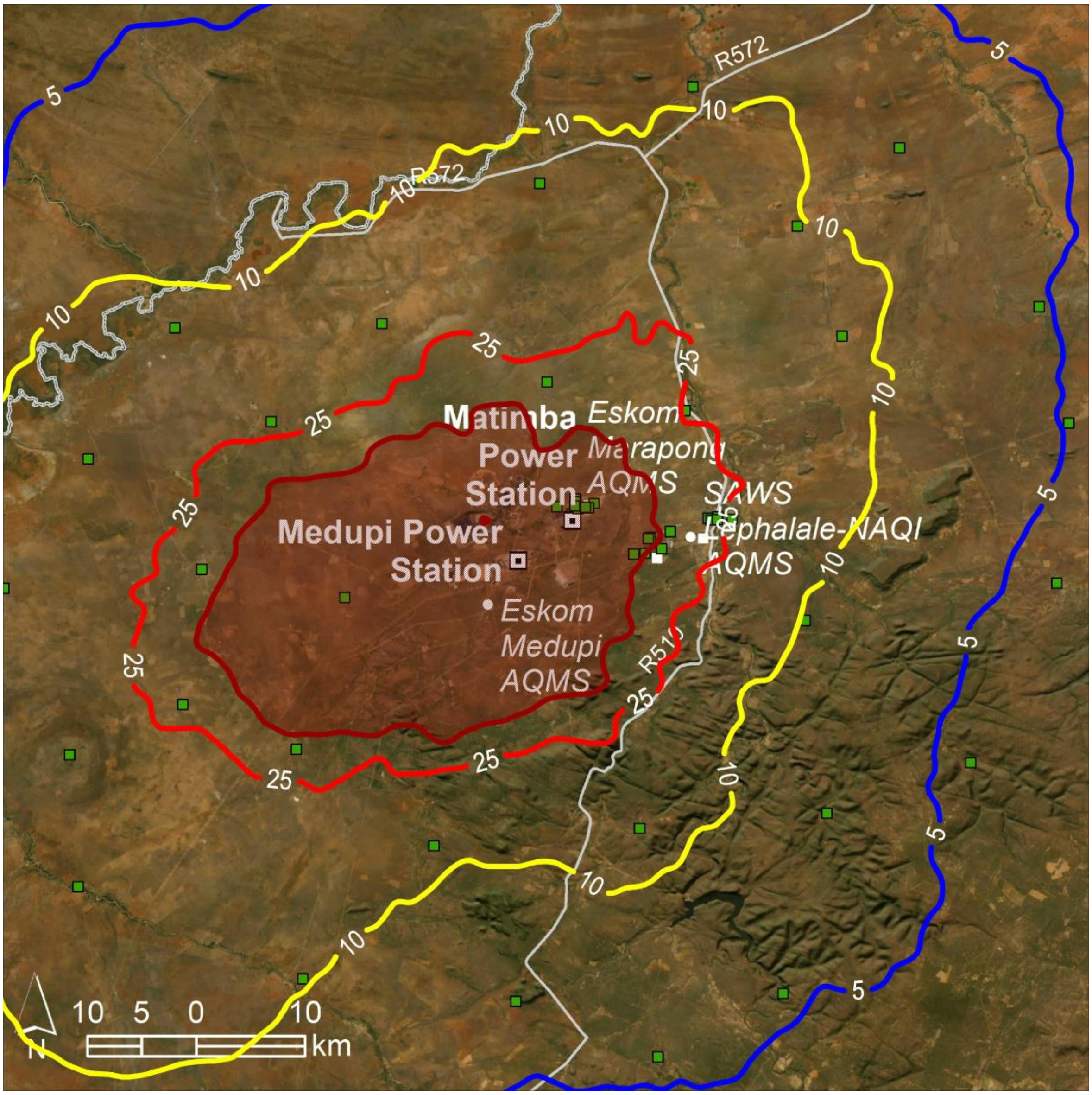


Figure 6-44: Predicted 99th percentile of the 24-hour $PM_{2.5}$ concentrations in µg/m³ for Scenario C (2036) (NAAQS Limit is 25 µg/m³)

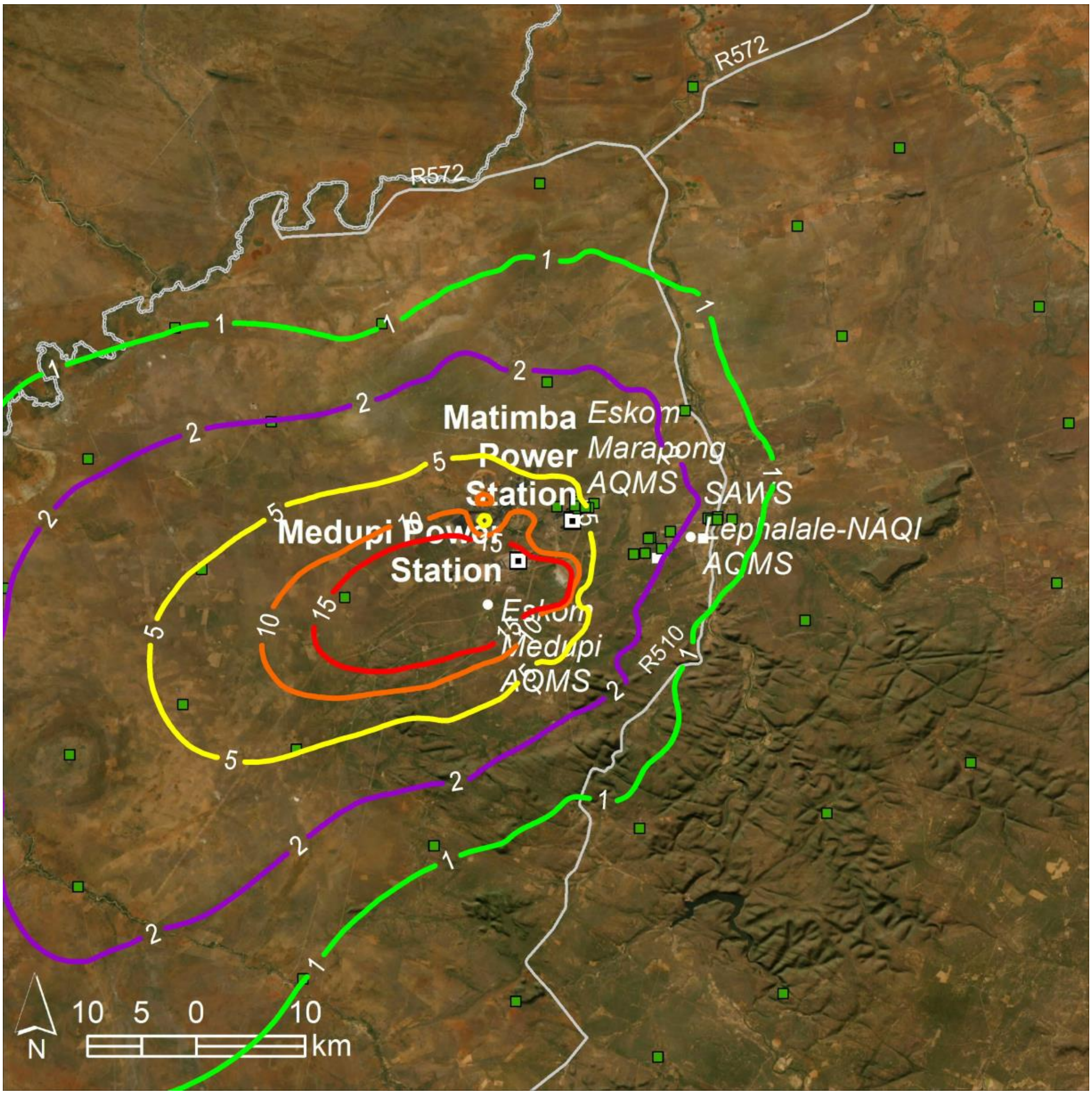


Figure 6-45: Predicted annual average $PM_{2.5}$ concentrations in µg/m³ for Scenario D (MES) (NAAQS Limit is 15 µg/m³)

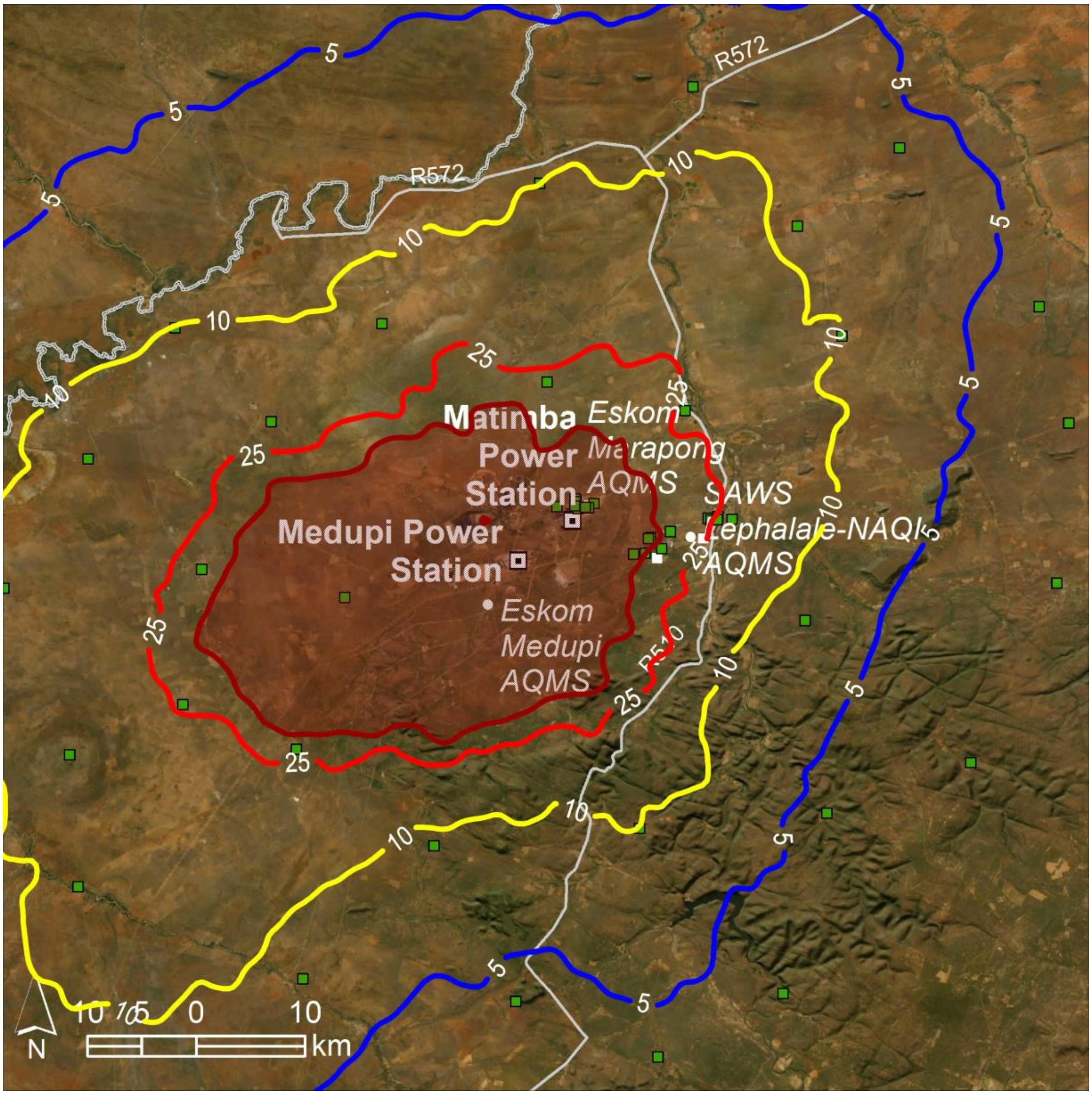


Figure 6-46: Predicted 99th percentile of the 24-hour $PM_{2.5}$ concentrations in $\mu g/m^3$ for Scenario D (MES) (NAAQS Limit is 25 $\mu g/m^3$)

7. SUMMARY AND CONCLUSION

In this AIR five emission scenarios are assessed collectively for the suite of 2 coal-fired power stations in the Waterberg to support Eskom's application for exemption from the MES for the 2 power stations. AIRs have been produced for the 2 power stations.

Dispersion modelling is used to demonstrate the effect of Eskom's emission reduction strategy by assessing 5 sequential emission scenarios. These are from Scenario 1 using actual emissions from 2021 to 2023, Scenario A using proposed 2025 emissions, Scenario B using proposed 2031 emissions and Scenario C using proposed 2036 emissions. Scenario D uses emissions that comply with the MES to demonstrate the relative effect of compliance.

Noteworthy findings from the modelling results may be summarised as:

i) Ambient SO_2 and NO_2 concentrations are attributed to the stack emissions only, while ambient PM_{10} and $PM_{2.5}$ concentrations are attributed to the stack emissions and the low-level fugitive sources. The stack emissions generally have an effect some distance from the source, while low-level emissions have an effect close to the source.

ii) The predicted ambient concentrations are lower than the monitored concentrations for all pollutants at all AQMS, except at the Medupi AQMS where predicted and measured are higher in general. It is expected that measured concentrations will be higher than modelled since AQMS are exposed to all sources of the pollutants while the modelled concentrations result from power station emission only.

Generally, the difference between the modelled concentrations and the measured concentrations are indicative of the contribution of other sources at the respective AQMS.

The PM_{10} and $PM_{2.5}$ data recovery rate at the Medupi AQMS in 2022 and 2023 was poor so it is likely that the reported averages are unreliable.

iii) For Scenario 1 (Current):

a. Predicted SO_2 and NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.

b. Predicted PM_{10} and $PM_{2.5}$ concentrations comply with the NAAQS, except close to the power stations where the limit value of the 24-hour NAAQS are exceeded as a result of the fugitive sources. Exceedances of the limit value for PM_{10} are predicted once at 2 sensitive receptor points respectively and thereof compliant with the NAAQS. For $PM_{2.5}$ exceedances of the limit value were predicted at 17 sensitive receptor points, at 10 of which the limit value was exceeded more than 12 times, hence non-compliant with the NAAQS.

iv) For Scenario A (2025):

a. Predicted annual and 1-hour SO_2 concentrations comply with the NAAQS throughout the modelling domain, but exceedances of the 24-hour limit value are predicted at 10 sensitive receptor points.

b. Predicted NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.

c. Predicted PM_{10} and $PM_{2.5}$ concentrations comply with the NAAQS, except close to the power stations where the limit value of the 24-hour NAAQS are exceeded as a result of the fugitive sources. Exceedances of the limit value for PM_{10} are predicted once at 5 sensitive receptor points respectively and thereof compliant with the NAAQS. For $PM_{2.5}$ exceedances of the limit value were predicted at 17 sensitive receptor points, at 10 of which the limit value was exceeded more than 12 times, hence non-compliant with the NAAQS.

v) For Scenario B (2031):
   a. Predicted annual and 1-hour SO_2 concentrations comply with the NAAQS throughout the modelling domain, but exceedances of the 24-hour limit value are predicted at 10 sensitive receptor points.
   b. Predicted NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.
   c. Predicted PM_{10} and $PM_{2.5}$ concentrations comply with the NAAQS, except close to the power stations where the limit value of the 24-hour NAAQS are exceeded as a result of the fugitive sources. The number of predicted exceedances for PM_{10} decrease to 2, while the number of exceedances for $PM_{2.5}$ increase to 27 sensitive receptor points. The increase corresponds to the more stringent $PM_{2.5}$ limit value of 25 $\mu g/m^3$ which is implemented in 2030. At 14 of these points limit value was exceeded more than 12 times, hence non-compliant with the NAAQS.

vi) For Scenario C: (2036):
   a. Predicted annual and 1-hour SO_2 concentrations comply with the NAAQS throughout the modelling domain, but exceedances of the 24-hour limit value are predicted at 9 sensitive receptor points.
   b. Predicted NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.
   c. Predicted PM_{10} and $PM_{2.5}$ concentrations comply with the NAAQS, except close to the power stations where the 24-hour limit value of the NAAQS for $PM_{2.5}$ are exceeded as a result of fugitive sources. Exceedances of the limit value for $PM_{2.5}$ are predicted at 25 sensitive receptor points. At 14 of these points, the limit value was exceeded more than 12 times, hence non-compliant with the NAAQS.

vii) For Scenario D:
   a. Predicted SO_2 and NO_2 concentrations comply with the NAAQS for all averaging periods throughout the modelling domain.
   b. Predicted PM_{10} and $PM_{2.5}$ concentrations comply with the NAAQS, except close to the power stations where the 24-hour limit value of the NAAQS for $PM_{2.5}$ are exceeded as a result of fugitive sources. Exceedances of the limit value for $PM_{2.5}$ are predicted at 25 sensitive receptor points. At 14 of these points, the limit value was exceeded more than 12 times, hence non-compliant with the NAAQS.

Given the conservative approach to the fugitive emission source simulations, and that this has provided an absolute worst-case emission scenario, and based on recommendations received from uMoya-Nilu, Eskom will be undertaking an additional modelling scenario, assessing only PM, SO_2, and NO_X stack emissions. NO_X and SO_2 emissions will be included in this scenario to ensure secondary particulate formation is accounted for. This will provide improved insight to impacts directly related to stack emissions, which are the focus of this exemption application.

8. REFERENCES

Auer, A.H. (1978): Correlation of Land Use and Cover with Meteorological Anomalies, Journal of Applied Meteorology, 17:636-643.

CARB (2024): https://ww2.arb.ca.gov/capp-resource-center/community-assessment/sensitive-receptor-assessment.

CSIRO (2008): TAPM V4. User Manual. Prepared by Peter Hurley, CSIRO Marine and Atmospheric Research Internal Report No. 5, October 2008, ISBN: 978-1-921424-73-1.

DEA (2009): National Ambient Air Quality Standards, Government Gazette, 32861, Vol. 1210, 24 December 2009.

DEA (2010): Listed Activities and Associated Minimum Emission Standards identified in terms of Section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Government Gazette 33064, Notice No. 248 of 31 March 2010.

DEA (2012): National Ambient Air Quality Standard for Particulate Matter of Aerodynamic Diameter less than 2.5 micrometers, Notice 486, 29 June 2012, Government Gazette, 35463.

DEA (2013a): Regulations Prescribing the Format of the Atmospheric Impact Report, Government Gazette 36904, Notice No. 747 of 11 October 2013.

DEA (2013b): Listed Activities and Associated Minimum Emission Standards identified in terms of Section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Government Gazette 37054, Notice No. 893 of 22 November 2013.

DEA (2014a): Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa, Government Notice R.533, Government Gazette, no. 37804, 11 July 2014.

DEA (2014b): Environmental Assessment Regulations, 2014 identified in terms of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Government Gazette 38282, Notice No. R 982 of 4 December 2014.

DEA (2019): Listed Activities and Associated Minimum Emission Standards identified in terms of Section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Government Gazette 42472, Notice No. 893 of 22 May 2019.

DEA (2020): Listed Activities and Associated Minimum Emission Standards identified in terms of Section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Government Gazette 43174, Notice No. 421 of 27 March 2020.

Hurley, P. (2000): Verification of TAPM meteorological predictions in the Melbourne region for a winter and summer month. Australian Meteorological Magazine, 49, 97-107.

Hurley, P.J., Blockley, A. and Rayner, K. (2001): Verification of a prognostic meteorological and air pollution model for year-long predictions in the Kwinana industrial region of Western Australia. Atmospheric Environment, 35(10), 1871-1880.

Hurley, P.J., Physick, W.L. and Ashok, K.L. (2002): The Air Pollution Model (TAPM) Version 2, Part 21: summary of some verification studies, CSIRO Atmospheric Research Technical Paper No. 57, 46 p.

SANAS (2012): Tr 07-03 Supplementary Requirements for the Accreditation of Continuous Ambient Air Quality Monitoring Stations (pp. 112).

uMoya-NILU (2024a): Atmospheric Impact Report in Support of the Application for Exemption from the Minimum Emission Standards for Medupi Power Station, Report No.: uMN214-24, October 2024.
uMoya-NILU (2024b): Atmospheric Impact Report in Support of the Application for Exemption from the Minimum Emission Standards for Matimba Power Station, Report No.: uMN213-24, October 2024.
USEPA (1995): A user's guide for the CALPUFF dispersion model (version 5). Prepared by Scire, J., Strimaitis, D. and Yamartino, Robert.
USEPA (2005): Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions, 40 CFR Part 51, US Environmental Protection Agency 40 CFR Part 51.
USEPA (2024a): https://www.epa.gov/newenglandhc/environmental-issues-concern-urban- communities-resources.
USEPA (2024b): Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources. Chapter 13: Miscellaneous Sources. http://www.epa.gov/ttn/chief/ap42/ch13/index.html.

9. FORMAL DECLARATIONS

A declaration of the accuracy of the information contained in this Atmospheric Impact Report is included here. A declaration of the independence of the practitioners in the uMoya-NILU consultancy team that compiled this AIR is also included.

DECLARATION OF ACCURACY OF INFORMATION – APPLICANT

Name of Enterprise: uMoya-NILU Consulting (Pty) Ltd

Declaration of accuracy of information provided:

Atmospheric Impact Report in terms of Section 30 of the Act

I, Mark Zunckel [duly authorised], declare that the information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality office is a criminal office in terms of section 51(1)(g) of this Act.

Signed at Durban on this 4th day of November 2024.

SIGNATURE

Managing Director – uMoya-NILU Consulting
CAPACITY OF SIGNATORY

DECLARATION OF INDEPENDENCE – PRACTITIONER

Name of Practitioner: Mark Zunckel

Name of Registered Body: South African Council for Natural Scientific Professionals

Professional Registration Number: 400449/04

Declaration of independence and accuracy of information provided:

Atmospheric Impact Report in terms of Section 30 of the Act

I, Mark Zunckel declare that I am independent of the applicant. I have the necessary expertise to conduct the assessment required for the report and will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. I will disclose to the applicant and the air quality officer all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the air quality officer. The information provided in the atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality office is a criminal office in terms of section 51(1)(g) of this Act.

Signed at Durban on this 4th day of November 2024.

____
SIGNATURE

Managing Director – uMoya-NILU Consulting
CAPACITY OF SIGNATORY

ANNEXURE 1: PREDICTED CONCENTRATIONS AT SENSIIVE RECEPTORS

Predicted concentrations in µg/m³ at the sensitive receptors for Scenario 1 (Current), together with the limit value of the NAAQS and number of exceedances (NoE)

	SO_2				NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	NoE	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	350	125	12	50	200	40	75	12	40	40	12	20
Phegelelo Senior Secondary	137.1	118.9		5.7	15.4	0.7	69.9		5.5	**69.9**	**13**	5.5
Contractors Village	127.8	80.7		5.3	14.8	0.6	**76.5**	1	7.8	**76.5**	**24**	7.8
Ditheku Primary School	136.4	112.7		5.6	15.5	0.6	70.7		5.5	**70.7**	**13**	5.5
Ditheko Primary School	149.7	111.5		6.2	17.8	0.7	69.4		5.0	**69.4**	10	5.0
Marapong Training Centre	135.2	104.5		5.9	15.2	0.7	71.3		5.9	**71.3**	**13**	5.9
Marapong Clinic	149.7	120.3		6.4	17.0	0.7	73.6		5.4	**73.6**	**15**	5.4
Tielelo Secondary School	136.1	119.0		5.8	15.2	0.7	71.3		5.6	**71.3**	**13**	5.6
Grootegeluk Medical Centre - Community Center	141.0	99.5		6.0	15.5	0.7	71.6		5.8	**71.6**	**14**	5.8
Lephalale College	161.5	80.8		6.1	20.7	0.7	51.7		3.2	**51.7**	1	3.2
Nelsonskop Primary School	152.0	116.8		6.4	16.7	0.7	73.2		5.5	**73.2**	**13**	5.5
Hansie en Grietjie Pre-Primary School	159.3	82.2		6.2	20.8	0.7	52.6		3.3	**52.6**	2	3.3
Sedibeng Special School for the Deaf and Disabilities	152.1	73.7		6.0	19.3	0.6	44.2		2.6	**44.2**	1	2.6
Kings College	162.7	79.4		6.6	20.6	0.7	51.6		3.4	**51.6**	1	3.4
Bosveld Primary School	157.9	76.2		6.3	20.4	0.7	46.6		3.0	**46.6**	1	3.0
Lephalale Medical Hospital	134.8	108.8		5.8	15.9	0.7	73.8		5.9	**73.8**	**15**	5.9
Ellisras Hospital	158.1	71.9		5.7	19.6	0.6	43.6		2.7	**43.6**	1	2.7
Laerskool Ellisras Primary School	141.0	60.4		4.9	15.9	0.5	31.1		1.9	31.1		1.9
Hoerskool Ellisras Secondary School	148.0	60.6		5.0	16.8	0.5	31.9		2.0	31.9		2.0
Marlothii Learning Academy	145.7	59.5		5.0	16.3	0.5	32.7		2.0	32.7		2.0
Hardekool Akademie vir C.V.O	135.9	63.6		4.8	14.7	0.5	27.0		1.6	27.0		1.6
Lephalale Clinic	141.7	58.5		4.9	15.7	0.5	30.7		1.9	30.7		1.9
Ons Hoop	116.0	66.9		4.3	10.3	0.4	26.8		1.8	26.8		1.8
Woudend	50.0	38.5		1.8	3.5	0.2	12.0		0.6	12.0		0.6
Ramabara's	114.4	53.7		4.5	11.3	0.4	12.9		0.9	12.9		0.9

	SO2				NO2		PM10 Total			PM2.5 Total		
	1-hr	**24-hr**	**NoE**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**12**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Ga-Shongoane	54.9	31.1		2.0	3.8	0.2	6.8		0.4	6.8		0.4
Bulge River	112.7	35.5		5.0	12.8	0.5	8.6		0.8	8.6		0.8
Kaingo Mountain Lodge	95.8	34.6		4.3	9.7	0.4	8.6		0.8	8.6		0.8
Community	131.5	43.1		6.3	15.4	0.7	9.6		1.0	9.6		1.0
Kiesel	146.9	57.1		6.3	18.7	0.7	16.1		2.8	16.1		2.8
Kremetartpan	226.2	80.4		9.4	31.3	1.1	34.6		5.9	34.6		5.9
Mbala Private Camp	182.9	67.0		8.8	24.0	1.0	15.7		1.7	15.7		1.7
Steenbokpan	193.2	70.7		7.1	25.9	0.8	**78.3**	1	17.4	**78.3**	**92**	17.4
Receptor	96.9	52.6		3.7	9.9	0.3	26.7		2.3	26.7		2.3
Sandbult	128.6	59.4		4.7	14.5	0.5	36.5		5.5	36.5		5.5
Hardekraaltjie	68.4	30.2		2.5	5.4	0.2	15.0		1.3	15.0		1.3
Receptor	102.6	71.8		3.9	9.9	0.4	34.9		2.5	34.9		2.5
Receptor	76.2	42.9		2.6	5.6	0.2	18.2		1.3	18.2		1.3
Receptor	65.2	42.5		2.3	4.2	0.2	14.6		0.9	14.6		0.9
Receptor	59.2	39.1		2.2	4.0	0.2	13.6		0.7	13.6		0.7
Receptor	72.3	41.4		2.7	5.4	0.2	14.0		0.8	14.0		0.8
Ditaung	50.0	27.9		1.8	3.1	0.1	7.5		0.4	7.5		0.4
Letlora	48.7	32.1		1.7	3.2	0.1	9.4		0.5	9.4		0.5
Receptor	165.0	60.0		6.5	20.5	0.7	31.7		6.1	31.7		6.1
Glenover	130.5	48.2		5.3	15.9	0.6	19.3		3.5	19.3		3.5
Oxford Safaris	82.2	36.4		3.0	8.0	0.3	14.6		2.2	14.6		2.2
Receptor	83.8	37.5		2.9	7.4	0.2	18.5		2.1	18.5		2.1
Tholo Bush Estate	103.6	39.0		4.2	9.7	0.4	9.2		0.8	9.2		0.8
Receptor	165.0	55.1		7.1	20.3	0.7	17.1		1.4	17.1		1.4
Receptor	66.4	29.3		2.7	5.2	0.2	7.4		0.5	7.4		0.5
Cheetah Safaris	146.7	55.3		7.1	18.4	0.8	13.3		1.5	13.3		1.5
Rhinoland Safaris	57.0	30.3		2.2	4.5	0.2	5.9		0.4	5.9		0.4

Predicted concentrations in µg/m³ at the sensitive receptors for Scenario A (2025), together with the limit value of the NAAQS and number of exceedances (NoE)

	SO_2				NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	NoE	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	350	125	12	50	200	40	75	12	40	40	12	20
Phegelelo Senior Secondary	272.5	**171.2**	**13**	10.8	43.2	1.5	70.5		5.7	**70.5**	**13**	5.7
Contractors Village	259.1	**145.9**	2	10.3	40.2	1.4	**77.7**	1	8.0	**77.7**	**24**	8.0
Ditheku Primary School	274.2	**163.6**	12	10.6	43.8	1.5	71.8		5.7	**71.8**	**13**	5.7
Ditheko Primary School	332.4	**166.2**	**16**	11.9	50.9	1.7	74.2		5.2	**74.2**	10	5.2
Marapong Training Centre	287.9	**195.5**	**14**	11.6	44.2	1.6	74.7		6.1	**74.7**	**13**	6.1
Marapong Clinic	324.4	**184.4**	**22**	12.5	48.9	1.8	**78.5**	1	5.7	**78.5**	**15**	5.7
Tielelo Secondary School	273.9	**178.2**	**18**	11.0	43.9	1.5	72.4		5.8	**72.4**	**13**	5.8
Grootegeluk Medical Centre - Community Center	298.1	**190.2**	**13**	11.9	46.9	1.7	74.9		6.1	**74.9**	**14**	6.1
Lephalale College	264.1	89.9		9.9	40.0	1.3	53.2		3.4	**53.2**	1	3.4
Nelsonskop Primary School	318.0	**172.2**	**24**	12.5	49.8	1.7	**77.5**	1	5.8	**77.5**	**14**	5.8
Hansie en Grietjie Pre-Primary School	263.3	90.5		10.0	40.3	1.3	54.2		3.5	**54.2**	2	3.5
Sedibeng Special School for the Deaf and Disabilities	248.8	78.4		9.3	36.6	1.2	43.3		2.8	**43.3**	1	2.8
Kings College	278.1	93.1		10.8	42.9	1.5	53.2		3.7	**53.2**	1	3.7
Bosveld Primary School	265.7	89.4		10.1	40.4	1.3	46.6		3.2	**46.6**	1	3.2
Lephalale Medical Hospital	273.6	**170.2**	**17**	11.4	43.5	1.6	**75.6**	1	6.1	**75.6**	**15**	6.1
Ellisras Hospital	242.3	93.2		9.0	36.1	1.2	44.7		2.8	**44.7**	1	2.8
Laerskool Ellisras Primary School	218.4	89.8		7.4	28.9	0.9	32.7		2.1	32.7		2.1
Hoerskool Ellisras Secondary School	228.0	81.9		7.7	30.3	0.9	33.8		2.2	33.8		2.2
Marlothii Learning Academy	223.4	83.2		7.6	30.0	0.9	33.8		2.1	33.8		2.1
Hardekool Akademie vir C.V.O	201.1	83.2		7.0	26.8	0.8	27.4		1.8	27.4		1.8
Lephalale Clinic	217.7	84.0		7.4	29.1	0.9	31.7		2.0	31.7		2.0
Ons Hoop	190.2	94.6		6.2	21.1	0.7	27.8		1.9	27.8		1.9
Woudend	67.8	48.0		2.3	6.2	0.2	12.2		0.7	12.2		0.7
Ramabara's	143.7	64.2		5.8	18.1	0.6	14.1		1.0	14.1		1.0
Ga-Shongoane	68.3	38.0		2.4	5.8	0.2	7.7		0.5	7.7		0.5
Bulge River	130.7	43.8		6.2	16.6	0.7	9.0		1.0	9.0		1.0

	SO_2				NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**NoE**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**12**	**50**	**200**	**40**	**75**	**12**	**40**	**40**	**12**	**20**
Kaingo Mountain Lodge	104.6	35.0		4.9	11.8	0.5	8.5		0.9	8.5		0.9
Community	155.3	52.4		8.4	21.7	1.0	10.2		1.2	10.2		1.2
Kiesel	179.2	73.1		8.6	26.8	1.1	17.2		3.0	17.2		3.0
Kremetartpan	296.2	106.7		14.0	47.9	2.0	36.9		6.2	36.9		6.2
Mbala Private Camp	241.9	81.9		12.9	37.7	1.7	16.9		2.0	16.9		2.0
Steenbokpan	293.2	99.7		11.7	46.7	1.6	**79.7**	1	17.7	**79.7**	**92**	17.7
Receptor	142.8	57.7		5.0	17.3	0.5	26.4		2.5	26.4		2.5
Sandbult	173.3	75.5		6.8	23.4	0.8	38.2		5.7	38.2		5.7
Hardekraaltjie	96.4	42.8		3.2	8.7	0.3	15.6		1.4	15.6		1.4
Receptor	163.3	92.3		5.5	21.5	0.7	35.5		2.7	35.5		2.7
Receptor	100.3	56.2		3.5	9.3	0.3	18.4		1.4	18.4		1.4
Receptor	89.3	50.7		2.8	7.5	0.3	15.1		1.0	15.1		1.0
Receptor	78.0	48.9		2.9	6.4	0.3	14.6		0.8	14.6		0.8
Receptor	100.7	49.8		3.4	8.7	0.3	15.5		0.9	15.5		0.9
Ditaung	66.4	36.2		2.2	5.1	0.2	7.6		0.5	7.6		0.5
Letlora	64.2	36.4		2.1	4.8	0.2	10.3		0.5	10.3		0.5
Receptor	202.2	73.8		9.3	29.7	1.2	33.2		6.3	33.2		6.3
Glenover	159.9	62.9		7.2	23.3	0.9	20.7		3.6	20.7		3.6
Oxford Safaris	103.7	41.9		4.0	12.3	0.4	15.6		2.3	15.6		2.3
Receptor	110.9	40.5		3.9	11.8	0.4	19.4		2.2	19.4		2.2
Tholo Bush Estate	122.4	48.3		5.1	13.8	0.5	10.8		0.9	10.8		0.9
Receptor	196.9	69.3		9.1	25.9	1.1	17.9		1.6	17.9		1.6
Receptor	79.7	32.1		3.2	7.9	0.3	7.5		0.6	7.5		0.6
Cheetah Safaris	186.8	68.1		10.0	27.7	1.3	14.5		1.7	14.5		1.7
Rhinoland Safaris	68.2	32.2		2.5	6.2	0.2	6.3		0.5	6.3		0.5

Predicted concentrations in µg/m³ at the sensitive receptors for Scenario B (2031), together with the limit value of the NAAQS and number of exceedances (NoE)

	SO_2				NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	NoE	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	350	125	12	50	200	40	75	12	40	25	12	15
Phegelelo Senior Secondary	255.1	**159.4**	**15**	10.4	40.3	1.4	67.8		5.5	**67.8**	**49**	5.5
Contractors Village	268.4	**139.1**	4	10.5	42.3	1.4	**75.8**	1	7.9	**75.8**	**76**	7.9
Ditheku Primary School	256.7	**149.2**	11	10.2	40.1	1.4	68.7		5.5	**68.7**	**50**	5.5
Ditheko Primary School	307.0	**154.5**	12	11.1	45.4	1.5	68.3		5.1	**68.3**	**50**	5.1
Marapong Training Centre	261.8	**186.1**	**14**	11.2	42.6	1.5	70.5		6.0	**70.5**	**57**	6.0
Marapong Clinic	315.1	**165.9**	12	11.7	47.7	1.6	72.7		5.5	**72.7**	**51**	5.5
Tielelo Secondary School	254.4	**169.5**	**15**	10.6	40.4	1.4	69.7		5.6	**69.7**	**51**	5.6
Grootegeluk Medical Centre - Community Center	271.9	**186.1**	**17**	11.4	42.8	1.6	71.1		5.9	**71.1**	**57**	5.9
Lephalale College	232.9	81.9		9.0	33.1	1.1	51.0		3.3	**51.0**	**18**	3.3
Nelsonskop Primary School	297.1	**163.7**	**18**	11.6	43.9	1.6	72.2		5.6	**72.2**	**55**	5.6
Hansie en Grietjie Pre-Primary School	233.8	82.2		9.2	33.5	1.2	51.8		3.4	**51.8**	**18**	3.4
Sedibeng Special School for the Deaf and Disabilities	217.5	71.1		8.5	30.6	1.0	41.5		2.7	**41.5**	8	2.7
Kings College	250.9	86.1		10.0	35.6	1.3	52.1		3.5	**52.1**	**20**	3.5
Bosveld Primary School	241.7	75.0		9.4	33.4	1.2	45.7		3.1	**45.7**	12	3.1
Lephalale Medical Hospital	262.4	**186.9**	**15**	11.1	41.2	1.5	72.7		5.9	**72.7**	**57**	5.9
Ellisras Hospital	220.0	76.1		7.9	30.2	1.0	43.5		2.7	**43.5**	7	2.7
Laerskool Ellisras Primary School	175.7	65.8		6.3	22.3	0.7	30.9		1.9	**30.9**	1	1.9
Hoerskool Ellisras Secondary School	184.7	68.1		6.6	23.6	0.7	31.8		2.1	**31.8**	1	2.1
Marlothii Learning Academy	182.4	67.2		6.5	23.3	0.7	32.1		2.0	**32.1**	1	2.0
Hardekool Akademie vir C.V.O	165.8	62.8		5.9	20.3	0.6	26.6		1.7	**26.6**	1	1.7
Lephalale Clinic	177.5	65.9		6.3	22.4	0.7	30.1		1.9	**30.1**	1	1.9
Ons Hoop	153.4	71.3		5.1	16.4	0.6	25.8		1.8	**25.8**	1	1.8
Woudend	53.4	30.7		1.7	4.5	0.1	10.2		0.6	10.2		0.6
Ramabara's	111.6	51.0		4.6	12.9	0.5	11.5		0.9	11.5		0.9
Ga-Shongoane	49.7	27.6		1.7	3.9	0.1	5.7		0.4	5.7		0.4
Bulge River	90.1	32.1		4.5	10.9	0.4	7.3		0.8	7.3		0.8
Kaingo Mountain Lodge	70.4	26.4		3.5	7.3	0.3	6.5		0.7	6.5		0.7

	SO_2				NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**NoE**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**12**	**50**	**200**	**40**	**75**	**12**	**40**	**25**	**12**	**15**
Community	109.3	39.7		6.4	14.8	0.7	7.7		1.0	7.7		1.0
Kiesel	130.0	50.7		6.7	19.1	0.8	14.7		2.7	14.7		2.7
Kremetartpan	211.6	78.8		11.3	33.0	1.5	33.6		5.9	**33.6**	1	5.9
Mbala Private Camp	172.9	60.2		10.2	26.1	1.3	14.0		1.7	14.0		1.7
Steenbokpan	231.4	83.2		10.2	35.6	1.4	**75.5**	1	17.6	**75.5**	**270**	**17.6**
Receptor	112.4	45.8		4.0	12.9	0.4	23.4		2.3	23.4		2.3
Sandbult	135.6	56.6		5.6	17.2	0.6	34.0		5.5	**34.0**	1	5.5
Hardekraaltjie	76.8	32.3		2.5	6.4	0.2	13.7		1.2	13.7		1.2
Receptor	144.8	72.2		4.5	17.8	0.5	32.1		2.5	**32.1**	1	2.5
Receptor	86.5	38.3		2.7	7.4	0.2	15.7		1.2	15.7		1.2
Receptor	65.8	35.8		2.0	5.5	0.2	13.2		0.8	13.2		0.8
Receptor	62.9	35.9		2.1	5.0	0.2	11.4		0.7	11.4		0.7
Receptor	79.3	37.5		2.6	6.6	0.2	12.6		0.8	12.6		0.8
Ditaung	49.7	26.3		1.6	3.3	0.1	6.0		0.4	6.0		0.4
Letlora	50.3	28.1		1.6	3.3	0.1	8.4		0.5	8.4		0.5
Receptor	150.5	62.4		7.4	21.7	0.9	31.4		6.1	**31.4**	1	6.1
Glenover	118.7	49.9		5.6	16.3	0.7	19.1		3.4	19.1		3.4
Oxford Safaris	77.3	30.8		3.2	8.7	0.3	13.7		2.2	13.7		2.2
Receptor	85.7	31.5		3.1	8.3	0.3	16.8		2.1	16.8		2.1
Tholo Bush Estate	83.2	32.0		3.6	8.2	0.3	7.7		0.7	7.7		0.7
Receptor	133.5	44.6		6.7	16.5	0.7	14.0		1.3	14.0		1.3
Receptor	57.5	24.1		2.3	4.9	0.2	5.5		0.4	5.5		0.4
Cheetah Safaris	131.8	53.5		8.1	19.4	1.0	12.4		1.5	12.4		1.5
Rhinoland Safaris	49.7	22.4		1.9	4.1	0.1	4.9		0.4	4.9		0.4

Predicted concentrations in µg/m³ at the sensitive receptors for Scenario C (2036), together with the limit value of the NAAQS and number of exceedances (NoE)

	SO_2				NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	NoE	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	350	125	12	50	200	40	75	12	40	25	12	15
Phegelelo Senior Secondary	135.3	**146.2**	2	7.3	32.3	1.2	66.1		5.4	**66.1**	**49**	5.4
Contractors Village	128.7	**129.7**	1	7.3	32.9	1.2	74.0		7.7	**74.0**	**76**	7.7
Ditheku Primary School	129.7	**130.6**	2	7.2	32.4	1.2	66.8		5.4	**66.8**	**50**	5.4
Ditheko Primary School	202.4	115.8		8.0	40.7	1.3	65.8		4.9	**65.8**	**50**	4.9
Marapong Training Centre	134.3	**152.4**	4	8.0	34.9	1.4	68.7		5.8	**68.7**	**57**	5.8
Marapong Clinic	179.5	**131.9**	2	8.5	40.9	1.4	71.1		5.3	**71.1**	**51**	5.3
Tielelo Secondary School	123.3	**148.8**	6	7.5	32.4	1.3	67.9		5.5	**67.9**	**51**	5.5
Grootegeluk Medical Centre - Community Center	141.6	**148.1**	5	8.2	36.0	1.4	68.7		5.7	**68.7**	**57**	5.7
Lephalale College	188.7	66.1		6.4	32.1	1.1	49.0		3.1	**49.0**	**18**	3.1
Nelsonskop Primary School	175.4	**141.7**	5	8.5	39.6	1.4	70.3		5.5	**70.3**	**55**	5.5
Hansie en Grietjie Pre-Primary School	187.2	66.1		6.5	32.5	1.1	49.9		3.2	**49.9**	**18**	3.2
Sedibeng Special School for the Deaf and Disabilities	173.1	57.9		6.0	29.9	1.0	39.8		2.5	**39.8**	8	2.5
Kings College	194.9	65.2		7.2	35.0	1.2	48.6		3.3	**48.6**	**20**	3.3
Bosveld Primary School	189.7	60.4		6.7	33.3	1.1	42.9		2.9	**42.9**	**13**	2.9
Lephalale Medical Hospital	129.8	**146.8**	7	7.8	33.2	1.3	71.3		5.8	**71.3**	**57**	5.8
Ellisras Hospital	164.3	56.4		5.7	28.8	0.9	40.3		2.5	**40.3**	7	2.5
Laerskool Ellisras Primary School	137.4	48.9		4.6	22.2	0.7	28.6		1.7	**28.6**	1	1.7
Hoerskool Ellisras Secondary School	143.3	50.7		4.8	23.5	0.7	29.5		1.9	**29.5**	1	1.9
Marlothii Learning Academy	140.3	50.1		4.7	23.4	0.7	29.5		1.8	**29.5**	1	1.8
Hardekool Akademie vir C.V.O	127.0	47.8		4.3	20.2	0.6	24.3		1.5	24.3		1.5
Lephalale Clinic	137.3	49.1		4.6	22.4	0.7	27.7		1.7	**27.7**	1	1.7
Ons Hoop	117.6	59.3		3.8	16.2	0.5	23.5		1.6	23.5		1.6
Woudend	37.8	25.7		1.3	4.5	0.2	9.5		0.5	9.5		0.5
Ramabara's	87.1	35.5		3.5	13.1	0.5	9.8		0.7	9.8		0.7
Ga-Shongoane	38.9	19.6		1.4	4.1	0.1	4.9		0.3	4.9		0.3
Bulge River	68.9	24.3		3.3	11.8	0.5	6.1		0.6	6.1		0.6

	SO_2				NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**NoE**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**12**	**50**	**200**	**40**	**75**	**12**	**40**	**25**	**12**	**15**
Kaingo Mountain Lodge	53.7	19.8		2.6	7.8	0.3	5.5		0.6	5.5		0.6
Community	84.6	30.5		4.7	15.8	0.8	6.8		0.8	6.8		0.8
Kiesel	94.1	37.7		4.6	19.4	0.8	13.2		2.6	13.2		2.6
Kremetartpan	150.2	54.3		7.5	34.3	1.5	31.4		5.7	**31.4**	1	5.7
Mbala Private Camp	127.3	44.5		7.1	27.0	1.3	12.3		1.5	12.3		1.5
Steenbokpan	164.8	53.8		6.8	34.6	1.2	73.6		17.3	**73.6**	**269**	**17.3**
Receptor	85.0	35.4		2.9	12.6	0.4	22.1		2.2	22.1		2.2
Sandbult	96.6	37.6		3.9	17.1	0.6	32.6		5.4	**32.6**	1	5.4
Hardekraaltjie	55.7	25.0		1.9	6.2	0.2	12.5		1.1	12.5		1.1
Receptor	91.6	50.8		3.2	16.5	0.5	30.2		2.4	**30.2**	1	2.4
Receptor	60.8	31.8		2.1	7.3	0.2	13.9		1.1	13.9		1.1
Receptor	49.1	29.0		1.5	5.5	0.2	11.9		0.8	11.9		0.8
Receptor	45.5	27.6		1.6	4.6	0.2	10.8		0.6	10.8		0.6
Receptor	57.5	29.9		1.9	6.3	0.2	11.8		0.7	11.8		0.7
Ditaung	36.6	18.2		1.2	3.4	0.1	5.3		0.3	5.3		0.3
Letlora	36.9	20.7		1.2	3.2	0.1	7.5		0.4	7.5		0.4
Receptor	108.1	39.7		5.1	21.2	0.9	29.2		5.9	**29.2**	1	5.9
Glenover	84.5	32.9		3.9	16.7	0.6	17.4		3.3	17.4		3.3
Oxford Safaris	54.2	21.8		2.2	8.6	0.3	12.9		2.1	12.9		2.1
Receptor	62.2	22.3		2.2	8.5	0.3	15.6		1.9	15.6		1.9
Tholo Bush Estate	65.5	23.4		2.8	9.2	0.3	6.9		0.6	6.9		0.6
Receptor	109.1	35.9		5.0	18.6	0.8	12.6		1.1	12.6		1.1
Receptor	43.0	18.7		1.8	5.3	0.2	4.5		0.4	4.5		0.4
Cheetah Safaris	96.9	38.2		5.4	19.9	1.0	10.3		1.3	10.3		1.3
Rhinoland Safaris	36.8	17.7		1.4	4.3	0.2	4.1		0.3	4.1		0.3

Predicted concentrations in µg/m³ at the sensitive receptors for Scenario D (MES), together with the limit value of the NAAQS and number of exceedances (NoE)

	SO_2				NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	**24-hr**	**NoE**	**Ann**	**1-hr**	**Ann**	**24-hr**	**NoE**	**Ann**	**24-hr**	**NoE**	**Ann**
Receptor	**350**	**125**	**12**	**50**	**200**	**40**	**75**	**12**	**40**	**25**	**12**	**15**
Phegelelo Senior Secondary	68.6	48.2		2.9	32.3	1.2	61.7		5.1	**61.7**	**49**	5.1
Contractors Village	68.9	39.3		2.9	32.9	1.2	70.4		7.5	**70.4**	**76**	7.5
Ditheku Primary School	69.2	46.4		2.8	32.4	1.2	62.7		5.1	**62.7**	**50**	5.1
Ditheko Primary School	90.1	42.7		3.1	40.7	1.3	61.9		4.7	**61.9**	**50**	4.7
Marapong Training Centre	74.1	51.2		3.1	34.9	1.4	64.6		5.6	**64.6**	**57**	5.6
Marapong Clinic	89.8	48.2		3.3	40.9	1.4	67.0		5.1	**67.0**	**51**	5.1
Tielelo Secondary School	69.5	46.7		3.0	32.4	1.3	63.6		5.2	**63.6**	**51**	5.2
Grootegeluk Medical Centre - Community Center	76.5	51.6		3.2	36.0	1.4	65.0		5.5	**65.0**	**57**	5.5
Lephalale College	69.6	24.8		2.6	32.1	1.1	44.8		2.9	**44.8**	**18**	2.9
Nelsonskop Primary School	82.6	49.8		3.3	39.6	1.4	66.0		5.2	**66.0**	**55**	5.2
Hansie en Grietjie Pre-Primary School	70.1	25.3		2.7	32.5	1.1	45.7		2.9	**45.7**	**18**	2.9
Sedibeng Special School for the Deaf and Disabilities	65.6	21.6		2.5	29.9	1.0	35.7		2.2	**35.7**	8	2.2
Kings College	72.3	23.7		2.9	35.0	1.2	44.8		3.1	**44.8**	**20**	3.1
Bosveld Primary School	69.8	22.3		2.7	33.3	1.1	39.1		2.6	**39.1**	**13**	2.6
Lephalale Medical Hospital	70.4	52.4		3.1	33.2	1.3	66.8		5.5	**66.8**	**57**	5.5
Ellisras Hospital	64.3	22.9		2.3	28.8	0.9	36.7		2.3	**36.7**	7	2.3
Laerskool Ellisras Primary School	54.7	20.8		1.9	22.2	0.7	25.2		1.5	**25.2**	1	1.5
Hoerskool Ellisras Secondary School	57.1	21.6		2.0	23.5	0.7	26.0		1.7	**26.0**	1	1.7
Marlothii Learning Academy	55.8	21.2		1.9	23.4	0.7	26.2		1.6	**26.2**	1	1.6
Hardekool Akademie vir C.V.O	50.5	20.0		1.8	20.2	0.6	20.7		1.3	20.7		1.3
Lephalale Clinic	54.6	20.5		1.9	22.4	0.7	24.4		1.5	24.4		1.5
Ons Hoop	47.0	23.4		1.5	16.2	0.5	20.3		1.4	20.3		1.4
Woudend	17.0	10.8		0.6	4.5	0.2	7.6		0.4	7.6		0.4
Ramabara's	35.4	15.3		1.4	13.1	0.5	7.1		0.5	7.1		0.5
Ga-Shongoane	16.2	8.7		0.6	4.1	0.1	3.3		0.2	3.3		0.2
Bulge River	30.8	10.2		1.5	11.8	0.5	4.1		0.4	4.1		0.4

	SO_2				NO_2		PM_{10} Total			$PM_{2.5}$ Total		
	1-hr	24-hr	NoE	Ann	1-hr	Ann	24-hr	NoE	Ann	24-hr	NoE	Ann
Receptor	**350**	**125**	**12**	**50**	**200**	**40**	**75**	**12**	**40**	**25**	**12**	**15**
Kaingo Mountain Lodge	23.9	7.9		1.2	7.8	0.3	3.6		0.4	3.6		0.4
Community	37.0	13.5		2.0	15.8	0.8	4.3		0.6	4.3		0.6
Kiesel	42.9	17.1		2.1	19.4	0.8	11.3		2.3	11.3		2.3
Kremetartpan	69.8	25.8		3.5	34.3	1.5	28.0		5.3	**28.0**	1	5.3
Mbala Private Camp	57.6	19.5		3.2	27.0	1.3	9.1		1.1	9.1		1.1
Steenbokpan	73.1	24.1		3.0	34.6	1.2	70.3		17.1	**70.3**	**269**	**17.1**
Receptor	34.8	14.8		1.2	12.6	0.4	18.9		2.0	18.9		2.0
Sandbult	42.3	17.6		1.7	17.1	0.6	29.5		5.1	**29.5**	1	5.1
Hardekraaltjie	23.6	10.2		0.8	6.3	0.2	10.1		1.0	10.1		1.0
Receptor	42.6	21.8		1.4	16.5	0.5	26.6		2.2	**26.6**	1	2.2
Receptor	25.6	12.7		0.9	7.3	0.2	11.1		1.0	11.1		1.0
Receptor	21.3	12.0		0.7	5.5	0.2	9.8		0.6	9.8		0.6
Receptor	18.9	12.2		0.7	4.6	0.2	8.5		0.5	8.5		0.5
Receptor	23.7	12.9		0.8	6.3	0.2	9.5		0.5	9.5		0.5
Ditaung	15.6	8.4		0.5	3.4	0.1	3.7		0.2	3.7		0.2
Letlora	15.6	8.6		0.5	3.2	0.1	5.7		0.3	5.7		0.3
Receptor	47.7	17.7		2.3	21.2	0.9	26.9		5.6	**26.9**	1	5.6
Glenover	37.5	15.5		1.8	16.7	0.6	15.4		3.1	15.4		3.1
Oxford Safaris	24.5	10.0		1.0	8.6	0.3	11.4		1.9	11.4		1.9
Receptor	27.4	9.7		1.0	8.5	0.3	13.1		1.8	13.1		1.8
Tholo Bush Estate	28.9	11.3		1.2	9.2	0.3	4.6		0.4	4.6		0.4
Receptor	47.2	15.5		2.2	18.6	0.8	9.8		0.8	9.8		0.8
Receptor	18.9	7.3		0.8	5.3	0.2	3.0		0.2	3.0		0.2
Cheetah Safaris	44.0	17.3		2.5	19.9	1.0	7.6		1.0	7.6		1.0
Rhinoland Safaris	16.1	7.6		0.6	4.3	0.2	2.7		0.2	2.7		0.2

ANNEXURE 2: NEMA REGULATION – APPENDIX 6

Specialist Reports as per the NEMA EIA Regulations, 2014 (as amended), must contain the information outlined in According to Appendix 6 (1) of the Regulations. Table A1 indicates where this information is included in the AIR.

Table A1: Prescribed contents of the Specialist Reports (Appendix 6 of the EIA Regulations, 2014)

Relevant section in GNR. 982	Requirement description	Relevant section in this report
(a) details of—	(i) the specialist who prepared the report; and	Section 2.7
	(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Section 2.7 & Annexure 2
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Section 12
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section 1, 2.1 & 3.2
(cA)	an indication of the quality and age of base data used for the specialist report;	Section 5 & 6
(cB)	a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 6.1
(d)	the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Site investigation not applicable
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 5 & 6.2
(f)	details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 6.3 & 6.4
(g)	an identification of any areas to be avoided, including buffers;	None identified
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 6.3.2
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge; Note: Uncertainties should be qualified within the report – there will always be uncertainties due to gaps in knowledge should also be qualified – a gap is to record that not all knowledge can be obtained for a study.	Section 2.9
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 6.4
(k)	any mitigation measures for inclusion in the EMPr;	Section 9

Relevant section in GNR. 982	Requirement description	Relevant section in this report
	Note: We need to include whether these mitigation measures (excluding ongoing monitoring) can be practically implemented prior to commencement or not.	
(l)	any conditions for inclusion in the environmental authorisation;	Section 9
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 9
(n) a reasoned opinion—	(i) whether the proposed activity, activities or portions thereof should be authorised;	Section 10
	(iA) regarding the acceptability of the proposed activity or activities; and	Section 10
	(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan; Note: We need to include whether these mitigation measures (excluding ongoing monitoring) can be practically implemented prior to commencement or not.	Section 10
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 1
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Addressed in April 2021 AIR
(q)	any other information requested by the competent authority.	Addressed in April 2021 AIR
(2)	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Section 1 & 6.2.1

ANNEXURE 3: CURRICULUM VITAE

MARK ZUNCKEL

Firm	:	uMoya-NILU (Pty) Ltd
Profession	:	Air quality consultant
Specialization	:	Air quality assessment, air quality management planning, air dispersion modelling, boundary layer meteorology, project management
Position in Firm	:	Managing director and senior consultant
Years with Firm	:	Since 1 August 2007
Nationality	:	South African
Year of Birth	:	1959
Language Proficiency	:	English and Afrikaans

EDUCATION AND PROFESSIONAL STATUS

Qualification	Institution	Year
National Diploma (Meteorology)	Technikon Pretoria	1980
BSc (Meteorology)	Univ. of Pretoria	1984
BSc Hons (Meteorology)	Univ. of Pretoria	1988
MSc	Univ. of Natal	1992
PhD	Univ. Witwatersrand	1999

Registered Natural Scientist: South African Society for Natural Scientific Professionals
Ex-Council Member: National Association for Clean Air
Member: National Association for Clean Air

EMPLOYMENT AND EXPERIENCE RECORD

Period	**Organisation details and responsibilities/roles**
1976 – May 1992	South African Weather Bureau : Observer, junior forecaster, senior forecast, researcher, assistant director
June 1992 – July 2007	CSIR: Consultant and researcher, Research group Leader: Atmospheric Impacts
August 2007 to present	uMoya-NILU Consulting: Managing Director and senior air quality consultant

Key and Recent Project Experience:

1996	Project leader & Principal researcher: Atmospheric impact assessment for the proposed Mozal aluminium smelter in Maputo, Mozambique.

1996 Project leader & Principal researcher: Dry sulphur deposition during the Ben MacDhui High Altitude Trace Gas and Transport Experiment (BATTEX) in the Eastern Cape.

1997 Project leader & Principal researcher: Atmospheric impact assessment of the proposed capacity expansion project for Alusaf in Richards Bay.

1997 Project leader & Principal researcher: The Uruguayan ambient air quality project with LATU.

1997 Principal researcher on the Air quality specialist study for the Strategic Environmental Assessment on the industrial and urban hinterland of Richards Bay.

1997 Project leader & Principal researcher: Feasibility study for the implementation of a fog detection system in the Cape Metropolitan area: Meteorological aspects.

2001 Project leader & Principal researcher: Air quality specialist study for the Environmental Impact Assessment for the proposed expansion of the Hillside Aluminium Smelter, Richards Bay.

2001-03 Researcher: The Cross Border air Pollution Impact (CAPIA) project. A 3-year modelling and impacts study in the SADC region.

2002 Project leader & Principal researcher: Air quality assessment specialist study for the proposed Pechiney Smelter at Coega.

2002 Project leader & Principal researcher: Air quality assessment specialist study for the proposed N2 Wild Coast Toll Road.

2002-05 Project leader on the NRF project – development of a dynamic air pollution prediction system

2004 Project leader on the specialist study for expansion at the Natal Portland Cement plant at Simuma, KwaZulu-Natal.

2004-05 Researcher: National Air Quality Management Plan implementation project for Department Environmental Affairs and Tourism.

2005 Researcher in the assessment of air quality impacts associated with the expansion of the Natal Portland Cement plant at Port Shepstone.

2006-07 Project team leader of a multi-national team to develop the National Framework for Air Quality Management for the Department of Environment Affairs and Tourism

2007 Air quality assessment for Mutla Early Production System in Uganda for ERM Southern Africa on behalf of Tullow Oil.

2007-10 Lead consultant on the development of a dust mitigation strategy fro the Bulk Terminal Saldanha and an ambient guideline for Fe_2O_3 dust for Transnet Projects and on-going monitoring.

2008 Lead consultant on the Air quality status quo assessment and scoping for the EIA for the Sonangol Refinery

2008-09 Lead consultant on the development of the air quality management plan for the Western Cape Provincial. Department of Environmental Affairs and Development Planning.

2008-10 Lead consultant on the development of the Highveld Priority Area air quality management plan for the Department of Environmental Affairs and Tourism.

2008 Lead consultant in the development of an odour management and implementation strategy for eThekwini, focussing on Wastewater Treatment Works and odourous industrial sources

2008&10 Lead consultant on the Air Quality Specialist Study for the EIA for the proposed Kalagadi Manganese Smelter at Coega

2008	Lead consultant on the Air Quality Assessment for the Proposed Construction and Operation of a Second Cement Mill at NPC-Cimpor, Simuma near Port Shepstone.
2008	Lead consultant on the Air Quality Specialist Study Report for the New Multi-Purpose Pipeline Project (NMPP) for Transnet Pipelines.
2008	Lead consultant on the Air quality assessment for the proposed UTE Power Plant and RMDZ coal mine at Moatize, Mozambique for Vale.
2008-09	Lead consultant on the Dust source apportionment study for the Coedmore region in Durban for NPC-Cimpor.
2009	Consultant on the Air quality specialist study for the upgrade of the Kwadukuza Landfill, KwaZulu-Natal
2009-10	Lead consultant on the Audit of ambient air quality monitoring programme and air quality training for air quality personnel at PetroSA
2010	Lead consultant on the Qualitative assessment of impact of dust on solar power station at Saldanha Bay
2010	Lead consultant on the Air quality specialist study for the EIA for the Kalagadi Manganese Smelter at Coega
2009-10	Lead consultant on the Air quality specialist study for the Environmental Management Framework for the Port of Richards Bay
2010	Lead consultant on the Air quality status quo assessment and abatement planning at Idwala Carbonates, Port Shepstone
2010	Lead consultant on the Air quality status quo assessment and abatement planning at Sappi Tugela, Mandeni
2010–11	Air quality status quo assessment and revision of the Air Quality Management Plan for City of Johannesburg
2010	Lead consultant on the Air quality status quo assessment and abatement planning at First Quantum Mining’s Bwana Mkubwa and Kansanshi mines, Zambia
2010–11	Lead consultant on the Air quality specialist study for the EIA for the Alternative Fuel and Resources Project at Simuma, Port Shepstone
2010–11	Lead consultant on the Air quality specialist study for the EIA for the Coke Oven re-commissioning at ArcelorMittal Newcastle
2010	Qualitative air quality assessment for the EIA for the Mozpel sugar to ethanol project , Mozambique
2011	Development of the South African Air Quality Information System – Phase II The National Emission Inventory
2011	Ambient baseline monitoring for Riversdale’s Zambezi Coal Project in Tete, Mozambique
2010-11	Ambient quality baseline assessment for the Ncondeze Coal Project, Tete Mozambique
2011-12	Air quality assessment for the mining and processing facilities at Longmin Platinum in Marikana
2012	Air quality assessment for the proposed LNG and OLNG power stations in Mozambique
2012	Modelling study in Abu Dhabi for the transport and deposition of radio nuclides
2012	Air quality assessment for the proposed manganese ore terminal at the Ngqura Port
2012-13	Air quality management plan development for Stellenbosch Municipality
2012-12	Air quality management plan development for the Eastern Cape Province

2013	Air quality specialist for Tullow Oil Waraga-D and Kinsinsi environmental audit in Uganda
2013	Air quality specialist study for the EIA for the Thabametsi IPP station
2013	Air quality management plan for the Ugu District Municipality
2013-14	Air quality specialist study for the application for postponement of the minimum emission standards for 9 Eskom power stations
2014	Air quality specialist study for the application for postponement applications of the minimum emission standards for the Engen Refinery in Merebank, Durban
2014-15	Baseline assessment and AQMP development for the uThungulu District Municipality
2013-15	Baseline assessment, AQMP and Threat Assessment for the Waterberg-Bojanala Priority Area
2014-15	Review of the 2007 AQMP for eThekwini Municipality, including metropolitan emission inventory development for all sectors, i.e. industrial, transport, waste management, biomass burning, residential fuel burning, dispersion modelling and strategy development
2014-14	Dispersion modelling study for Richards Bay Minerals
2015	Air quality assessment for Rainbow Chickens at Hammersdale
2015	Air quality status quo assessment and planning for TNPA ports in South Africa
2016- 7	Lead author of the National State of Air Report for 2005 to 2015, including national emission inventory development for all sectors, i.e. industrial, transport, waste management, biomass burning, residential fuel burning
2016	Air quality assessment for Kanshansi Mine, Solwesi, Zambia
2016	Assessment of air quality impacts associated with activities at the Venetia Mine, Limpopo Province
2016	Assessment of air quality impacts associated with activities at the Komati Anthracite Mine, Mpumalanga Province
2016	Air quality assessment for the proposed Powership Project at the Port of Nacala, Mozambique
2016	Air quality assessment for the proposed Richards Bay Gas to Power Project
2017	Baseline assessment and review of the 2009 AQMP for Gauteng Province, including emission inventory development for all sectors, i.e. industrial, transport, waste management, biomass burning, residential fuel burning, and dispersion modelling
2017	Baseline assessment and air quality management plan for Northern Cape Province
2017	Air quality assessment for the EIA for the Thabametsi Power Station in Limpopo Province
2017	Air quality assessment for the EIA for the proposed Tshivasho Power Station in Limpopo Province
2018	Air quality assessment for the EIA for the proposed Bellmall Thermal Plant in Ekurhuleni
2018	Air quality assessment for the EIA for the proposed Simba Oil mini Refinery in Tororo, Uganda
2018-19	Air dispersion modelling for input to the Atmospheric Reports for the postponement application for 14 Eskom power stations
2019	Air quality impact assessment for the proposed NamPower expansion project in Walvis Bay
2019	Air quality assessment for the mine expansion project at the Akanani Mine

2019	Air quality impact assessment for the proposed power plant at Nacala, Mozambique
2020	AIR for the KarpowershipSA proposal in the Ports of Ngqura, Richards Bay and Saldanha Bay
2020	AIR for the Coega Development Corporation gas-to-power project at 4 sites in the CDC
2020	AIRs for 10 Eskom coal-fired power power stations on the Highveld to support their postponement application
2020	AIR for the proposed Azure Power gas-to-power project in the Western Cape
2021	Air quality assessment for the proposed optimisation project at Beeshoek Iron Ore Mine, Postmasburg, Northern Cape
2021	AIR for the proposed Frontier Power Gas-to-Power project at Saldanha Bay, Western Cape
2021	AIR for the 2021 shutdown and start-up at Engen Refinery in Merebank
2021	AIR for the proposed expansion of the Swartkops Ore handling facility in Port Elizabeth, Eastern Cape
2016-21	AEL compliance monitoring for Joseph Grieveson, Durban, including dust fallout monitoring and reporting
2018-21	Dust fallout and HF monitoring and reporting for Hulamin, Richards Bay
2018-21	Dust fallout and H_2S monitoring and reporting for at KwaDukuza Landfill for Dolphin Coast Landfill Management (DCLM)
2019-21	AEL compliance monitoring for Umgeni Iron and Steel Foundry, including dust fallout monitoring and reporting

PUBLICATIONS

Author and co-author of 34 articles in scientific journals, chapters in books and conference proceedings. Author and co-author of more than 300 technical reports and presented 47 papers at local and international conferences.

ATHAM RAGHUNANDAN

Firm	:	uMoya-NILU Consulting (Pty) Ltd
Profession	:	Air Quality Consultant
Specialization	:	Meteorological and Atmospheric Dispersion Modelling, Air Quality Specialist Studies, Project Management, Data Processing, Emission Inventories
Position in Firm	:	Senior Air Quality Consultant
Years with Firm	:	14 years (appointed in 2008)
Nationality	:	South African
Year of Birth	:	1977
Language Proficiency		:English (mother tongue), Afrikaans (fair)

EDUCATION AND PROFESSIONAL STATUS

Qualification	Institution	Year
M.A. (Atmospheric Sciences)	University of Natal, Durban	2003
B.A. Hons. (Environmental Sciences)	University of Durban–Westville	2001
B.Paed. (Education)	University of Durban–Westville	2000

Memberships:

- National Association for Clean Air (NACA)
- South African Society for Atmospheric Sciences (SASAS)
- South African Council of Educators (SACE)

EMPLOYMENT AND EXPERIENCE RECORD

Period	Organisation details and responsibilities/roles
Jan 2003 – Oct 2008	CSIR: Consultant/Researcher in Air Quality Group, Research Group Leader – Air Quality Research Group
Nov 2008 – present	uMoya-NILU: Senior Air Quality Consultant

Key and Recent Project Experience:

2003	Baseline air dispersion modelling study for Natal Portland Cement (Pty) Ltd – Simuma Plant, Port Shepstone – Modelling and Reporting
2004	Air Quality Screening Study for MOZAL 3 – Modelling and Reporting
2005	Air Quality Specialist Study for the Proposed Kudu Combined Cycle Gas Turbine Power Station at Oranjemund, Namibia (Site D) – Modelling and Reporting
2005	Air Quality Specialist Study for the Proposed Kudu Combined Cycle Gas Turbine Power Plant at Uubvlei, Namibia – Modelling and Reporting
2005	Air Quality Specialist Study for a Proposed Cement Milling, Storage and Packaging Facility and a Second Clinker Kiln at Natal Portland Cement (Pty) Ltd – Simuma Plant, Port Shepstone – Modelling and Reporting
2005	Technology Review: Air quality specialist study for the Coega Aluminium Smelter at Coega, Port Elizabeth – Modelling and Reporting
2005	Assessment of Development Scenarios for Hillside Aluminium using Sulphur Dioxide (SO_2) as an Ambient Air Quality Indicator – Modelling and Reporting
2005	Air Quality Scoping Study for Eskom’s Proposed Open Cycle Gas Turbine Power Station at Atlantis – Modelling and Reporting
2005	Air Quality Specialist Study for Eskom’s Proposed Open Cycle Gas Turbine Power Station at Atlantis, Western Cape – Modelling and Reporting
2005	Air Quality Specialist Study for the Proposed Tata Steel Ferrochrome Project at Richards Bay – Alton North Site – Modelling and Reporting
2005	Air Quality Audit for the Amathole District Municipality - Compilation of detailed emissions inventory
2006	A Regional Scale Air Dispersion Modelling Study for Northeastern Uruguay – Modelling and Reporting

2006	Air Dispersion Modelling Study for Natal Portland Cement (Pty) Ltd for the Proposed AFR Programme at the Simuma Plant, Port Shepstone – Modelling and Reporting
2007	Development of an air quality management strategy for particulate matter at the Bulk Terminal Saldanha - Project Leader and Reporting
2007	Air Quality and Human Health Specialist Study for the Proposed Coega Integrated LNG to Power Project (CIP) within the Coega Industrial Zone, Port Elizabeth, South Africa - Project Leader, Modelling and Reporting
2008	Dispersion Modelling for the Proposed Coega Aluminium Smelter (CAL) at Port Elizabeth - Project Leader, Modelling and Reporting
2008	Modelled and Measured Vertical Ozone Profiles over Southern Africa (as part of the Young Researcher Establishment Fund (2005-2008)) - Project Leader
2008	Air Quality Specialist Study for the Proposed N2 Wild Coast Toll Highway - Project Leader, Modelling and Reporting
2008	Initial Air Quality Impact Assessment for the Proposed Illovo Ethanol Plant in Mali, West Africa - Project Leader, Modelling and Reporting
2008	Modelling Mercury Stack Emissions from South African Coal-fired Power Power stations – Modelling and Reporting
2009	Air Quality Management Plan for the Western Cape Province – Baseline Assessment – Modelling
2009	Proposed Exxaro AlloyStream™ Manganese Project in the Coega Industrial Development Zone: Air Quality Impact Assessment – Modelling and Reporting
2009	Air Quality Specialist Study for the Kalagadi Manganese Smelter at Coega, Eastern Cape – Modelling and Reporting
2009	Qualitative Air Quality Impact Assessment for the Wearne Platkop Quarry – Modelling and Reporting
2009	Specialist Air Quality Study for the Vopak Terminal Durban Efficiency Project – Modelling
2009	Qualitative Air Quality Impact Assessment for the Proposed ETA STAR Coal Mine at Moatize, Mozambique – Modelling and Reporting
2009	Specialist Air Quality Study for the Kwadukuza Landfill Upgrade Project – Modelling and Reporting
2010	Ambient dust assessment at Saldanha Bay for the period October 2006 to September 2009 for Transnet Bulk Terminal Saldanha – Reporting
2010	Dust Impact Assessment for the Proposed Saldanha Bay Pilot PV plant – Reporting
2010	Modelling Particulate Emission Concentration Scenarios for Eskom's Kriel Power Station – Modelling and Reporting
2010	Air Quality Dispersion Modelling for MOZAL, Mozambique – Modelling and Reporting
2010	Air Quality Management Plan for the Highveld Priority Area – Air Quality Baseline Assessment for the Highveld Priority Area – Modelling
2010	Ambient Air Quality Modelling and Monitoring at Sappi, Mandeni – Modelling and Reporting
2010	Dust Impact Study at Idwala Carbonates – Modelling and Reporting
2010	Air quality specialist study for the EIA for the proposed re-commissioning of an existing coke oven battery at ArcelorMittal South Africa, Newcastle Works – Modelling

2010	Air quality specialist study for the proposed storage and utilisation of alternative fuels and resources at NPC-Cimpor's Simuma facility, Port Shepstone, KwaZulu-Natal – Modelling and Reporting
2010	Air quality status quo assessment and abatement planning at First Quantum Mining's Bwana Mkubwa and Kansanshi mines, Zambia – Modelling
2010	Air quality specialist study for the proposed briquetting plant at the Mafube Colliery – Modelling and Reporting
2011	Air quality modelling study for the Copeland reactor at Sappi Stanger – Modelling and Reporting
2011	Air quality modelling study for the Copeland reactor at Sappi Tugela – Modelling and Reporting
2011	Air quality monitoring and modelling study for the Copeland reactor at Mpact Paper, Piet Retief – Modelling and Reporting
2011	Air Quality Study for the Basic Environmental Assessment for the Proposed Biomass Co-Firing Facility at the Arnot Power Station – Modelling and Reporting
2011	Assessment of Scenarios for Developing and Implementing a Sulphur Dioxide Emissions Licensing Strategy for Hillside Aluminum – Modelling and Reporting
2011-12	Air quality assessment for the mining and processing facilities at Lonmin Platinum in Marikana – Modelling and Reporting
2012	Development of an Air Quality Management Plan for Anglo's Mafube Colliery in Mpumalanga – Modelling and Reporting
2012	Air quality assessment for the proposed manganese ore terminal at the Ngqura Port – Modelling and Reporting
2012	Air Quality Impact Assessment for NPC Cimpor – Modelling and Reporting
2013	Air Quality Impact Assessment for Proposed AfriSam Plant in Coega – Modelling
2013	Air quality assessment for the Orion Engineered Carbons Co-Gen Plant – Modelling
2013	Air quality assessment for the Orion Engineered Carbons - Main Boiler – Modelling
2013	Air quality assessment for the EIA for the Sekoko Coal Mine – Modelling and Reporting
2013	Air quality specialist study for the EIA for the Thabametsi IPP station – Modelling and Reporting
2013	Air quality specialist study for the EIA for the Mamathwane Common User facility – Modelling and Reporting
2013-14	Air quality specialist study for the application for postponement of the minimum emission standards for 16 Eskom power stations: Acacia, Arnot, Camden, Duvha, Grootvlei, Hendrina, Kendal, Komati, Kriel, Lethabo, Majuba, Matimba, Matla, Madupi, Tutuka, Port Rex – Modelling and Reporting
2014	Air quality specialist study for the application for postponement of the minimum emission standards for the Engen Refinery in Merebank, Durban – Modelling and Reporting
2013-14	Baseline assessment and air quality management plan for the Waterberg-Bojanala Priority Area – Modelling

2013	Air Quality Specialist Study for the EIA for the Pandora Platinum Mine Joint Venture – Modelling and Reporting
2013	Air Quality Specialist Study for the EIA for the Proposed New Tailings Storage Facility (TD8) and Associated Infrastructure at Lonmin's Western Platinum Mine and Eastern Platinum Mine – Modelling and Reporting
2015	Waterberg-Bojanala Priority Area Air Quality Management Plan and Threat Assessment – Modelling
2015	Air Quality Management Plan for eThekwini Municipality – Modelling and Reporting
2015	Air Quality Management Plan for the uThungulu District Municipality – Modelling and Reporting
2015	Dispersion Modelling for Richards Bay Minerals – Modelling and Reporting
2015	Atmospheric Impact Report in support of Sancryl Chemicals's application for a verification to the existing AEL as a result of the introduction of Ethyl Acrylate and Vinyl Acetate, Prospecton – Modelling and Reporting
2016	Dispersion Modelling Study for the City of Johannesburg – Modelling and Reporting
2016	Air Quality Specialist Study for the Department of Energy's Emergency Power IPP Project at Richards Bay and Saldanha Bay – Modelling and Reporting
2016	Atmospheric Impact Report in support of the EIA for the Proposed Gas to Power Plant in Zone 1F of the Richards Bay IDZ – Modelling and Reporting
2016	Atmospheric Impact Report for the EIA for the proposed Tshivhaso Coal-fired Power Plant, Lephalale – Modelling and Reporting
2016	TNPA Air Quality Study – Dispersion Modelling for 8 Ports in South Africa: Port of Richards Bay, Durban, East London, Ngqura, Port Elizabeth, Mossel Bay, Cape Town and Saldanha Bay – Modelling and Reporting
2016	Atmospheric Impact Report for Durran's Calcination Plant – Modelling and Reporting
2016	Air Quality Assessment for the EIA for the Floating Power Plant in Nacala, Mozambique – Modelling and Reporting
2016	Ambient Air Quality Assessment for 2016 for Kansanshi Mining Plc – Modelling and Reporting
2016	Air Quality Impact Assessment for the EIA for the Proposed Hilli FLNG Project in Cameroon – Modelling and Reporting
2016	Kansanshi Smelter and TSF1 Modelling Scenarios for Kansanshi Mining Plc – Modelling and Reporting
2016	Air Quality Assessment the Proposed Accommodation Facility at the Venetia Mine in Limpopo – Modelling and Reporting
2016	Atmospheric Impact Report in support of the EIA for the Proposed Optimisation of the Process Plant at Nkomati Anthracite Mine – Modelling and Reporting
2017	Atmospheric Impact Report in support of the DRDAR Atmospheric Emission License (AEL) application for the proposed replacement and use of an incinerator at their State Veterinary Laboratories located in Grahamstown, Middelburg and Queesntown in the Eastern Cape – Modelling and Reporting
2017	Baseline Assessment and Review of the 2009 AQMP for Gauteng Province, including emission inventory development for all sectors, i.e. industrial,

	transport, waste management, biomass burning, residential fuel burning, and dispersion modelling – Modelling and Reporting
2017	Baseline Assessment and Air Quality Management Plan for Northern Cape Province – Modelling and Reporting
2017	Atmospheric Impact Report in support of Maloka Machaba Surfacing's application for an Atmospheric Emission License (AEL) for a proposed asphalt plant located in Polokwane – Modelling and Reporting
2017	Assessment of modelling scenarios involving an increase in the open area of the cone on the Common Stack for the pretreater, reformer and CHD furnaces at Engen Refinery – Modelling and Reporting
2017	Atmospheric Impact Report in support of the Atmospheric Emission License (AEL) application and stack-height assessment for the proposed Thabametsi Power Plant near Lephalale, Limpopo – Modelling and Reporting
2017	Dispersion Modelling Study for the Beeshoek Mine, near Postmasburg, Northern Cape – Modelling and Reporting
2018	Air quality assessment for the EIA for the proposed Bellmall Thermal Plant in Ekurhuleni – Modelling and Reporting
2018	Air quality assessment for the EIA for the proposed Simba Oil mini Refinery in Tororo, Uganda – Modelling and Reporting
2018-19	Air dispersion modelling for input to the Atmospheric Reports for the postponement application for 14 Eskom power stations – Modelling and Reporting
2019	Air quality impact assessment for the proposed NamPower expansion project in Walvis Bay – Modelling and Reporting
2019	Air quality assessment for the mine expansion project at the Akanani Mine – Modelling and Reporting
2019	Air quality impact assessment for the proposed power plant at Nacala, Mozambique – Modelling and Reporting
2019	Atmospheric Impact Report in Support of the Atmospheric Emission License (AEL) Amendment Application and Basic Assessment for Dow Southern Africa - New Germany – Modelling and Reporting
2019	Atmospheric Impact Report in support of Tau-Pele Construction's application for an Atmospheric Emission License (AEL) for a proposed emulsion and asphalt plant located in Indwe, Eastern Cape – Modelling and Reporting
2019	Atmospheric Impact Report in Support of the EIA for the Proposed Material Source and Processing Sites Along the N3 Between Durban and Hilton, KwaZulu-Natal: RCL1, RCL9 and Harrison's Quarry – Modelling and Reporting
2019	Atmospheric Impact Report in Support of the Atmospheric Emission License (AEL) Amendment Application and Basic Assessment for the Vopak Efficiency (Growth 4) Expansion Project, Durban, South Africa – Modelling and Reporting
2020	AIR for the KarpowershipSA proposal in the Ports of Ngqura, Richards Bay and Saldanha Bay – Modelling and Reporting
2020	AIR for the Coega Development Corporation gas-to-power project at 4 sites in the CDC – Modelling and Reporting
2020	AIRs for 10 Eskom coal-fired power power stations on the Highveld to support their postponement application – Modelling and Reporting
2020	AIR for the proposed Azura Power gas-to-power project in the Western Cape – Modelling and Reporting

2020	Atmospheric Impact Report for the proposed 315 MW LPG Power Plant at Saldanha Bay – Modelling and Reporting
2021	Air quality assessment for the proposed optimisation project at Beeshoek Iron Ore Mine, Postmasburg, Northern Cape – Modelling and Reporting
2021	Air quality assessment for the proposed expansion at Akanani Mine in Limpopo – Modelling and Reporting
2021	AIR for the proposed Frontier Power Gas-to-Power project at Saldanha Bay, Western Cape
2021	AIR for the 2021 shutdown and start-up at Engen Refinery in Merebank – Modelling and Reporting
2021	AIR for the proposed expansion of the Swartkops Ore handling facility in Port Elizabeth, Eastern Cape – Modelling and Reporting
2021	Atmospheric Impact Report in support of the Proposed 200 MW Engie CB Hybrid Power Project in the Coega Special Economic Zone (SEZ) – Modelling and Reporting
2021	Air Quality Impact Assessment for the proposed Mining of TSF-1 at the Stibium Mopani Mine near Gravelotte, Limpopo Province – Modelling and Reporting
2021	Addendum to the Atmospheric Impact Report in support of the proposed Mulilo-Total 200 MW Gas-fired Power Station, Coega Special Development Zone, Eastern Cape – Reporting
2021	Air Quality Assessment for the EIA for the Tete 1 400 MW Coal-Fired Power Plant, Tete Province, Mozambique – Modelling and Reporting
2021	Atmospheric Impact Report in support of Tugela Asphalt's application for an Atmospheric Emission License (AEL) for a proposed asphalt plant located in Mandini, KwaZulu-Natal – Modelling
2021	Atmospheric Impact Report for Nkomati Mine – Modelling and Reporting
2022	Emission Inventory for Lanxess for 2021 – Reporting
2022	Annual Report for Puregas: Atmospheric Emission License - Submission to the City of Ekurhuleni in compliance with the Atmospheric Emission Licence of the facility for the Reporting Period Year 2021 – Reporting
2022	Emission Inventory for Puregas for 2021 – Reporting
2022	Emission Inventory for Dow Advanced Materials for 2020 – Reporting
2022	Atmospheric Impact Report for the Engen Cape Town Terminal – Modelling and Reporting

PUBLICATIONS

Author and co-author of 5 articles in scientific journals and conference proceedings. Author and co-author of more than 200 technical reports for external contract clients. Presented 4 papers at local conferences. A full list of publications, conference papers and contract reports is available on request.

NOPASIKA XULU

Firm	:	uMoya-NILU (Pty) Ltd
Profession	:	Senior Air Quality Consultant
Specialization	:	Air Quality Assessment, Air Dispersion Modelling; Project Management; Data Analysis; Report Writing and Reviews
Position in Firm	:	Senior Air Quality Consultant
Years with Firm	:	Since 27 March 2023
Nationality	:	South African
Year of Birth	:	1985
Language Proficiency	:	English and IsiZulu (read, write. Speak)

EDUCATION AND PROFESSIONAL STATUS

Qualification	Institution	Year
BSc. Environmental Studies	Univ. of Witwatersrand	2011
BSc Hons (Env. Studies)	Univ. of Witwatersrand	2012
BSc MSc (Env Sciences)	NWU Potchefstroom	2017

EMPLOYMENT AND EXPERIENCE RECORD

Period	Organisation details and responsibilities/roles
Oct 2016 – Dec 2018	Gondwana Environmental Solutions (Pty) Ltd: Air Quality Management Plans; Report Writing; Business Development and Marketing, Researcher,
July 2019 – March 2023	Rayten Engineering Solutions (Pty) Ltd: Air Quality Consultant, Project Management; Report Writing and Review; Data Analysis; Dispersion Modelling and Air Quality Impact Assessment; Research; Compiling Atmospheric Emission License (AEL) Applications; Populating National Atmospheric Emissions Inventory System; AEL Compliance Auditing; Dust Emission Reduction Plans; Greenhouse Gas Emissions Inventory Reporting; Facilitating/ Attending meetings; Liaising with Clients and Suppliers.

March 2023 – Present: uMoya – Nilu Consulting (Pty) Ltd Senior Air Quality Consultant, Dispersion Modelling and Air Quality Impact Assessments; Project Management

Key Project Experience:

2019 – 2023: Project Leader: Air Quality Impact Assessment projects (Harmony Moab Khotsong; EzeeTile Bloemfontein, EzeeTile Mokopane; Transvaal Galvanizers; Duho Drying; Lingaro Drying; Nama Copper Pty Ltd) Project Leader: AEL Applications and Reporting (Harmony Kopanang Operations; Harmony Mponeng Operations; Sibanye Gold Mines; Sibanye Platinum

Mines; TotalEnergies Marketing; Matt Cast Supplies CC; Independent Crematorium SA; City of Tshwane Crematorium; Buffalo City Municipality Crematorium; Wahl Industries; Transvaal Galvanizers)

2014 – 2017: Researcher: Air Quality Assessment in low-income residential areas in the Highveld

Publications: Author: Xulu, N.A., Piketh, S.J. Feig,G.T., Lack, D.A and Garland,R.M., (2020).Characterizing Light Absorbing Aerosols in a Low –Income Settlement in South Africa. Aerosol Air Quality Aerosol Air Quality Research. https://doi.org/10.4209/aaqr.2019.09.004

CONTACT INFORMATION:

Email: nopasika@umoya-nilu.co.za

Phone: +27 63 1289 447