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Dear Mr Masila

ESKOM'S APPLICATION FOR EXEMPTION FROM MINIMUM EMISSION STANDARDS AND POSTPONEMENT OF THE MINIMUM EMISSION STANDARDS TIMEFRAMES FOR ESKOM POWER STATIONS
COMMENTS ON THE U-MOYA-NILU CONSULTING (PTY) LTD PLAN OF STUDY SUPPORT

1. We act for groundWork, Earthlife Africa Johannesburg (ELA) and the following community groups: Middelburg Environmental Justice Network; Greater Middelburg Residents' Association; Guqa Community Service Centre; Southern Africa Green Revolutionary Council; Greater Delmas Civic Movement; and Schoongesicht Community Movement. Our clients are interested and affected parties in Eskom's applications for postponement of and/or exemption from the compliance time-frames for the minimum emission standards (MES) published in terms of section 21 of the National Environmental Management: Air Quality Act, 2004 (AQA).

2. We make the submissions below on uMoya-NILU Consulting (Pty) Ltd's Plan of Study (PoS) Report in support of Eskom's applications. These submissions have been prepared with the technical assistance of Professor Eugene Cairncross, a chemical engineer with expertise in this area.

3. **Objectives of the Plan of Study**

   3.1. The PoS proposes to model the dispersion of selected stack pollutant emissions (SO_2, NOx and PM_{10}) from 14 coal-fired power stations and two liquid fuel (diesel or kerosene) fired power stations.

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3.2. The objective(s) of the PoS are not comprehensively stated in terms of all the relevant legislative provisions.

3.3. Section 1.2.1 of the PoS: "Purpose and objectives of the air dispersion modelling under consideration" states that:

> *"… Supporting studies are needed to fulfil the requirements for these applications stipulated in the Air Quality Act and the Minimum Emission Standards*."

3.4. The Background Information Document (BID) refers to the preparation of Atmospheric Impact Reports (AIRs), and, in this context, doing atmospheric dispersion modelling "*to predict ambient air quality and… to ascertain how emissions from the various power stations influence ambient air quality*." The BID infers that the focus of the dispersion modelling will be "... ***ascertaining how compliance with the ambient air quality standards*** will be affected by the delayed implementation of the MES or not meeting the MES at all" (our emphasis). AIRs will apparently be prepared for each of Eskom's applications and there will be an opportunity to comment on these AIRs, as well as on the applications themselves.

3.5. Section 30(a) of the National Environmental Management: Air Quality Act, 2004 (AQA) provides that an air quality officer may require any person to submit to the air quality officer an atmospheric impact report in a prescribed form "*if the air quality officer reasonably suspects that the person has on one or more occasions contravened or failed to comply with this Act or any conditions of a licence and that such contravention or failure has had, or may have, a detrimental effect on the environment, including health, social conditions, economic conditions, ecological conditions or cultural heritage, or has contributed to the degradation of ambient air quality*". In relation to the AIR's "prescribed form", draft regulations prescribing this format were promulgated for comment on 23 November 2012.

3.6. The PoS of the dispersion modelling study focuses on assessing compliance with the ambient air quality standards rather than on a more comprehensive assessment of the impact of power station emissions on "*the environment, including health, social, economic and ecological conditions*", as required in an AIR.

3.7. This partial focus of the PoS has a significant influence on the proposed scope of these studies, including that of the pollutants selected for the study, the modelling domains (extent of the areas included in the modelling) proposed and the proposed model outputs.

4. The pollutants selected for the modelling studies - the non-inclusion of $PM_{2.5}$

4.1. For the 14 coal-fired power stations, the PoS proposes to model the dispersion of SO_2, NOx and PM_{10} (PM_{10}**:** particulate matter less than 10 microns in diameter) only. $PM_{2.5}$ ($PM_{2.5}$: particulate matter less than 10 microns in diameter) should also be included in the assessment of the environmental impact of Eskom's power station emissions, both as a primary pollutant emitted directly from the stacks and as a secondary pollutant formed in the atmosphere. The modelling methodology proposed in the PoS may or may not be an appropriate method of assessing the impact of $PM_{2.5}$

4.2. An assessment of the environmental impact of $PM_{2.5}$ originating from Eskom's emissions should be included for several reasons:

4.2.1. $PM_{2.5}$ is one of the substances for which national ambient air quality standards have been set. Annual and daily average standards for PM2.5 were promulgated on 29 June 2012[1], and came into effect immediately. A consideration of PM2.5 impacts is therefore mandatory.

4.2.2. There are serious health risks associated with exposure to $PM_{2.5.}$ In this regard, the World Health Organisation Summary of Air Quality and Health[2] provides as follows:

[1] Government Gazette No. 35463. 29 June 2012.

"PM affects more people than any other pollutant. The major components of PM are sulfate, nitrates, ammonia, sodium chloride, carbon, mineral dust and water. It consists of a complex mixture of solid and liquid particles of organic and inorganic substances suspended in the air. The particles are identified according to their aerodynamic diameter, as either PM10 (particles with an aerodynamic diameter smaller than 10 µm) or ***PM2.5 (aerodynamic diameter smaller than 2.5 µm). The latter are more dangerous since, when inhaled, they may reach the peripheral regions of the bronchioles, and interfere with gas exchange inside the lungs****."* (our emphasis)

4.2.3. The chemical composition of $PM_{2.5}$ and its toxicity vary depending on the emission source characteristics and is not a simple proportion of the mass concentration of the $PM_{2.5}$ size range relative to that of PM_{10}.[3] Thus, although the size definition of PM_{10} includes the smaller size fraction $PM_{2.5}$, the health impacts of $PM_{2.5}$ should be considered separately and in addition to those associated with PM_{10} exposure.

4.2.4. Ambient $PM_{2.5}$ is a complex mixture of aerosols (liquid and solid particles) of various chemical compositions and may constitute 10-70 or 80% of the ambient PM_{10} fraction[4], depending on emission source characteristics and seasonal factors. Reported primary $PM_{2.5}$ (i.e. reported as directly emitted from combustion source stacks) varies according to the method used to measure emission concentrations.[5] Secondary $PM_{2.5}$, formed through condensation processes during the cooling of the stack gas, and formed through subsequent chemical reactions from precursors such as SO_2 and NOx (both major emissions from Eskom power stations), may constitute 30-70% of the total ambient $PM_{2.5}$.[6] Thus the mass concentrations of both primary and secondary $PM_{2.5}$ are significant. This factor, combined with the enhanced toxicity of $PM_{2.5}$, means that an assessment of the contribution of the Eskom power station emissions to current and future ambient $PM_{2.5}$ under different scenarios is essential to a full assessment of the environmental impacts of the power station emissions under consideration.

4.2.5. For commonly-used emission control technologies (electrostatic precipitators and fabric filters), the efficiency of removal of the smaller size fraction $PM_{2.5}$ is lower than that of the removal of the larger PM_{10} size range. Therefore, estimates of achievable emission reduction efficiencies under various emission scenarios should take congnisance of this factor.

4.2.6. CALPUFF (implemented with a chemistry module) may, in principle, be used to estimate the formation and dispersion of $PM_{2.5}$, but its predictive accuracy should be carefully evaluated against

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2 WHO factsheet N°313. Air quality and health. September 2011.

3 Giuliano Polichettia, Stefania Coccoa, Alessandra Spinalia, Valentina Trimarcoa, Alfredo Nunziatab. Review: Effects of particulate matter (PM10, PM2.5 and PM1) on the cardiovascular system. Toxicology 261 (2009) 1–8.

4 St. Pateraki, D.N. Asimakopoulos, H.A. Flocas, Th. Maggos, Ch. Vasilakos. The role of meteorology on different sized aerosol fractions (PM10, PM2.5, PM2.5–10). Science of the Total Environment 419 (2012) 124–135;
Ewa Dabek-Zlotorzynskaa, Tom F. Danna, P. Kalyani Martinelangoa, Valbona Celoa, Jeffrey R. Brook, David Mathieua, Luyi Dinga, Claire C. Austina. Canadian National Air Pollution Surveillance (NAPS) PM2.5 speciation program: Methodology and PM2.5 chemical composition for the years 2003-2008. Atmospheric Environment 45 (2011) 673-686.

5 Pechan Report No. 05.08.003/9012-452. Evaluation of Potential $PM_{2.5}$ Reductions by Improving Performance of Control Devices: $PM_{2.5}$ Emission Estimates. Prepared for: U.S. Environmental Protection Agency Research Triangle Park, NC 27711. September 25 2005.

6 St Pateraki footnote 4;
Lingxiao Yang, Shuhui Cheng, Xinfeng Wang, Wei Nie, Pengju Xu, Xiaomei Gao, Chao Yuan, Wenxing Wang. Source identification and health impact of PM2.5 in a heavily polluted urban atmosphere in China. Atmospheric Environment 75 (2013) 265-269;
Kirk R. Baker and Kristen M. Foley. A nonlinear regression model estimating single source concentrations of primary and secondarily formed PM2.5. Atmospheric Environment 45 (2011) 3758-3767.

previously published limitations of the use of CALPUFF for this purpose. The CAMx model appears to yield more accurate results, but this modelling system is complex and resource-intensive.

4.2.7. Baker and Foley[7] have recently proposed a non-linear regression model, based on modelling applied to 99 large point sources and a comparison between predicted and a large number (several thousand) of observed values. Separate regression models are proposed for primary $PM_{2.5}$, $PM_{2.5}$ sulphate ion, and $PM_{2.5}$ nitrate ion. Regression model inputs include facility emissions rates in tons per year and the distance between the source and receptor. An alternative method of source apportionment of ambient $PM_{2.5}$ involves sample collection and chemical analysis, followed by statistical analysis of the resulting data.[8]

4.2.8. The United States Environmental Protection Agency (EPA) has published guidance documents for $PM_{2.5}$ Permit Modelling[9] including a procedure to use "pollutant offset ratios" to estimate secondary $PM_{2.5}$ emissions based on precursor (SO_2 and NOx in this case) emission rates, and procedures using full gridded photochemical modelling.

4.3. In the circumstances, one or other established method, including verification against ambient data, should be used to determine of the contribution of Eskom power stations to total (primary and secondary) ambient $PM_{2.5}$.

5. Proposed modelling approach

5.1. The proposal to model each power station as an isolated source

The height of the coal-fired power station stacks (150 to 300m) and the magnitude of emissions (10000 to 154000 tons per year for SO_2 and NOx; 1000 to 7500 tons per year for PM) strongly suggest that regional transport of these emissions is important. The time dependency of secondary $PM_{2.5}$ formation, the possibility of pollutant recirculation under certain meteorological conditions and the location of all the coal-fired power stations as clusters within either the Vaal Triangle, Highveld or Waterberg Priority Areas all further support the need for a regional scale approach to modelling. In the case of the coal-fired power stations, the proposal to model each power station as an isolated source with a receptor domain of 60x60km centred on the source should therefore be reviewed. Our clients suggest that modelling the coal-fired power station emissions should be done as multiple sources within the three 'airsheds' associated with each of the Vaal Triangle, Highveld and Waterberg Priority Areas to account for the combined and cumulative impacts of clusters of sources.

5.2. The proposal to use CALPUFF for near source (near field) (<50km) modelling

5.2.1. The PoS proposes using CALPUFF only for all modelling. Although a modelling domain of 60x60km is proposed, it obviously includes the nearer field region of 50x50km. The US EPA regards AERMOD as the preferred model for distances up to 50km. In its 2008 Memorandum providing clarification of the regulatory status of the CALPUFF modelling system for near-field applications, with [pollutant] transport distance up to 50 kilometers,[10] it indicated that:

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7 Baker & Foley footnote 6.

8 For example: Myoungwoo Kim, Seemantini R. Deshpande, Kevin C. Crist. Source apportionment of fine particulate matter (PM2.5) at a rural Ohio River Valley site. Atmospheric Environment 41 (2007) 9231–9243.

9 EPA, 2013. Draft Guidance for PM2.5 Permit Modelling ***Public Review Draft 03/04/2013.*** http://www.epa.gov/ttn/scram/guidance/guide/Draft_Guidance_for_PM25_Permit_Modeling.pdf;
EPA, 2010. Modeling Procedures for Demonstrating Compliance with PM2 5 NAAQS. http://www.epa.gov/region07/air/nsr/nsrmemos/pm25memo.pdf

10 EPA, 2008. Attachment A: Technical Issues Related to Use of the CALPUFF Modeling System for Near-field Applications. 26 September, 2008. http://www.epa.gov/scram001/7thconf/calpuff/calpuff_near-field_technical_issues_092608.pdf

"The basic requirements for justifying use of CALPUFF for near-field regulatory applications consist of three main components:

1) a determination that treatment of complex winds is critical to estimating design concentrations;
2) a determination that the preferred model (AERMOD) is not appropriate or less appropriate than CALPUFF; and
3) a demonstration that the five criteria listed in paragraph 3.2.2(e) of the Guideline[11] for use of CALPUFF as an alternative model are adequately addressed."

5.2.2. The Department of Environmental Affairs (DEA) air quality modelling guidelines[12] also recommend the use of AERMOD for near-source (<50km) modelling.

5.2.3. A recent (September 2012) US EPA evaluation of CALPUFF and other long-range transport models ranked CALPUFF lowest or second lowest, depending on ranking criteria used, among the six dispersion models evaluated.[13] This suggests that, while CALPUFF is still a candidate to assess regional air pollution impacts, its use should be reassessed.

5.2.4. Our clients therefore propose that AERMOD be used for near-source (<50km) modelling for SO_2, NOx and primary PM_{10} dispersion, consistent with the DEA guidelines. Alternatively, SCIPUFF should be considered for both near-field and long- range dispersion modelling. If CALPUFF is used, the motivation and justification for its use should be provided as per the US EPA guidelines.

5.3. <u>The absence of proposals for comparison of modelling outputs with ambient measurements</u>

5.3.1. The PoS proposes not to conduct any comparison of modelling outputs with ambient measurements, on the basis that it is not a mandatory requirement of the DEA dispersion modelling guideline, and that "*the accuracy of the modelling in this assessment is enhanced by every effort to minimise the 'reducible' uncertainties in input data and model parameterisation*" (Section 5.5). However air quality models (such as CALPUFF) of necessity constitute a simplified approximation to the real world. Models such as CALPUFF (and AERMOD) are sensitive to several of the parameters (and others not specifically listed) assumed in Tables 5 and 6 of the PoS.[14] That is, a change in the assumed values of these parameters within a feasible range of values may result in a significant change in predicted model outputs. Therefore a comparison between model-predicted ambient concentrations and monitored values is essential to establish the accuracy of the modelling. A number of statistical methods are available for such comparisons.[15] Unless such a 'reality check' is done, the credibility of model predictions under 'what-if' scenarios is seriously undermined.

5.3.2. Our clients propose that modelling outputs, particularly the predicted ambient concentrations, should first be evaluated against ambient air quality data.

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[11] EPA, 2005. Guideline on Air Quality Models, 40 CFR Part 51, Appendix W. Published in the *Federal Register*, Vol. 70, No. 216, November 9, 2005. http://www.epa.gov/scram001/guidance/guide/appw_05.pdf

[12] DEA, 2012. Guideline to Air Dispersion Modelling for Air Quality Management in South Africa, draft regulation.

[13] EPA, 2012. Documentation of the Evaluation of CALPUFF and Other Long Range Transport Models Using Tracer Field Experiment Data. http://www.epa.gov/scram001/reports/EPA-454_R-12-003.pdf

[14] ENVIRON International Corporation. Comparison of Single-Source Air Quality Assessment Techniques for Ozone, PM2.5, other Criteria Pollutants and AQRVs. EPA Contract No: EP-D-07-102. September 2012;
Thomas G. Grosch and Russell F. Lee. Sensitivity of the AERMOD air quality model to the selection of land use parameters;
EPA, 2012 footnote 13.

[15] EPA, 2013 footnote 9;
EPA, 2012 footnote 13;
Hezhong Tian, Peipei Qiu, Ke Cheng, Jiajia Gao, Long Lu, Kaiyun Liu, Xingang Liu. Current status and future trends of SO2 and NOx pollution during the 12th FYP period in Guiyang city of China. Atmospheric Environment 69 (2013) 273-280.

5.4. The methodology proposed for "ambient impact analysis and ambient levels"

5.4.1. Section 4 of the PoS contains the methodology for addressing the stated objective of the modelling study. Section 4.1 states that "*annual average modelled ambient concentrations and the 99th percentile concentration of daily and hourly predictions will be assessed against National Ambient Air Quality Standards for SO_2, NO_2 and PM_{10}.*"

5.4.2. Our client suggest that the main purpose of the modelling should be to provide estimates of pollutant exposure, that is estimates of hourly, daily (24 hourly) and annual averaged concentration levels, throughout the modelling domain over an appropriate range of concentration values. This would enable an assessment of the impact of power station emissions on "*the environment, including health, social, economic and ecological conditions*", as required in an AIR. A presentation of the "*99th percentile concentration of daily and hourly predictions*" is insufficient for this purpose.

5.4.3. The second aspect of the methodology, as per section 4.1 of the PoS, is also problematic. It is provided that: "*other sources of SO_2, NOx and PM_{10} will not be characterised and included in the respective model runs. Each power station will be modelled in isolation of other sources and background concentrations will be obtained from ambient measurements of NO_2, SO_2 and PM_{10} at monitoring stations in the respective modelling domain. Of these, the most suitable upwind monitoring station will be selected and hourly measured data for the period of 2010-2012 will analysed to develop an understanding of the characteristics of the background concentrations, including seasonal and diurnal variation. This assessment will be used to determine the relative contribution of the respective power stations to ambient SO_2, NO_2 and PM_{10} concentrations in the respective modelling domains."*

5.4.4. The proposal to study ambient monitoring data from a selected "upwind monitoring station" to determine "background" (non-power station, in this context) concentrations, and hence the relative contribution of power station emissions, appears to be subjective. Given the potential long-range impacts of each power station within an airshed, the dispersion characteristics of secondary pollutants ($PM_{2.5,}$ in this context) and the likelihood of pollutant recirculation, none of the monitoring stations within each airshed can be considered to be free from power station emissions. It is, in any event, not clear exactly how "*an understanding of the characteristics of the background concentrations, including seasonal and diurnal variation*" will be used "*to determine the relative contribution of the respective power stations to ambient SO_2, NO_2 and PM_{10} concentrations in the respective modelling domains*".

5.4.5. Our clients suggest that an established method for source apportionment be used to determine the contribution of power station emissions.[16] The modelling should include all significant pollution sources within each modelling domain, and the accuracy of the modelling should be assessed against ambient data. A second established method of source apportionment of $PM_{2.5}$, including sampling and chemical analysis (speciation), could be used to complement the modelled estimates of secondary $PM_{2.5}$.

5.5. Emissions to be modelled

5.5.1. Section 5.3 of the PoS proposes to evaluate two scenarios:

5.5.1.1. "*Scenario 1: Emissions from current operating conditions at each power station to assess their relative contribution to current ambient SO_2, NO_X and PM_{10} concentrations near the respective stations.*

5.5.1.2. *Scenario 2: Emissions that Eskom believe can be achieved at each power station to assess the worst possible ambient air quality situation with respect to SO_2, NO_X and PM_{10} concentrations in the vicinity of the respective stations."*

[16] EPA, 2013 footnote 9.

5.5.2. The PoS proposes to use annual average emissions for the three year period 2010 to 2012 in Scenario 1 to "*assess their relative contribution to current ambient SO_2, NO_X and PM_{10} concentrations near the respective stations*". However, actual emission rates vary significantly from the annual average values, by as much as 30% to 40% according to the BID (page 3). The use of annual average emission rates for modelling, rather than daily emission rates, may therefore underestimate actual emissions by a corresponding percentage, and, as a result, underestimate the relative contributions to ambient concentrations and impacts proportionately. While the use of annual average values may be acceptable for modelling actual annual average concentrations, it is not acceptable for estimating hourly and daily concentrations. Note that adverse health effects occur in response to both short-term average exposures (hourly and daily average) to SO_2, NOx and PM, and to long-term annual average exposures.

5.5.3. The description and meaning of Scenario 2 is not clear.

5.5.4. It is proposed that the following modelling scenarios be evaluated:

5.5.4.1. Scenario A: modelling of all source emissions, using actual daily average power station emission rates and appropriate time-varying emission rates for all other emission sources for the period, to be used primarily to evaluate model accuracy against ambient data. Meteorology: 2010 to 2012.

5.5.4.2. Scenario B: modelling all sources, using a power station emissions scenario based on the granting of postponement of the implementation of the s.21 AQA MES. That is, using current power station emission control technology under 'worst case' (for example poor quality coal) conditions. Meteorology: 2010 to 2012.

5.5.4.3. Scenario C: at 'worst case' conditions as in Scenario B above, but with s.21 AQA MES emission controls in place.

5.5.4.4. Scenario D: under abnormal/ upset conditions. Short-term (3-4 days) modelling runs under dfferent meteorological conditions.

5.5.5. In order to estimate the contribution of Eskom emissions to total ambient concentration, two modelling runs have to be conducted in each of scenarios A, B and C: one with all sources and one with Eskom sources only ("brute force zero out" method).[17]

5.6. <u>Modelling of emissions from the liquid fuel-fired power stations Acacia and Port Rex</u>

5.6.1. These stations operate on a short-term basis, as required. Emssion rates and expected duration of operation are not given in the PoS, nor are emission rates provided. Although these units are much smaller than the coal-fired units, the exceptionally short stack heights of 14m and the location of these units within urban areas is noted. The liquid fuels used in these units generate significant SO_2, NOx and PM emissions, and may well have significant impacts on surrounding communities.

5.6.2. Data on emission rates during operation, and worst case fuel compositions, which have a significant influence on emission rates, should be stated in the PoS.

6. Conclusion and next steps

6.1. Our clients have made various significant proposals for the improvement of the PoS. We trust that these submissions will be considered and implemented. In the circumstances, we request that an amended PoS

[17] EPA, 2013, footnote 9.

be made available. In this regard, let us know whether you require more information regarding any of the proposals made by our clients.

6.2. We are also instructed to request, as we hereby do, that the terms of reference for the AIRs are made available for comment before the AIRs are prepared.

6.3. In order for our clients to prepare for and prioritise involvement in further steps in this process, kindly also provide us with en envisaged timeline for each step.

7. We look forward to receipt of the documents requested on 1 July 2013.

8. Kindly keep us updated.

Yours sincerely
CENTRE FOR ENVIRONMENTAL RIGHTS

per:

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