Project done on behalf of
Turgis Consulting

AIR QUALITY IMPACT ASSESSMENT ADDENDUM: PROPOSED TREKKOPJE URANIUM MINE, SWAKOPMUND (NAMBIA)

Report No.: APP/07/LC-01 Rev 0.0

DATE: OCTOBER 2007

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EXECUTIVE SUMMARY

Airshed Planning Professionals (Pty) Ltd were originally appointed to assist Ferret Mining and Environmental Services Pty (Ld) in assessing the potential human health risks associated with the proposed Trekkopje Uranium Mining operation near Swakopmund. Subsequent to the original assessment (Burger and Le Roux, 2006), modifications to the originally proposed mining process resulted in different particulate emission rates, and subsequently different air pollution concentrations and particulate fallout rates.

The most notable difference between the original and subsequent assessments is the increase in proposed mining production rate from 40 000 tonnes per day to 100 000 tonnes per day. It was, however, established that the impact would not be proportional (i.e. 2.5 times) since the differences in other mining activities resulted in lower increases.

CONCLUSIONS AND RECOMMENDATIONS

Assuming no mitigation, the calculated emissions resulted in the maximum inhalable particulate daily average air concentration to exceed the current, less conservative South African standard of 180 µg/m³ beyond the southern section of the license area, when mining activity is on the southwestern section of the license area. The proposed, more conservative South African standard of 75 µg/m³ was predicted to be exceeded for a considerable area beyond the southern boundary (up to ~ 9km). Only the conservative EC and UK annual average standards of 30 µg/m³ and 40 µg/m³ were predicted to be exceeded outside the licence area.

In terms of the South African Department of Environmental Affairs and Tourism's criteria, dust deposition is classified as follows:

SLIGHT	- < 250 mg/m^2/day [barely visible to the naked eye]
MODERATE	- 250 to 500 mg/m^2/day
HEAVY	- 500 to 1 200 mg/m^2/day [fine layer of dust on a surface]
VERY HEAVY	- >1 200 mg/m^2/day [easily visible with irregular cleaning of surface]

The predicted dustfall levels to the south of the license area indicate a significant area falling within the VERY HEAVY category. Even the HEAVY category is estimated to extend beyond 10 km.

The South African Department of Minerals and Energy (DME) use the 1 200 mg/m^2/day threshold level as an action level. In the event that on-site dustfall exceeds this threshold, the specific causes of high dustfall should be investigated and remedial steps taken.

Recommended Mitigation Measures

It is clear from the predictions that dust fallout may be a concern outside the mining licence area. If the moisture of the material transferred could be raised from the very dry 0.22% to about 1%, more than 95% control could be achieved at the material transfer points. This would reduce the overall emissions by about 40% (TSP) and 50% (PM10), respectively. This would reduce the HEAVY impact zone to a distance of about 5 km from the licence area.

A further reduction can be achieved by controlling emissions from the crusher and screening process. With a control efficiency of 75% to 80%, the TSP emissions can be reduced by a further 10%.

Transporting the ore, topsoil and spoils within the mining area constitute the largest source of emissions. Minimising these transport distances would obviously reduce emissions. Further controls would require the treatment of road surfaces. Wetting of roads could perhaps be done using seawater, however, this may increase corrosion of vehicles. Reducing the emissions from road surfaces by about 50% would reduce the emissions a further 20%.

If these three mitigation measures had to be introduced, the VERY HEAVY category (i.e. more than 1 200 mg/m²/day) would be contained within the boundaries of the licence area.

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1. INTRODUCTION

Subsequent to the original assessment (Burger and Le Roux, 2006), modifications to the originally proposed mining process would result in different particulate emission rates. The most notable difference is the increase in proposed mining production rate from 40 000 tonnes per day to 100 000 tonnes per day. However, although this would lead to a proportional increase in particulate emission rates from processes such as crushing and tipping, some processes would not increase proportionally. These changes in emissions would therefore lead to different predicted airborne particulate concentrations and fallout rates than the original assessment.

The sequence of mining and processing the ore assumed in this Addendum is as follows:

1. Ore is mined from the open pit at a rate of 100,000 tonnes per day (tpd). Mining is either by digging the softer material or by blasting where required.
2. This ore is picked up by large excavators and loading into 177 t dump trucks.
3. Ore is then dumped onto two Run-of-Mine (RoM) stockpiles, each of which, have a capacity of 300,000 t.
4. Ore is then sent to through the primary crusher. This crushes the ore to a size that can be handled by a conveyor belt.
5. The crushed ore is then sent by the mobile pit conveyors onto the main overland feed conveyor.
6. Ore is then passed through the secondary crushers. These crush the ore to a size suitable for heap leaching.
7. The finely crushed ore is placed in silos which act as a flow buffer.
8. The ore then is collected in the agglomeration drums and placed on the pad feed conveyor and placed on the heap leach pad.
9. The chemical solution used to extract uranium is allowed to cycle repeatedly through the heap leach pad, picking up the uranium from the crushed ore.
10. Once the chemical solution has become fully loaded with uranium it is drained off. This solution is referred to as the “Pregnant Solution”.
11. The waste or barren ore is then reclaimed using a bucket wheel excavator and sent by conveyor to be replaced in the open pit by a stacker.
12. The Pregnant Solution is subjected to an Ion Exchange process where the U308 is concentrated. The resultant concentrated solution is dewatered and dried prior to being drummed and shipped out.

The same emission estimation methodology as in the original assessment is used in the Addendum (Section 2). Furthermore, the original dispersion model was again employed to predict the ground level air concentrations and fallout rates (Section 3).

2. AIR EMISSIONS INVENTORY

It is anticipated that the mining would comprise a series of different operations including land clearing (albeit of minimal extent), topsoil removal, material loading and hauling, stockpiling, grading, bulldozing, compaction, (etc.). Each of these operations has a limited duration (i.e. not continuous) and the potential for intermittent dust generation. It is therefore anticipated that the extent of dust emissions would vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing meteorological conditions. This is in contrast to most other fugitive dust sources where emissions are either relatively steady or follow a discernible annual cycle. It is therefore often necessary to estimate area wide emissions, without regard to the actual plans of any individual construction process.

Sources of atmospheric emission associated with the operational phase would primarily include the following:

- Drilling and Blasting operations (assumed ANFO);
- Excavation using backhoe;
- Material transfer:
    - Into haul trucks;
    - In-pit jaw crusher;
    - From jaw crusher onto conveyor belt; and
    - From conveyor belt onto stockpile at process plant.
- In-pit jaw crushing and screening;
- Wheel entrainment:
    - Hauling of ore to in-pit jaw crusher;
    - Hauling of topsoil & spoils (overburden); and
    - Miscellaneous vehicles on road between mining area and process plant.
- Wind erosion:
    - Exposed mining areas;
    - Topsoil stockpiles; and
    - Spoils (overburden) stockpiles;
    - Tailings disposal area.

In the re-quantification of emissions emphasis was placed on particulate emissions due to the potential for significant changes in these emissions. Emissions of Total Suspended Particulates (TSP) and inhalable particulates, i.e. particulates with aerodynamic diameters less than 10 micron (PM10) were quantified using the comprehensive set of emission factors published by the US Environmental Protection Agency (US-EPA) in its AP-42 document *Compilation of Air Pollution Emission Factors*. Empirically derived *predictive emission factor equations* are available for vehicle-entrained dust from roadways, aeolian erosion from open areas, drilling, blasting and for materials handling operations.

Estimated total annual uncontrolled TSP and PM10 emissions for each source type is given in Table 2-1.

Table 2-1: Estimated airborne particulate emission rates for first year of operation.

Uncontrolled Emissions (tpa)	TSP	PM10
Wind Erosion		
Topsoil dumps	210.6	16.4
Spoils dumps	199.4	19.6
Run-off-mine stockpile	386.4	41.7
Materials Handling		
Tipping	8 754	3 065
Loading	4 377	1 532
In-pit excavation	4 739	1 659
Vehicle Entrainment		
Topsoil Road	92	30
Spoils Road	2 023	662
In-pit Road	13 925	4 094
Transport Road	548	179
Processing		
In-pit crushing and screening	7300	730
Drilling and Blasting		
Drilling	83	43
Blasting	76	39
TOTAL	***42 714***	***12 111***

In-pit roads would generate the majority of particulates (~33% of total TSP and ~34% of total PM10) with tipping ranking second (~20% of total TSP and ~25% of total PM10). The third highest TSP emission would be from crushing and screening (17% of total TSP), whereas the third highest PM10 emissions would be from loading operations from stockpiles.

Wind erosion , drilling and blasting constitute relatively small particulate contribution.

3. PREDICTED AIR POLLUTION IMPACT OF PROPOSED MINE

3.1. Simulations Results

The calculated emissions of particulates from the proposed mining operation were used to predict the ground level air concentrations and fallout rates in the vicinity of the various sources. The following table lists the figures presented below.

Table 3-1: Table listing isopleth plots presented below.

Description	Figure Number
Highest daily average predicted PM10 ground level concentrations – After first year of operation.	Figure 3-1
Highest daily average predicted PM10 ground level concentrations – After last year of operation.	Figure 3-2
Annual average predicted PM10 ground level concentrations – After first year of operation.	Figure 3-3
Annual average predicted PM10 ground level concentrations – After first year of operation.	Figure 3-4
Highest 30-day dustfall – After first year of operation.	Figure 3-5
Highest 30-day dustfall – After last year of operation.	Figure 3-6

3.2. Analysis

None of the simulation included any mitigation measures, since specific measures were not provided. The maximum inhalable particulate daily average air concentration was predicted to exceed the current, less conservative South African standard of 180 µg/m³ beyond the southern section of the license area, when mining activity is on the southwestern section of the license area. The proposed, more conservative South African standard of 75 µg/m³ was predicted to be exceeded for a considerable area beyond the southern boundary (up to ~9km).

Only the conservative EC and UK annual average standards of 30 µg/m³ and 40 µg/m³ were predicted to be exceeded outside the licence area.

In terms of the South African Department of Environmental Affairs and Tourism's criteria, dust deposition is classified as follows:

SLIGHT	-	less than 250 mg/m²/day
MODERATE	-	250 to 500 mg/m²/day
HEAVY	-	500 to 1 200 mg/m²/day
VERY HEAVY	-	more than 1 200 mg/m²/day

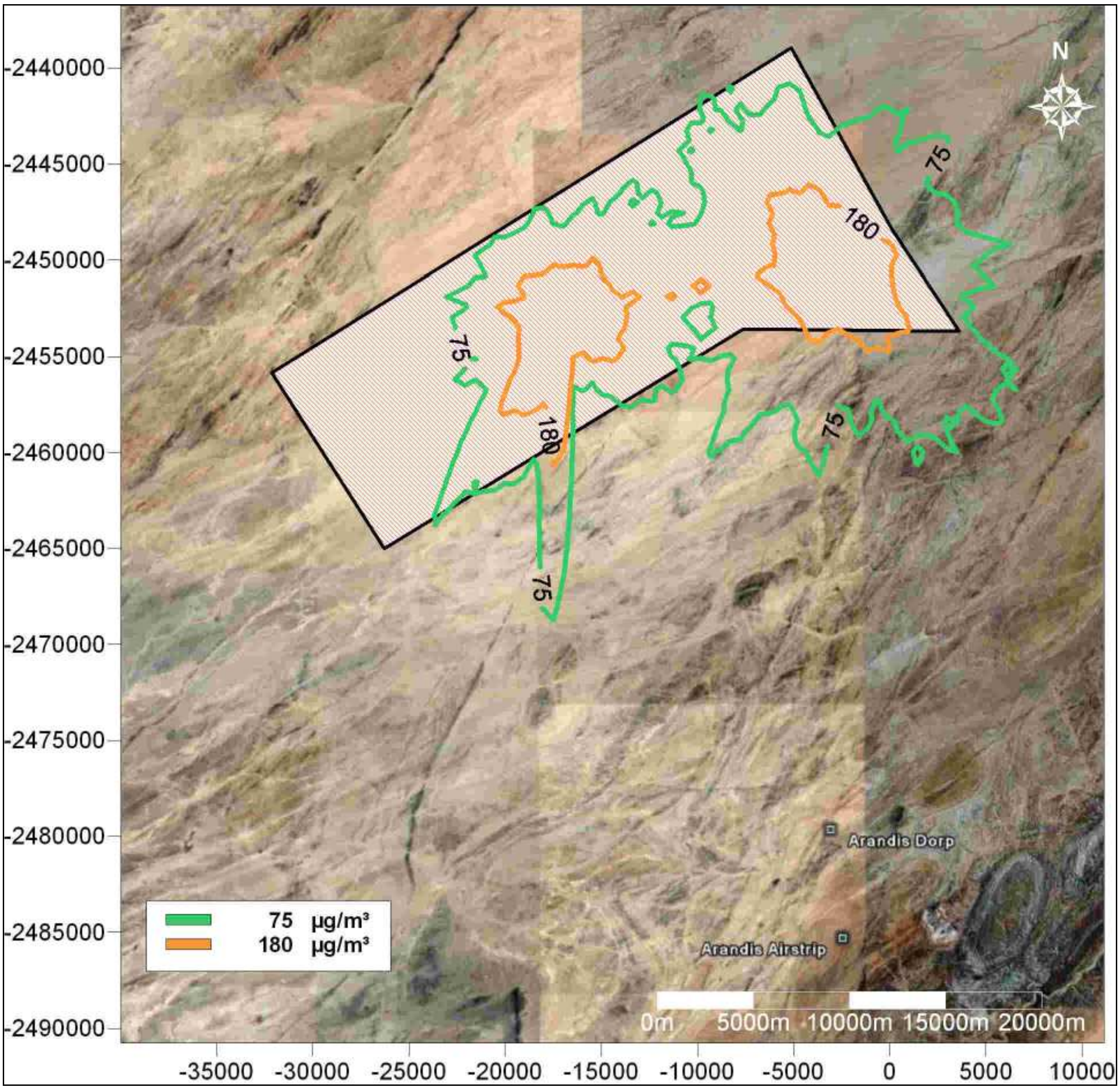

Figure 3-1: Maximum daily average predicted inhalable (PM10) ground level concentrations (µg/m³) for first year of mining. The current South African standard is 180 µg/m³. The proposed standard is 75 µg/m³. The World Bank adopted a guideline of 70 µg/m³.

The predicted dustfall levels to the south of the license area indicate a significant area falling within the VERY HEAVY category. Even the HEAVY category is estimated to extend beyond 10 km.

"Slight" dustfall is barely visible to the naked eye. "Heavy" dustfall indicates a fine layer of dust on a surface, with "very heavy" dustfall being easily visible should a surface not be cleaned for a few days. Dustfall levels of > 2 000 mg/m^2/day constitute a layer of dust thick enough to allow a person to "write" words in the dust with their fingers.

The South African Department of Minerals and Energy (DME) use the 1 200 mg/m^2/day threshold level as an action level. In the event that on-site dustfall exceeds this threshold, the specific causes of high dustfall should be investigated and remedial steps taken.

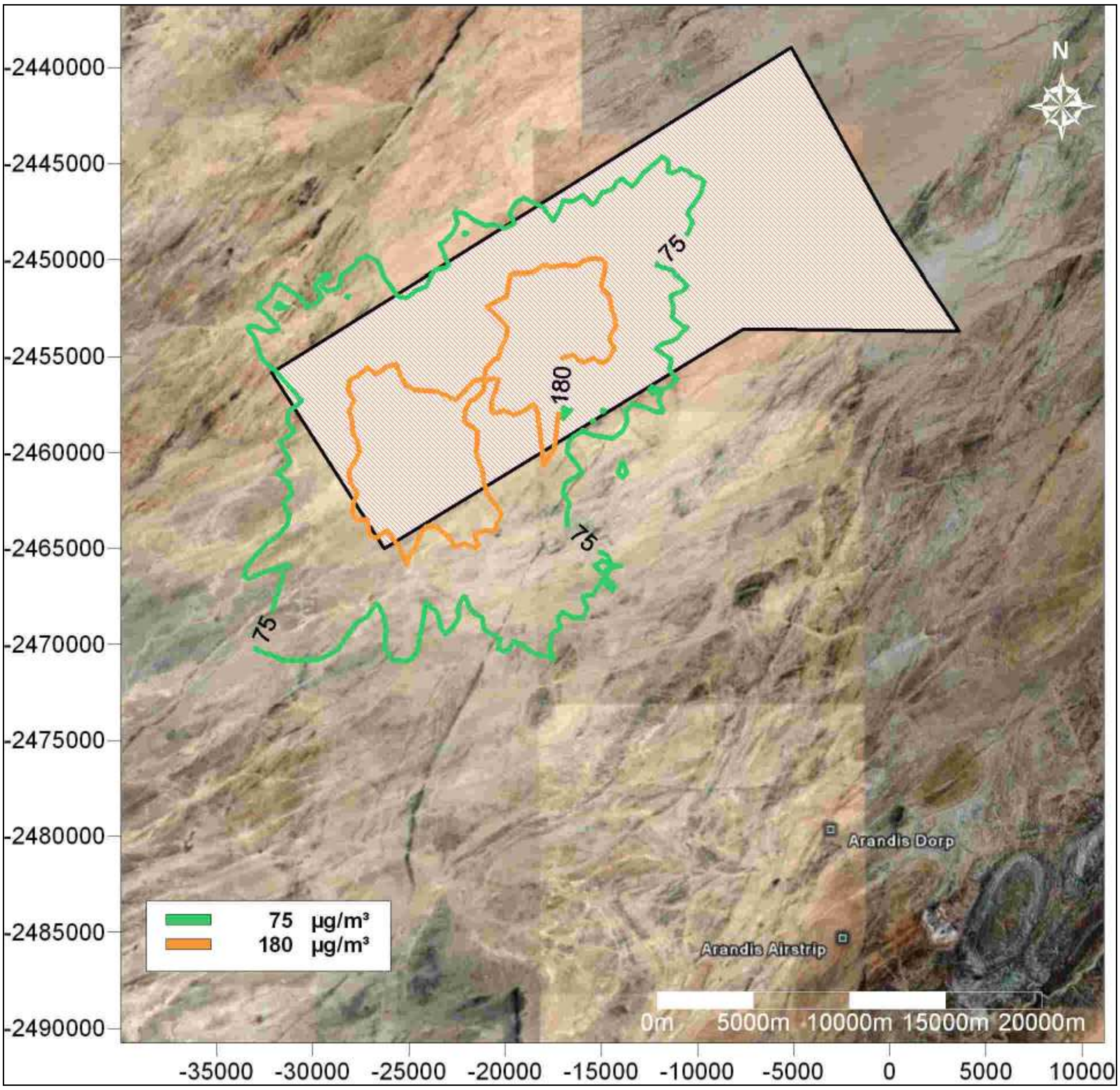

Figure 3-2: Maximum daily average predicted inhalable (PM10) ground level concentrations (µg/m³) for last year of mining. The current South African standard is 180 µg/m³. The proposed standard is 75 µg/m³. The World Bank adopted a guideline of 70 µg/m³.

It is clear from the predictions that dust fallout may be a concern outside the mining licence area. It is therefore recommended to apply some form of mitigation. If the moisture of the material transferred could be raised from the very dry 0.22% to about 1%, more than 95% control could be achieved at the material transfer points. This would reduce the overall emissions by about 40% (TSP) and 50% (PM10), respectively. This would reduce the HEAVY impact zone to a distance of about 5 km from the licence area.

A further reduction can be achieved by controlling emissions from the crusher and screening process. With a control efficiency of 75% to 80%, the TSP emissions can be reduced by a further 10%.

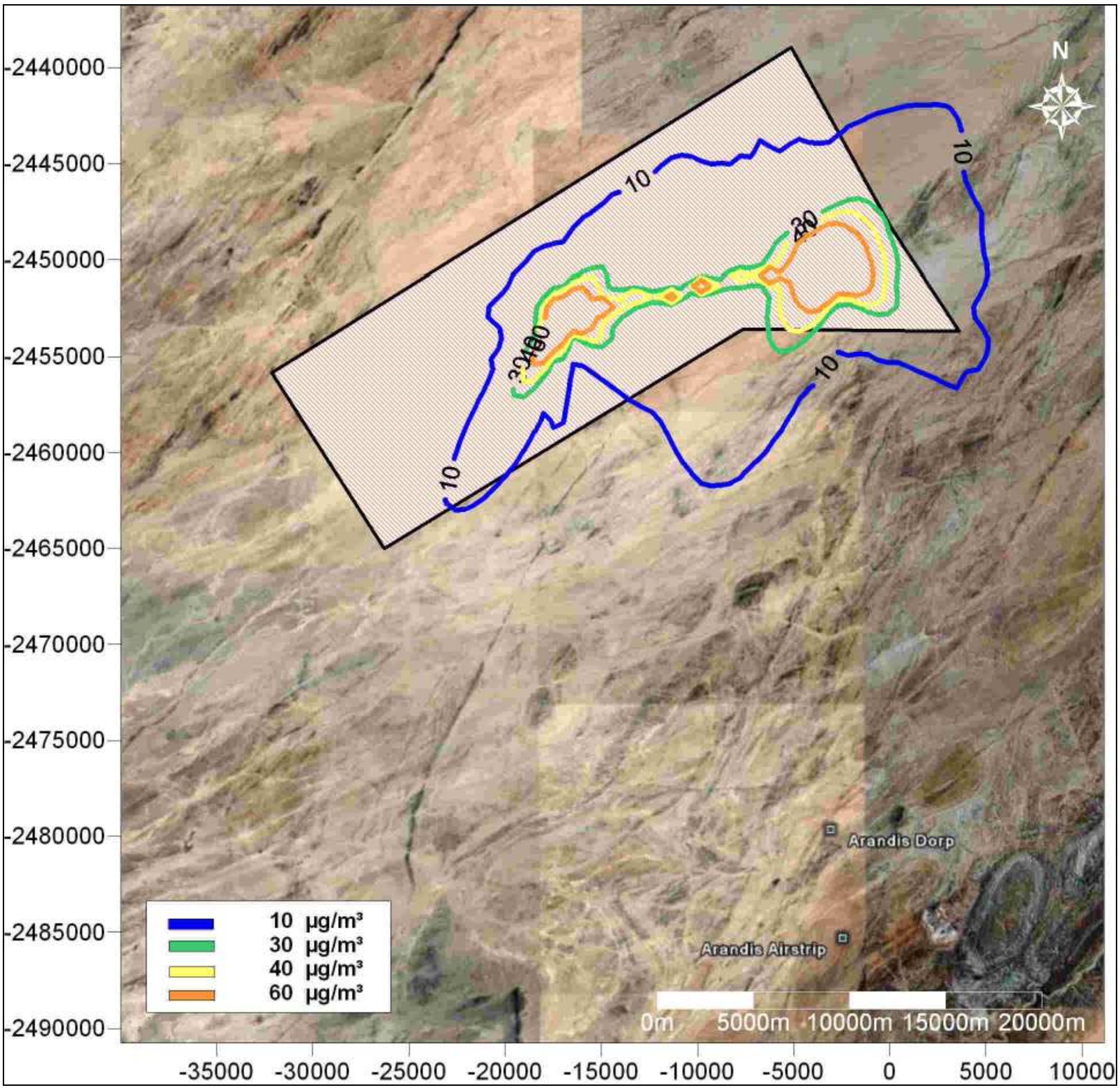

Figure 3-3: Annual average predicted PM10 ground level concentrations (µg/m³) for first year of mining. The current South African standard is 60 µg/m³. The proposed South African standard is 40 µg/m³. The EC and UK standards and the World Bank guideline are 30 µg/m³, 40 µg/m³ and 50 µg/m³, respectively.

Transporting the ore, topsoil and spoils within the mining area constitute the largest source of emissions. Minimising these transport distances would obviously reduce emissions. Further controls would require the treatment of road surfaces. Wetting of roads could perhaps be done using seawater, however, this may increase corrosion of vehicles. Reducing the emissions from road surfaces by about 50% would reduce the emissions a further 20%.

If these three mitigation measures had to be introduced, the VERY HEAVY category (i.e. more than 1 200 mg/m^2/day) would be contained within the boundaries of the licence area.

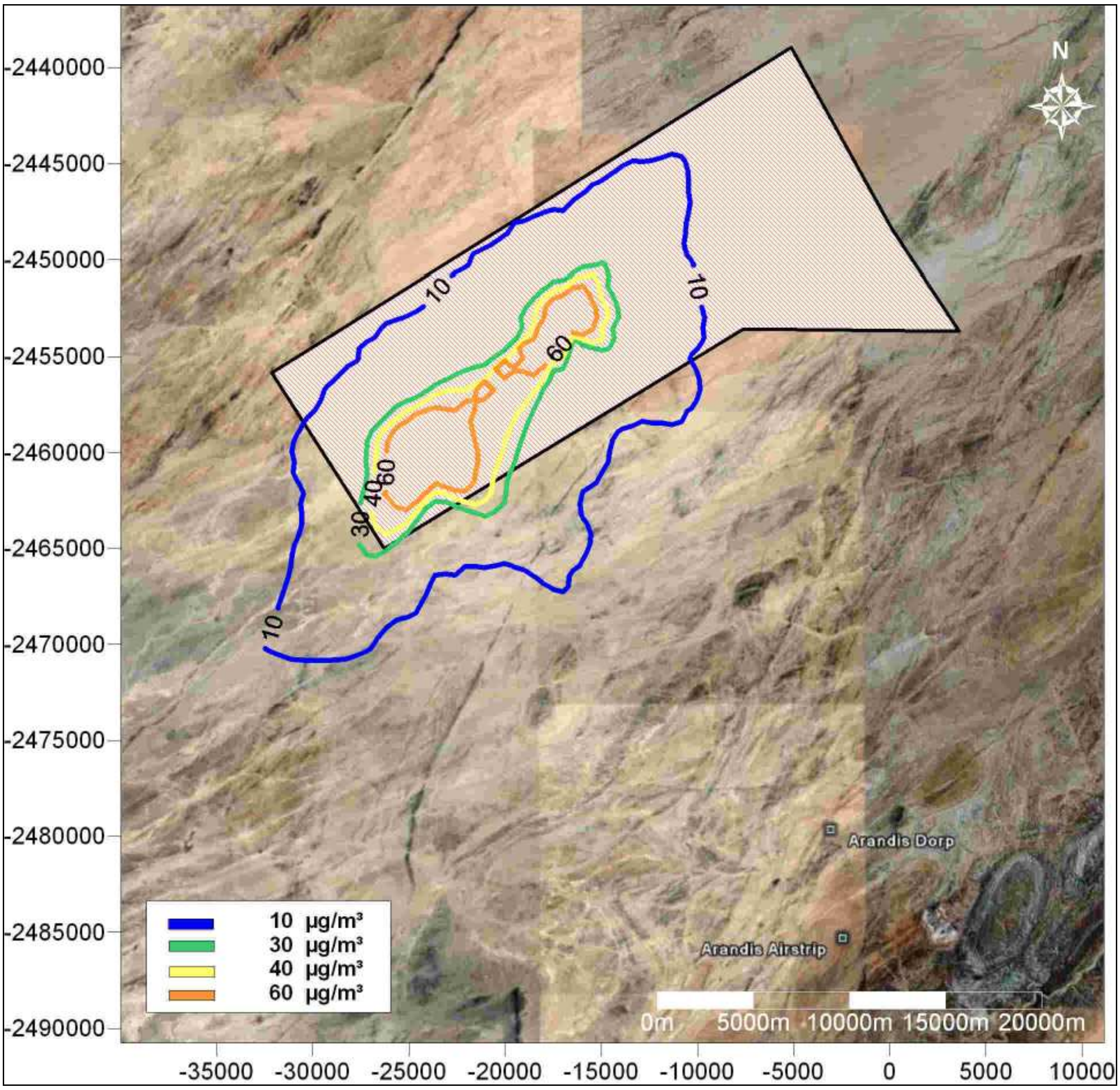

Figure 3-4: <u>Annual average</u> predicted <u>PM10</u> ground level concentrations (µg/m³) for <u>last year</u> of mining. The current South African standard is 60 µg/m³. The proposed South African standard is 40 µg/m³. The EC and UK standards and the World Bank guideline are 30 µg/m³, 40 µg/m³ and 50 µg/m³, respectively.

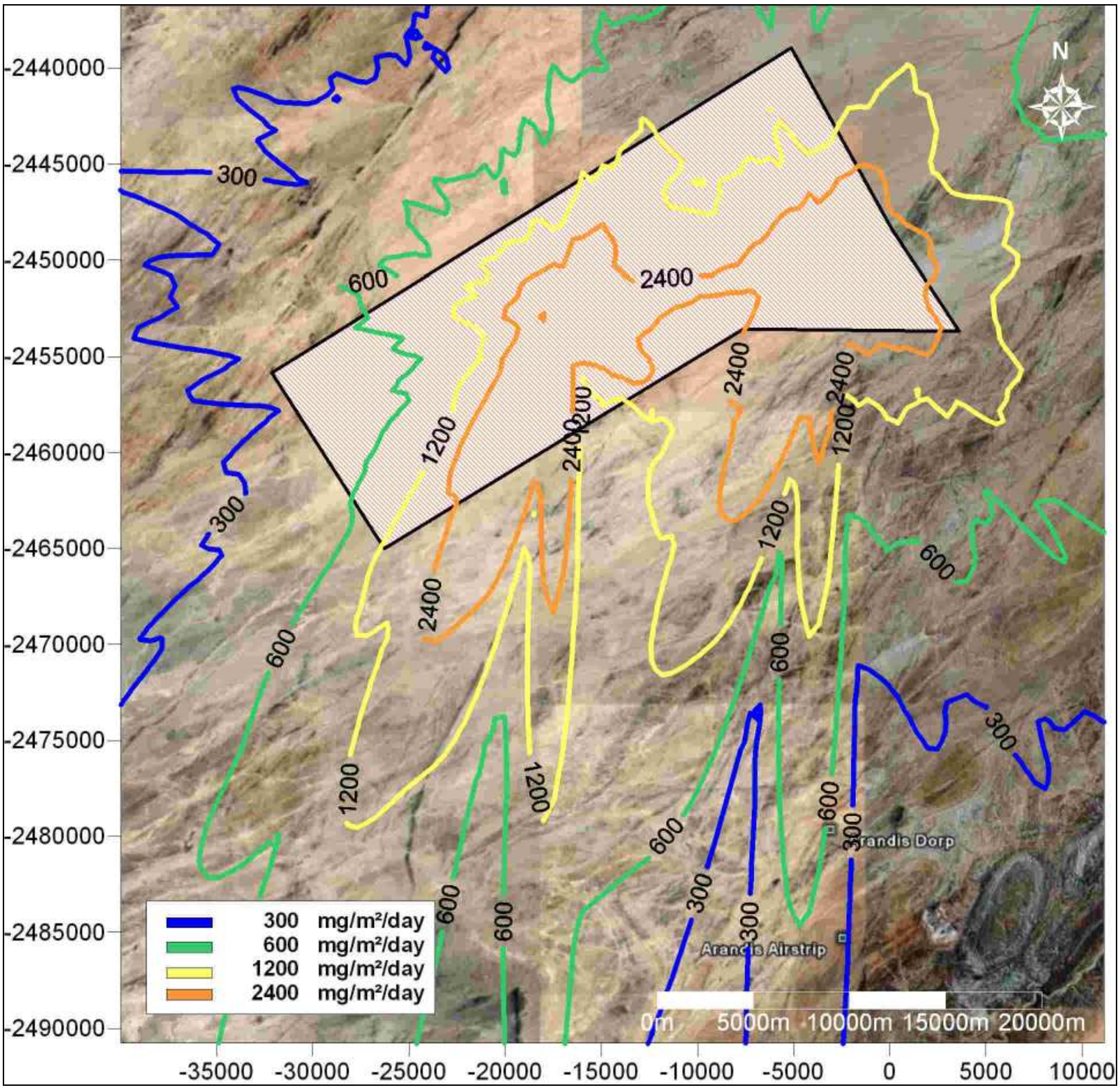

Figure 3-5: Maximum 30-day <u>dust fallout rate</u> (mg/m²-day) predicted for the first year of mining. The South African Department of Minerals and Energy (DME) uses the 1 200 mg/m²-day threshold level as an action level. In the event that on-site dustfall exceeds this threshold, the specific causes of high dustfall should be investigated and remedial steps taken.

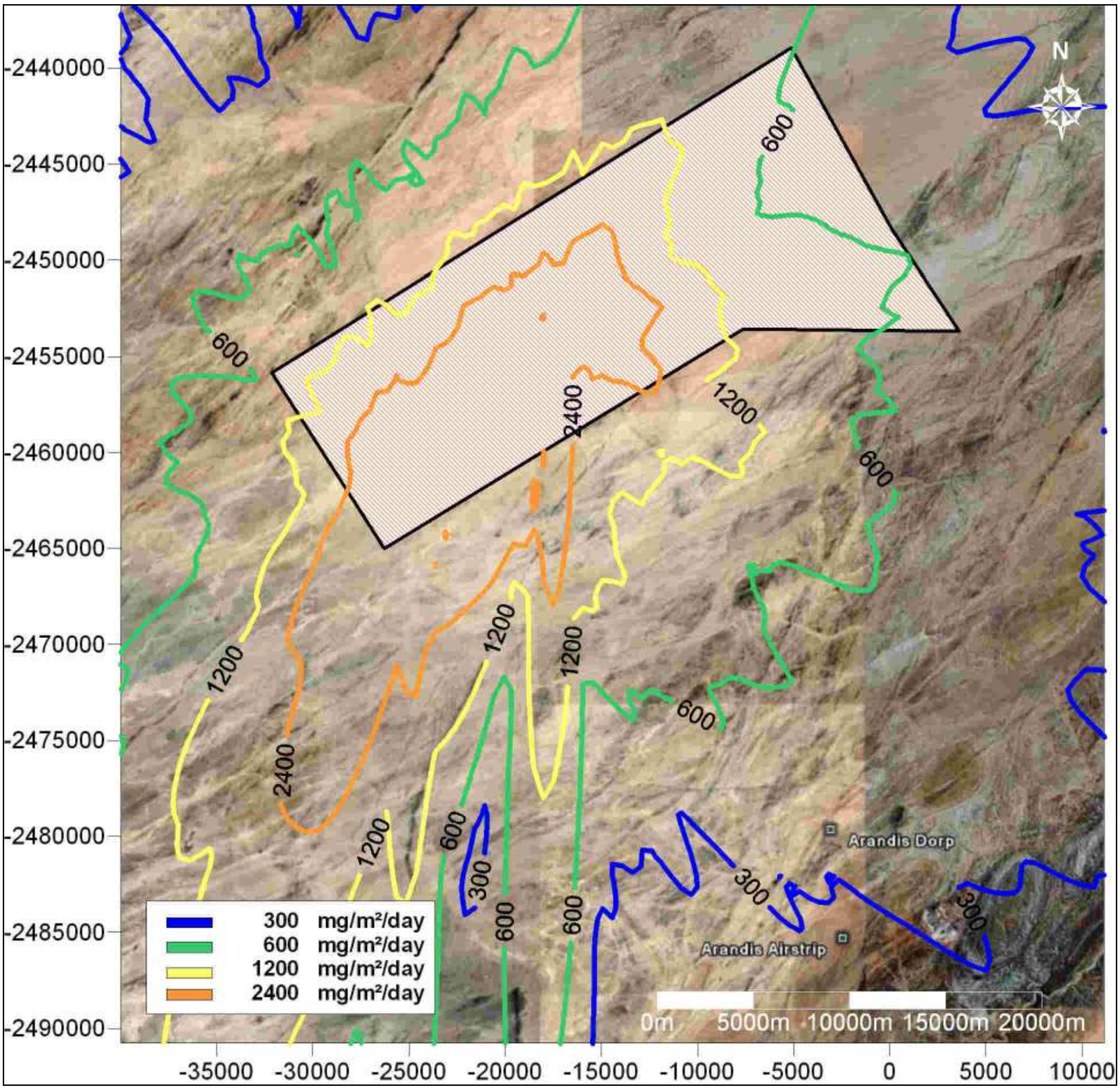

Figure 3-6: Maximum 30-day <u>dust fallout rate</u> (mg/m²-day) predicted for the last year of mining.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusions

Assuming no mitigation, the calculated emissions resulted in the maximum inhalable particulate daily average air concentration to exceed the current, less conservative South African standard of 180 µg/m³ beyond the southern section of the license area, when mining activity is on the southwestern section of the license area. The proposed, more conservative South African standard of 75 µg/m³ was predicted to be exceeded for a considerable area beyond the southern boundary (up to ~ 9km). Only the conservative EC and UK annual average standards of 30 µg/m³ and 40 µg/m³ were predicted to be exceeded outside the licence area.

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HEAVY	- 500 to 1 200 mg/m^2/day [fine layer of dust on a surface]
VERY HEAVY	- >1 200 mg/m^2/day [easily visible with irregular cleaning of surface]

Dustfall levels of > 2000 mg/m^2/day constitute a layer of dust thick enough to allow a person to "write" words in the dust with their fingers.

The predicted dustfall levels to the south of the license area indicate a significant area falling within the VERY HEAVY category. Even the HEAVY category is estimated to extend beyond 10 km.

The South African Department of Minerals and Energy (DME) use the 1 200 mg/m^2/day threshold level as an action level. In the event that on-site dustfall exceeds this threshold, the specific causes of high dustfall should be investigated and remedial steps taken.

4.2. Recommended Mitigation Measures

It is clear from the predictions that dust fallout may be a concern outside the mining licence area. If the moisture of the material transferred could be raised from the very dry 0.22% to about 1%, more than 95% control could be achieved at the material transfer points. This would reduce the overall emissions by about 40% (TSP) and 50% (PM10), respectively. This would reduce the HEAVY impact zone to a distance of about 5 km from the licence area.

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If these three mitigation measures had to be introduced, the VERY HEAVY category (i.e. more than 1 200 mg/m²/day) would be contained within the boundaries of the licence area.

5. REFERENCES

Burger L W and Le Roux, N (2006) *Air Quality Impact Assessment: Proposed Trekkopje Uranium Mine, Swakopmund (Nambia)*, Airshed Planning Professionals Report No.: APP/06/FMES-01