



AIR QUALITY IMPACT ASSESSMENT

Prepared for

**RHEEBOK BRICK HOLDINGS (PTY) LTD
GREAT BRAK RIVER**

**FINAL REPORT
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AIR QUALITY IMPACT ASSESSMENT

1 INTRODUCTION

Rheebok Brick Holdings (Pty) Ltd (Rheebok) currently manufactures clay bricks by means Habla zigzag kilns at their premises in Great Brak River in the Western Cape Province.

The process operated by Rheebok is regarded as a listed activity in terms of Section 21 of the National Environmental Management: Air Quality Act, Act 39 of 2004. An atmospheric emission license (AEL) No. WCED014 was issued to Rheebok by the Garden Route District Municipality (GRDM) on 1 March 2021, and it is valid until 28 February 2026. The AEL allows Rheebok to produce 12 000 tons of bricks per month.

Rheebok wishes to convert its operations from the zigzag kiln technology to a rotating kiln process, but do not wish to increase its operating capacity beyond 12 000 tons of fired bricks per month. This change in technology requires a variation of the AEL and Rheebok subsequently appointed Cape Environmental Assessment Practitioners (Cape EAPrac) to carry out the necessary steps to obtain the required environmental authorisation for the planned changes.

In support of the AEL renewal and variation application, Rheebok appointed Lethabo Air Quality Specialists (Pty) Ltd (LAQS) to carry out an air quality impact assessment to show potential changes in air quality under both current operations and future operations.

LAQS modelled the dispersion of pollutants emitted from Rheebok's current zigzag kiln operations to show the impact that these emissions currently have on air quality in the area. LAQS subsequently modelled the dispersion of pollutants from the planned rotating kiln operations to estimate ground-level concentrations of pollutants with the new process in operation and compared the outcomes of both against official ambient air quality standards where possible.

This report discusses the steps followed by LAQS to comply with this requirement.

2 RELEVANT GOVERNMENT REGULATIONS

The following Government Regulations apply to this air quality impact assessment and are referred to in the report where applicable.

- 1 "*National Ambient Air Quality Standards*" as published in Government Notice 1210 of 24 December 2009 (GN1210)
- 2 "*List of Activities That Result in Atmospheric Emissions*" as published in Government Notice 893 of 22 November 2018, as amended (GN893)
- 3 "*Regulations Regarding Air Dispersion Modelling*" as published in Government Notice GN R.533 of 11 July 2014 (GN R.533)



3 ATMOSPHERIC EMISSION LICENSE REQUIREMENTS

Both the zigzag and rotating kiln processes are included in the *National List of Activities Which Result in Atmospheric Emissions* as published in GN893. The activities fall under the following category:

Subcategory 5.9: Ceramic Production

Description	The production of tiles, bricks, refractory bricks, stoneware or porcelain ware by firing, excluding clamp kilns		
Application	All installations producing 100 ton per annum or more		
Substance or mixture of substances		Plant status	mg/Nm ³ under normal conditions of 273 Kelvin and 101.3 kPa
Particulate matter	N/A	New	50
Sulphur dioxide	SO ₂	New	400
Total fluorides measured as HF	F as HF	New	50

- (a) The following special arrangement shall apply:
- (i) Where co-feeding with waste materials with calorific value allowed in terms of the National Norms and Standards for Disposal of Waste Disposal to Landfill published in terms of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) as amended, occurs, additional requirements under subcategory 1.6 shall apply.
 - (ii) The applicable minimum emission standard for Total Fluorides shall be as set out in this subcategory above.
 - (iii) Additional requirements under subcategory 1.6 shall continue to apply even after the waste ceases to be waste in terms of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)

4 PROCESS DESCRIPTION

4.1 BRICK-MAKING PROCESS

Regardless of the technology applied, the process essentially consists of the following three basic steps:

- Milling, mixing and forming
- Brick drying
- Brick firing (vitrification).



The manner in which these steps are currently being followed, and will occur in the new kiln, are described below.

4.2 CURRENT OPERATIONS

A zigzag kiln consists of several individual chambers. Although the chambers are separated from each other, the arrangement of the chambers allow sequential air flow from one chamber to the next. Each chamber has an opening to atmosphere, and these are usually closed, unless a chamber is being packed or cleaned. Unbaked bricks (green bricks) are packed by hand.

A fan draws ambient air into the kiln through the open chamber, and it serves as the combustion air in the brick vitrification process. The air is channelled from one chamber to the next and is eventually exhausted to atmosphere via a stack. In the process the air flows over hot vitrified bricks (red bricks) where it is heated and the bricks are cooled down in preparation for unpacking by hand.

The hot air eventually ignites the internal coal in the bricks, thus initiating the vitrification process. After vitrification, the hot gas is channelled to the following chambers filled with green bricks, thus drying and preheating the green bricks in preparation for vitrification.

When the red bricks in a chamber have cooled down sufficiently, they are removed by hand, the chamber cleaned and green bricks packed in the chamber by hand.

In zigzag kilns the bricks, therefore, the bricks remain stationary while the vitrification fire is channelled from one chamber to the next by the air flow induced by a fan. A schematic flow diagram off a zigzag kiln is shown in Figure 1.

HABLA ZIGZAG KILN

Effective tunnel length of Hoffmann increased with “zigzags” made of green bricks

Larger capacity and more efficient than other kilns

Needs fan to draw air through = needs source of electricity

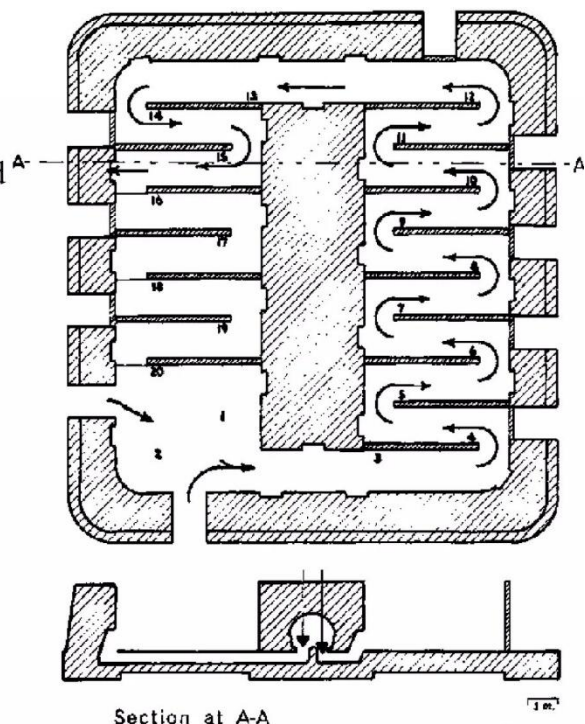




Figure 1: Zigzag kiln

4.3 PLANNED FUTURE OPERATIONS

The new process is referred to as a "moving kiln" or "rotating kiln" as the operation is arranged in a circular format. In this process, the bricks are stationary, and the kiln moves in a clockwise direction in steps of a few metres every 2.5 to 3 hours, depending on the type of bricks being produced. The fully enclosed "kiln" contains various operational zones, e.g., two drying zones, a preheating zone, a firing zone and two cooling zones and these are shown in Figure 2.

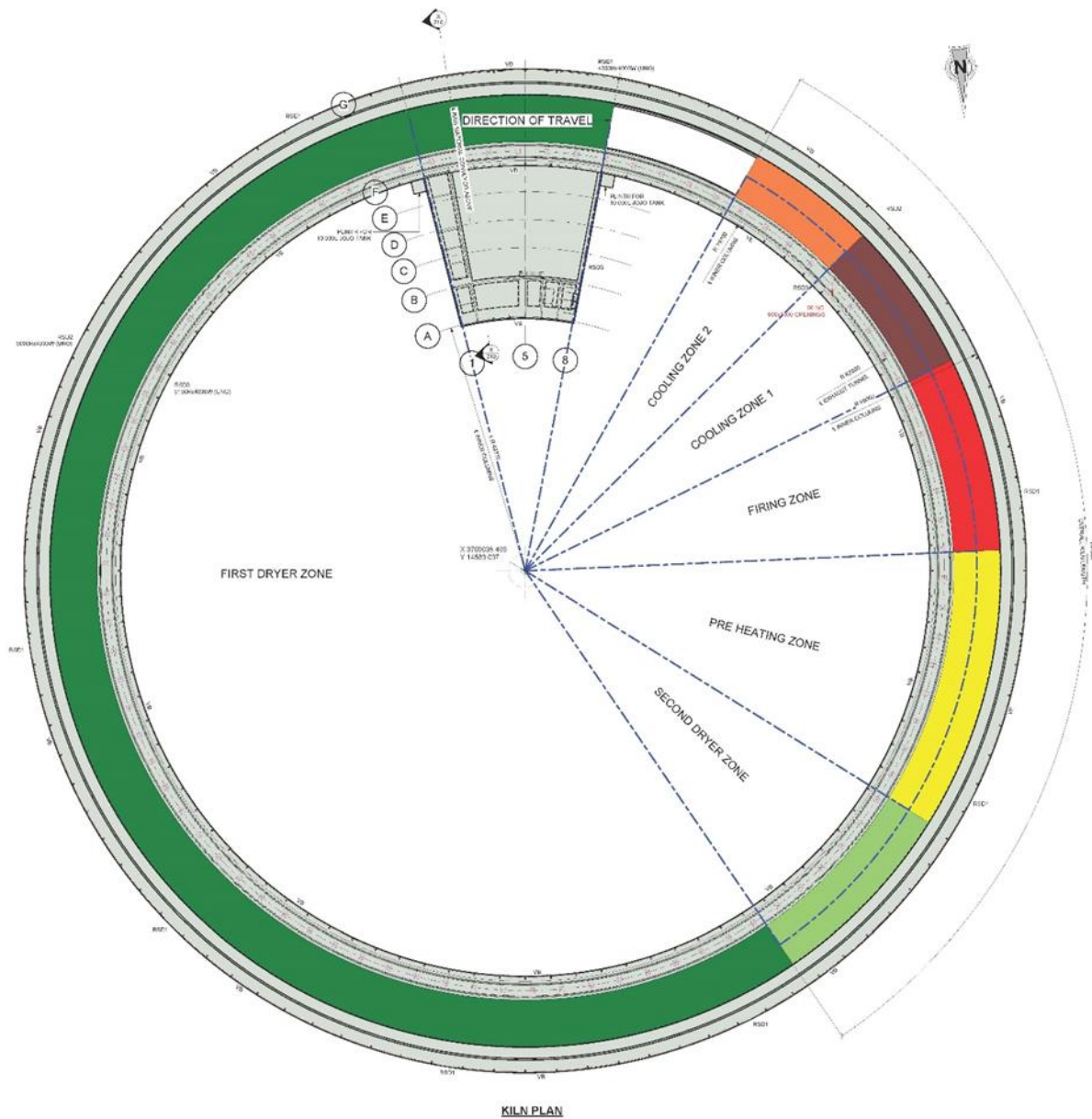


Figure 2: Operational zones; Direction of kiln movement is clockwise



The same brick preparation that is currently used is followed to the green brick stage. The green bricks are subsequently packed by a stationary mechanical robot in a predetermined pattern on a continuously moving conveyor belt. At the green brick stacking point, another robot removes the green bricks from the conveyor belt for stacking, again in predetermined patterns, in preparation for firing. Green bricks are allowed to air dry for a few days in the 1st open drying zone before entering the kiln's 2nd enclosed drying zone.



Figure 3: Green brick stacking

The energy for vitrification in the kiln is obtained solely from the internal coal contained in the bricks. Depending on the type of bricks being made, e.g., maxis, perforated, etc., the coal content may vary, thus implying a varying rate of combustion air required in the kiln. The rate of air required is determined by the temperature of the bricks in the firing zone, e.g., approximately 950 °C. Combustion air is drawn into the kiln over the fired red bricks, thus providing cooling of the fired bricks.

After the firing zone, the hot air is blended with ambient air to a temperature similar to that in the current drying operations, i.e., 120 – 150 °C and is used to dry and pre-heat dry green bricks and drying air-dried green bricks in the kiln's 2nd drying section before vitrification.



Figure 4: Typical example of the red brick section

Fired, or "red" bricks are removed mechanically from the kiln area after completion of the process.

The whole process is carried out under roof, thus preventing negative impacts on the process due to inclement weather.

Flue gases generated in the process are extracted continuously by induced draught fans, ducted in underground channels and vented to atmosphere via a dedicated wet scrubber to remove particulate matter and gaseous pollutants. Effluent from the scrubber is collected in a multi-stage pit where it is clarified and recycled to the blending and mixing stage of the process. The scrubber is designed to produce the following emissions:

- TPM: < 30 mg/Nm³
- SO₂: < 300 mg/Nm³

An aerial photograph of a similar installation is shown below.



Figure 5: Aerial photograph of a moving brick kiln structure showing the brick mixing / forming station, stack and effluent ponds next to the stack

5 DISPERSION MODELLING STUDY

The Department of Environmental Affairs moved to homogenise dispersion modelling in South Africa by publishing relevant regulations in Government Notice GN R.533.

The dispersion modelling study was carried out with EnviMan, a GIS-based emissions management software suite produced by Narsil AB in Sweden. The dispersion modelling component of the suite consists of the following four modules:

evMapper: A map manipulation tool

evEmissioner: An extensive, relational emissions data base

evMet: A meteorological data management program

evPlanner: The actual dispersion model



5.1 evMAPPER

evMapper is a digital map compiler. It is used to define GIS map sets to be used by all EnviMan GIS modules. It can import a variety of digital maps and structure the data in suitable forms, e.g., sheets, objects, etc.

It is the basis of the EnviMan GIS suite as it defines all co-ordinates for subsequent use by the various EnviMan modules.

5.2 evEMISSIONER

evEmissioner is a comprehensive, relational emissions database that locates emission sources at fixed co-ordinates on the map compiled with evMapper. Sources are placed on the map by the user, and the co-ordinates are automatically generated by evMapper.

evEmissioner can handle particulate and gaseous emissions from the following sources:

- Point sources, e.g., industrial stacks
- Area sources, e.g., landfill sites
- Grid sources, e.g., complete informal settlement areas
- Line sources, e.g., motor vehicle emissions

Of these, point sources on Rheebook's site are applicable to this air quality impact assessment.

5.3 evMET

evMet uses meteorological data collected at ground level to calculate meteorological data sets used in dispersion modelling studies. Of primary importance are those parameters that determine scaling of the boundary air layer. These are:

- Wind speed
- Wind direction
- Temperature
- Solar radiation

These parameters are used by evMet to calculate all of the parameters, e.g., stability of the air boundary layer, mixing heights, climate sets, etc., which are required by evPlanner in calculating the dispersion of pollutants from a source.

5.4 evPLANNER

evPlanner is the dispersion module of the EnviMan suite and links with evMapper, evEmissioner and evMet to carry out dispersion modelling activities. It is designed to run simulations of air quality based on emission data created in evEmissioner for the following scenarios:



- Hypothetical weather definitions, i.e., user-supplied information about temperature, wind speed, wind direction, cloud cover, etc.
- True weather period, i.e., using recorded data from a weather monitoring station to simulate plume dispersion hour-by-hour over a defined period
- Statistical weather period, i.e., using a pre-calculated sample of various weather conditions that typically occur during a year. This allows the creation of annual air quality maps for comparison against national guidelines and limit values.

Of these scenarios, the statistical period is applicable to the study of plume dispersion from Rheebok's operations.

evPlanner makes use of three different dispersion models, two of which are aimed at motor vehicle emissions. Use is made of the AERMOD dispersion model for the purposes of calculating the dispersion of plumes from point, area and grid sources. AERMOD is a USEPA-approved Gaussian plume dispersion model and is capable of simulating dispersion of pollutants over a distance up to approximately 50 km from the source.

AERMOD is listed as an approved dispersion model in GN R.533.

5.5 INPUT DATA

5.5.1 evMapper

A bitmap of the area around the Rheebok's operations site was obtained from Google Earth® and imported into evMapper as a suitable multi-layer digital map of the area was not readily available.

The map is shown in Figure 6 below. For dispersion modelling purposes the area covered by the map was divided into a 50m x 50m grid.

The emissions data base (evEmissioner) links with the map and places emission sources on specific locations, as defined by the user.



Figure 6: Map covering 6.9 km x 4.2 km. Rheebock's site is indicated by a red boundary.

5.5.2 evEmissioner

Compulsory information for point sources is:

- Height of stack
- Internal diameter of stack
- External diameter of stack
- Flue gas temperature
- Flue gas velocity
- Height and width of adjacent structures that could influence the wind profile

Output units:

Given an input of tons per annum, the output of evPlanner is in units of micrograms per cubic meter ($\mu\text{g}/\text{m}^3$).



5.5.3 evMet

No locally measured meteorology data set that includes all of the required parameters is available for the region. As a result, use was made of an extensive meteorological data set that was compiled from long-term measurements conducted in Mossdustria, Mossel Bay. The data set was kindly provided by GRDM, and this data set was used as input data for evMet. The data set covered a period of ten years and is regarded as reliable and of sufficient quality for calculating a boundary layer scaling set. Parameters covered are:

- Wind speed
- Wind direction
- Temperature
- Humidity
- Solar radiation

5.5.4 evPlanner

Planner does not require any user input as it extracts data from evMapper, evEmissioner and evMet.

5.6 EMISSIONS

Controlled pollutants and emission limits for ceramic processes, as listed under Sub-category 5.9 of GN893, are given in Table 1 below.

Pollutant	Kiln stacks mg/Nm ³ under normal conditions of 273 Kelvin and 101.3 kPa.
Total particulate matter (TPM)	50
Sulphur dioxide (SO ₂)	400
Total fluorides (as HF)	50

Table 1: Official Emission Limits for new plant, mg/Nm³

LAQS modelled the dispersion of pollutants from both the current zigzag operations, including the drying process, and the proposed new movable kiln operations. The emissions from the two processes are discussed below.

In the absence of particle size distribution data LAQS assumed that all particulate matter emitted from both the old and new process meets PM₁₀ requirements. This is probably an overestimation as PM₁₀ particulates form a sub-set of total particulate matter (TPM).



5.6.1 Current Zigzag Kiln Operations

Currently, Rheebok operates three zigzag kilns on their site. The kilns are identical as are the three stacks serving the kilns. However, the results of emission measurements conducted since 2022, kindly provided by Rheebok, showed a significant degree of variability in all measured parameters, thus making the estimation of annual emissions from each stack a difficult task. Examples are:

- Flue gas temperatures ranging from 28 °C to in excess of 80 °C.
- Measured concentrations of total particulate matter (TPM) ranging from less than 9 mg/m³ to in excess of 43 mg/Nm³.
- Measured concentrations of sulphur dioxide (SO₂) ranging from below minimum detection limits to in excess of 200 mg/Nm³.
- Measured concentrations of hydrogen fluoride (HF) varying from below detection limits to in excess of 5 mg/Nm³.

As a result, LAQS inspected the individual test results and selected what it regarded as representative pollutant concentrations to estimate total combined annual emissions from the three zigzag stacks. It is accepted that the selection process is fraught with uncertainty, but LAQS throughout opted for higher concentration rather than lower values which probably resulted in over-estimation of some concentrations. The following values were used:

Stack details: The three stacks serving the current operations have identical dimensions			
Stack height, m	11		
Stack diameter, m	1		
Flue gas temperature, °C	72		
Flue gas velocity, m/s	12.6		
Emissions:		Combined annual emissions, tons	
Concentrations	Avg. concentration, mg/Nm ³	Actual	At AEL limits
TPM	37.5	27.4	35.4
SO ₂	109	79.1	283.4
HF	5	3.6	35.4

Table 2: Estimated annual emissions from zigzag kilns

Unfortunately, the emission test results did not include any details of the concentrations of NO_x emissions.



5.6.2 Proposed Moving Kiln Operations

As is required by GN R.533, LAQS used the emission limits to estimate annual emissions from the new plant.

Rheebok obtained stack design parameters from their preferred supplier and LAQS used these parameters, together with the official emission limits, to calculate various properties required for dispersion modelling purposes. For the sake of comparison, LAQS estimated annual emissions that could realistically be expected, using typical emissions measured at similar installations in South Africa. The results are:

Stack details:			
Stack height, m	19		
Stack diameter, m	3		
Flue gas temperature, °C	50(*)		
Flue gas velocity, m/s	3.5		
Emissions		Annual emissions, tons	
Concentrations	Avg. concentration, mg/Nm ³	Actual	At AEL limits
TPM	25	14.5	28.9
SO ₂	24	13.9	231.4
HF	4.7	1.4	28.9

(*): See below

Table 3: Estimated annual emissions from new rotating kilns

Manufacturer specified a flue gas temperature of 100 °C. LAQS regards this as too high as the flue gas will pass through a wet scrubber which will result in a substantial reduction in flue gas temperature. LAQS assumed a value of 50 °C which is a typical of wet scrubber flue gas temperatures in industry.

6 RESULTS

Tables 2 and 3 show that the total annual emissions at AEL limits do not differ substantially between the two types of technologies, but the estimated emissions from the new kiln at expected concentrations are substantially lower than from the existing operations.

However, due mainly to the substantial difference in stack heights, the dispersion of pollutants differs substantially. As a result, the dispersion of pollutants emitted from the existing kilns at AEL limits are shown graphically as well.



LAQS modelled the dispersion of the three pollutants discussed above. The dispersion of air pollutants under the following two scenarios were investigated for comparison purposes:

- Emissions from the current zigzag kiln operations at estimated annual emissions.
- Emissions from the new kiln, both at the expected concentrations and at the maximum levels stipulated in GN893 (Table 2).

All simulations were carried out for a receptor height of 2 metres above ground level and a plume dispersion period of 60 minutes. This simulation period ensured that very low winds, e.g., 1 m/s, would carry pollutants some distance from the plant.

For all simulations, the approach was to determine both annual average ground-level concentrations and 99-percentile concentrations (the levels below which concentrations will occur for 99% of the time) of all of the pollutants listed in Section 5.6 above. A 99-percentile level was chosen as it is the closest comparison to the ambient air quality standard exceedance allowed legally (please see Section 7 below).

In addition, the maximum estimated ground-level concentrations were determined, as well as where these would occur. The annual average and 99-percentile concentrations at the nearest residential area was determined as well.

In addition to the graphical presentations, results are summarised in tabular format in Table 4.

6.1 EMISSIONS FROM THE EXISTING ZIGZAG KILN

6.1.1 Emissions at AEL Limits

The outcome of the dispersion modelling study is shown graphically in Figures 7 to 11 below.

Figures 7 and 8 respectively show the annual average and 99-percentile daily ground-level concentrations of PM10 particulates.

Figures 9 and 10 respectively show the average 8-hour and 99-percentile ground-level concentrations for sulphur dioxide (SO₂).

Figure 11 shows the annual average concentrations for total fluorides as HF.



Figure 7: Zigzag Kiln operations: AEL Limits; Annual Average PM10 Concentrations
Maximum scale is 10 µg/m³; the ambient air quality standard is 40 µg/m³



Figure 8: Zigzag Kiln operations: AEL Limits; 99-percentile PM10 Daily Averaged Concentrations
Maximum scale is at the ambient air quality standard 75 µg/m³



Figure 9: Zigzag Kiln operations: AEL Limits; Annual average SO₂ Concentrations
Maximum scale is at the ambient air quality standard 50 µg/m³



Figure 10: Zigzag Kiln operations: AEL Limits; 99-percentile SO₂ Concentrations
Maximum scale is at the ambient air quality standard 350 µg/m³



Figure 11: Zigzag Kiln operations: AEL Limits; Annual Average F as HF Concentrations
Maximum scale is 10 µg/m³, no official ambient air quality standard has been set



6.1.2 Emissions at Typical Concentrations

The outcome of the dispersion modelling study is shown graphically in Figures 12 to 16 below. Figures 12 and 13 respectively show the annual average and 99-percentile daily ground-level concentrations of PM10 particulates.

Figures 10 and 15 respectively show the average 8-hour and 99-percentile ground-level concentrations for sulphur dioxide (SO₂).

Figure 16 shows the annual average concentrations for total fluorides as HF.



Figure 12: Zigzag Kiln operations: Typical Emission; Annual Average PM10 Concentrations
Maximum scale is 2 µg/m³; the ambient air quality standard is 40 µg/m³



Figure 13: Zigzag Kiln operations: Typical Emission; 99-percentile PM10 Daily Averaged Concentrations
Maximum scale is 40 $\mu\text{g}/\text{m}^3$; the ambient air quality standard is 75 $\mu\text{g}/\text{m}^3$



Figure 14: Zigzag Kiln operations: Typical Emission; Annual average SO₂ Concentrations
Maximum scale is 10 µg/m³; the ambient air quality standard is 50 µg/m³



Figure 15: Zigzag Kiln operations: Typical Emission; 99-percentile SO₂ Concentrations
Maximum scale is at the ambient air quality standard 350 µg/m³



Figure 16: Zigzag Kiln operations: Typical Emission; Annual Average F as HF Concentrations
Maximum scale is 2 µg/m³; no official ambient air quality standard



6.2 EMISSIONS FROM NEW ROTATING KILN

6.2.1 Emissions at AEL Limits

The same modelling and assessment approach, as described in Section 6.1, was used to estimate ground-level concentrations, should emissions occur at the maximum levels specified in GN893, i.e., as shown in Section 5.6.2. The results obtained are shown graphically below and are summarised in tabular format in Table 4 below.

The outcome of the dispersion modelling study is shown graphically in Figures 17 to 21 below.

Figures 17 and 18 respectively show the annual average and 99-percentile daily ground-level concentrations of PM₁₀ particulates (all particulate emissions assumed to be PM₁₀ particles).

Figures 19 and 20 respectively show the average 8-hour and 99-percentile ground-level concentrations for sulphur dioxide (SO₂).

Figure 21 shows the annual average ground-level concentrations for total fluorides as HF.



Figure 17: Rotating Kiln Maximum Emissions: AEL Limits; Annual Average PM10 Concentrations
Maximum scale is 5 µg/m³; the ambient air quality standard is 40 µg/m³



Figure 18: Rotating Kiln Maximum Emissions: AEL Limits; 99-percentile PM10 Daily Averaged Concentrations
Maximum scale is 20 $\mu\text{g}/\text{m}^3$; the ambient air quality standard is 75 $\mu\text{g}/\text{m}^3$



Figure 19: Rotating Kiln Maximum Emissions: AEL Limits; Annual average SO₂ Concentrations
Maximum scale is 20 µg/m³; the ambient air quality standard is 50 µg/m³



Figure 20: Rotating Kiln Maximum Emissions: AEL Limits; 99-percentile SO₂ Concentrations
Maximum scale is at the air quality standard of 350 µg/m³



Figure 21: Rotating Kiln Maximum Emissions: AEL Limits; Annual Average F as HF Concentrations
Maximum scale is 0.2 $\mu\text{g}/\text{m}^3$. No official ambient air quality standard



6.2.2 Expected Emissions at Expected (Typical) Concentrations

The same modelling and assessment approach, as described in Section 6.1, was used to estimate ground-level concentrations, should emissions occur at the maximum levels specified in GN893, i.e., as shown in Section 5.6.2. The results obtained are shown graphically below and are summarised in tabular format in Table 4 below.

The outcome of the dispersion modelling study is shown graphically in Figures 22 to 26 below.

Figures 22 and 23 respectively show the annual average and 99-percentile daily ground-level concentrations of PM10 particulates (all particulate emissions assumed to be PM10 particles).

Figures 24 and 25 respectively show the average 8-hour and 99-percentile ground-level concentrations for sulphur dioxide (SO₂).

Figure 26 shows the annual average ground-level concentrations for total fluorides as HF.



Figure 22: Rotating Kiln Expected Emissions: Typical Emissions; Annual Average PM10 Concentrations
Maximum scale is 2 µg/m³; the ambient air quality standard is 40 µg/m³



Figure 23: Rotating Kiln Expected Emissions: Typical Emissions; 99-percentile PM10 Daily Averaged Concentrations
Maximum scale is 40 µg/m³; the ambient air quality standard is 75 µg/m³



Figure 24: Rotating Kiln Expected Emissions: Typical Emissions; Annual average SO₂ Concentrations
Maximum scale is 2 µg/m³; the ambient air quality standard is 50 µg/m³



Figure 25: Rotating Kiln Expected Emissions: Typical Emissions; 99-percentile SO₂ Concentrations
Maximum scale is 20 µg/m³; the ambient air quality standard is 75 µg/m³



Figure 26: Rotating Kiln Expected Emissions: Typical Emissions; Annual Average F as HF Concentrations
Maximum scale is 0.2 $\mu\text{g}/\text{m}^3$. No official ambient air quality standard



Estimated ground-level concentrations at maximum allowed emission rates are listed in Table 4 below.

AT AEL EMISSION LIMITS										
	Maximum annual average				AQ standard	Maximum 99-percentile				AQ standard
	Zigzag	Where?	New kiln	Where?		Zigzag	Where?	New kiln	Where?	
PM10	1.8	South-eastern fenceline	0.6	300 - 350 m north of site centre	40	57.8	South-eastern fenceline	8.0	300 - 350 m north of site centre	75
SO ₂	14.5		4.8		50	664		91.0		350
HF	1.8		<0.1		--					--
AT ACTUAL OR TYPICAL EMISSION LEVELS										
PM10	1.3	South-eastern fenceline	0.3	300 – 350 m north of site centre	40	8.0	South-eastern fenceline	4	330 - 350 m north of site centre	75
SO ₂	5.8		0.3		50	91.0		5.5		350
HF	0.2		<0.1		--					--

Table 4: Results Summary, Moving Kiln Maximum Emissions, µg/m³
 Values indicated in red imply that the air quality standard will be exceeded



7 DISCUSSION

The results of any computer model are only as reliable as the quality of the input data.

7.1 evEMISSIONER

For existing operations, the annual emissions of the air pollutants discussed in this report were calculated from results obtained during the last four years' emission surveys and LAQS's opinion of typical emissions where the survey results seemed unlikely.

The annual emissions from the new process were calculated from official emission limits, as stipulated in GN R.533, and design flue gas velocities. Once operational, the actual velocities during full operation of the process may differ.

It is accepted that LAQS's approach will result in a degree of uncertainty, but throughout the procedure LAQS followed a conservative approach in which maximum emissions were overestimated, rather than underestimated. This approach must be regarded *a* worst-case scenario.

7.2 evMET

The meteorological data collected in Mossel Bay is comprehensive and very few gaps exist in the final data set. The various sensors used to collect the data are calibrated annually in accordance with SANAS TR-07 03 and the dataset is, therefore, regarded as highly reliable. It must be borne in mind, though, that the monitoring station is located approximately 9 km west of south-west of Rheebook's site. The distribution of winds in the Mossel Bay area is shown graphically in Figure 27 below.



Windrose diagram
Wind direction: Mossel Bay Wind Direction Station Conc
Classifier: Mossel Bay Wind speed Station Conc
StartDate: 2016/01/01
StopDate: 2016/12/31 11:59:00 PM
Resolution: 60 minutes
Number of sectors: 45
Sectors width: 8
Number of observations: 10601
Unit: % occurrence in wind sector

— 0.0 < Wind speed <= 30.0
— 3.0 < Wind speed <= 6.0
— 1.0 < Wind speed <= 3.0
— 0.0 < Wind speed <= 1.0

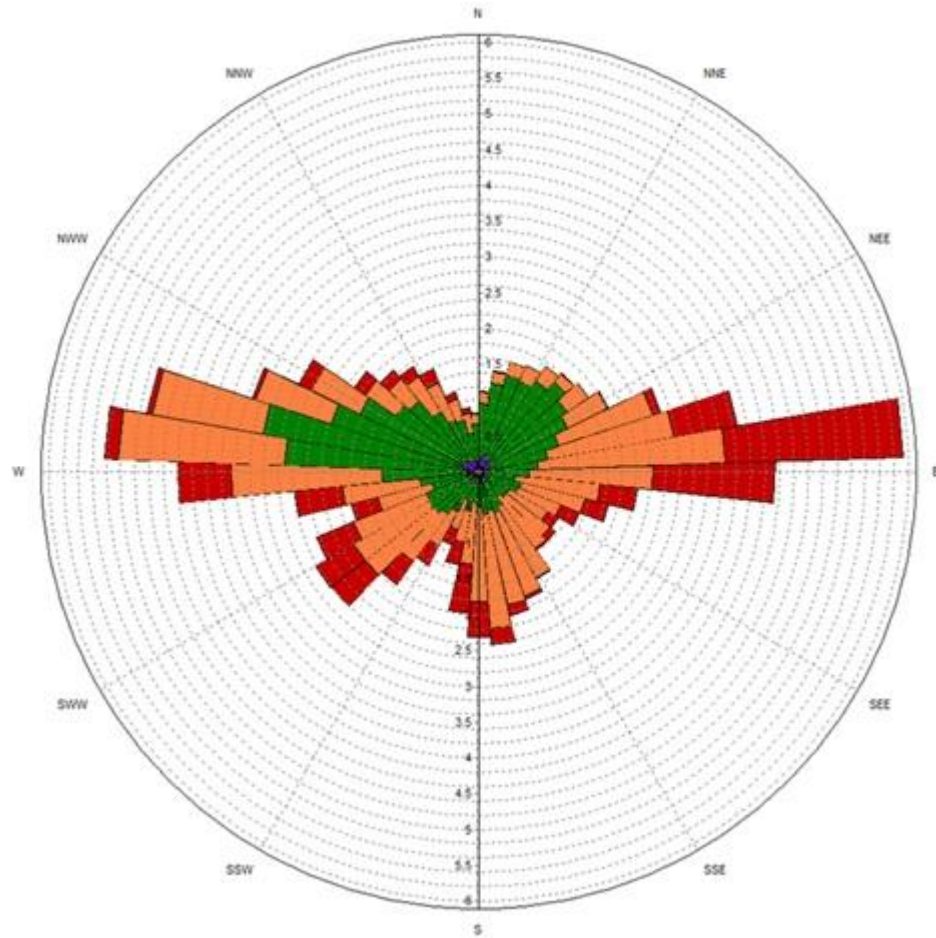


Figure 27: Frequency of Wind Direction



7.3 evPLANNER

As was stated previously, the user provides no direct data input to evPlanner. It uses Aermol, a USEPA-approved Gaussian plume dispersion model, and there is no reason to doubt the reliability of the dispersion calculations. Aermol is also listed as an approved plume dispersion model in GN R.533.

7.4 IMPACT OF SURROUNDING STRUCTURES

The design stack height of 19 metres is sufficiently higher than surrounding structures so that LAQS is of the opinion that the plant structure will not influence the dispersion of pollutants from the various stacks. The heights of adjacent structures were taken into account in the modelling of dispersion from the existing zigzag kiln stacks.

8 IMPACT ON OVERALL AIR QUALITY

Ambient air quality standards for some pollutants were published by the Department of Environmental Affairs (DEA) in Government Notice No. 1210 on 24 March 2009 (GN1210). Of the pollutants discussed in this study, ambient air quality standards for PM₁₀ and SO₂ have been set and these limits are:

National Ambient Air Quality Standards for Particulate Matter (PM₁₀)

Averaging Period	Concentration	Frequency of Exceedance
24 hours	75 µg/m ³	4
1 year	40 µg/m ³	0

National Ambient Air Quality Standards for Sulphur Dioxide (SO₂)

Averaging Period	Concentration	Frequency of Exceedance
24 hours	125 µg/m ³	4
1 year	50 µg/m ³	0

No official ambient air quality standard for HF exists in South Africa. However, the World Health Organization specifies a 1-hour reference exposure guideline concentration of 630 µg/m³.

The number of exceedances mentioned is approximately 1% of the time, i.e., daily exceedances of 4 times per year are marginally more than 1% of the time (3.65). Similarly, 88



exceedances of hourly limits form approximately 1% of the total number of hours per year (1% of 8 760 is 87.6). As a result, LAQS modelled 99-percentile concentrations to reflect the maximum level below which concentrations may occur for 1% of the time.

The summarised results given in table 5 below were extracted from Table 4.

Pollutant	Annual average		99-percentile	
	Zigzag	Moving kiln	Zigzag	Moving kiln
PM10	1.8	0.6	57.8	8.0
SO ₂	14.5	4.8	664	91.0
HF	1.8	<0.1		

Table 5: Results Summary, Zigzag vs Moving Kiln Emissions, µg/m³
Values indicated in red imply that the air quality standard will be exceeded

As can be seen from the table, emissions from the proposed process will result in a significantly lower impact on air quality, even though emissions are based on official emission limits, and that no exceedance of air quality standards is expected. It was mentioned in Section 5.6.2 that the difference in AEL-based pollutant levels do not differ substantially between the combined zigzag kilns and the new rotating kiln. The major difference in estimated ground-level concentrations is primarily due the substantially higher stack (19 metres as opposed to 11 metres) that will serve the new kiln.

Due to a difference in location and stack height, the point of maximum concentration will shift from Rheebock's south-eastern fenceline to a point located approximately 300 – 350 metres north of the centre of Rheebock's property. That area is currently unoccupied.

8.1 PM10 PARTICULATE MATTER

The highest annual average concentration of PM10 is estimated to be 1.8 µg/m³ and is due to emissions from the existing zigzag kiln stacks, while the maximum annual average expected from the new kiln is 0.6 µg/m³. Both concentrations are well below the current ambient air quality standard.

The maximum 99-percentile daily concentration was shown to be 57.8 µg/m³ for the zigzag kiln and 8.0 µg/m³ for the new rotating kiln. Both concentrations are below the official ambient air quality standard

8.2 SULPHUR DIOXIDE

The highest annual average concentration of SO₂ is estimated to be 14.5 µg/m³ for the zigzag kiln and 4.8 µg/m³ for the rotating kiln, both of which are well below the current ambient air quality standard.



Should the SO₂ emissions from the existing here zigzag kilns occur at the maximum allowable level of 400 mg/Nm³, unlikely as it may be, the maximum 99-percentile hourly concentration was shown to be 466 µg/m³, i.e., well in excess of the air quality standard of 350 µg/m³. In the case of the new rotating kiln, the estimated maximum 99-percentile concentrations can be expected to be 91 µg/m³ which is well below the ambient air quality standard.

8.3 HYDROGEN FLUORIDE

The highest annual average concentration of HF is estimated to be 1.8 µg/m³ and is due to emissions from the existing zigzag kiln stacks. While the maximum annual average expected from the new kiln is less than 0.1 µg/m³.

No official air quality standard for HF has been published in South Africa with the result that the results cannot be evaluated accordingly. However, both maximum 99-percentile concentrations are well below the WHO exposure guideline value of 630 µg/m³.

8.4 IMPACT OF EXPECTED TYPICAL EMISSIONS

The estimated ground-level concentrations of the pollutants discussed above must be interpreted with extreme care. As is required by GN R.533, annual emissions were based on the emission limits for ceramic processes as published in GN893.

Typical expected particulate matter emissions from the new kiln are expected to be approximately 25 mg/Nm³. Should emissions occur at this concentration, and all particulate matter comply with the definition of PM₁₀ particulates, the calculated annual emission rate will reduce to approximately 14.5 tons per annum, i.e., approximately 50% of the value based on maximum allowed emissions.

This will result in the following lower concomitant ground-level concentrations:

- Maximum annual average: 0.6 µg/m³
- Maximum 99-percentile: 8.0 µg/m³

Both of these concentrations are well within the ambient air quality limit.

Similarly, the design SO₂ concentration in the flue gas is given as less than 300 mg/Nm³, but typical concentrations recorded in similar installations are approximately 24 mg/Nm³. Emissions at this concentration will reduce the maximum annual average and maximum 99-percentile concentrations to 4.8 µg/m³ and 91 µg/m³ respectively, both of which are below the ambient air quality standards.

An additional emissions reduction strategy is, therefore, not recommended by LAQS.

8.5 GENERAL

From the various graphical presentations, it can be seen that the maximum 99-percentile concentrations are expected to occur approximately 300 to 350 metres north of the centre of Rheebook's property and on vacant land.



It must be borne in mind, though, that while annual emissions may reduce, the fact that a wet scrubber will be used to reduce emissions will result in an increase in the moisture content of the stack as water is absorbed from the scrubber while reducing the flue gas temperature from approximately 200 to 120 °C to approximately 50 to 60 °C.

This will result in a more visible plume from the new stack as water vapour condenses in the lower ambient temperatures. The visibility can be expected to be higher during colder periods, but the visible steam plume should disappear fairly quickly, thus reducing the plume visibility over distance.

9 CONCLUSIONS

The annual emissions discussed in Section 5.6 were based on the official emission limits for ceramic processes, as stipulated by GN R.533. It is accepted that this approach is essential in air quality management applications as authorities need to be aware of the potential impact of emissions at maximum allowable emission limits.

In reality, measured emissions from similar installations show that actual emissions from rotating brick kilns are low and, in Rheebook's case, lower than from the existing zigzag kilns.

The resulting lower mass emission rates and substantially higher stack implies that the estimated ground-level concentrations will be substantially lower than is currently experienced in the area surrounding Rheebook's operations. LAQS is, therefore, of the opinion that the new process will not result in any serious threat to air quality in the area surrounding Rheebook's site.

10 RECOMMENDATIONS

LAQS is of the opinion that no continuous emission monitoring equipment will be required to monitor the various emissions addressed by this report, but that emissions should be verified by a reputable and independent contractor on an annual basis, as required by GN893.

Care should be exercised that these annual emissions verification tests are conducted by an SANAS-accredited contractor, as specified in GN893, and strictly according to the emission methods listed in Appendix A of GN893. The results thus obtained will be representative, reliable and defensible, albeit based on very short measurement periods only. The results should be used to verify the findings of this report.

Based on the findings of this air quality impact assessment, LAQS recommends that an AEL be issued to Rheebook as the impact of the new process is shown to be substantially lower than the existing process.