AIR QUALITY IMPACT ASSESSMENT

Prepared for

CAPE LIME (PTY) LTD
VREDENDAL

FINAL REPORT
JANUARY 2020

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CK 2018/109208/07

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AIR QUALITY IMPACT ASSESSMENT

1 INTRODUCTION

Messrs Cape Lime (Pty) Ltd (Cape Lime) manufactures lime products at its plant outside Vredendal in the Western Cape.

The process operated by Cape Lime is regarded as a controlled emitter in terms of Section 21 of the National Environmental Management: Air Quality Act, Act 39 of 2004. An atmospheric emission license (AEL) (No. WC/WC/025) was issued to Cape Lime by the West Coast District Municipality in June 2016 and it expires in June 2021.

Cape Lime is currently in the process of upgrade its EMPr in order to be compliant to the NEMA EIA Regulations 2014 as amended and appointed Waste Aside to assist with the process.

As part of the EMPr upgrading process, a specialist air quality impact assessment is required and Waste Aside requested Lethabo Air Quality Specialists (Pty) Ltd (LAQS) to assist in this regard.

Cape Lime is also considering expanding their operations, resulting in a three-fold increase of its production rate, and the impact that such an expansion may have is included in the work done by LAQS.

As a result of dust-related complaints, LAQS included sources of particulate emissions other than the limestone processing plant, i.e. roads, mining operations, stockpiles and material handling operations in the air quality impact assessment.

LAQS modelled the dispersion of pollutants emitted from Cape Lime's current operations to estimate ground-level concentrations of pollutants.

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 (GN893)

3. "*Regulations Regarding Air Dispersion Modelling*" as published in Government Notice GN R.533 of 11 July 2014 (GN R.533)

3 PROCESS DESCRIPTION

Limestone (calcium carbonate, $CaCO_3$) is mined in Cape Lime's open-cast mine and transported to a primary crusher by dump trucks. The primary crusher is located some distance from the processing plant.

Crushed limestone is transported by road to a secondary crusher which is located adjacent to the processing plant. Crushed limestone is passed over a screen to provide an appropriate size distribution of limestone for processing.

The crushed and screened fed to a calciner where the calcium carbonate is converted to calcium oxide (CaO) is produced.

The calcium oxide is then passed to a hydration plant where it reacts with water to form calcium hydroxide ($Ca(OH)_2$) or slaked lime.

Limestone aggregate and dolomite are also sold to customers who collect the material from site by means of road transport.

In addition, high-grade dolomite is mined and crushed prior to being sold to external clients who also remove this material by road transport.

4 ATMOSPHERIC EMISSION LICENSE REQUIREMENTS

The processes used by Cape Lime are included in the *National List of Activities Which Result in Atmospheric Emissions* as published in Government Notice No. 893 on 22 November 2013 (GN893). The activities fall under the following categories:

-- Sub-category 5.6, "*Lime production*" with a general description of "*The processing of lime, magnesite, dolomite and calcium sulphate*". All installations are included in the definition.

5 DISPERSION MODELLING STUDY

The Department of Environmental Affairs moved to homogenise dispersion modelling in South Africa by publishing relevant in Government Notice GN R.533 on 11 July 2014 (GN R.533). Throughout this report mention is made of compliance with this set of Regulations.

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

Mapper: A map manipulation tool
Emissioner: An extensive, relational emissions data base
EnviMet: A meteorological data management program
Planner: The actual dispersion model

5.1 MAPPER

Mapper 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 EMISSIONER

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

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

-- Point sources, e.g. industrial stacks
-- Area sources, e.g. stockpiles, tailings, etc.
-- Grid sources, e.g. complete informal settlement areas
-- Line sources, e.g. motor vehicle emissions

Of these, point, are and line sources on Cape Lime's site are applicable to this air quality impact assessment.

5.3 ENVIMET

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

5.4 PLANNER

Planner is the dispersion module of the EnviMan suite and links with Mapper, Emissioner and Envimet to carry out dispersion modelling activities. It is designed to run simulations of air quality based on emission data created in Emissioner 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 Cape Lime's operations.

Planner 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 Mapper

A bitmap of the area covering Cape Lime's operations was obtained from Google Earth® and imported into Mapper as a suitable multi-layer digital map of the area was not readily available.

The map is shown in Figure 1 below. For dispersion modelling purposes the area covered by the map was divided into a 100m x 100m grid.

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

Figure 1: Map covering 11.7 km x 7.1 km

5.5.2 Emissioner

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

Compulsory information required for area sources are:

- Area over which emissions occur
- Release height of the source
- Definition of pollutants
- Annual mass emission rates of pollutants

Compulsory information required for road traffic sources are:

- Route over which emissions occur
- Vehicle fleet classification
- Vehicle fleet composition
- Number of vehicles in each class making use of the route
- Average speed of each vehicle class in the vehicle fleet
- Hourly and monthly variations in operations
- Road, pavement and roadside structure details (widths, heights)
- Definition of pollutants
- Annual mass emission rates of pollutants

Relevant details of the stacks were extracted from Cape Lime's existing AEL and/or by dedicated questionnaire.

Output units:

Given an input of tons per annum, the output of Planner is in units of micrograms per cubic meter (µg/m^3).

5.5.3 EnviMet

A set of meteorological parameters collected at Vredendal's aerodrome which is located approximately 5.3 km west of Cape Lime's site and was procured by LAQS and imported into EnviMet. The dataset covers the period from 1 July 2016 to 31 October 2019 and includes the necessary parameters required by EnviMet.

All of the data included in the dataset has been validated and bad or missing data forms less than 3.8% of the dataset.

5.5.4 Planner

Planner does not require any user input as it extracts data from Mapper, Emissioner and Envimet.

5.6 EMISSIONS

As mentioned above, point, area and line sources apply to Cape Lime's operations. The following classification was used:

- -- Point source: The calciner stack
- -- Area sources: The primary crusher, secondary crusher and stockpiles
- -- Line sources: Road from mine to the primary crusher
  Road from the primary crusher to the secondary crusher (Cape Lime materials only)
  Road from the primary crusher to R362 provincial road

5.6.1 Calciner stack

Controlled pollutants and emission limits for new processes covered by the two classifications, as listed under Sub-category 4.10 of GN893, are given in Table 1 below.

Pollutant	Drying
Total particulate matter (TPM)	50
Sulphur dioxide (SO_2)	400
Nitrogen oxides (as NO_2)	500

Table 1: Official Emission Limits for both new and existing plant, mg/Nm^3

As is required by GN R.533 LAQS used the emission limits to estimate annual emissions from the expanded operations.

Stack Conditions:

Cape Lime appointed Yellow Tree in Cape Town to carry out extensive emission measurements on each of the calciner stack

The following parameters were reported by Yellow Tree:

Parameter	
Height, m	32
Velocity m/s	16.5
Temperature °C	134
Diameter, m	1.47

TPM, mg/Nm^3	33
SO_2, mg/Nm^3	38
NOx as NO_2, mg/Nm^3	180

Table 2: Stack details

Emission Rates

As is stipulated in GN R.533, the estimated annual emissions of the four pollutants listed in Table 1 were calculated from the official emission limits as given in GN893 and the higher volumetric flow rate, yielding the following values:

	Annual emissions	
Pollutants	At limits	As measured
TPM	29.6	19.5
SO_2	236.6	22.5
NOx as NO_2	236.6	85.2

Table 3: Estimated Annual Emission from Cape Lime, tons

Official ambient air quality limits have been set for PM10 particulates, SO_2 and NO_2 in Government Notice R1210 of 24 December 2009 (GN1210).

In the absence of particle size distribution data LAQS assumed that all particulate matter emitted from all of the calciner meet PM10 requirements. This is possibly an overestimation as PM10 particulates form a sub-set of total particulate matter (TPM).

Virtually all NOx emissions from industry consist of nitrogen monoxide (NO) which is oxidised to NO_2 in ambient air due to the presence of ozone. In the absence of information about the ozone concentration LAQS followed the requirements of GN R.533 which states that the NO_2 fraction of NOx emitted must be assumed to be 0.8. This resulted in calculated annual NO_2 emissions given in Table 3 above and these values were used for dispersion modelling purposes.

5.6.2 Area Sources

Area source classification is typically applied to material handling applications where emissions occur freely into the atmosphere, e.g. mine blasting, crushing operations, stockpile loading, etc. Emissions occur over an area and relatively close to ground-level.

LAQS made use of emission factors published by the USA's Environmental Protection Agency (USEPA) in their CHIEF (Clearing House for Industrial Emission Factors) software (commonly referred to as "AP-42) and/or the Australian Government's National Pollution Inventory Emissions Estimation Technique manuals (NPIEET).

Mining (blasting) operations:

The emission factors published in NPIEET for mining and calculated annual emissions from mining operations are:

	TPM	PM10
Drilling	0.59 kg/hole	0.031 kg/hole
Blasting	0.00022 kg/m^2	0.000114 kg/m^2
Annual emissions, tons		
Holes drilled per annum, 320	0.189	0.010
Area blasted per annum, m^2, 6000	0.001	0.001
Total mining emissions	**0.190**	**0.011**

Table 4: Mining Emissions

Crushing operations:

Annual emissions from crushing operations are dependent on the mass of material crushed and the moisture content of the material.

According to information provided by Cape Lime, 30 000 tons per month pass through the primary crusher. The moisture content of the material is less than 1%, i.e. the material is dry. Crushing operations operate throughout the year except for a 3-week break in December / January, resulting in a calculated annual crushing capacity of 337 500 tons per annum. Limited dust suppression measures are taken at the primary crusher and the estimated efficiency of the system is 50%.

Secondary crushing operations entail the crushing of 5 400 tons per month, or 60 750 tons per annum. The moisture content is also less than 1%. Dust suppression by means of water sprays are applied at the secondary crusher and the estimated efficiency of the system is 90%.

The emission factors published in NPIEET for mining and calculated annual emissions from crushing operations are:

	TPM	PM10
Primary crushing (dry materials)	0.2 kg/ton	0.02 kg/ton
Secondary crushing (dry materials)	0.6 kg/ton	0.02 kg/ton
Annual emissions, tons		
Primary crusher	33.8	3.4

Secondary crusher	3.6	0.4
Total crusher emissions	**37.4**	**3.8**

Table 5: Crusher Emissions

Stockpiles:

Annual emissions from stockpiles are dependent on the mass of material handled and the moisture content of the material. Emissions occur both during loading to and loading from stockpiles. Three stockpiles are of note, either through their annual emissions, or location relative to the lime processing plant. These are:

-- Primary stockpile: 30 000 tons per month (337 500 tons per annum)

-- Secondary crusher (material handling): 5 40 tons per month (60 750 tons per annum)

-- Coal stockpile: 900 tons per month (10 125 tons per annum)

Dust suppression by means of water sprays are applied at each stockpile and the estimated efficiency of the system is 65%.

The emission factors published in NPIEET for mining and calculated annual emissions from crushing operations are:

	TPM	PM10
Minerals, loading to	0.004 kg/ton	0.0017 kg/ton
Loading from	0.03 kg/ton	0.013 kg/ton
Coal, loading to	0.004 kg/ton	0.0017 kg/ton
Loading from	0.03 kg/ton	0.013 kg/ton
Annual emissions, tons		
Primary crusher	0.44	0.21
Secondary crusher	0.7	0.3
Coal stockpile	0.34	0.15
Total material handling	**1.48**	**0.66**

Table 6: Crusher Emissions

Wind generated emissions:

Annual wind-generated emissions from stockpiles are dependent on the area of a stockpile, particle size distribution of material, mean wind speed and moisture content of the material. According to AP-42 wind speeds above 10 m/s (36 km/h) at a height of 15 cm above the ground is required for effective wind erosion of stockpiles. Such winds are rare and gusts of high wind speeds are the main cause of such emissions.

In the absence of suitable wind data, emission factors published in the NPIEET for mining was used to estimate annual wind-generated emission from the various stockpiles.

Dust suppression by means of water sprays are applied at each stockpile and the estimated efficiency of the system is 65%.

The emission factors published in NPIEET for mining and calculated annual emissions from crushing operations are:

	TPM	PM10
Emission factors	0.4 kg/ha/h	0.1 kg/ha/a
Annual emissions, tons		
Stockpile, 5.9 ha	7.2	1.8
Coal stockpile, 0.24 ha	0.3	0.1
Waste area, 0.23 ha	0.3	0.1
Total wind generated	**7.8**	**2.0**

Table 7: Crusher Emissions

5.6.3 Line Sources

In its section dealing with particulate emissions from roads, AP-42 differentiates between traffic on industrial roads and those on public roads and empirical equations are provided to estimate emissions accordingly. In addition, most of the roads are unpaved.

For the sake of this study LAQS regarded all roads as "industrial roads". AP-42 provides the following equation for calculating emissions:

$$E = 0.2819\ k\ (\frac{s}{12})^a\ (\frac{W}{3})^b \text{ where}$$

E = Emissions, kg/vehicle km travelled
s = surface material silt content, %
W = mean vehicle weight, tons (assumed to be 30 tons)
k, a, b = empirical constants

The following empirical values for k, a and b for TPM and PM10 are given:

	TPM	PM10
k:	4.9	1.5
a:	0.7	0.9
b:	0.45	0.45

Applying these factors LAQS calculated the following emission factors:

-- TPM: 3.008 kg/km
-- PM10: 0.855 kg/km

The empirical equation does not include vehicle speed, but the USEPA states that the equation is valid for mean vehicle speeds of 5 to 43 mph (8 to 70 km/h)

Three different road transport routes exist. These are:

-- Mine to primary crusher (all products)
-- Primary crusher to secondary crusher (limestone and dolomite)
-- Primary crusher to R362 provincial road (aggregate and dolomite)

Cape Lime provided details of the number of vehicles, vehicle distance travelled per day and the number of days per year that materials are transported along each of these routes.

Road surfaces are treated with water as dust suppressant and it is assumed that the efficiency of this method is 65%.

Applying the emission factors, vehicle distances and dust suppression efficiency to the three routes, LAQS calculated the following annual emissions:

-- TPM: 325 tons per annum
-- PM10: 92.4 tons per annum

5.6.4 Emissions Summary

The total estimated emissions from the complete operations are given below.

Source	TPM	PM10
Point source	19.5	19.5 (#)
Mining	0.190	0.011
Crushing	37.4	3.8
Stockpiles	1.48	0.66
Wind generated	7.8	2.0
Roads	325	92.4
Total	**391.4**	**118.4**

(#): Assumed that all particulate emissions are PM10

Table 8: Summarised Annual Emissions, tons

5.6.5 Future Operations

As is mentioned in Section 1, Cape Lime is considering expanding their operations by installing two additional calciners, thus effectively increasing their operations three-fold.

This expansion implies that all of the emissions discussed above, except for the quantity of material sold to external client, will increase threefold.

6 RESULTS

LAQS modelled the dispersion pollutants emitted from the various activities discussed above. The following scenarios were assessed:

- Calciner only: The calciner operation is the only activity subject to an AEL. As a result annual emissions from this operation must be calculated according to GN R.533, i.e. based on maximum emissions allowed by the AEL to show the maximum impact that emissions at the maximum level may have.

  Such a scenario will show a worst-case condition as measured emissions are below the emission limits. LAQS subsequently calculated annual emissions, based on measured values, to show a typical air quality impact scenario.

- Cumulative impact: The other operations on site, i.e. mining, crushing, stockpiles, road emissions, etc., are not controlled under Section 21 of the Air Quality Act. LAQS subsequently modelled the dispersion of TPM and PM10 emissions from all sources to show the cumulative impact of all source emissions.

The results obtained are given graphically and summarised in tabular format in the sections below. 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 4.6 above. A 99-percentile level was chosen as it is the closest comparison to the ambient air quality limit exceedences 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.

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 source.

6.1 CALCINER EMISSIONS

Emissions at Maximum Allowed Concentrations

The outcome of the dispersion modelling study is shown graphically in Figures 2 to 7 below.

Figures 2 and 3 respectively show the annual average and 99-percentile daily ground-level concentrations of PM10 particulates (all particulate emissions assumed to be PM10 particles).

Figures 4 and 5 respectively show the average 8-hour and 99-percentile ground-level concentrations for sulphur dioxide (SO_2).

Figures 6 and 7 respectively show the annual average and 99-percentile ground-level concentrations for nitrogen dioxide.

Emissions at Measured Concentrations

The dispersion of pollutants under typical calciner operations is shown graphically in Figures 8 to 13 below.

Figures 8 and 9 respectively show the annual average and 99-percentile daily ground-level concentrations of PM10 particulates (all particulate emissions assumed to be PM10 particles).

Figures 10 and 11 respectively show the average 8-hour and 99-percentile ground-level concentrations for sulphur dioxide (SO_2).

Figures 12 and 13 respectively show the annual average and 99-percentile ground-level concentrations for nitrogen dioxide

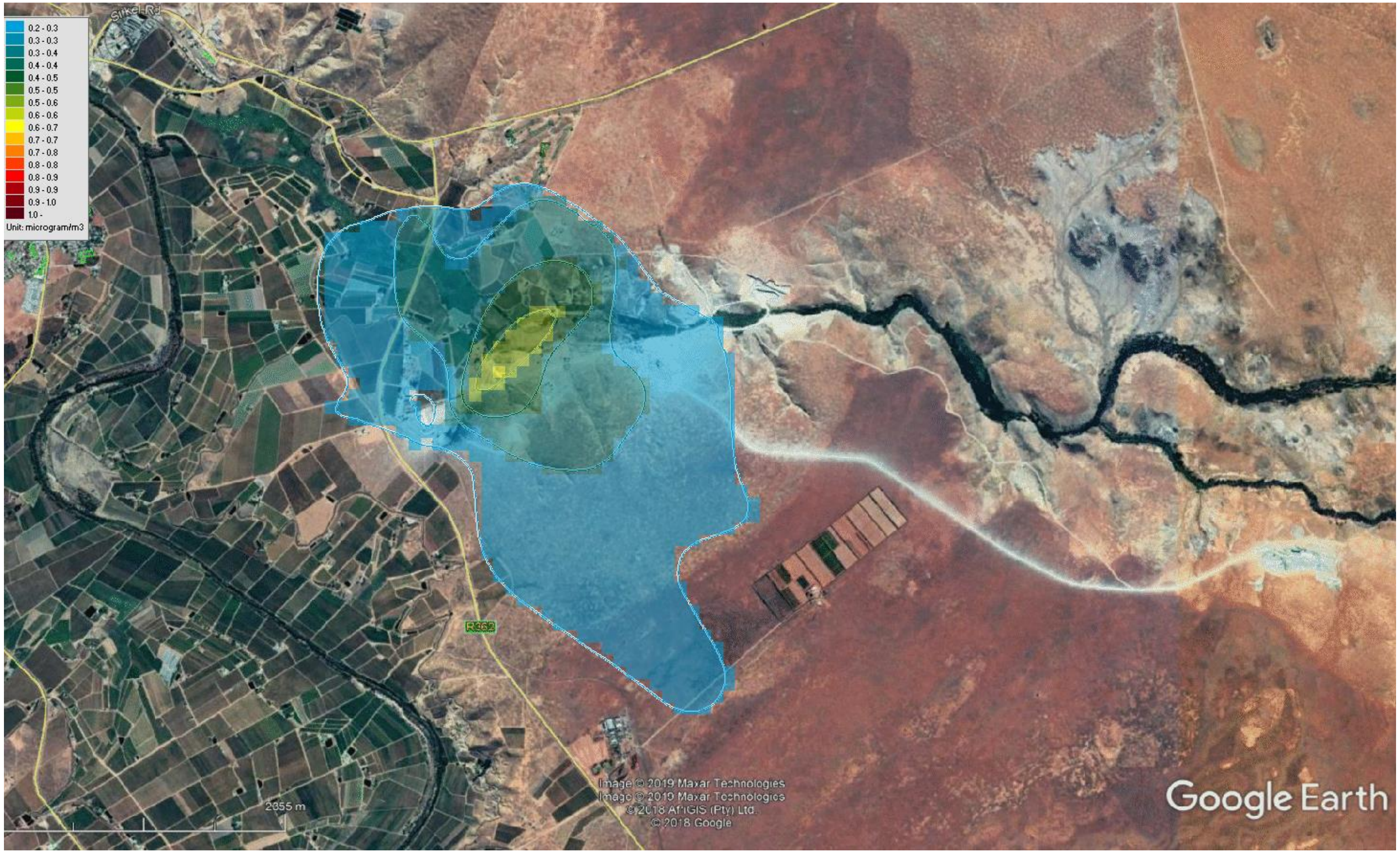

Figure 2: Maximum Emissions: Annual Average PM10 Concentrations
Maximum scale (burgundy) is 1.0 µg/m^3; air quality standard is 40 µg/m^3

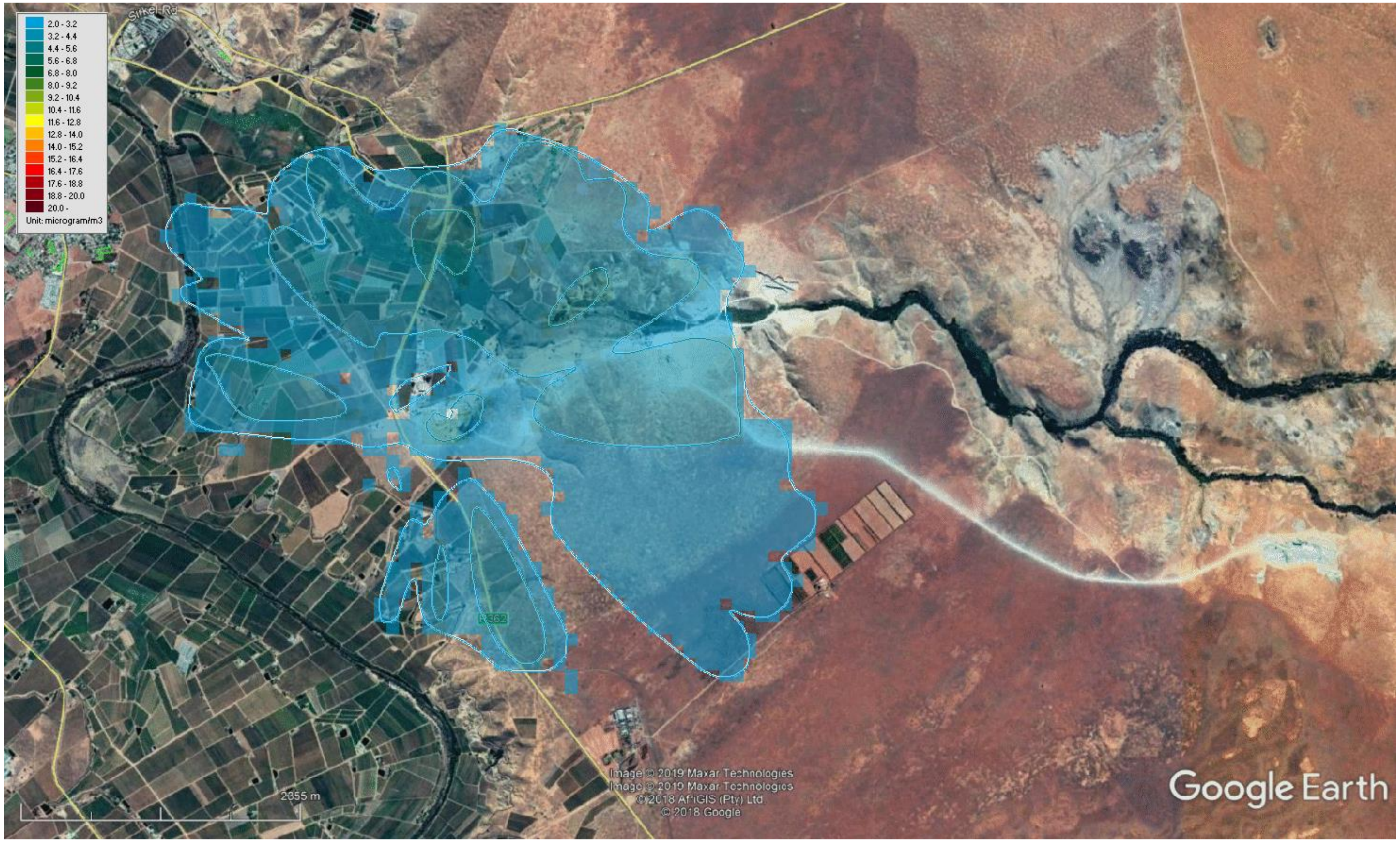

Figure 3: Maximum Emissions: 99-percentile PM10 Daily Averaged Concentrations
Maximum scale (burgundy) is 20 µg/m^3; air quality standard is 75 µg/m^3

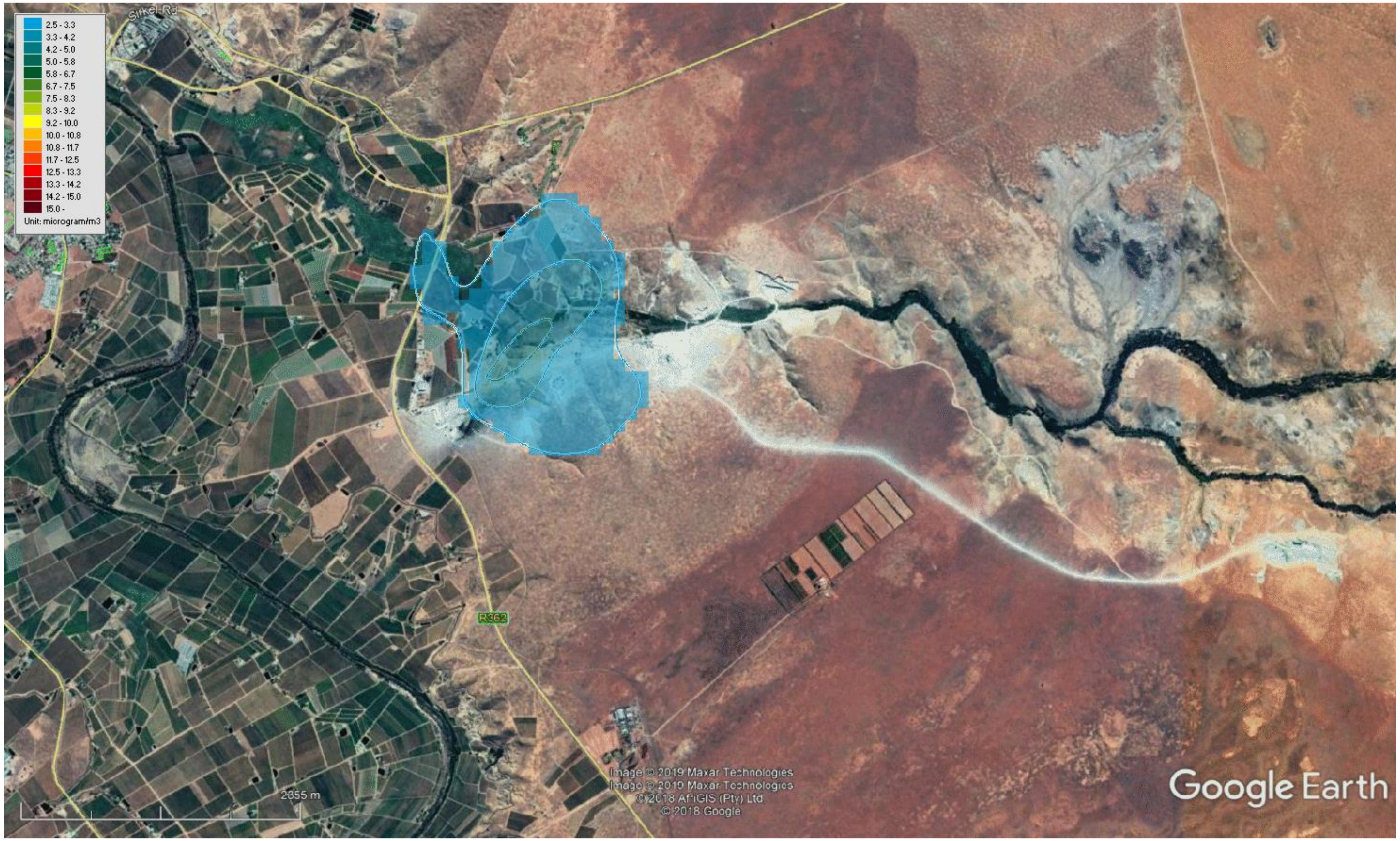

Figure 4: Maximum Emissions: Annual average SO_2 Concentrations
Maximum scale (burgundy) is 15 μg/m^3; air quality standard is 50 μg/m^3

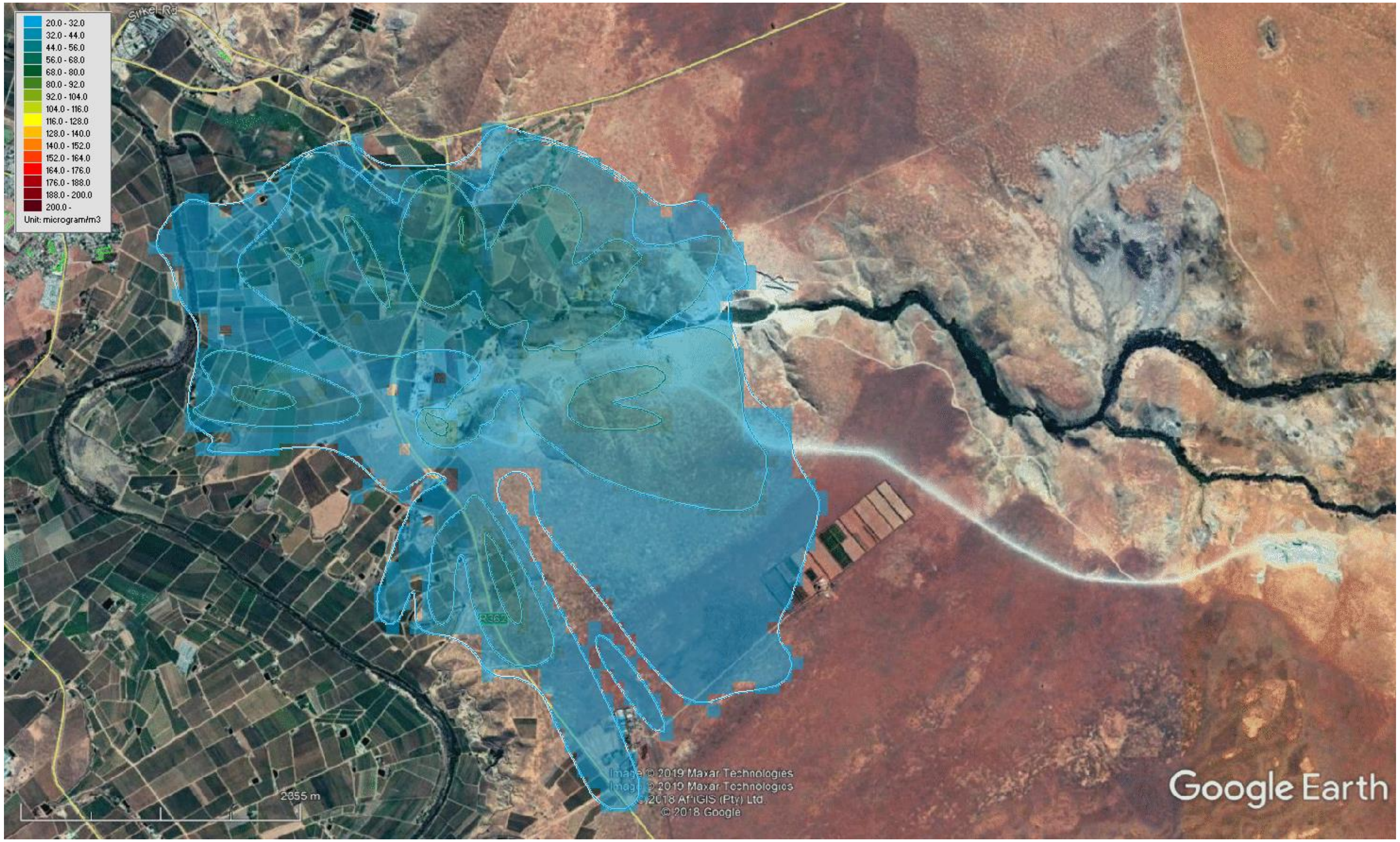

Figure 5: Maximum Emissions: 99-percentile SO_2 Concentrations
Maximum scale (burgundy) is 200 $\mu g/m^3$; air quality standard is 350 $\mu g/m^3$

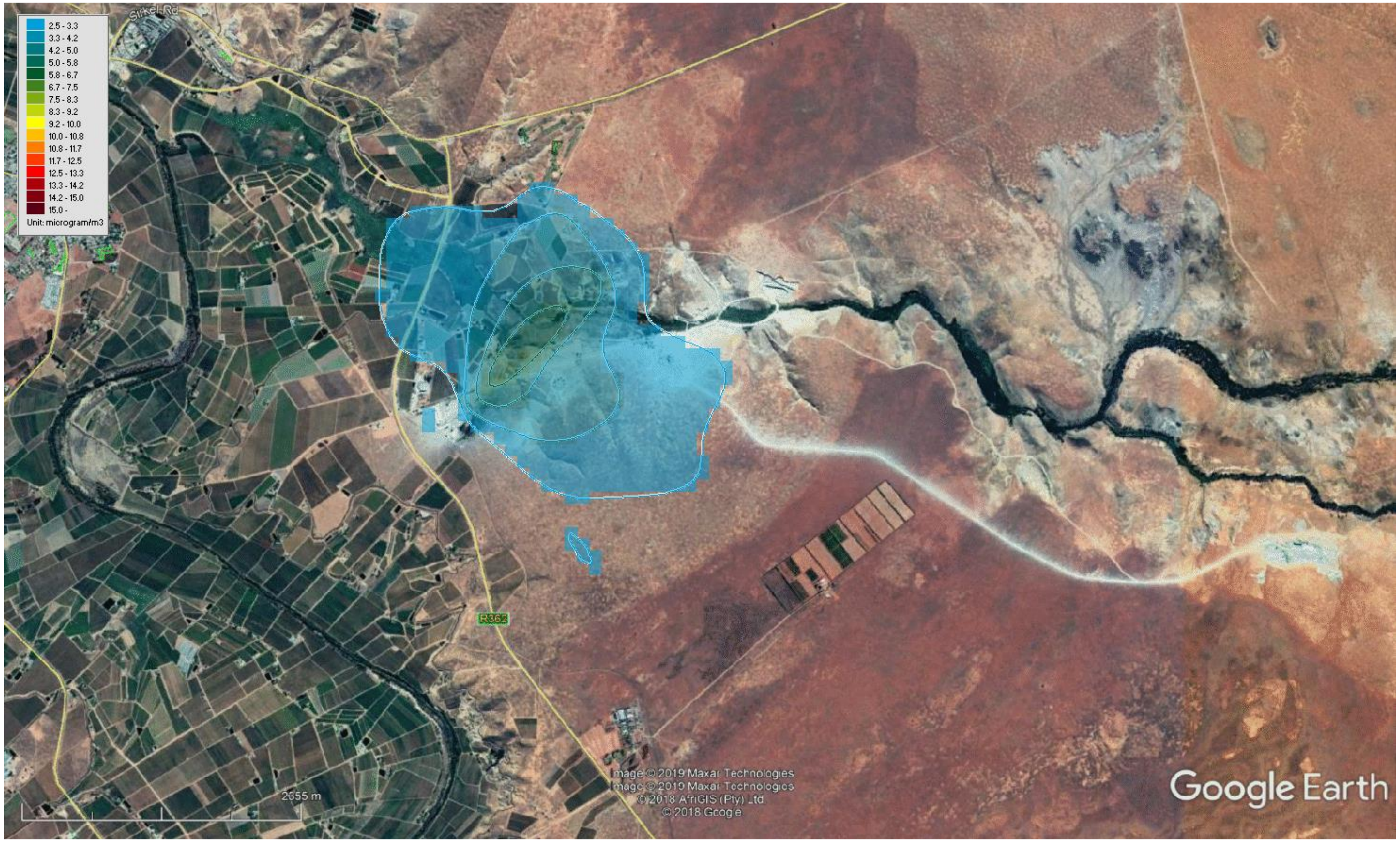

Figure 6: Maximum Emissions: Annual Average NO_2 Concentrations
Maximum scale (burgundy) is 15 $\mu g/m^3$; air quality standard is 40 $\mu g/m^3$

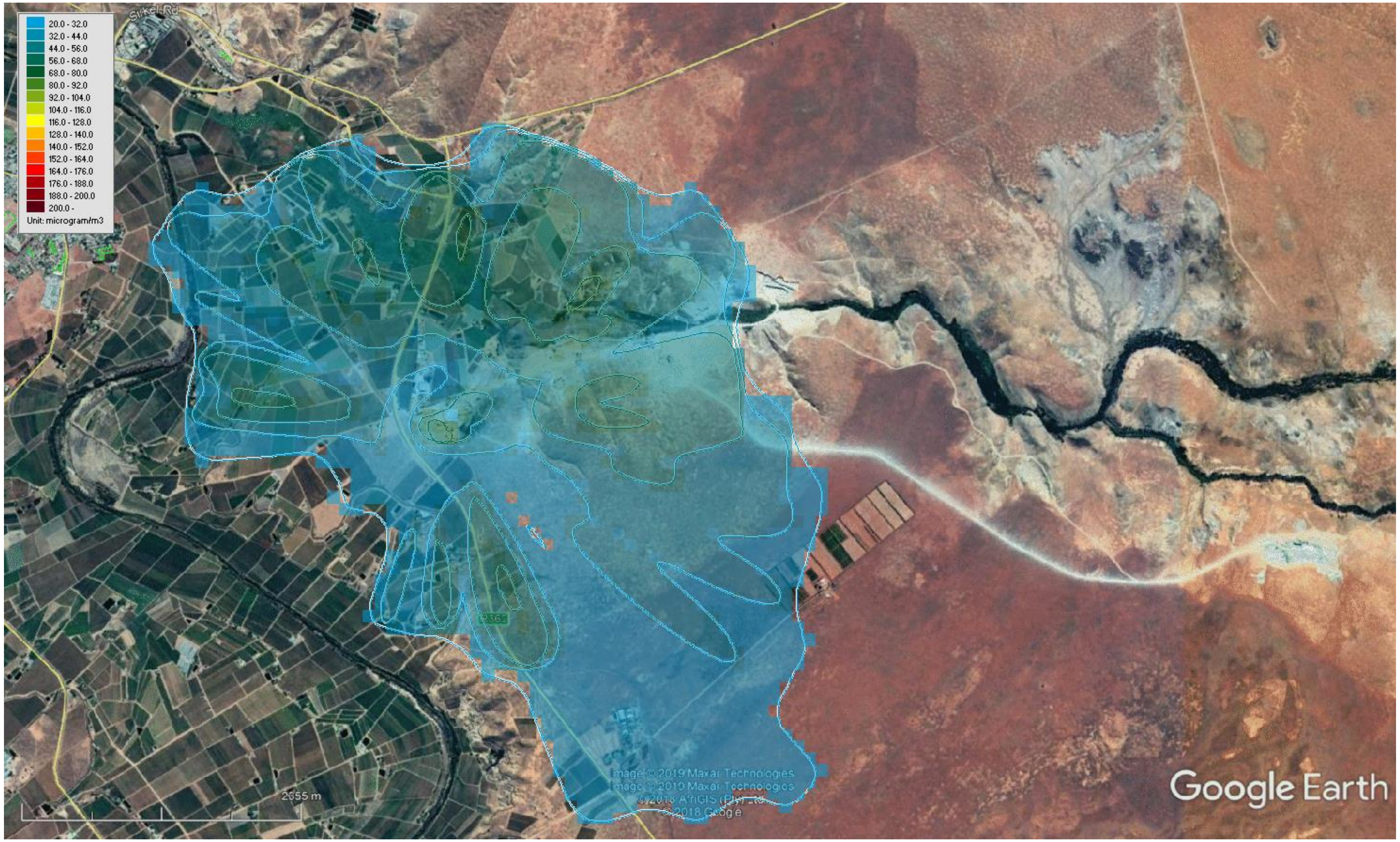

Figure 7: Maximum Emissions: 99-percentile NO_2 Concentrations
Maximum scale (burgundy) is set at the air quality standard 200 µg/m^3; exceedences will be shown in burgundy

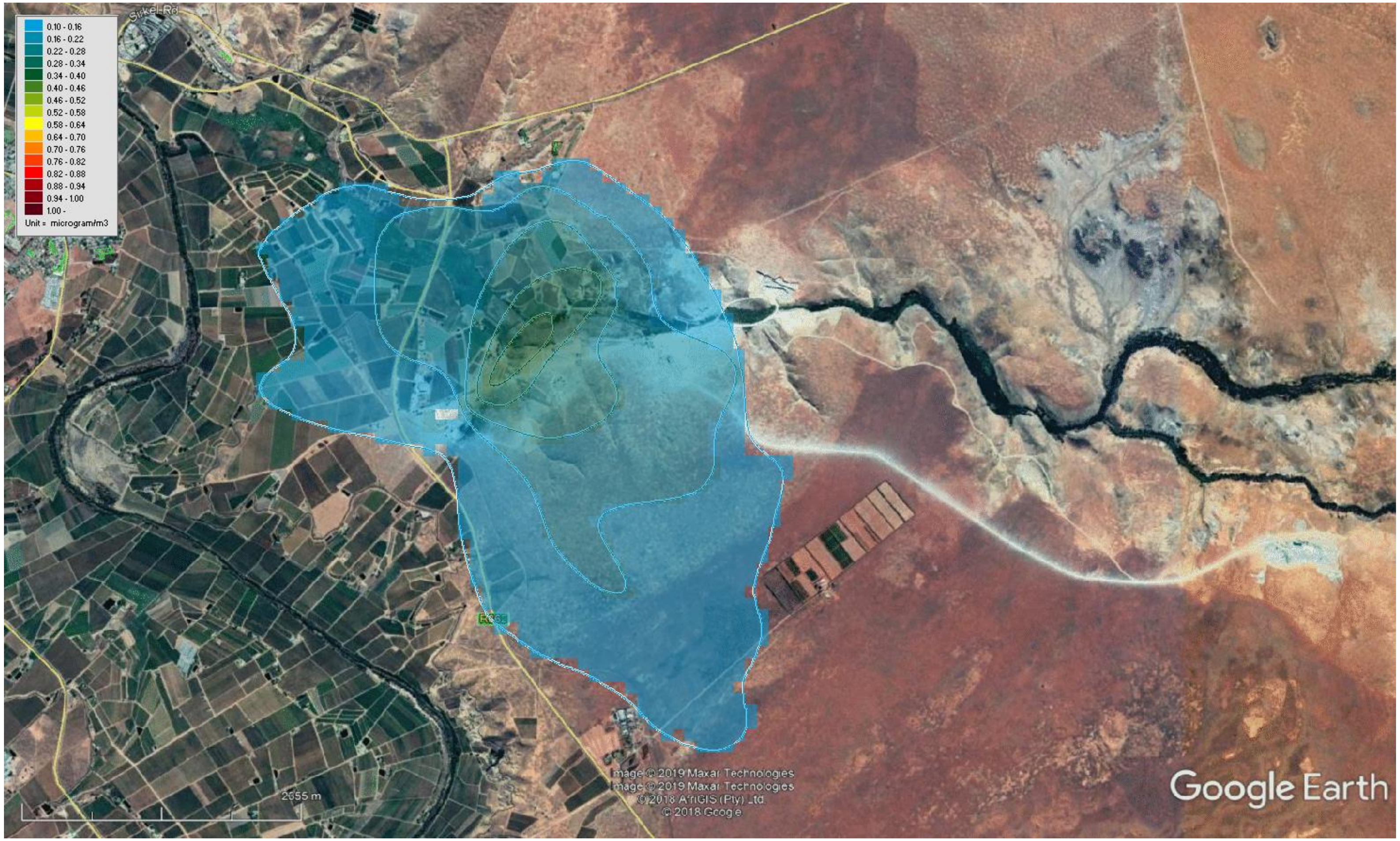

Figure 8: Typical Emissions: Annual Average PM10 Concentrations
Maximum scale (burgundy) is 1.0 μg/m^3; air quality standard is 40 μg/m^3

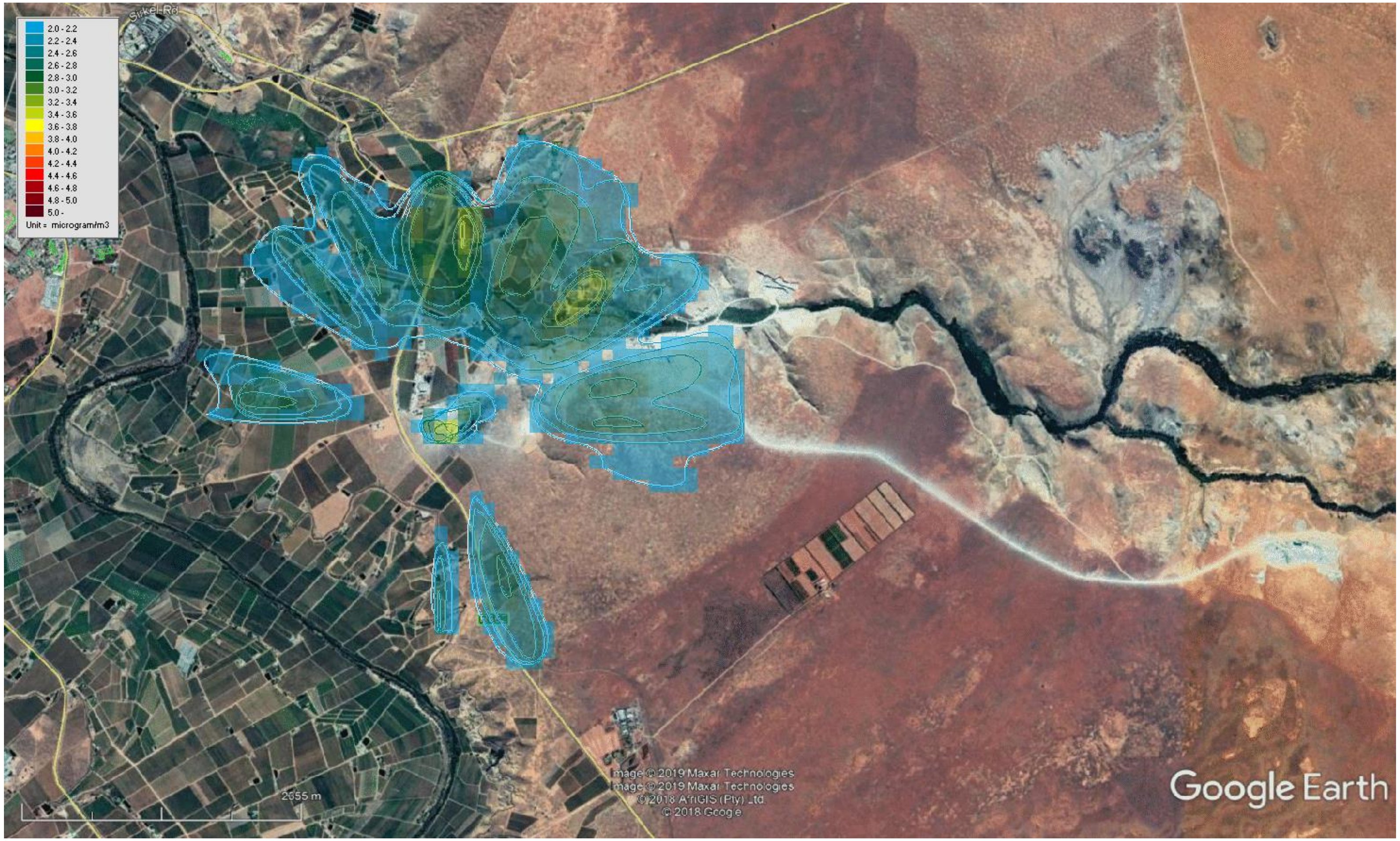

Figure 9: Typical Emissions: 99-percentile PM10 Daily Averaged Concentrations
Maximum scale (burgundy) is 5 µg/m^3; air quality standard is 75 µg/m^3

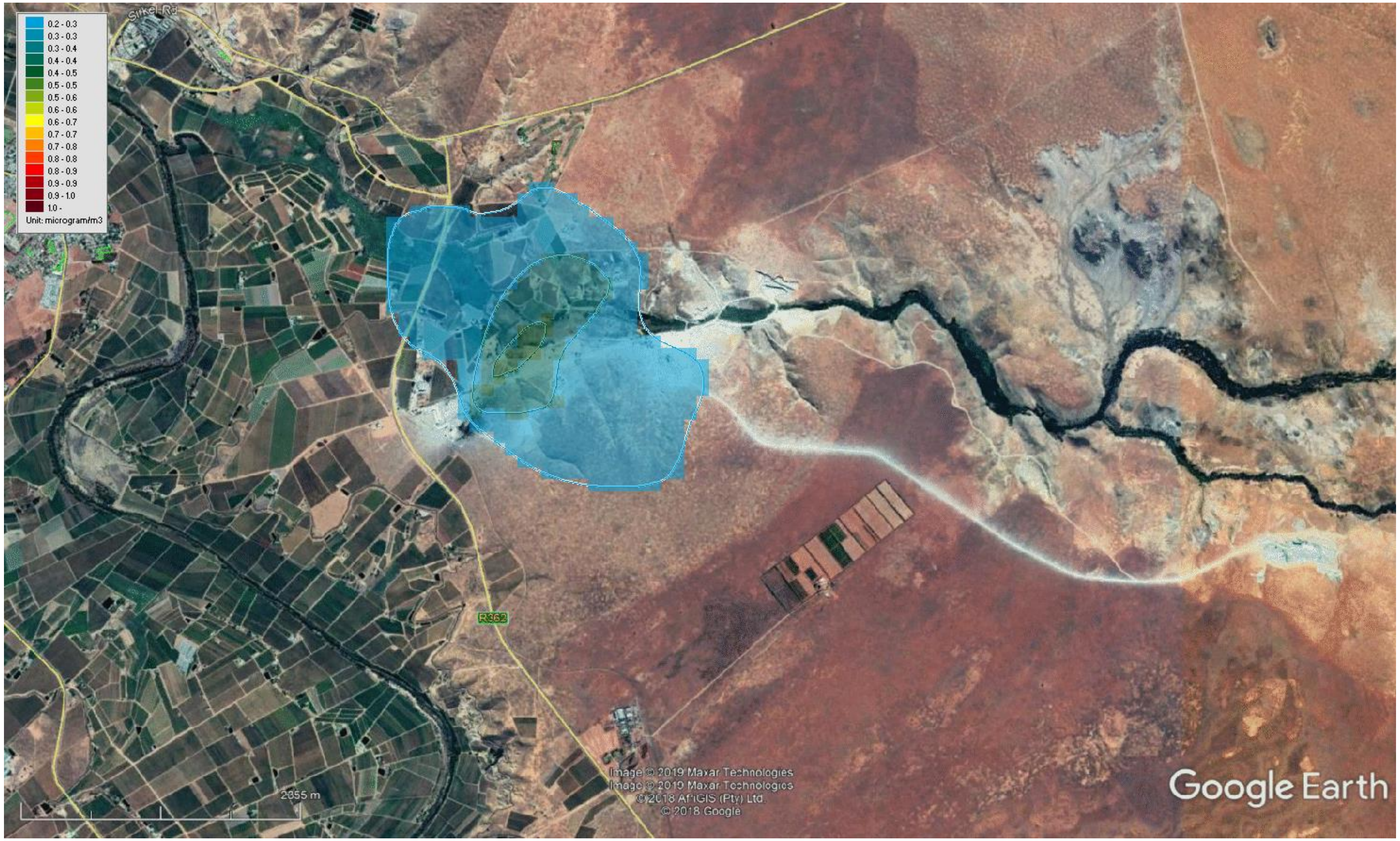

Figure 10: Typical Emissions: Annual average SO_2 Concentrations
Maximum scale (burgundy) is 1.0 μg/m^3; air quality standard is 50 μg/m^3

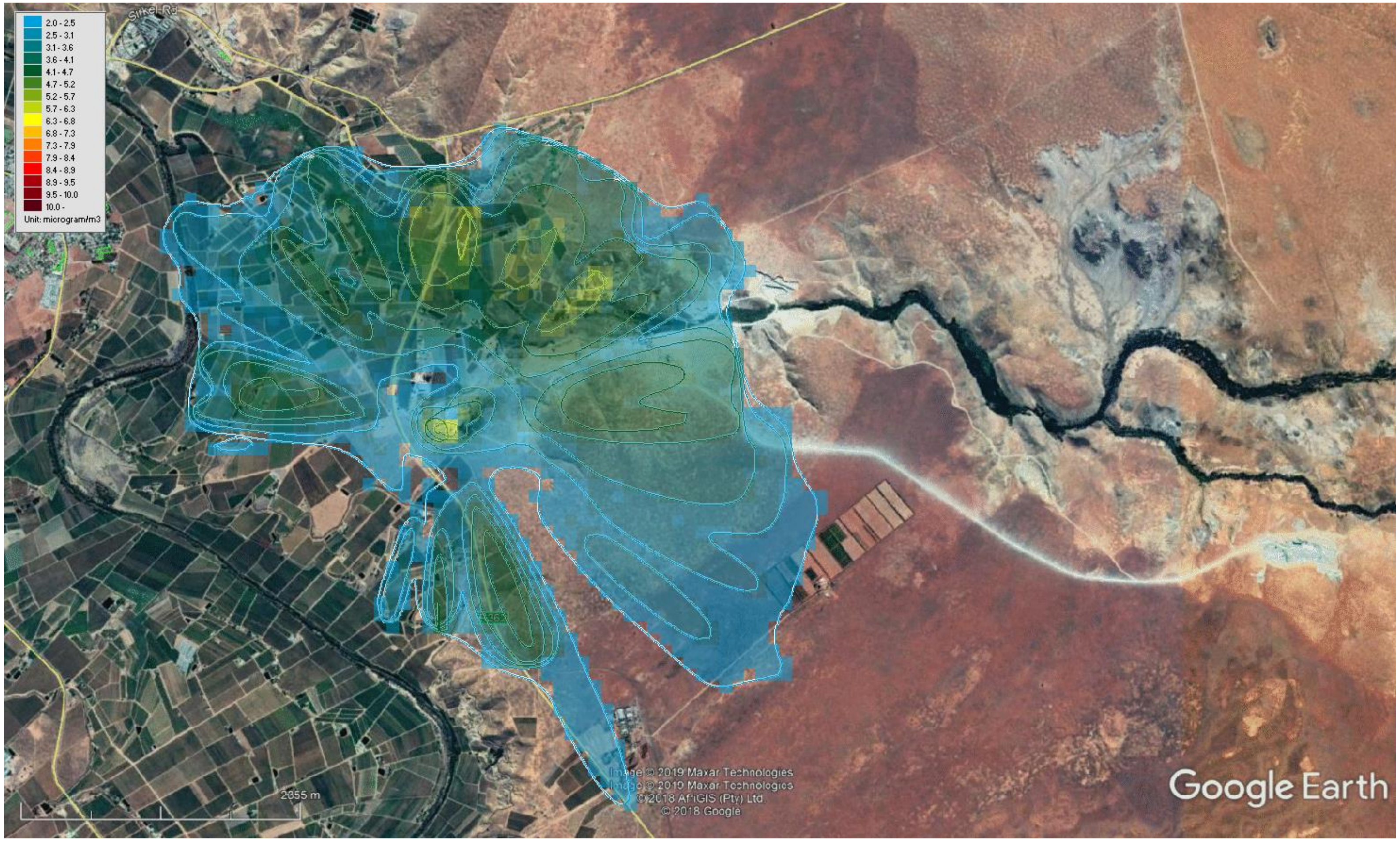

Figure 11: Typical Emissions: 99-percentile SO_2 Concentrations
Maximum scale (burgundy) is 10 µg/m^3; air quality standard is 350 µg/m^3

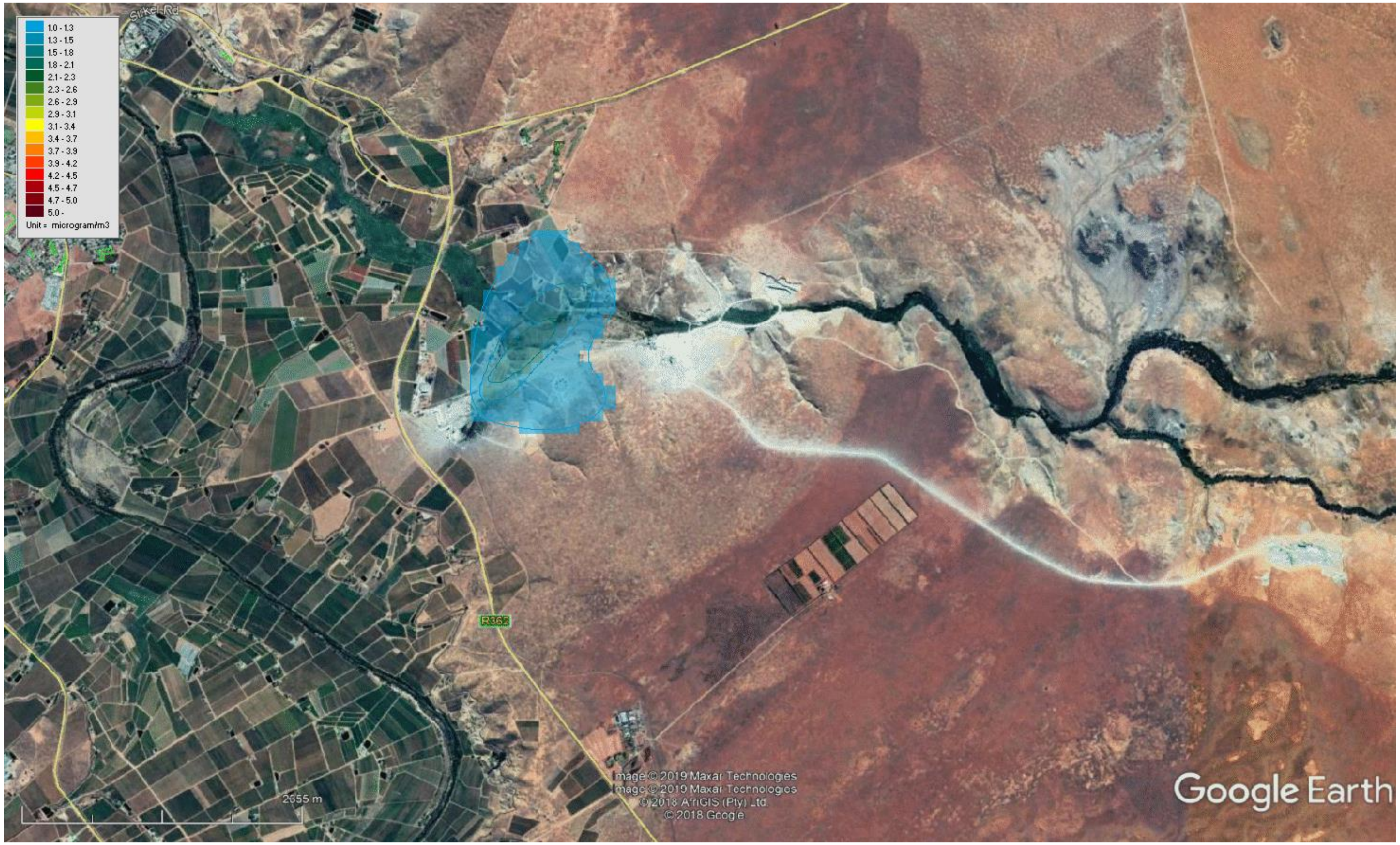

Figure 12: Typical Emissions: Annual Average NO_2 Concentrations
Maximum scale (burgundy) is 5 µg/m^3; air quality standard is 40 µg/m^3

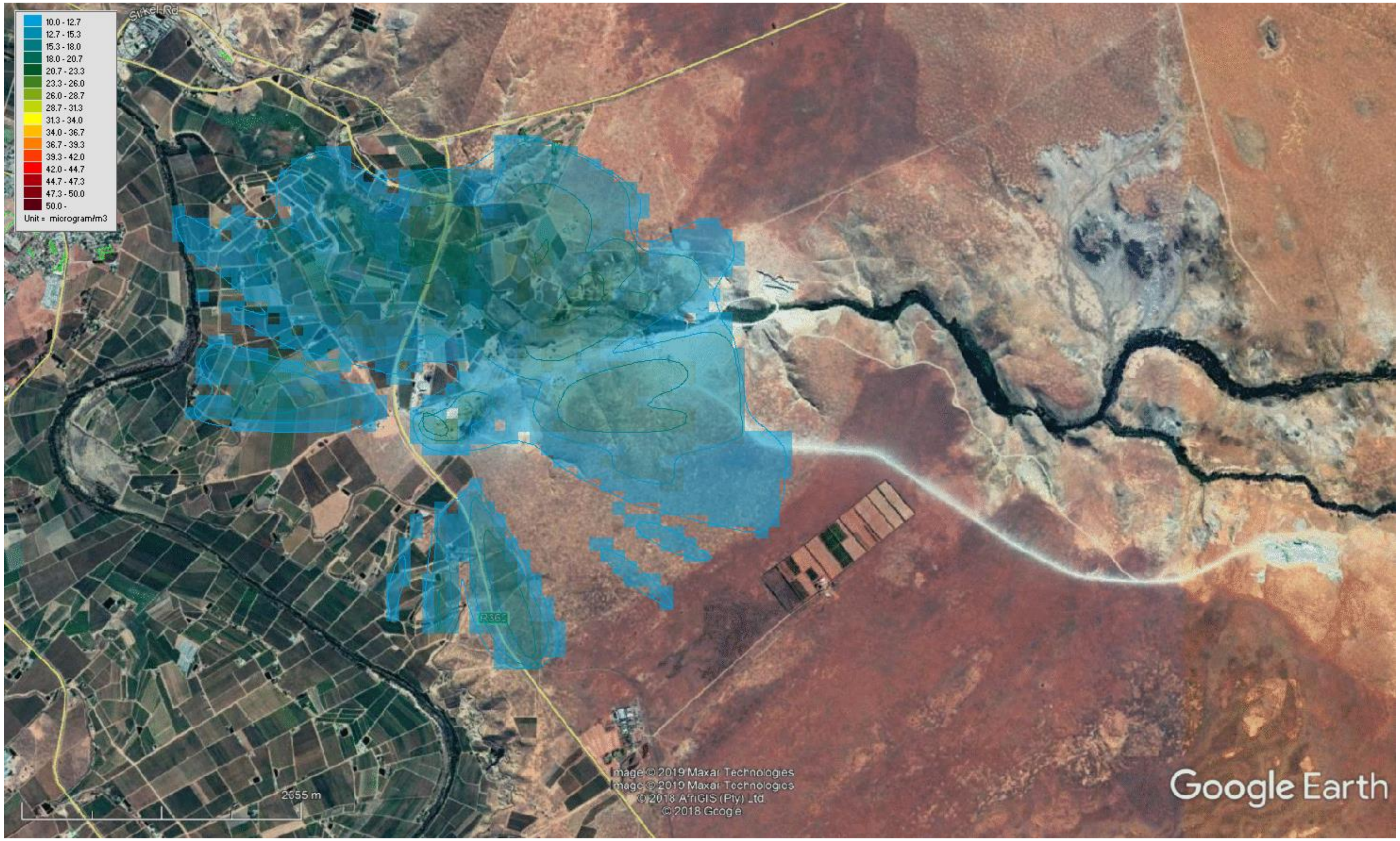

Figure 13: Typical Emissions: 99-percentile NO_2 Concentrations
Maximum scale (burgundy) is 50 μg/m^3; air quality standard is 200 μg/m^3

Estimated ground-level concentrations at maximum allowed emission rates are listed in Table 9 below.

Pollutant	Maximum Concentrations and locations	
	Annual average	99-percentile
PM10	0.6; 600m NE of stack	4.9; 1870m NE of stack
SO_2	4.8; 600m NE of stack	61; 1870m NE of stack
NO_2	5.7; 600m NE of stack	70.8; 1870m NE of stack
	Typical (measured) Concentrations	
PM10	1.1; 600m NE of stack	8.7; 1870m NE of stack
SO_2	1.4; 600m NE of stack	16.1; 1870m NE of stack
NO_2	5.2; 600m NE of stack	61.3; 1870m NE of stack

Table 9: Results Summary, Maximum Emissions, µg/m^3

The Figures and Table show that the estimated maximum ground-level effect of emissions from the calciner operation are all well below the official air quality standards. Emissions from this process do not, therefore, pose any risk to the environment.

6.2 CUMULATIVE TPM AND PM10 IMPACT

The same modelling and assessment approach, as described in Section 6, was used the estimate cumulative ground-level concentrations of TPM and PM10 from all identified sources. The results obtained are shown graphically below and are summarised in tabular format in Table 10 below.

The outcome of the dispersion modelling study is shown graphically in Figures 10 to 13 below.

Figures 10 and 11 respectively show the annual average and 99-percentile daily ground-level concentrations of PM10 particulates.

Figures 12 and 13 respectively show the annual average and 99-percentile daily ground-level concentrations of TPM particulates.

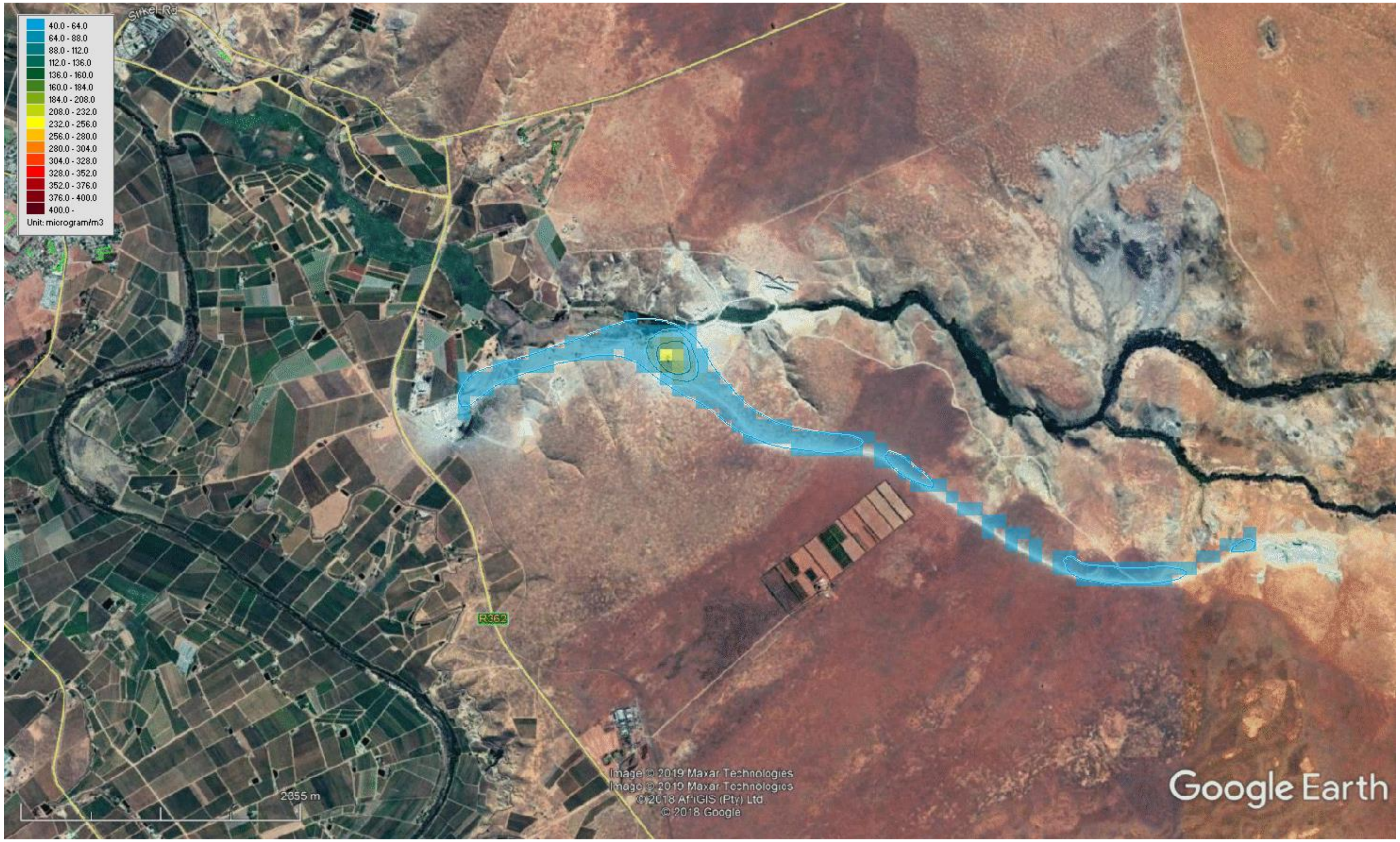

Figure 10: Maximum Emissions: Annual Average PM10 Concentrations
Minimum scale is set at air quality standard (40 µg/m^3). All highlighted areas indicate exceedence of air quality standard

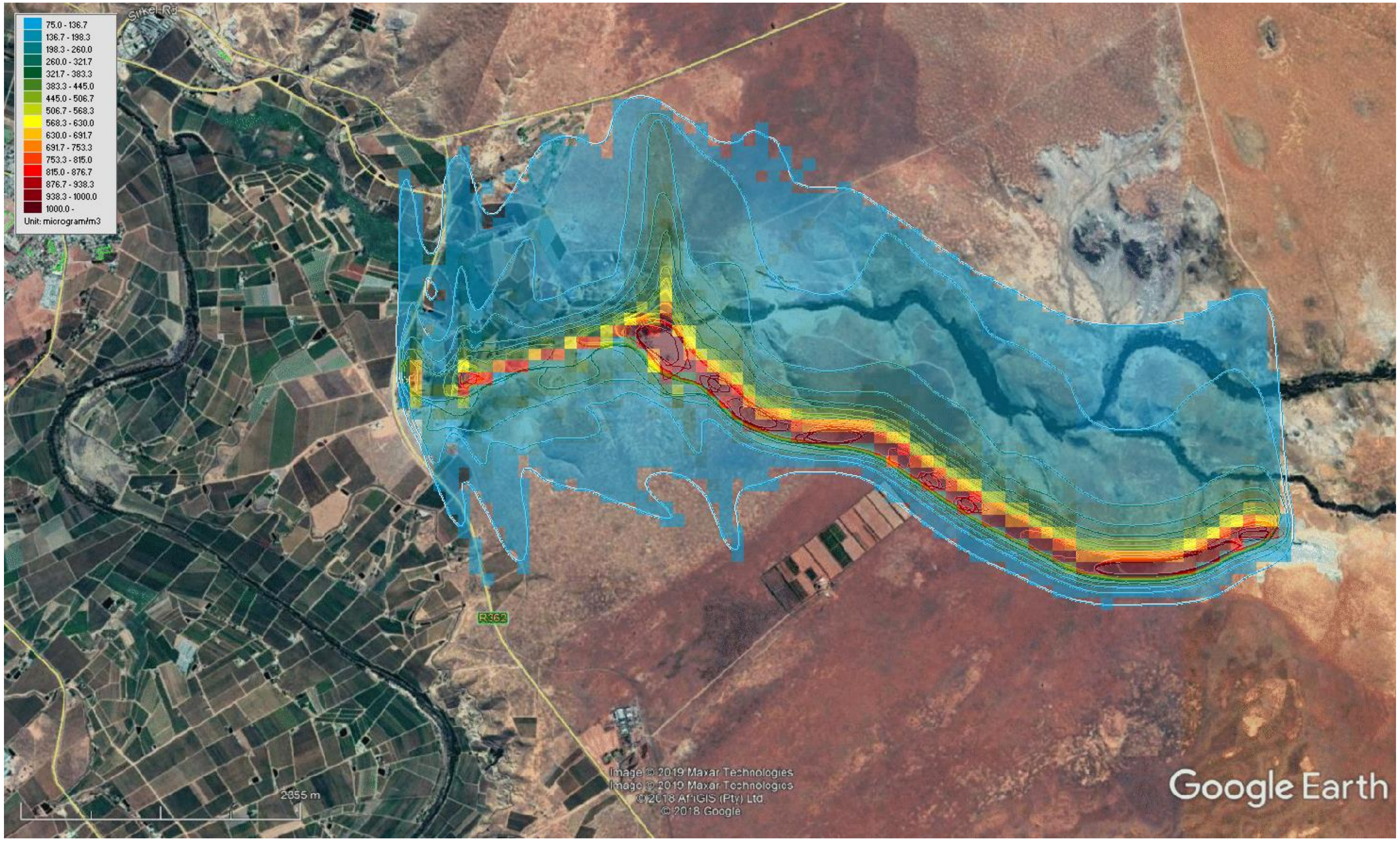

Figure 11: Maximum Emissions: 99-percentile PM10 Daily Averaged Concentrations
Minimum scale is set at air quality standard (75 µg/m^3). All highlighted areas indicate exceedence of air quality standard

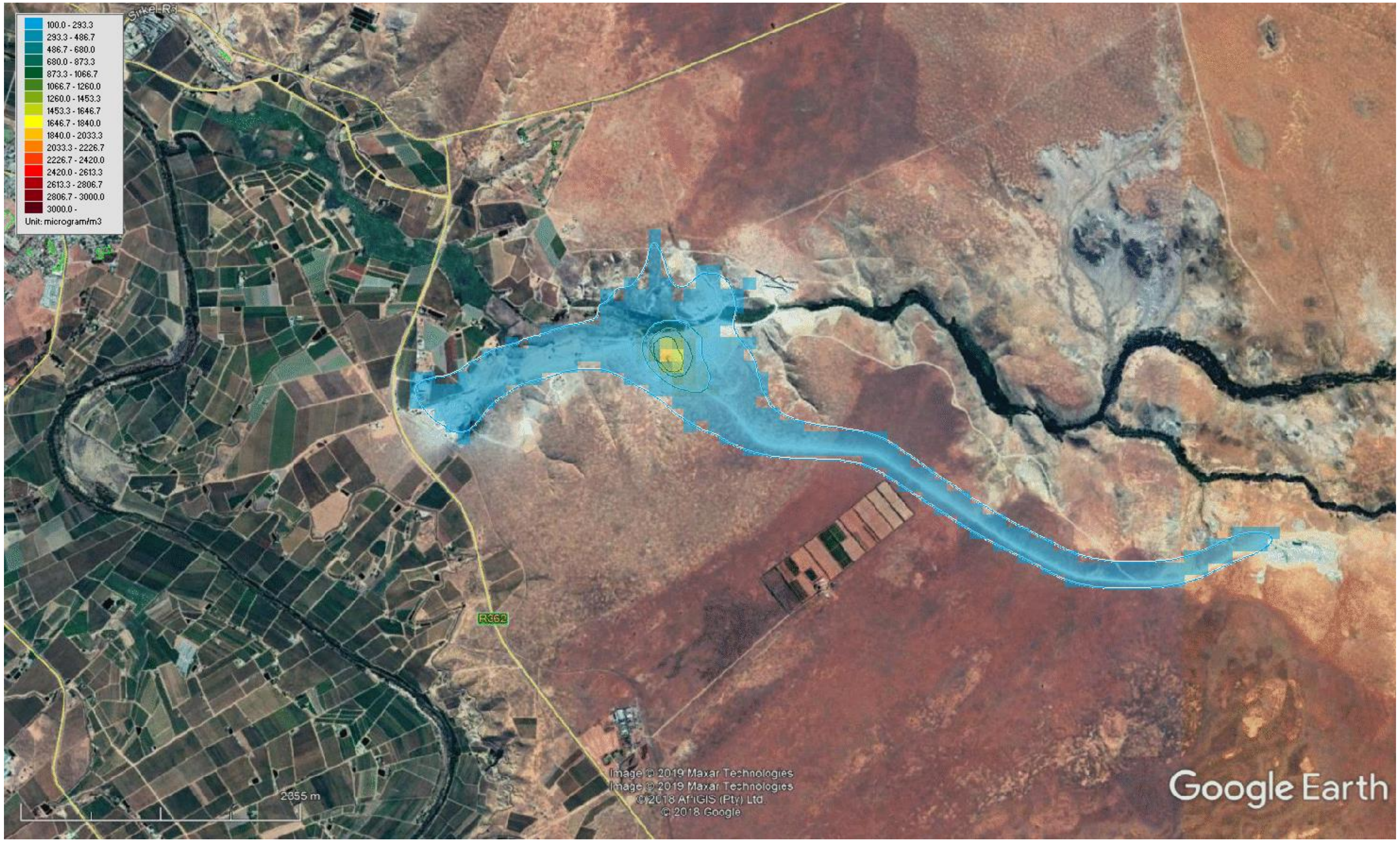

Figure 12: Maximum Emissions: Annual average TPM Concentrations
There are no air quality standards for TPM

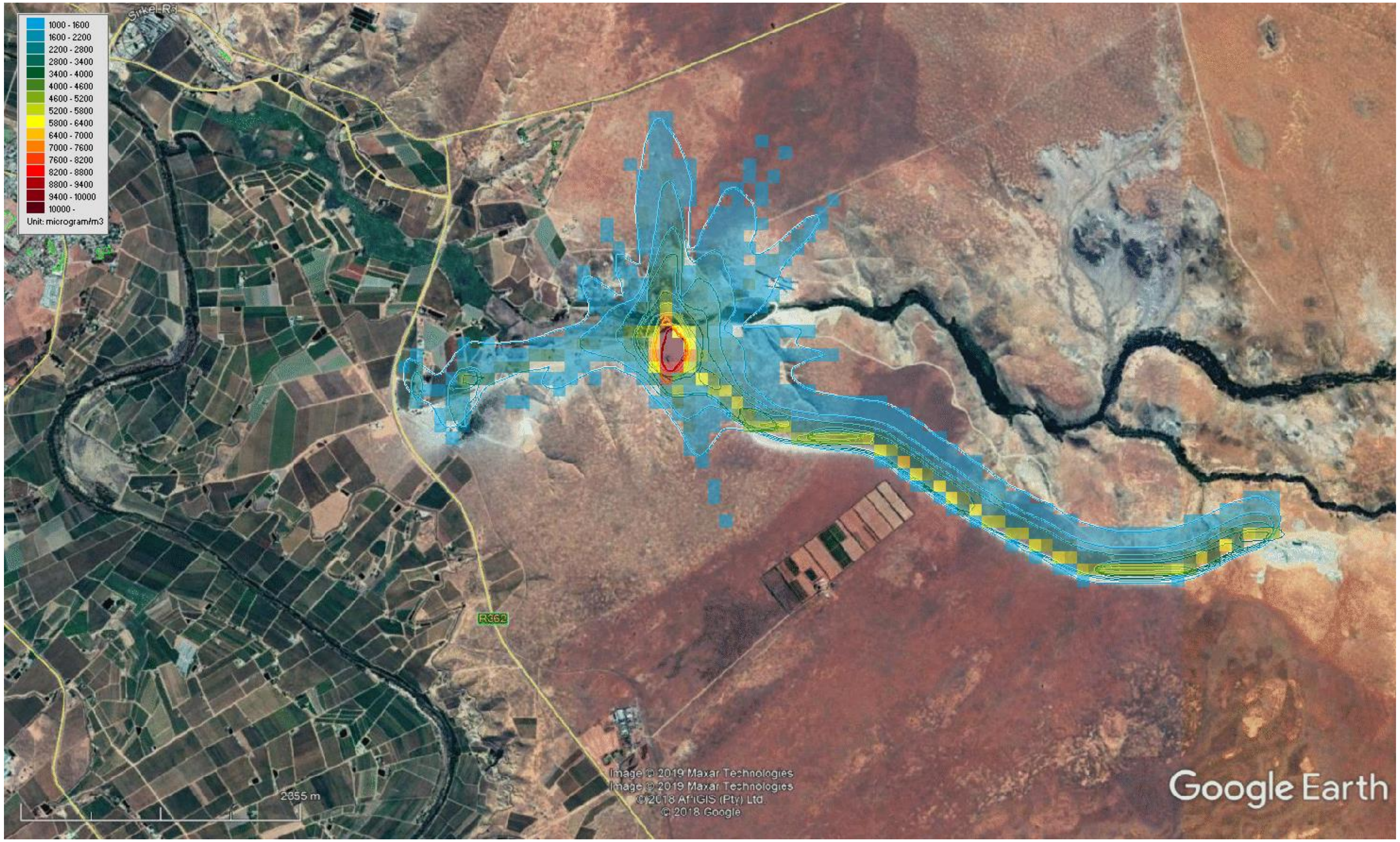

Figure 13: Maximum Emissions: 99-percentile TPM Daily Averaged Concentrations
There are no air quality standards for TPM

Estimated ground-level concentrations at maximum allowed emission rates are listed in Table 10 below.

	Maximum Concentrations	
	Annual average	99-percentile
PM10	146; N of primary crusher	2 350; N of primary crusher
TPM	1 080; N of primary crusher	12 050; N of primary crusher

Table 10: Results Summary, Typical Emissions, µg/m^3
Values in red show that air quality standards are exceeded

From Table 8 and the Figures above, the following can be derived:

-- The primary crusher is the greatest concentrated source of particulate emissions

-- Particulate emissions from road traffic impacts on the greatest area

-- The annual average and daily 99-percentile air quality standards for PM10 particulates is expected to be exceeded over a large area, including neighbouring vineyards.

Due to complaints by a neighbouring farmer, LAQS focused on the impact of TPM and PM10 emissions in the immediate vicinity of the processing plant, i.e. excluding emissions from the mining and primary crushing operations. The sources included in the evaluation are:

-- Calciner
-- Secondary crusher
-- Coal stockpile
-- Road traffic

The results are given in Figures 13 to 22 and summarised in Table 11 below.

Figures 13 and 14 respectively show the cumulative annual average and 99-percentile daily ground-level concentrations of PM10 particulates from all of the selected sources.

Figures 15 and 16 respectively show the cumulative annual average and 99-percentile daily ground-level concentrations of TPM from all of the selected sources.

Figure 17 and 18 respectively show the cumulative annual average ground-level concentrations of PM10 and TPM particulates from all sources directly relating to Cape Lime's operations, i.e. calciner, secondary crusher, coal stockpile and road traffic transporting raw material to site.

Figure 19 and 20 respectively show the cumulative annual average ground-level concentrations of PM10 and TPM particulates from all sources not directly relating to Cape Lime's operations, i.e. road traffic removing materials sold to external clients.

Figure 21 and 22 respectively show the cumulative annual average ground-level concentrations of PM10 and TPM particulates from all road traffic sources.

Figure 13: All Sources: Cumulative Annual Averaged PM10 concentrations
Minimum scale is set at air quality standard (40 µg/m^3). All highlighted areas indicate exceedence of air quality standard

Figure 14: All Sources: Cumulative 99-percentile PM10 concentrations
Minimum scale is set at air quality standard (75 µg/m^3). All highlighted areas indicate exceedence of air quality standard

Figure 15: All Sources: Cumulative Annual Averaged TPM concentrations
There are no air quality standards for TPM

Figure 16: All Sources: Cumulative 99-percentile TPM concentrations
There are no air quality standards for TPM

Figure 17: All Cape Lime Sources: Cumulative Annual Averaged PM10 concentrations
Minimum scale is set at air quality standard (40 µg/m^3). All highlighted areas indicate exceedence of air quality standard

Figure 18: All Cape Lime Sources: Cumulative Annual Averaged TPM concentrations
There are no air quality standards for TPM

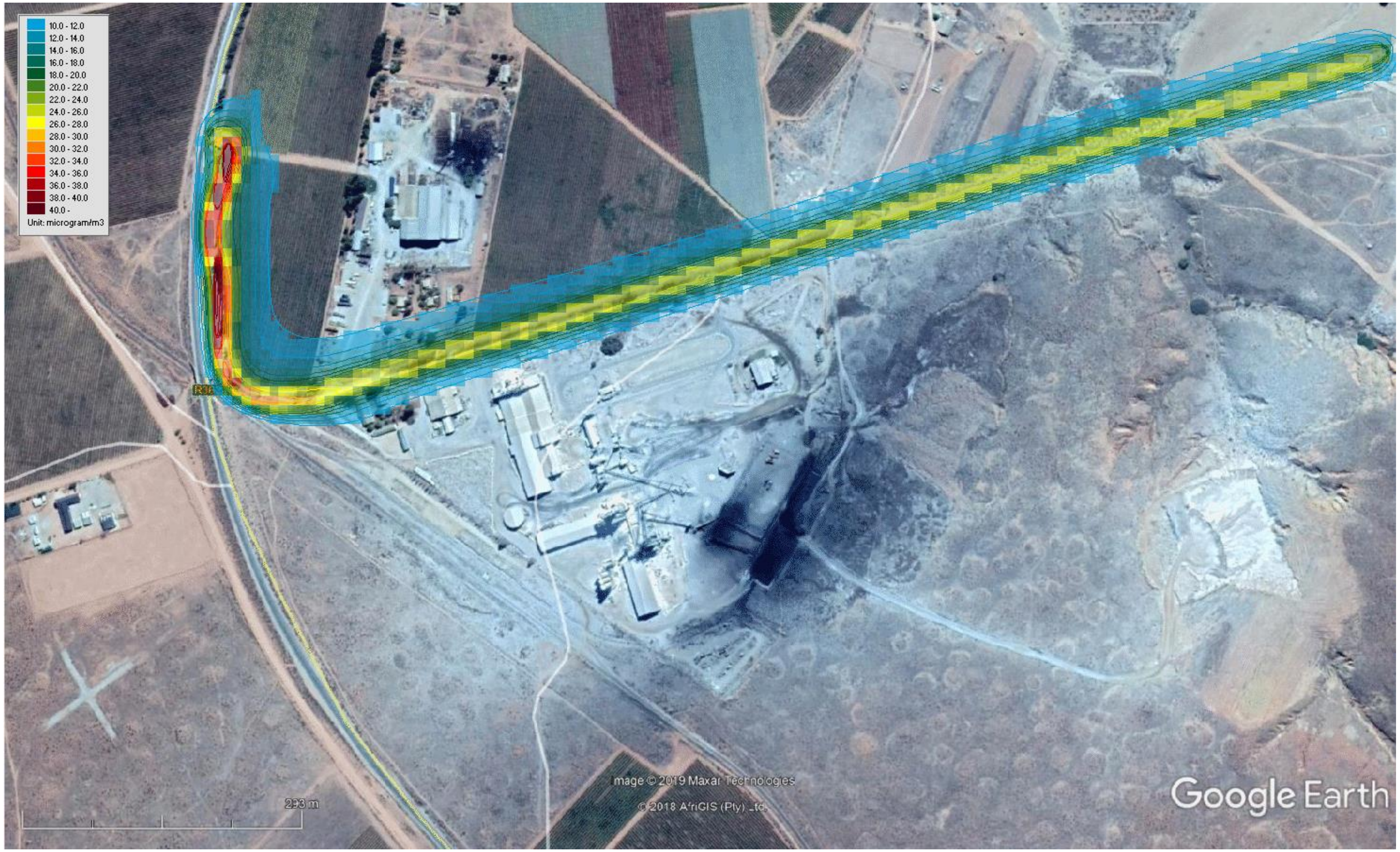

Figure 19: All External Sources: Cumulative Annual Averaged PM10 concentrations
Maximum scale is set at air quality standard (40 µg/m^3). All burgundy areas indicate exceedence of air quality standard

Figure 20: All External Sources: Cumulative Annual Averaged TPM concentrations
There are no air quality standards for TPM

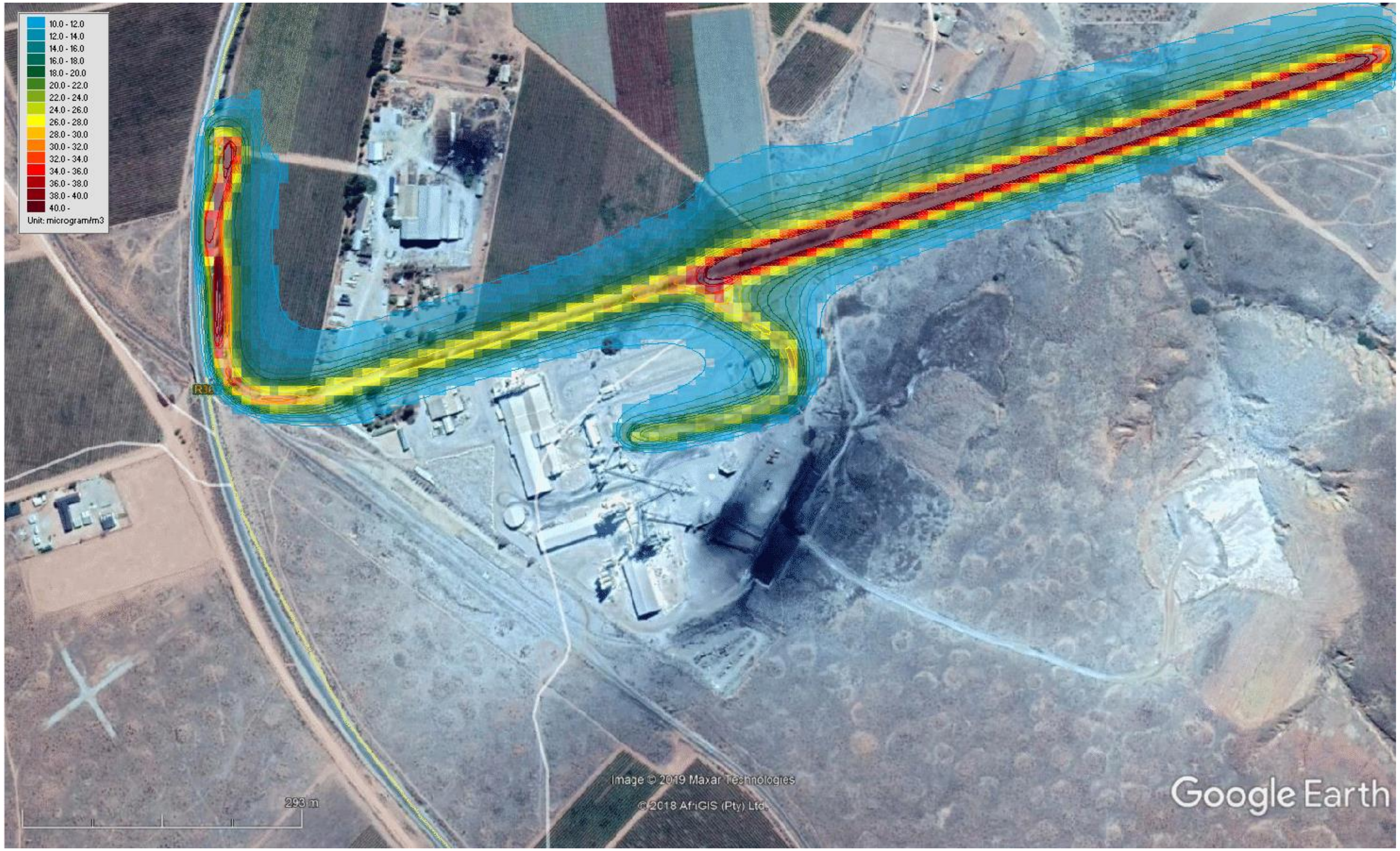

Figure 21: All Road Traffic: Cumulative Annual Averaged PM10 concentrations
Maximum scale is set at air quality standard (40 μg/m^3). All burgundy areas indicate exceedence of air quality standard

Figure 22: All Road Traffic: Cumulative Annual Averaged TPM concentrations
There are no air quality standards for TPM

LAQS selected a receptor point situated on the neighbouring farm's fence line where the turnoff of vehicles to Cape Lime's site is located. This point is located in the area of the highest particulate concentrations.

Three different types of sources are included in this evaluation, i.e. point, area and line sources. 99-percentile ground-level concentration from each type of source is highly dependent on weather conditions. Different weather conditions cause maximum concentrations from the various types of sources under varying weather conditions, i.e. stockpile emissions are highest at high wind speeds, maximum impact from point sources are highest at very low wind speeds, etc. It is, therefore, not meaningful to assess the contribution that each source has on 99-percentile concentration. A graphic presentation of areas where the 99-percentile PM10 concentrations are expected to exceed the air quality standards is shown in Figure 14.

As a result, estimated ground-level annual averaged concentrations at the receptor point are listed in Table 11 below.

Source	Maximum Annual Averaged Concentrations	
	PM10	TPM
All sources	51.1	189
Cape Lime operations	27.6	106
All external sources	23.5	82.7
All road sources	49.5	174

Table 11: Results Summary, Typical Emissions, µg/m^3
Values in red show that air quality standards are exceeded

The Table shows that emissions from road traffic are by far the major contributor of particulate deposition on the neighbouring property, so much so that the ambient air quality standard for PM10 particulates is exceeded in some areas.

7 DISCUSSION

7.1 MODEL RELIABILITY

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

7.1.1 Emissioner:

The annual emissions used in this air quality impact assessment are subject to a degree of uncertainty as a result of the following:

Calciner emissions:

The annual emissions of all pollutants included in this study were calculated from official emission limits, as stipulated in GN R.533, using measured flue gas conditions. These conditions are variable due to variations in process operating conditions, production rates, etc. and may, therefore, vary from time to time.

Measured pollutant concentrations were used to calculate typical annual emissions, but the measured concentrations are also subject to variation from time to time.

Mining and material handling emissions:

Annual emissions were calculated from emission factors obtained from the NPIEET for mining and annual production capacities calculated from monthly production data provided by Cape Lime.

Emission factors are subject to a degree of uncertainty and are generalised to accommodate a variety of materials.

The monthly production figures are regarded as average values and will vary from month to month, depending on on-site operating conditions. As there is no set pattern to such variations, it is not possible to compensate for the monthly variations so that variations in seasonal weather patterns can play its due role.

Stockpiles:

Several factors play a role in the emission of particulate matter due to winds, including wind speed, particle size distribution, particle density, age of a stockpile, etc. In the absence of the necessary data, especially wind gusts, an empirical emission factor from the NPIEET for mining was used.

Road traffic:

An empirical equation to estimate the emissions of particulate matter from heavy vehicles on industrial roads, publishes in the USEPA's AP-42, was used to estimate annual emissions from road traffic.

The reliability of this equation is rated by AP-42 as "B", which is defined as "*Tests are performed by a generally sound methodology, but lacking enough detail for adequate validation*". A degree of uncertainty is, therefore, associated with the equation.

It is, unfortunately, not possible to quantify the overall degree of uncertainty associated with the estimated annual emissions. As there is a linear relationship between emission quantities and ground-level concentrations, i.e. a change in emissions will result in a change of equal proportion in ground-level concentrations, the uncertainty in emissions imply an uncertainty in the estimated ground-level concentrations.

Throughout estimation of emissions LAQS attempted to reduce the uncertainties as much as possible by attempting to simulate operations as closely as allowed by available data.

7.1.2 EnviMet:

The meteorological data assembled by LAQS is comprehensive and gaps in the data are less than 3.6% of the total amount of data. The dataset was collected at the Vredendal aerodrome, approximately 20 km from Cape Lime's site, consists of validated data and contains all of the necessary parameters required for dispersion modelling purposes. LAQS is, therefore, of the opinion that the weather data set is reliable. The distribution of winds in the Vredendal area is shown graphically in Figure 23 below. It shows that the most frequent wind directions, and the highest wind speeds, are from a north-easterly direction.

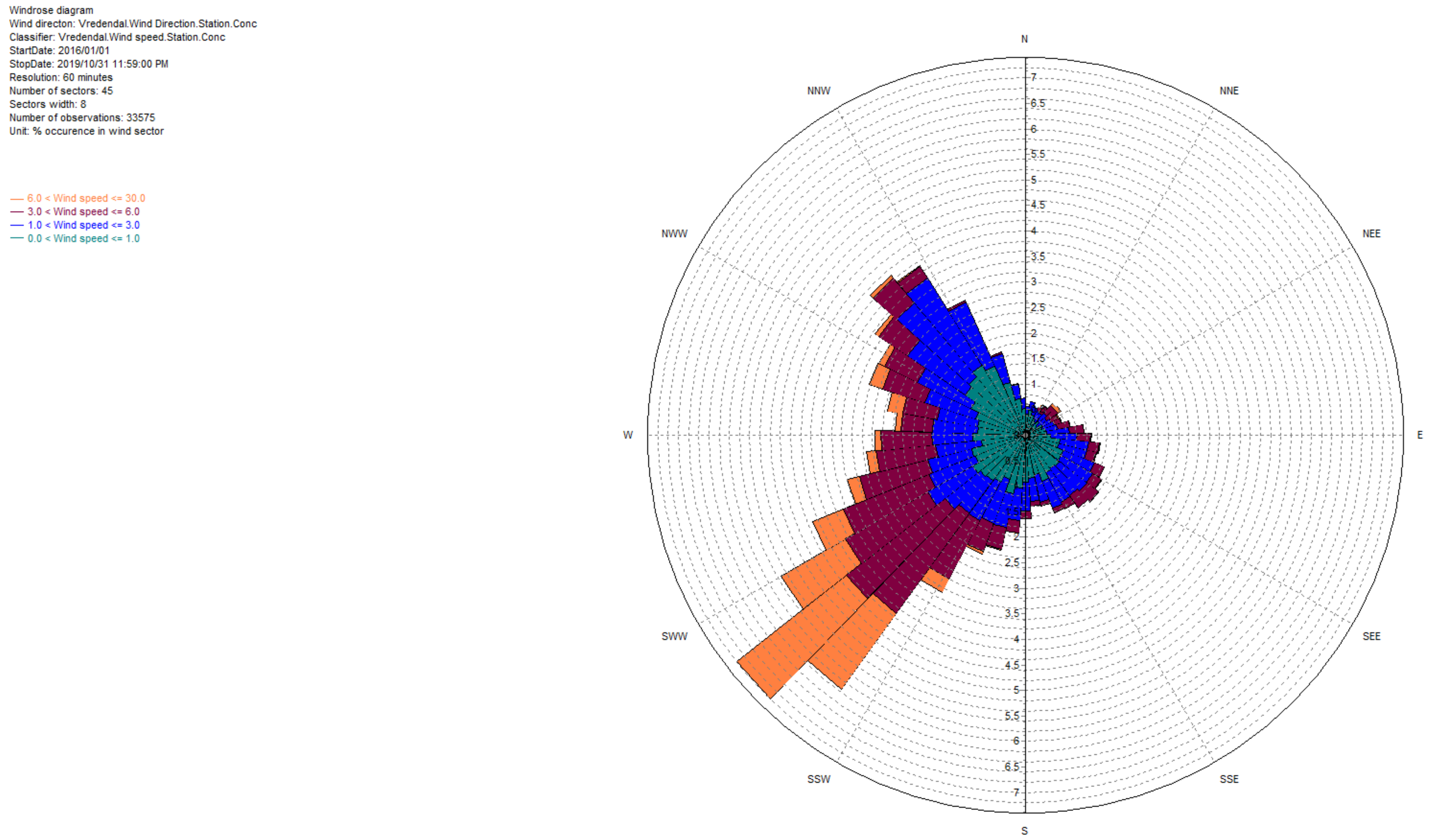

Figure 23: Frequency of Wind Direction

7.1.3 Planner:

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

7.1.4 Impact of surrounding structures:

The heights of adjacent structures were entered in the model to accommodate potential impact that these structures may have on dispersion of pollutants.

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). The standards are defined as "*a level fixed on the basis of scientific knowledge, with the aim of reducing harmful effects on human health (or the environment(or both)) to be attained within a given compliance period and not to be exceeded once attained*".

Of the pollutants discussed in this study, ambient air quality standards for Hg are not available, there are standards for; PM10, CO, NO_2 (a sub-set of NOx) are included and the limits are:

PM10

Annual average:	40 µg/m^3, no exceedences
Maximum daily concentration:	75 µg/m^3, 4 exceedences

SO_2

Annual running average	50 µg/m^3, no exceedences
1-hour maximum	350 mg/m^3, 88 exceedences

NOx (as NO_2)

Annual average limit	40 µg/m^3, no exceedences
1-hour maximum	200 µg/m^3, 88 exceedences

TPM: No official ambient air quality standards exist in South Africa.

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

8.1 PM10 PARTICULATE MATTER

All sources:

The highest annual average ground-level concentration of PM10 is estimated to be 1 080 µg/m^3, i.e. significantly higher than the current ambient air quality level. This estimated maximum annual average concentration will occur immediately north of the primary crusher.

The maximum 99-percentile daily ground-level concentration was shown to be 2 350 µg/m^3, also significantly higher than the current ambient air quality level. This estimated maximum annual average concentration will also occur immediately north of the primary crusher.

Calciner only:

Should emissions from the calciner be at the maximum allowed, the highest annual average ground-level concentration of PM10 is estimated to be 0.6 µg/m^3, i.e. well below the current ambient air quality level. This estimated maximum annual average concentration will occur approximately 600 m north-east of the calciner stack. The maximum annual average concentration, based on typical emissions, is estimated to be 0.4 µg/m^3.

The maximum 99-percentile daily concentration was shown to be 4.9 µg/m^3, i.e. also well below the current ambient air quality level. This estimated maximum annual average concentration will occur approximately 1 860 m north-east of the calciner stack. The maximum annual average concentration, based on typical emissions, is estimated to be 3.5 µg/m^3.

8.2 SULPHUR DIOXIDE

Should emissions from the calciner be at the maximum allowed, the highest annual average concentration of SO_2 is estimated to be 4.5 µg/m^3, i.e. well below the current ambient air quality level. This estimated maximum annual average concentration will occur approximately 600 m north-east of the calciner stack. The maximum annual average concentration, based on typical emissions, is estimated to be 0.6 µg/m^3.

The maximum 99-percentile daily concentration was shown to be 61.0 µg/m^3, i.e. also well below the current ambient air quality level. This estimated maximum annual average concentration will occur approximately 1 860 m north-east of the calciner stack. The maximum annual average concentration, based on typical emissions, is estimated to be 4.8 µg/m^3.

8.3 NITROGEN DIOXIDE

Should emissions from the calciner be at the maximum allowed, the highest annual average concentration of NO_2 is estimated to be 6.3 µg/m^3, i.e. well below the current ambient air quality level. This estimated maximum annual average concentration will occur approximately 600 m north-east of the calciner stack. The maximum annual average concentration, based on typical emissions, is estimated to be 1.7 µg/m^3.

The maximum 99-percentile daily concentration was shown to be 70.8 µg/m^3, i.e. also well below the current ambient air quality level. This estimated maximum annual average concentration will occur approximately 1 860 m north-east of the calciner stack. The maximum annual average concentration, based on typical emissions, is estimated to be 13.0 µg/m^3.

8.4 PROPOSED EXPANSION

Cape Lime is considering expanding its operations by installing an additional two calciners, effectively increasing the production capacity three-fold. Such an increase will imply a three-fold increase in all activities, excluding the quantity of material removed from site by external clients (aggregate and dolomite). In effect, virtually all emissions will increase three-fold, i.e. three times more mining activity, primary crushing activity, materials handling activities, stockpile activities, road transportation, secondary crushing activities, etc.

Bearing in mind the linear relationship between emissions and ground-level concentrations, a three-fold increase in emissions will imply a three-fold increase in all of the ground-level concentrations mention in this report, with concomitant impact on air quality in the area around Cape Lime's operations.

As far as the calciners are concerned, i.e. the only activities regulated under Section 21 of the Air Quality Act, the estimated ground-level concentrations of the three pollutants are expected to be below that ambient air quality standards published in GN1210, should two additional calciners be commissioned.

9 CONCLUSIONS

The results of the dispersion modelling study show that the estimated maximum ground-level concentrations of all controlled pollutants emitted from the calciner only are well below the relevant ambient air quality standards. Should Cape Lime expand its operations by installing two additional calciners, the combined impact of the three calciners is expected to result in ground-level concentrations that will still be below the official air quality standards.

However, as is shown in this report, the major sources of particulate emissions are the primary crusher and road traffic, and emission from these sources will have a major impact on air quality in the area.

Consideration should be given to more effective mitigation measures to reduce particulate emissions form the major sources to minimise the deposition of particulate matter on neighbouring areas. Such additional measures will have to be an essential component of all future expansion plans.

Some potential mitigation measures and typical efficiencies, as extracted from in NPIEET for mining, are:

Loading trucks	No control
Hauling	50% for level 1 watering (2 litres/m2/h) 75% for level 2 watering (> 2 litres/m2/h) 100% for sealed or salt-encrusted roads
Unloading trucks	70% for water sprays
Loading stockpiles	50% for water sprays 25% for variable height stacker 75% for telescopic chute with water sprays 99% for total enclosure
Unloading from stockpiles	50% for water sprays (unless underground recovery then, no controls needed)
Wind erosion from stockpiles	50% for water sprays 30% for wind breaks 99% for total enclosure 30% for primary earthworks (reshaping/profiling, drainage structures installed) 30% for rock armour and/or topsoil applied
Miscellaneous transfer and conveying	90% control allowed for water sprays with chemicals 70% for enclosure 99% for enclosure and use of fabric filters
Wind erosion	30% for primary rehabilitation 40% for vegetation established but not demonstrated to be self-sustaining. Weed control and grazing control.

Table 12: NPIEET Mitigation Measures

According to the USEPA, the following particulate emission reductions can be achieved:

-- Roads: Paving of surface: 85%

-- Aggregate stockpiles: Continuous spraying of chemical suppressant on material going to stockpile: 90%

Surfacing of roads is an expensive activity, but would result in a significant decrease in particulate emissions.

Various types of chemical dust suppressants are available, but added chemicals could have an impact on Cape Lime's production process and quality of product. As chemical dust suppressants are not 100% effective, chemically enhanced particulate matter being deposited on vineyards may have a detrimental effect on plant material.

10 RECOMMENDATIONS

LAQS is of the opinion that no continuous emission monitoring equipment will be required to monitor the various calciner 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. All results obtained over time should then be used to calculate more representative average pollutant emission values for the stack.

Care should be exercised that these annual emissions verification tests are conducted strictly according to the emission methods listed in Annexure A, "*Methods for Sampling and Analysis*", to GN893 as results thus obtained will be representative, reliable and defendable, albeit applicable to a very short period's measurements only.

Table 11 summarises the estimated concentrations of PM10 particulate matter at the turn-off into Cape Lime's property. The preceding graphic results show the extent to which particulate matter is expected to extend over the adjoining farm area. It is recommended that a dedicated monitoring program is designed and implemented so that these concentrations can be quantified to verify the model's predictions and qualified to determine the composition of the particulate matter.

Table 12 list particulate emission mitigation measures from various industrial activities and serious consideration should be given to the application of such measures to reduce current particulate emissions from the major sources highlighted in this report.