REVIEW OF THE
AIR QUALITY MANAGEMENT PLAN

DISPERSION MODELLING STUDY

Progress Report No. GRDM-2019 PR.4, draft Report

May 2019

COMPILED BY

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ABBREVIATIONS AND DEFINITIONS

AQA	Air Quality Act, Act 39 of 2004
AQM	Air Quality Monitoring
AQMP	Air Quality Management Plan
AQO	Air Quality Officer
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DEADP	Department of Environmental Affairs and Development Planning
DEA	Department of Environmental Affairs
EIA	Environmental Impact Assessment
GN R.533	Government Notice R.533 of 11 July 2014
GN1210	Government Notice 1210 of 24 March 2009
GRDM	Garden Route District Municipality
H_2S	Hydrogen Sulphide
IDP	Integrated Development Plan
IWMP	Integrated Waste Management Plan
mg/ton	Milligrams per ton
MSA	Municipal Systems Act
MSW	Municipal Solid Waste
NO	Nitrogen Monoxide
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
NPI	National Pollution Inventory
PM10	Particulate Matter with aerodynamic diameter smaller than 10 micron
SAAQIS	South African Air Quality Information System
SANRAL	South African National Roads Agency Limited
SAWS	South African Weather Service
SO_2	Sulphur Dioxide
SO_3	Sulphur Trioxide
THC	Total Hydrocarbon Content
tpa	Tons per Annum
TPM	Total Particulate Matter
USEPA	United States of America Environmental Protection Agency
WWTW	Wastewater treatment works

1 INTRODUCTION

An air quality management plan (AQMP) was compiled for the Garden Route District Municipality (GRDM) in 2007 and included in GRDM's Integrated Development Plan (IDP) shortly thereafter.

As is required by law, the AQMP must be revised on a 5 to 6-yearly basis to ensure that it remains current. As a result it was revised in 2012/13 and the revised plan was also included in GRDM's IDP.

The process of revision of the 2012/13 version of the AQMP commenced early in 2019 after Lethabo Air Quality Specialists (Pty) Ltd (LAQS) was awarded the contract to do so. The following items were included in the Service Level Agreement (SLA) entered into between GRDM and LAQS:

1 Assessment of compliance with existing AQMP
2 Status quo assessment
3 Compile an emissions inventory
4 Assess the level of air quality monitoring and modelling in the district
5 Assess the relevant municipal resources in the district
6 Review the air quality duties, functions and responsibilities within Garden Route District Municipality
7 Conduct a public participation process
8 Review and compile and AQMP for the Garden Route District Municipality

LAQS's findings of the first item are contained in its report No. GRDM-2091 Progress Report No. 1 of April 2019.

As the two items are interlinked, LAQS assessed the air quality status quo and municipal activity as a single investigation and its findings are contained in its report No. GRDM-2019 Progress Report No. 2 of April 2019.

The completed emissions inventory for the GRDM region is discussed in LAQS's No. GRDM-2019 Progress Report No. 3 of May 2019.

A key requirement of the status quo analysis is a dispersion modelling study which shows the impact that cumulative emissions may have on air quality in the various municipalities contained in the Garden Route region.

As such a study can only be carried out once an emissions inventory has been compiled, LAQS saw fit to report its findings as an individual progress report, the outcome of which would serve as motivation for planning future monitoring and modelling activities.

This progress report gives the outcome of the air quality impact assessment carried out by LAQS. It deals with emissions that occurred within the Garden Route district during 2018 and excludes all sources for which authorisations may have been granted, but which were not operational during 2018.

As it is wholly based on the 2018 emission inventory compiled by LAQS, it is highly recommended that this report is read in conjunction with the Emissions Inventory report.

2 RELEVANT LEGISLATION

The "*Regulations Regarding Air Dispersion Modelling*" as published in Government Notice GN R.533 of 11 July 2014 (GN R.533) defines the basis for this air quality study.

"*National 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). Except for odorous emissions, it includes all of the pollutants covered by this study.

3 THE DISPERSION MODEL

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:

Mapper: A map manipulation tool

Emissioner: An extensive, relational emissions data base

Envimet: A meteorological data management program

Planner: The actual dispersion model

3.1 MAPPER

Mapper is a digital map compiler. It is used to define GIS data sets and 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.

3.2 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. landfill sites

-- Grid sources, e.g. complete informal settlement areas

-- Line sources, e.g. motor vehicle emissions

Of these, point, area and line sources are applicable to this study. It is, of course, possible for an industry to have more than one type of emission source, e.g. both point and area sources.

3.3 ENVIMET

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

3.4 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 the various sources.

Planner makes use of three different dispersion models, two of which are aimed at motor vehicle emissions. The third is the Aermod dispersion model and is used for calculating the dispersion of emissions from point, area and grid sources. Aermod is an 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 also accepted as a suitable model for the purpose of this project by the South African Department of Environmental Affairs, as discussed in GN R.533.

4 INPUT DATA

4.1 MAPPER

A comprehensive digital map of the whole Garden Route region was kindly made available by GRDM's GIS department and imported into Mapper. The map was subdivided into smaller version, one for each of the seven municipalities that fall in the Garden Route district.

4.2 EMISSIONER

As stated above, point, area and line sources are applicable to emissions from the sources of odorous emission identified for this project. Line sources are divided into road traffic, aircraft and sea vessels making use of a harbour.

Compulsory information required for point source emissions are:

-- Stack height
-- Stack diameter
-- Flue gas velocity
-- Flue gas temperature
-- Dimensions (height, width) of structures immediately adjacent to each stack
-- Definition of pollutants
-- Annual mass emission rates of pollutants
-- Hourly and monthly variations in operations

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
- Type of fuel used, i.e. petrol or diesel
- Road, pavement and roadside structure details (widths, heights)
- Definition of pollutants
- Annual mass emission rates of pollutants
- Road traffic carrying capacity

Compulsory information required for air traffic sources are:

- Number of flights per day
- Type of aircraft used
- Number and aircraft engine type on each aircraft type
- Duration of various manoeuvres, e.g. approaching the airport, movement on the ground (taxi), take-off and climb-out

Compulsory information required for sea traffic sources are:

- Number of ships making use of a harbour
- Length overall of each ship
- Gross tonnage of each ship
- Date and time of arrival and departure of each ship
- Duration of various manoeuvres, e.g. at sea, approaching and departing from the harbour, manoeuvre into and out of harbour, time spent anchored or at quayside
- Physical dimensions of each ship
- Main and auxiliary engine size of each ship

Most of the required details were provided by GRDM or, where this information was lacking, supplemented with typical information extracted from LAQS's databases.

4 AREA OF STUDY

A comprehensive digital map of the whole Garden Route region in ArcView® shape file format was kindly made available by GRDM's GIS department and imported into Mapper. The map was subdivided into smaller version, one for each of the seven municipalities that fall in the Garden Route district.

The map covering the whole GRDM region as well as that used for each municipality within GRDM is shown below.

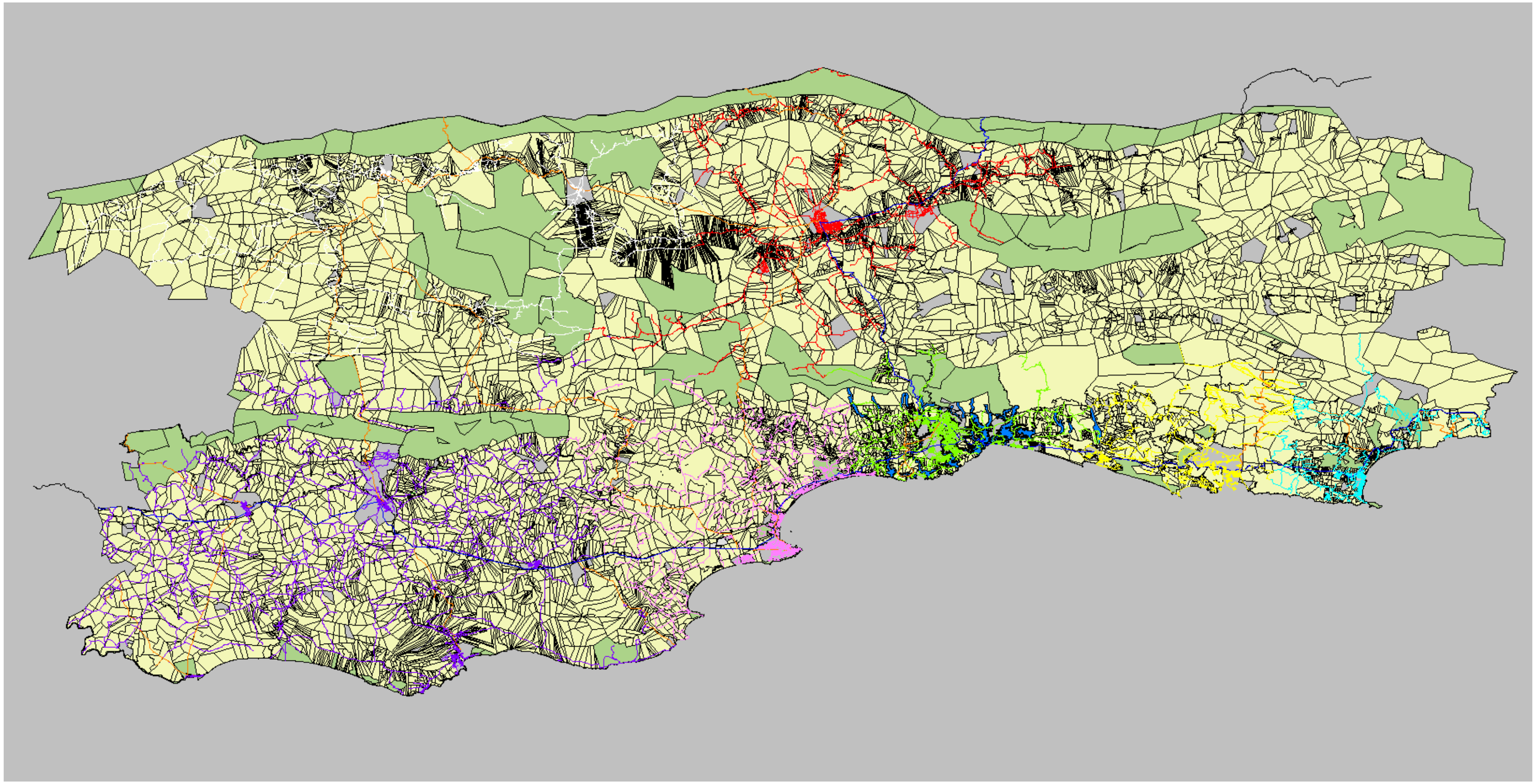

Figure 1: Garden Route District Map

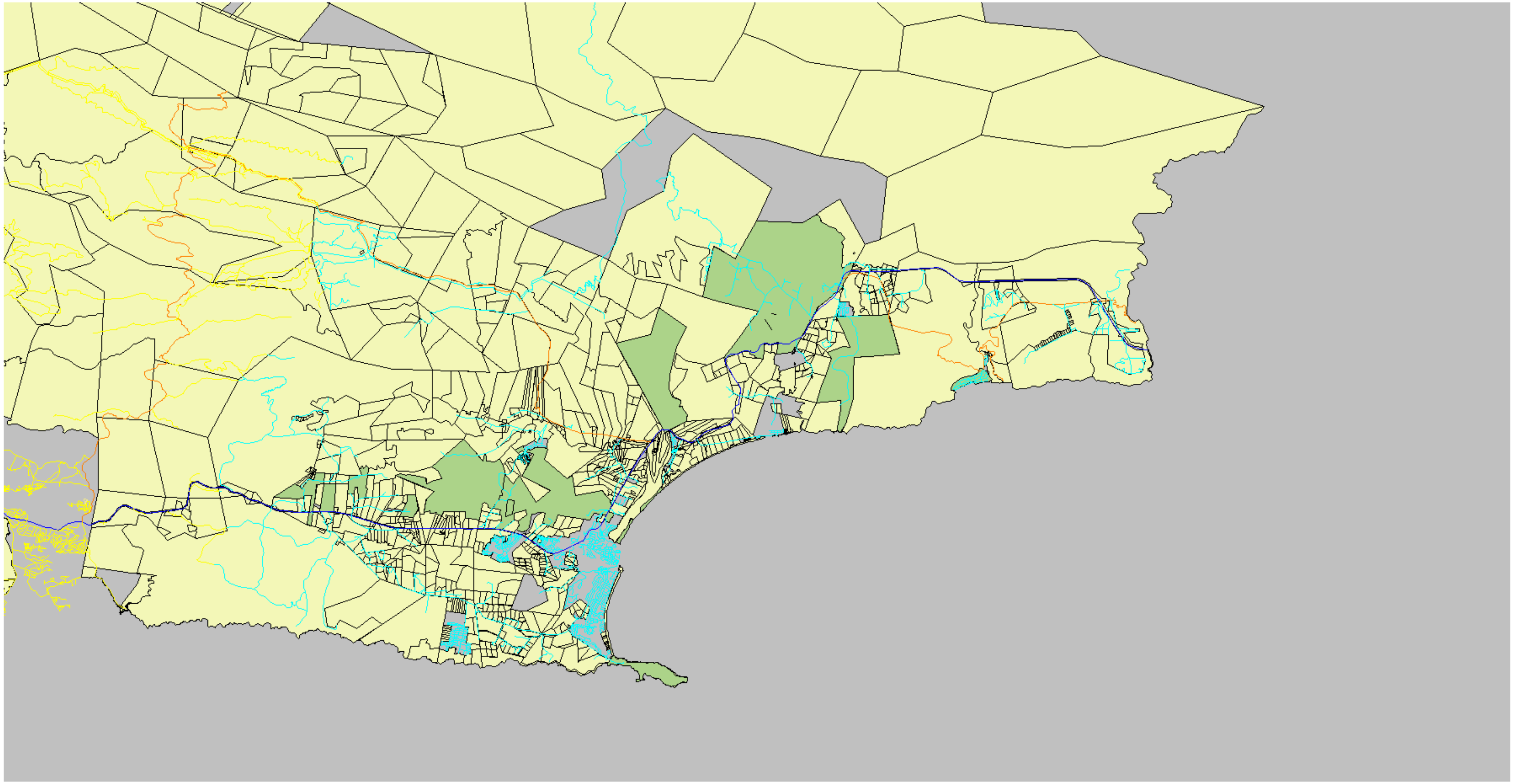

Figure 2: Map of Bitou Area

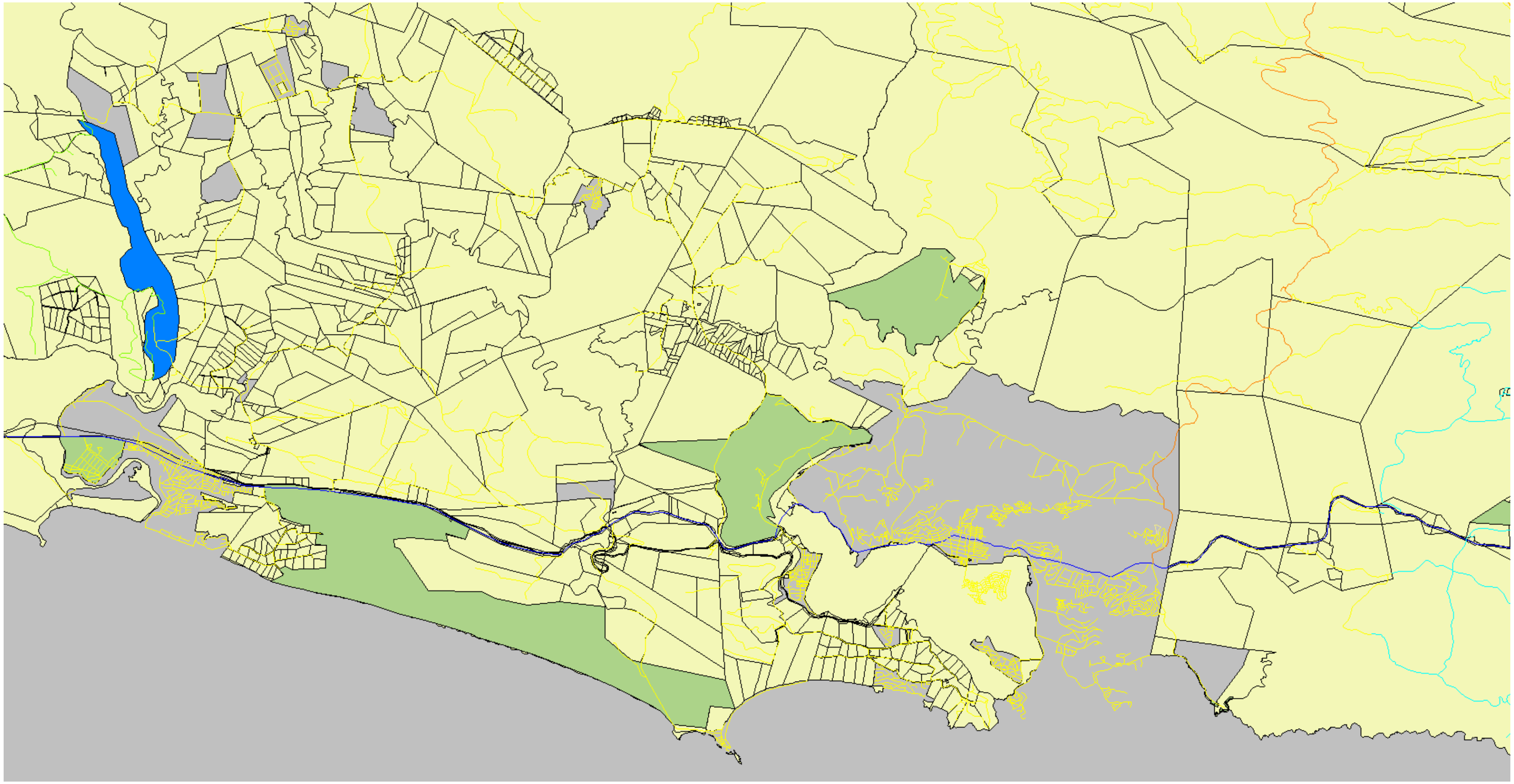

Figure 3: Map of Knysna Area

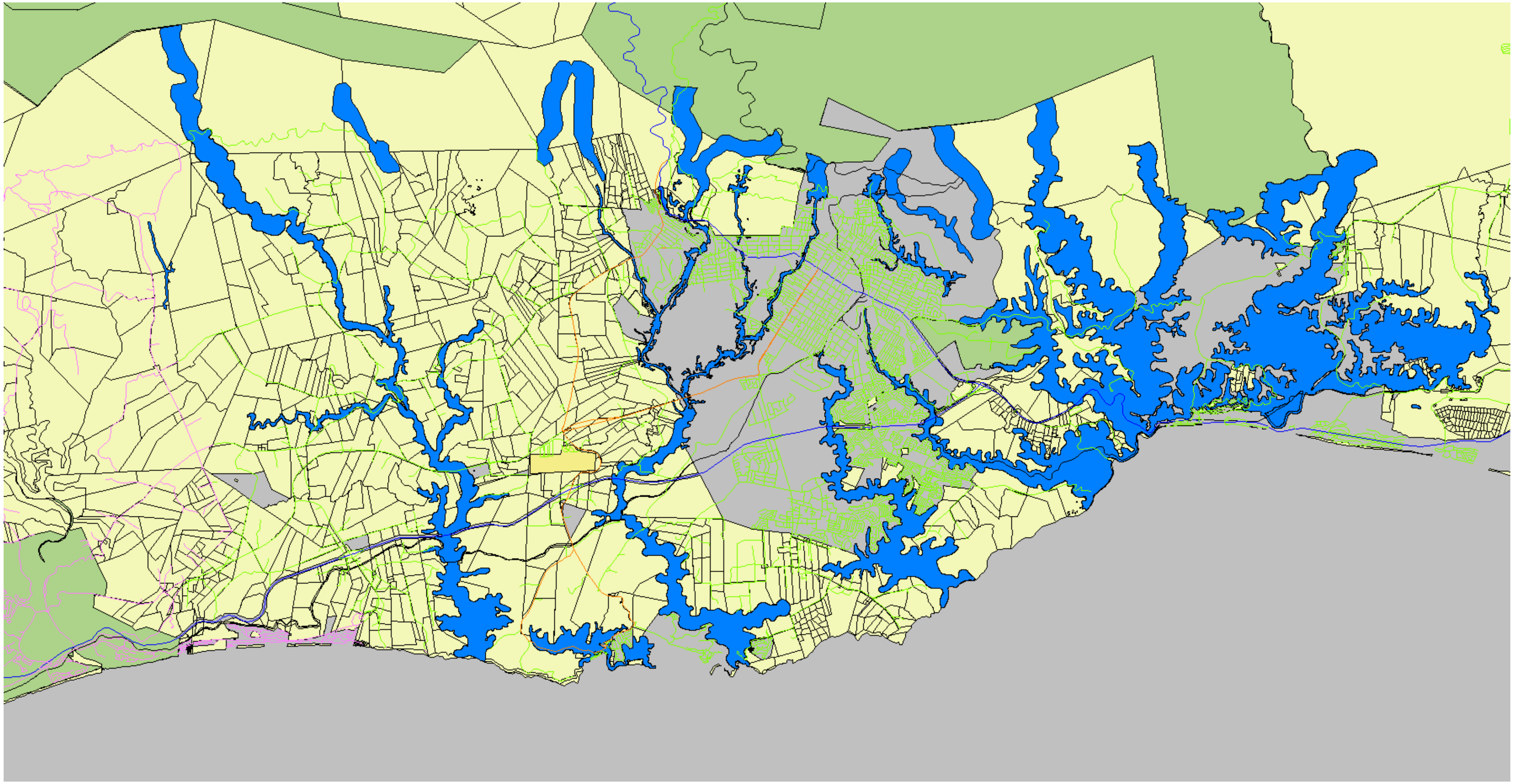

Figure 4: Map of George Area

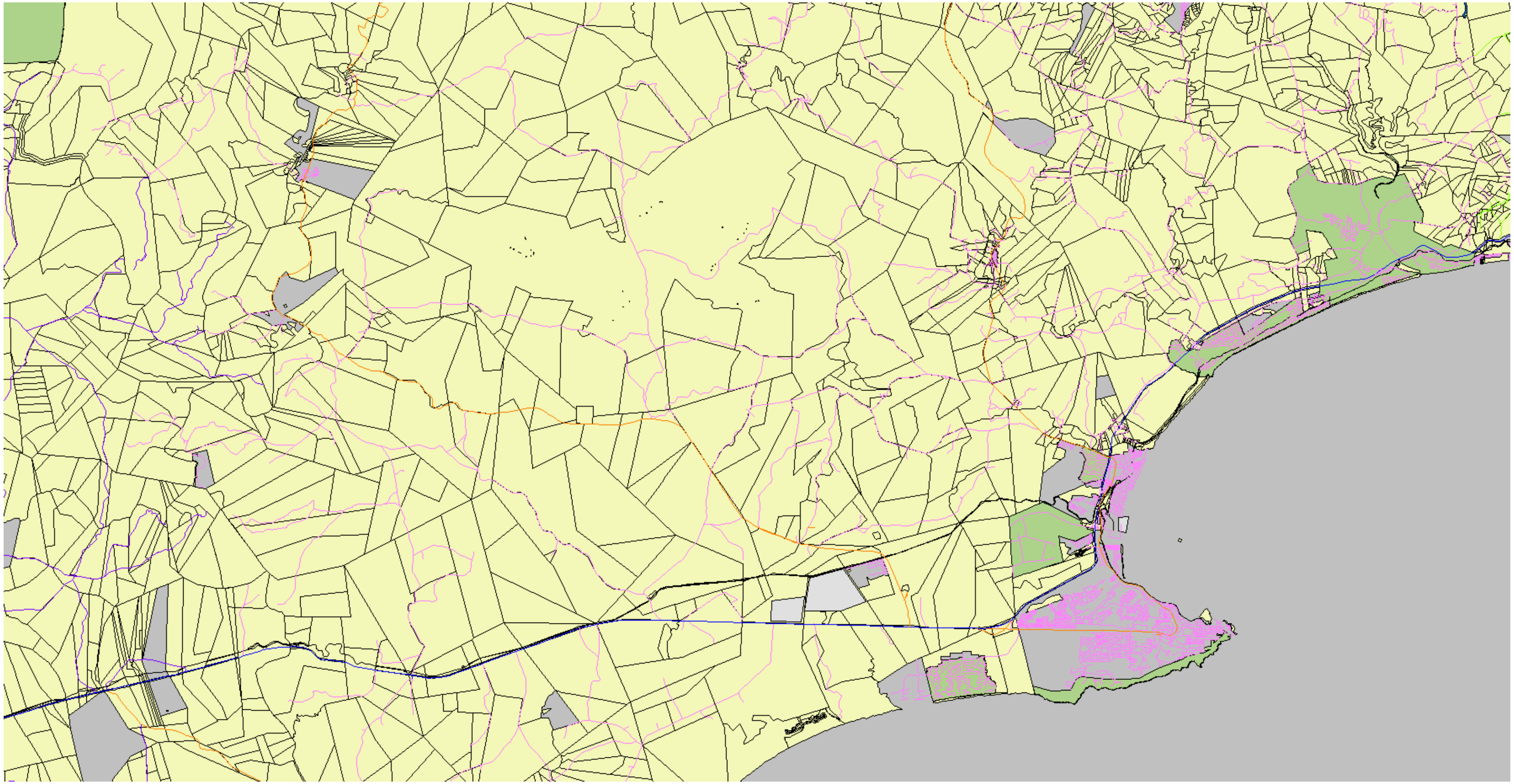

Figure 5: Map of Mossel Bay Area

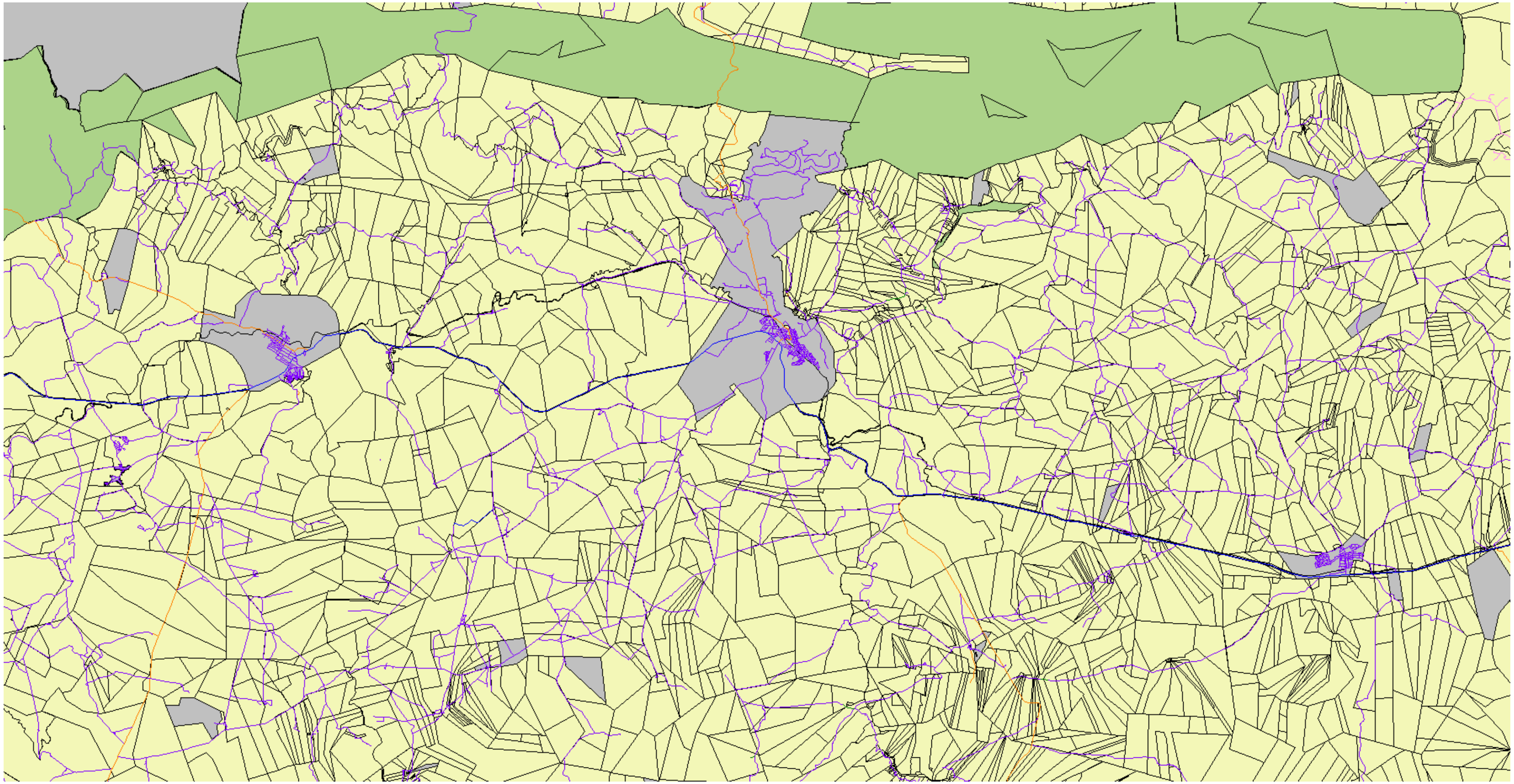

Figure 6: Map of Hessequa Area

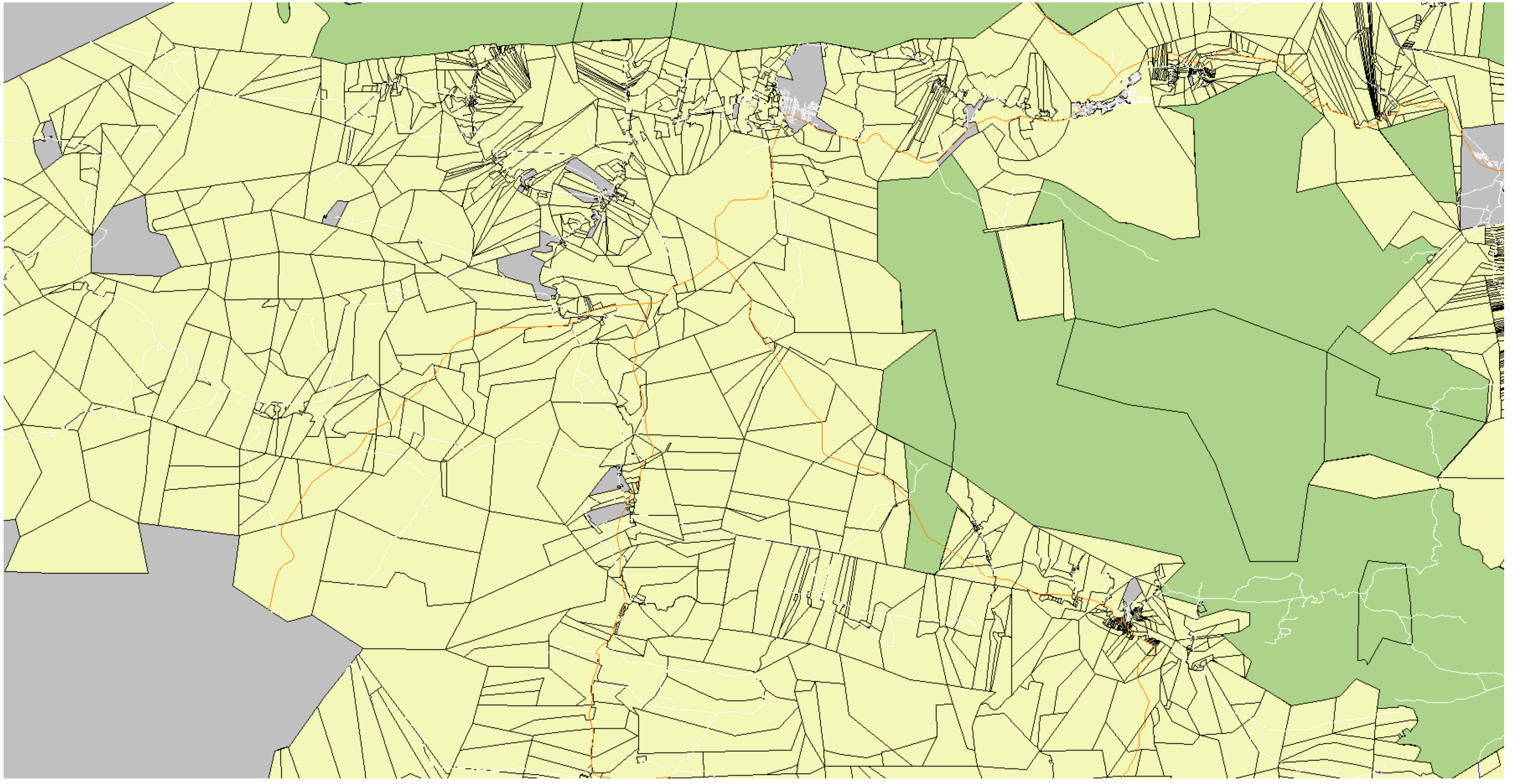

Figure 7: Map of Kannaland Area

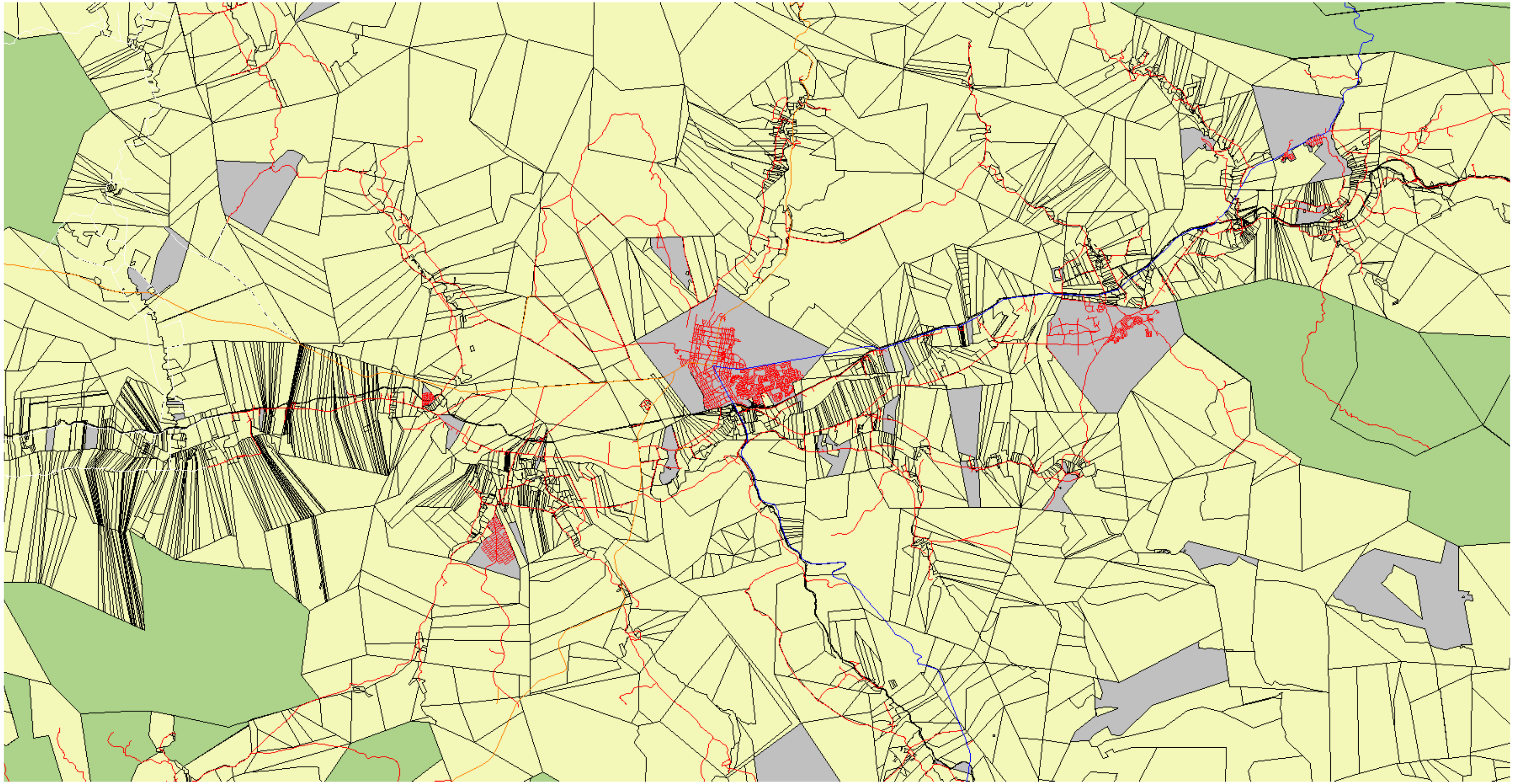

Figure 8: Map of Oudtshoorn Area

5 EMISSIONS DEFINITION

GN R.533 defines various procedures that may be followed in calculating annual emission rates of air pollutants, the deciding factor being the purpose of the air quality impact assessment. For new industrial processes, GN R.533 stipulates that maximum allowed emissions must be used to see if sufficient air space is available for the process, or to reserve air space for the process.

However, the purpose of this air quality impact assessment is to create an overview of the current state of air quality in the region, thus requiring the use of actual emissions, and not maximum allowed emissions, in calculating annual emissions from the various sources. "Actual emissions" are defined as emission that were actually quantified through measurements or the use of emission factors, based on an annual operating parameter relevant to a particular source, e.g. annual mass of fuel used, annual production capacity, etc.

While the emissions inventory included several air pollutants, LAQS only modelled the dispersion of those pollutants for which ambient air quality standards have been set in GN 1210. Those included are PM10 particulates, SO_2, NO_2 and CO.

As one of the most common complaints in the GRDM region relate to malodours, LAQS modelled the dispersion of odorous emissions as well, where sufficient source data was available. For this purpose LAQS grouped all odorous emissions, regardless of the components, into a single category which will include all H_2S, mercaptan, TMA and naphthalene emissions.

There are, however, some uncertainties created by the following:

-- Setting of emission limits for total particulate matter (TPM) while defining an air quality standard for PM10 particulates

-- NOx emissions in industry occur mostly as nitrogen monoxide (NO) while an air quality standard for nitrogen dioxide (NO_2) is defined. Where emissions limits for NOx are specified, it is for "NOx and NO_2" concentrations.

Some clarification of these two parameters is, therefore, necessary.

5.1 PM10 PARTICULATES

PM10 emissions need to be defined. "PM10" particles are commonly referred to as particles with diameters below 10 µm. This is not correct as the USEPA's definition of a PM10 particle is "the diameter of a particle that behaves aerodynamically like a spherical particle of unit density with a diameter of 10 µm".

All particles, however, are not spherical as some may be crystalline, others flakes or fibres, each having its own aerodynamic behaviour. In addition, aerodynamic behaviour is dependent on the momentum of a particle which, in turn, depends on the density of the material.

It is certain, however, that PM10 particles form a subset of total particulate matter (TPM), the parameters included in GRDM's emissions inventory. Where specific information about PM10 emissions was available it was included in the dispersion model. Where such information was not available, LAQS assumed that all particulate emissions complied with the definition of PM10 particulates. As PM10 particulates form a subset of TPM, this is an overestimation of PM10 emissions and must be regarded as a worst-case situation.

5.2 NO_2 EMISSIONS

As stated above, the most common form of nitrogen oxides emissions from industry is NO, while emission limits for NOx as NO_2 are defined by DEA. Atmospheric chemistry, specifically the presence of ozone, results in the conversion of NO to NO_2 in the atmosphere.

To compensate for this phenomenon GN R.533 specifies that NOx emissions must be converted to equivalent NO_2 emissions by multiplying NOx emission with a factor of 0.8 for dispersion modelling purposes.

6 EMISSION SOURCES

6.1 POINT SOURCE EMISSIONS

As the name suggests point source emissions are those that occur from individual points and industrial stacks are typical of this type of source. A detailed description of the various point sources, arranged by municipal area, is given in LAQS's report GRDM-2019 Progress Report No. 3 of May 2019 and this report should be consulted for specific details of each point source.

Where possible, PM10 concentrations were calculated and the equivalent NO_2 values calculated for dispersion modelling purposes.

Annual emissions from all point sources in GRDM are given in the tables below and are grouped by municipal area. In calculating annual emissions from each point source, LAQS's first choice of data was emission test reports submitted to GRDM. Where such measurements were not taken, or not all of the components were included in the test reports, annual emissions were calculated from internationally published emission factors, e.g. AP-42, Australian NPI, etc.

BITOU					
Source	**PM10**	**SO_2**	**NO_2**	**CO**	**Odours**
JC Pine Mills	0.7	1.3	0.6	3.1	

Table 1: Point Sources in Bitou, tons per annum

KNYSNA					
Source	**PM10**	**SO_2**	**NO_2**	**CO**	**Odours**
Geelhoutvlei Timbers	4.9	0.0	5.7	13.6	
Wilcross Timbers	1.3	0.1	1.6	2.0	

Table 2: Point Sources in Knysna, tons per annum

GEORGE					
Source	**PM10**	**SO_2**	**NO_2**	**CO**	**Odours**
Botha & Barnard	0.5	0.0	1.0	15.5	
Cape Pine	39.2	0.0	35.8	82.2	
George Crematorium	1.4	0.3	4.0	2.1	
Houttek Iuventus	0.7	0.0	0.6	27.1	
Much Asphalt	3.2	6.9	0.3	0.1	
Optimum Waste	0.6	0.0	8.0	10.6	
PG Bison – Thesen	44.1	11.2	41.0	268.6	
South Cape Galvanising	1.0				
Express Laundry	0.4	0.0	0.5	0.6	
George Timber & Palette	1.6	0.1	1.9	2.3	
Lancewood	131.4	50.5	24.9	13.5	
Nova Feeds	0.1	0.2	0.5	0.1	
Outeniqua Bakeries	0.0	0.1	0.4	0.1	
Pioneer Foods	0.0	0.1	0.4	0.1	
Ramcom trucks	0.0	0.0	0.1	0.0	

SAB Hop Farms	0.7	2.4	6.7	1.7	
Touw Meubels	0.5	0.0	0.6	0.8	
Woodfirst CC	55.3	3.5	67.7	82.9	

Table 3: Point Sources in George, tons per annum

MOSSEL BAY					
Source	**PM10**	**SO_2**	**NO_2**	**CO**	**Odours**
Gourikwa Power Station	1.0	5.7	1 059	48.7	
PetroSA	89.2	84.9	275.0	363.6	
PG Bison Woodline	4.8	0.3	5.8	7.2	3.3
Rheebok Bricks	50.6	39.0	24.7	42.1	
Southern Cape Fish Meal	0.3	0.7	1.0	1.3	30.0
South Cape Ostrich Tanners	0.7	8.8	2.6	0.1	0.5
Techno Asphalt	2.3	0.0	2.9	1.0	
Afripet	0.00	0.0	0.10	0.00	
Afro Fishing	0.6	10.0	1.1	0.2	
ATKV Hartenbos	0.00	0.00	0.10	0.00	
De Bakke Santos	0.00	0.1	0.3	0.1	
Mossel Bay Hospital	0.00	0.00	0.00	0.00	
Mossel Bay Panel Beaters	0.00	0.00	0.00	0.00	
Nestlé	99.0	141.1	46.4	37.1	
Point Caravan Park	0.00	0.00	0.00	0.00	
Power Pellet Fuel	0.00	0.00	0.00	0.00	
The Point Hotel	0.00	0.00	0.00	0.00	

Table 4: Point Sources in Mossel Bay, tons per annum

HESSEQUA					
Source	**PM10**	**SO_2**	**NO_2**	**CO**	**Odours**
Combo Timbers	0.3	0.0	0.1	1.8	
Imerys	0.1	0.1	0.7	0.6	
Organic Aloe	0.1	0.0	0.1	0.0	
Riversdale Saagmeule	7.1	0.0	4.5	2.5	
South Cape Poles	10.4	0.7	0.4	14.1	0.4
Jireh Foods	0.1	0.3	0.7	0.2	

Table 5: Point Sources in Hessequa, tons per annum

KANNALAND					
Source	**PM10**	**SO_2**	**NO_2**	**CO**	**Odours**
Parmalat	29.4	45.5	14.1	11.1	
Ladismith Kaas	46.0	65.5	21.5	17.2	
Ladismith Cellar	7.6	10.8	3.5	2.8	

Table 6: Point Sources in Kannaland, tons per annum

OUDTSHOORN					
Source	**PM10**	**SO_2**	**NO_2**	**CO**	**Odours**
Klein Karoo International	10.5	35.4	11.8	0.0	1.6
PSP Timbers	29.9	1.9	36.6	44.8	1.0
African Sky Hotels	0.0	0.0	0.1	0.0	
Cango Winery	0.0	0.0	0.1	0.0	
Dyselsdorp Liquorice	0.1	1.5	0.2	0.0	
Klein Karoo Dairy	0.0	0.0	0.1	0.0	
Parmalat	0.1	1.5	0.2	0.0	

Table 7: Point Sources in Oudtshoorn, tons per annum

6.2 AREA SOURCE EMISSIONS

An area source is one from which emissions do not occur from a discreet point or along a specifically defined line, but over an area on which industrial activities occur. Area sources exist in all of the municipalities within the Garden Route district and are listed below.

BITOU					
Source	**PM10**	**SO_2**	**NO_2**	**CO**	**Odours**
Kurland Bricks	45.9	30.2	24.1	20.1	
Vantell Bricks	18.0	11.8	9.5	7.9	

Table 8: Area Sources in Bitou, tons per annum

GEORGE					
Source	**PM10**	**SO_2**	**NO_2**	**CO**	**Odours**
Landfill site				1.02	0.32
George Airport			8.5	8.9	
Wastewater treatment works:					
Haarlem					0.01
Herold's Bay					0.055
Uniondale					0.242
Kleinkrantz					0.258
Outeniqua					3.889
Gwaiing					3.277

Table 9: Area Sources in George, tons per annum

MOSSEL BAY					
Source	**PM10**	**SO_2**	**NO_2**	**CO**	**Odours**
PG Bison Woodline					3.3
Southern Cape Fish Meal					30.0
Mossgas landfill				1.03	0.322

Wastewater treatment works:					
Pinnacle point					0.542
Ruitersbos					0.037
Grootbrak					0.558
Friemersheim					0.037
Regional					3.181
Brandwag					0.009
Herbertsdale					0.020

Table 10: Area Sources in Mossel Bay, tons per annum

HESSEQUA					
Source	**PM10**	**SO_2**	**NO_2**	**CO**	**Odours**
South Cape Poles	10.4	0.7	0.4	14.1	0.4
Spitskop stene	26.5	17.4	7.4	11.6	
Riversdale landfill				0.2	0.0
Wastewater treatment works:					
Stilbaai					0.5
Heidelberg					0.4
Riversdale					1.0
Albertinia					0.2
Melkhoutfontein					0.1
Jongensfontein					0.0
Witsand					0.0
Slangrivier					0.1
Gouritsmond					0.1
Garcia					0.01

Table 11: Area Sources in Hessequa, tons per annum

KANNALAND					
Source	**PM10**	**SO_2**	**NO_2**	**CO**	**Odours**
Ladismith landfill				0.06	0.019
Zoar landfill				0.04	0.013

Table 12: Area Sources in Kannaland, tons per annum

OUDTSHOORN					
Source	**PM10**	**SO_2**	**NO_2**	**CO**	**Odours**
Johnsons Bricks	58.5	38.4	16.3	25.6	
Klein Karoo International					0.5
PSP Timbers					1.0
Grootkop landfill				0.38	0.1
Wastewater treatment works					2.87

Table 13: Area Sources in Oudtshoorn, tons per annum

6.3 LINE SOURCE EMISSIONS

Line sources imply emissions that do not occur from single points, specific areas or on a large scale such as grid emissions, but along specifically defined lines or routes. Most typical of line sources are motor vehicle emissions and harbour sea traffic emissions.

Due to the relatively low traffic volumes, not all road sections in GRDM were included in the dispersion model. LAQS rather concentrated on those that carry the most traffic, i.e. N2, N12 and R102 in Mossel bay. The roads covered in this dispersion modelling study are given in the table below.

Road section	**Pollutant**		
	PM10	NO_2	CO
Nature's Valley	1.0	23.6	27.7
Before Plettenberg Bay	3.2	72.4	84.3
Goose Valley Plettenberg Bay	0.4	7.4	11.1

Between Plett & Knysna	4.3	94.1	116.3
Before Knysna	0.9	20.5	22.8
After Knysna (Brenton)	2.1	42.6	60.5
Before Sedgefield	5.4	108.9	171.9
Before Wilderness	2.5	47.2	56.7
Kaaimans Pass	0.7	13.7	16.3
George after N2/N12 split	1.0	17.1	35.0
George pre Thembalethu IC	1.0	17.4	34.8
George York St	5.5	100.1	200.5
Glentana	3.1	59.5	106.5
Groot Brak	2.2	42.2	74.1
Klein Brak	1.6	31.0	55.8
Hartenbos	3.1	57.8	112.3
Mossel Bay Die Bakke	2.0	37.1	69.5
Mossgas	0.8	20.2	17.1
Albertinia	7.7	170.4	218.8
Riversdale	6.6	148.1	183.0
Heidelberg	4.3	102.3	111.1
George to Oudtshoorn	1.8	33.2	63.0
Oudtshoorn to De Rust	3.7	66.8	122.4
R102 Voorbaai	1.7	30.2	53.1
R102 Heiderand	1.3	22.1	42.4

Table 14: Road Traffic emissions, tons per annum

7 AIR QUALITY STANDARDS

Ambient air quality standards for some pollutants were published by the Department of Environmental Affairs (DEA) in GN1210 on 24 March 2009. Of the pollutants discussed in this study, ambient air quality standards for PM10 particulate matter, SO_2, NO_2 (a sub-set of NOx) and CO are included. The limits and the number of times they may be exceeded are:

PM10

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

SO_2

Annual average limit	50 µg/m^3, no exceedances allowed
1-hour maximum	350 µg/m^3, 88 exceedances allowed

NO_2

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

CO

8-hour running average	10 mg/m^3, 11 exceedances allowed
1-hour maximum	30 mg/m^3, 88 exceedances allowed

These standards are referred to each section that follows the results of the dispersion modelling study for each of the seven municipalities in the Garden Route region.

8 RESULTS

LAQS modelled the dispersion of criteria pollutants for comparison of results against official ambient air quality standards as published by the Department of Environmental Affairs in GN1210. Of the pollutants included in GN1210, ambient air quality standards have been defined for PM10, SO_2, NO_2 and CO. In addition, the dispersion of odorous emissions was included in the study due to the high frequency of odour-related complaints submitted to GRDM.

The approach to the project was to determine both annual average and 99-percentile ground-level concentrations (the levels below which concentrations will occur for 99% of the time) of the four pollutants studied. A 99-percentile level was chosen as it is the closest approximation to the ambient air quality limit exceedances allowed legally (please see Section 7 above).

Except for carbon monoxide and odour results, the maximum of the scale shown in each figure was set to the ambient air quality standard, thus indicating areas where the air quality standard may be exceeded. As the ambient air quality standards for CO are very high, the scales used to show the results were set to the ground-level concentrations estimated by the dispersion model. The minimum scale shown in each relevant figure was set to the odour threshold value of H_2S, i.e. 0.7 µg/m^3, which is the lowest detection limit of the four odorous compounds included in this study (H_2S, mercaptans, TMA and naphthalene). All areas thus covered by the isopleths show the areas where odours may be detected.

In cases where the dispersion modelling results show that ambient air quality standards may be exceeded, the maximum estimated ground-level concentrations were determined.

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 low winds, e.g. 1 m/s, would carry pollutants some distance from each source.

Results are shown graphically below in the form of isopleths and point concentrations estimated at the five points listed above are given in tabular format.

8.1 BITOU

The dispersion of pollutants from all sources in Bitou is shown graphically in Figures 9 to 16 below.

Figures 9 and 10 respectively show the annual average and 99-percentile 24-hour average ground-level concentrations of all PM10 emissions.

Figures 11 and 12 respectively show the annual average and 99-percentile ground-level concentrations of all sulphur dioxide (SO_2) emissions.

Figures 13 and 14 respectively show the annual average and 99-percentile ground-level concentrations for all nitrogen oxides (NO_2) emissions.

Figures 15 and 16 respectively show the 8-hour average and 99-percentile ground-level concentrations for all carbon monoxide (CO) emissions.

No sources of odorous emissions were identified in Bitou.

High estimated concentrations are discussed after the graphic results and summarised in Table 15 below.

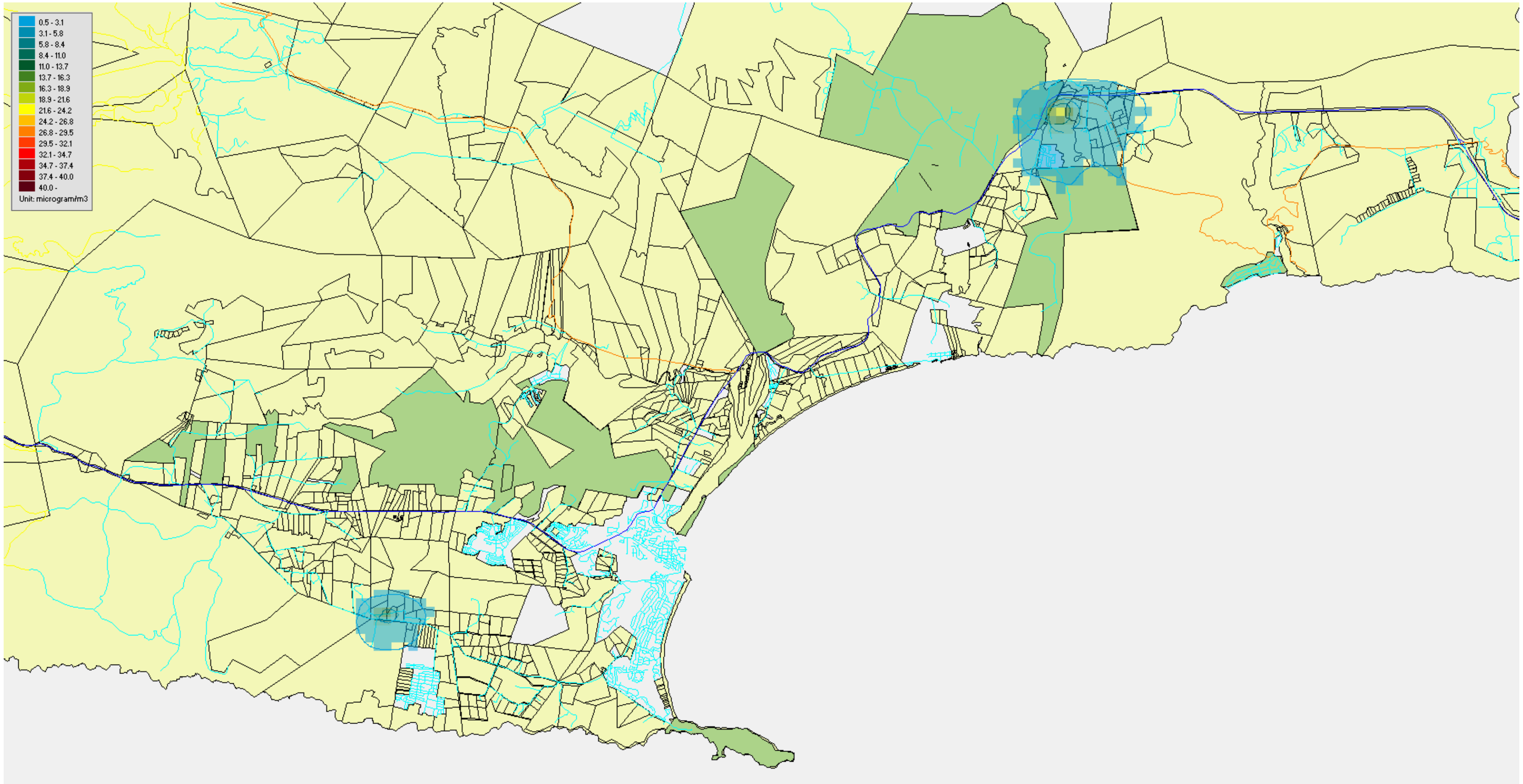

Figure 9: Bitou: Annual Average PM10 Concentrations

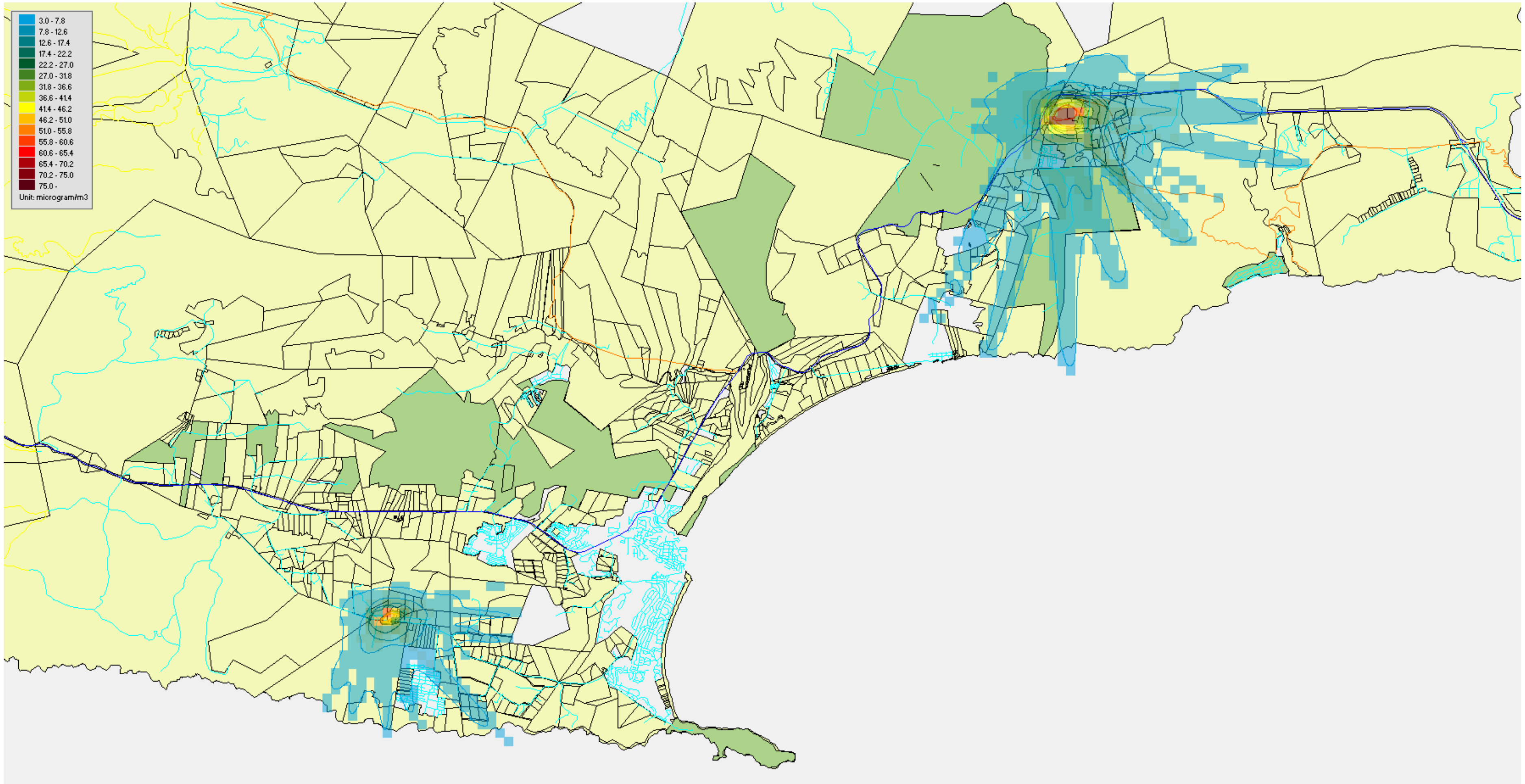

Figure 10: Bitou: 99-percentile PM10 Daily Averaged Concentrations

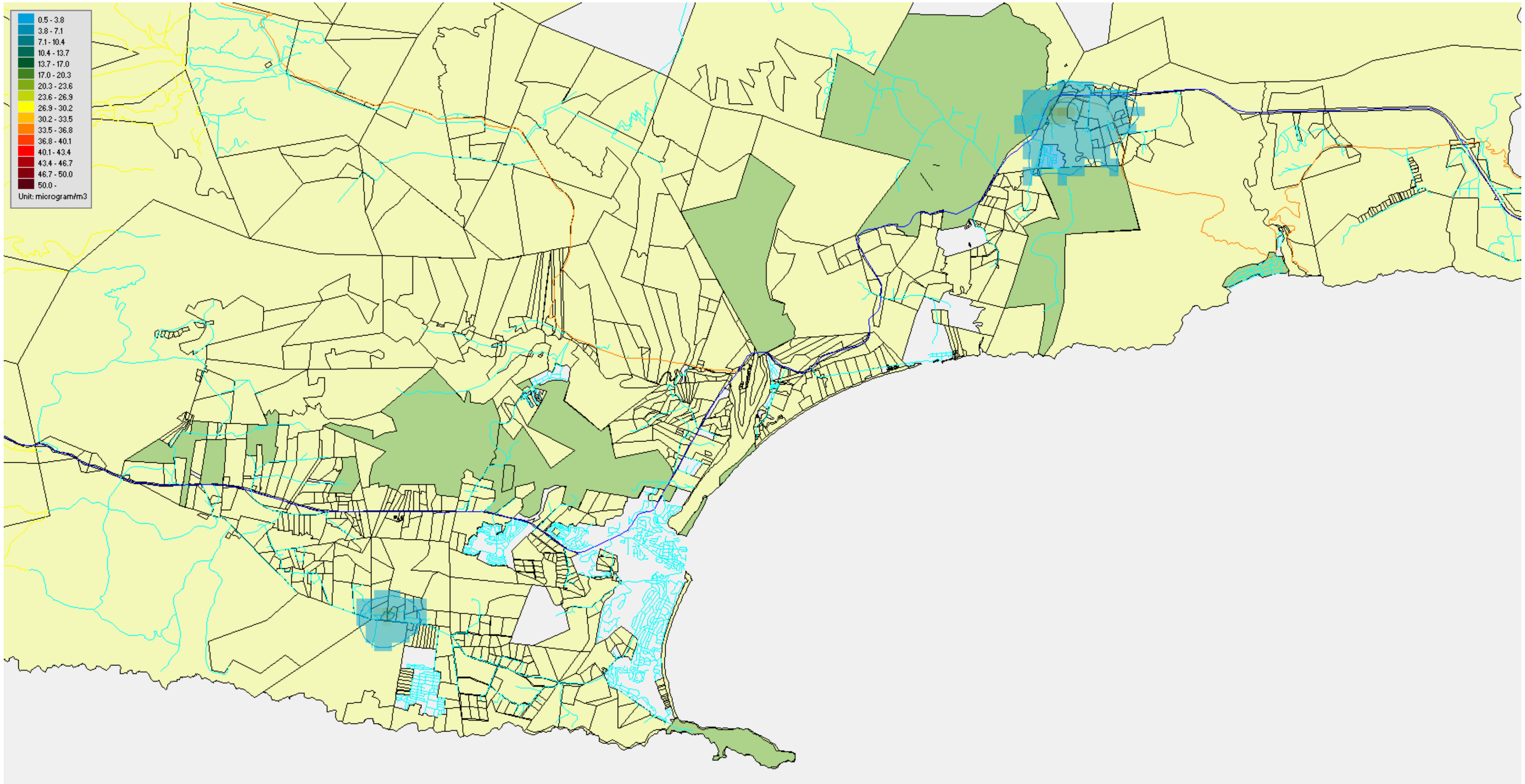

Figure 11: Bitou: Annual Average SO_2 Concentrations

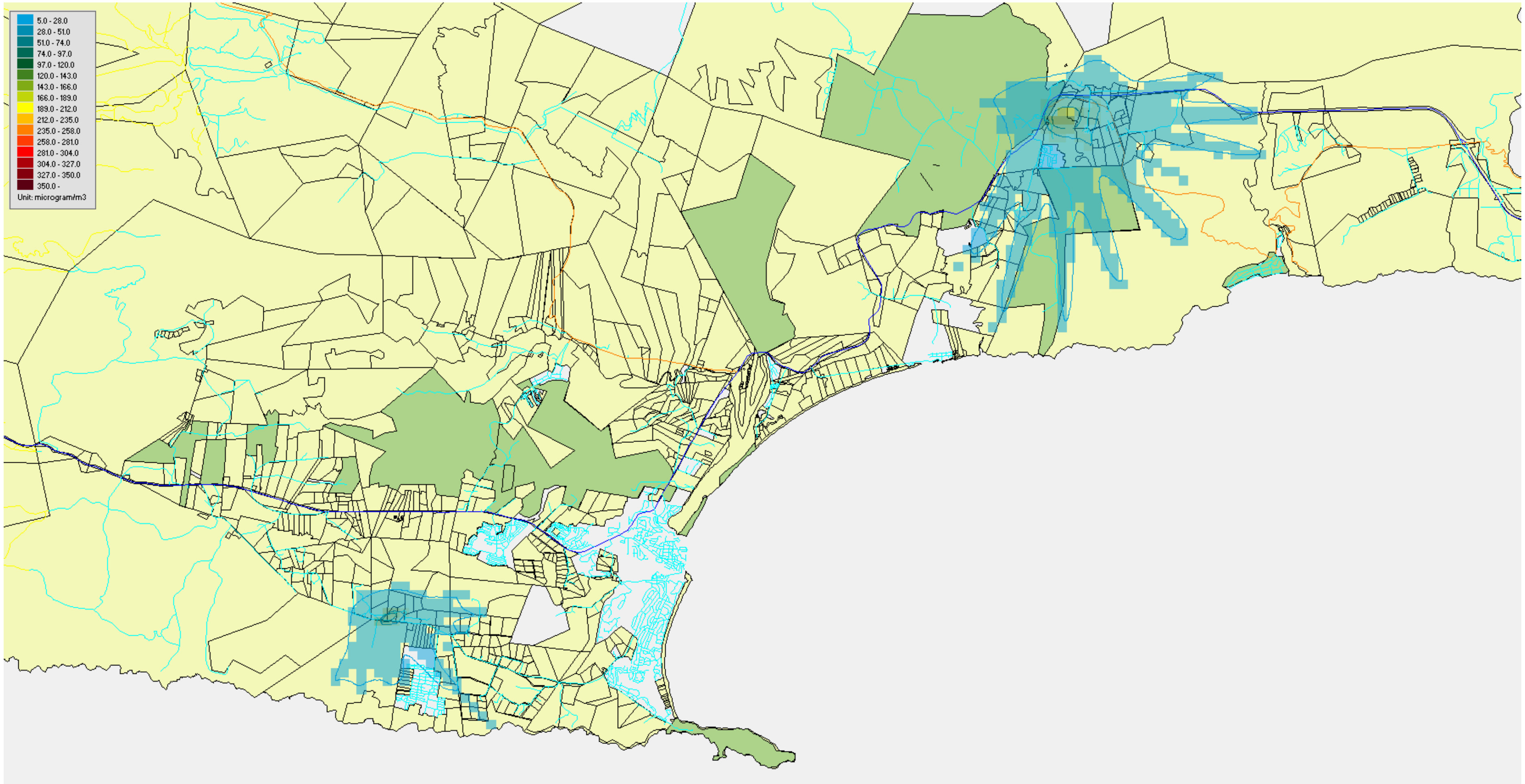

Figure 12: Bitou: 99-percentile SO_2 Concentrations

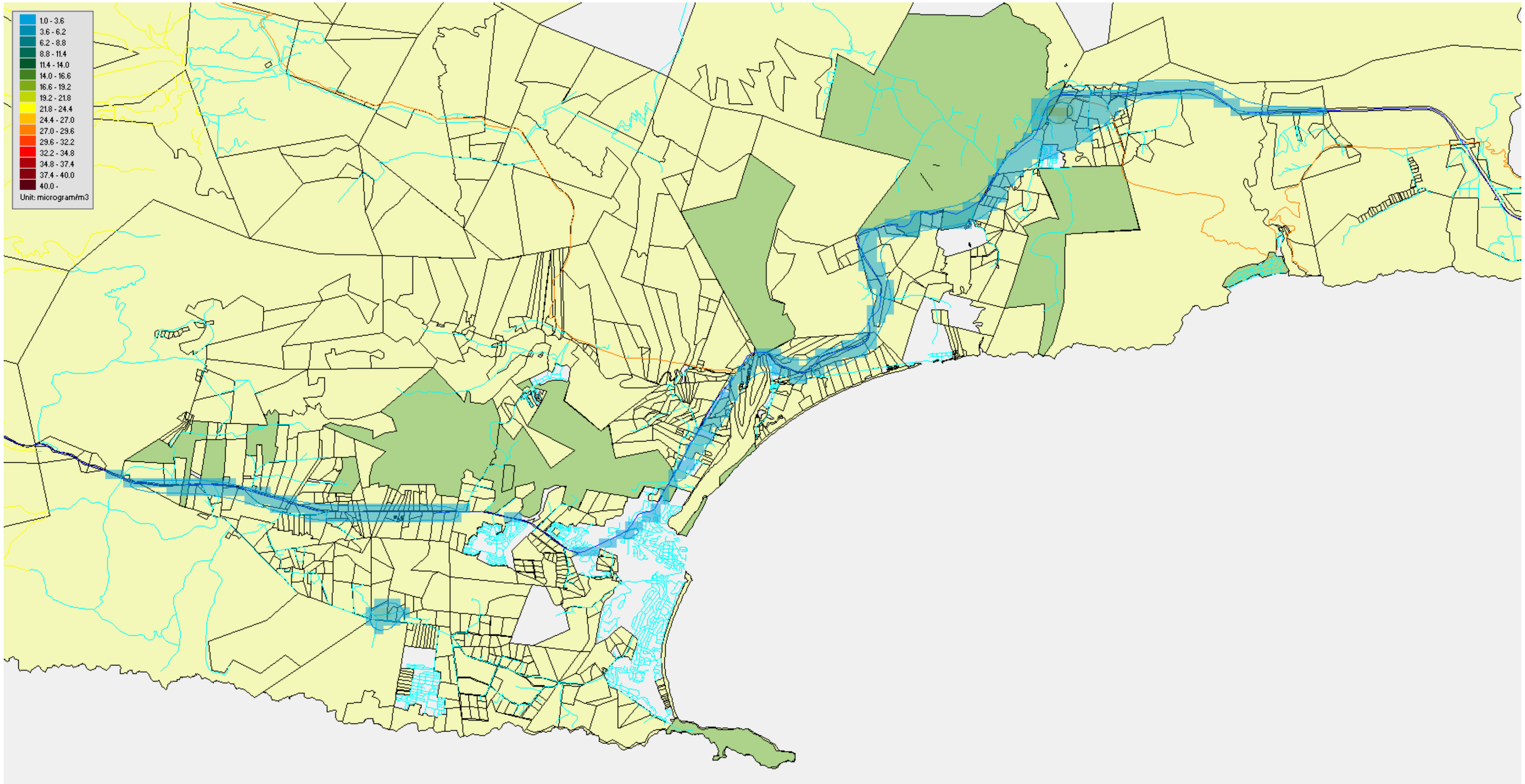

Figure 13: Bitou: Annual Average NO_2 Concentrations

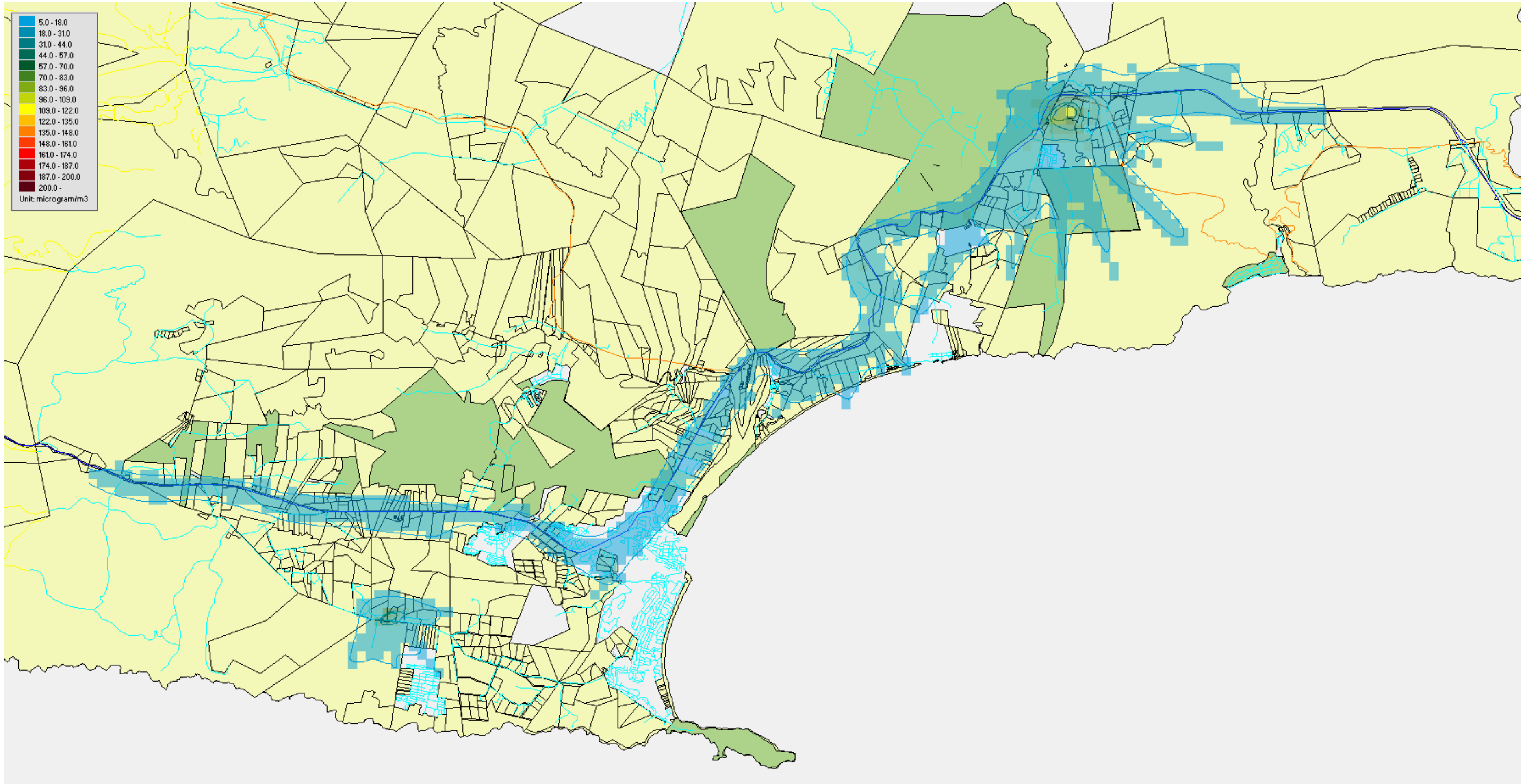

Figure 14: Bitou: 99-percentile NO_2 Concentrations

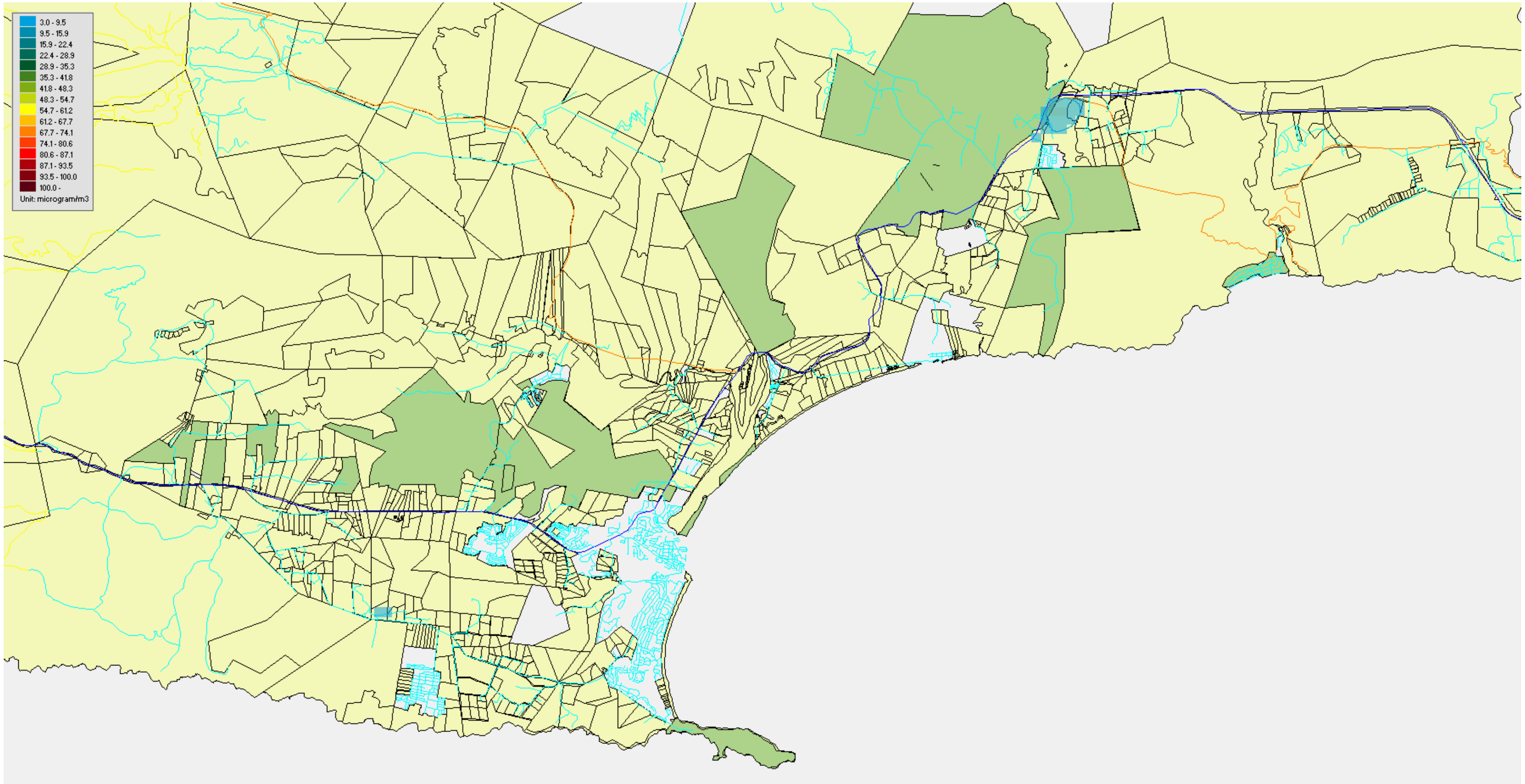

Figure 15: Bitou: 8-hour Average CO Concentrations

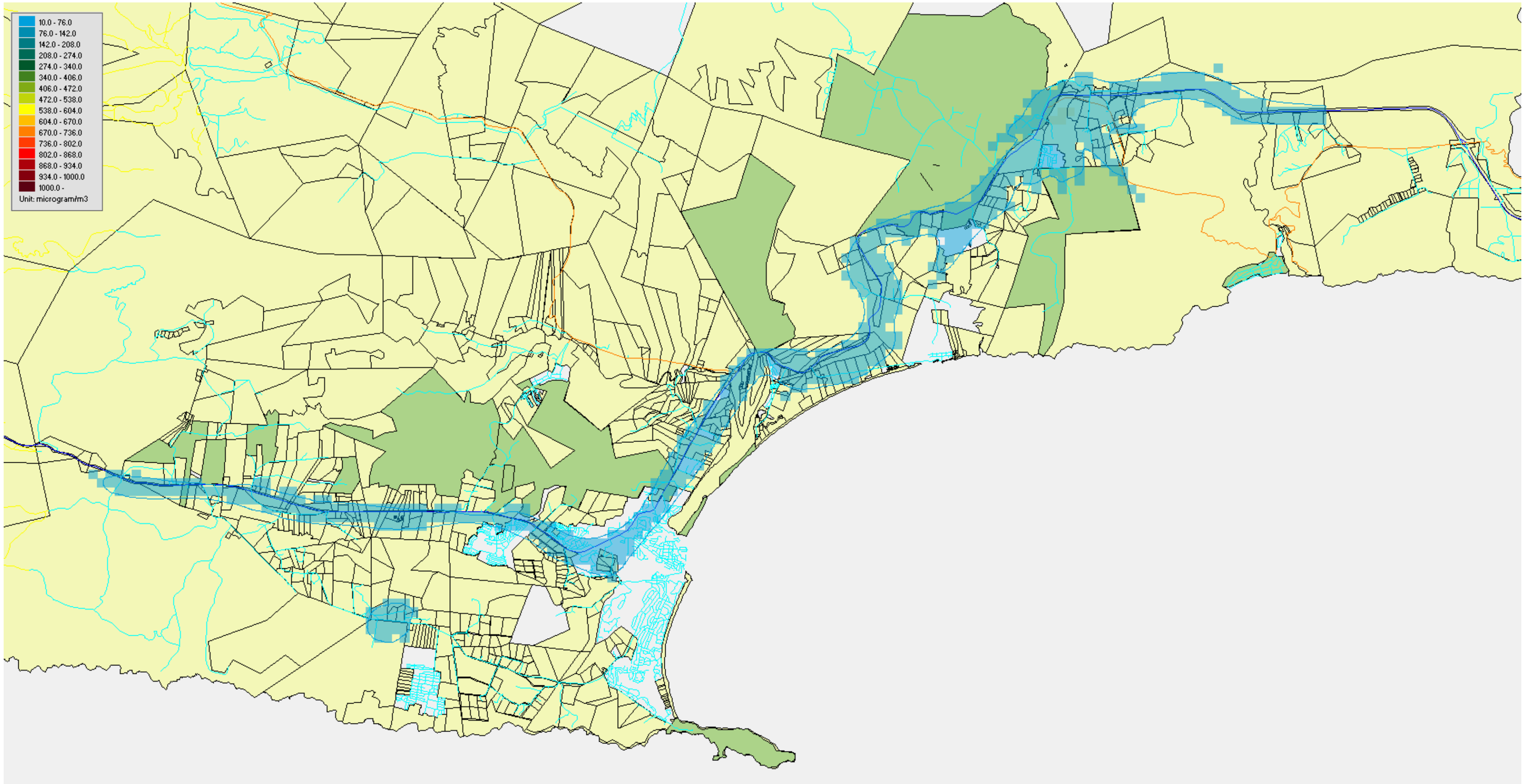

Figure 16: Bitou: 99-percentile CO Concentrations

The following information can be deduced from the isopleths shown in Figures 9 to 16 above:

-- Emissions of PM10 from the two brick manufacturing operations, i.e. Kurland Bricks and Vantell Bricks, have the highest impact on air quality in Bitou. It is estimated that the 99-percentile PM10 concentrations in the immediate vicinity of these two operations may exceed and relevant ambient air quality standard, albeit only marginally so in the case of Vantell Bricks.

-- Emissions of SO_2, NO_2 and CO all result in ground-level concentrations that are well below the official ambient air quality standards.

7.2 KNYSNA

The dispersion of pollutants from all sources in Knysna is shown graphically in Figures 17 to 24 below.

Figures 17 and 18 respectively show the annual average and 99-percentile 24-hour average ground-level concentrations of all PM10 emissions.

Figures 19 and 20 respectively show the annual average and 99-percentile ground-level concentrations for all nitrogen oxides (NO_2) emissions.

Figures 21 and 22 respectively show the 8-hour average and 99-percentile ground-level concentrations for all carbon monoxide (CO) emissions.

No significant sources of SO_2 and odorous emissions were identified in Knysna.

A more detailed investigation into the impact of traffic-related NO_2 emissions along Main Road in Knysna is given in Figures 23 and 24.

High estimated concentrations are discussed after the graphic results and summarised in Table 15 below.

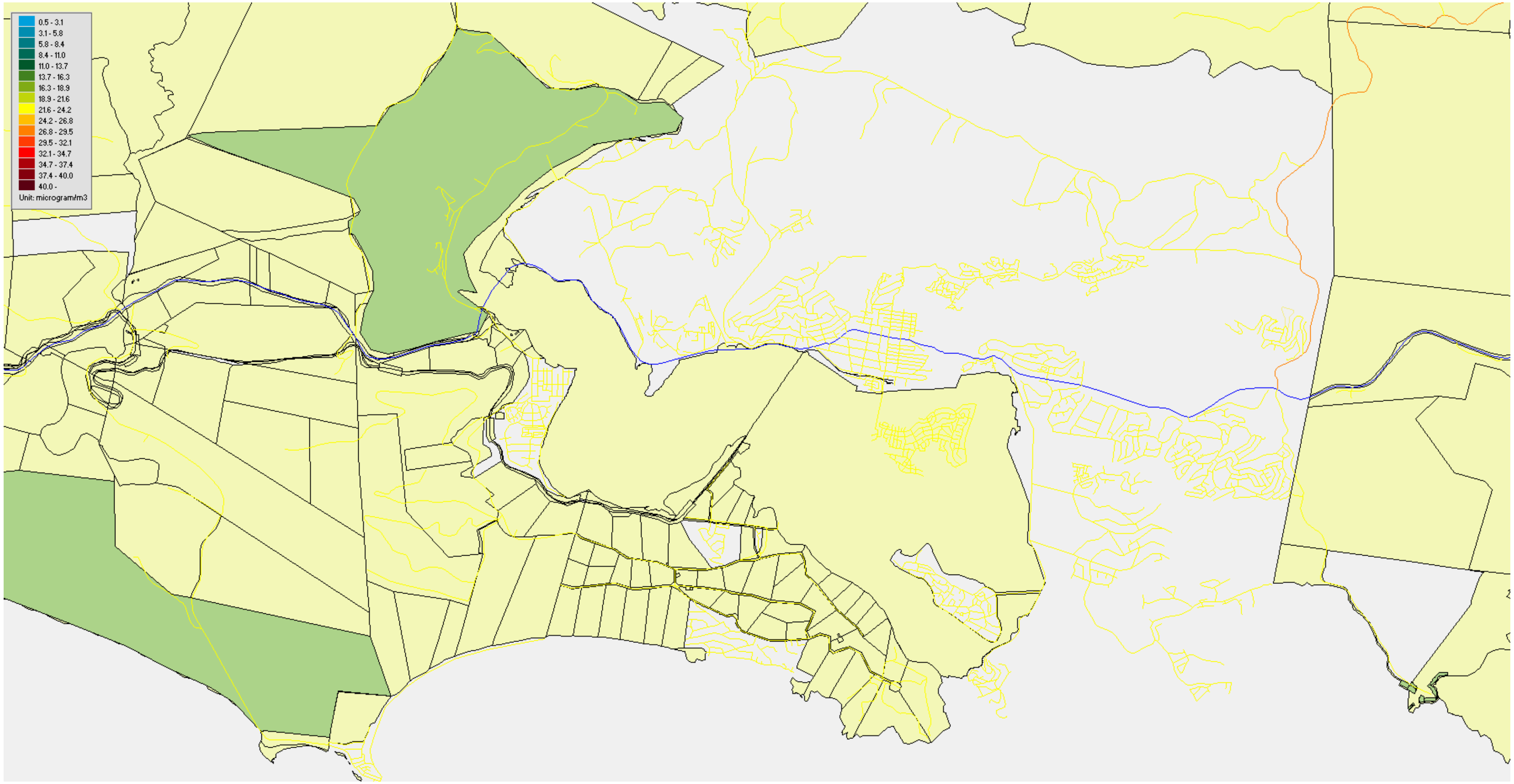

Figure 17: Knysna: Annual Average PM10 Concentrations

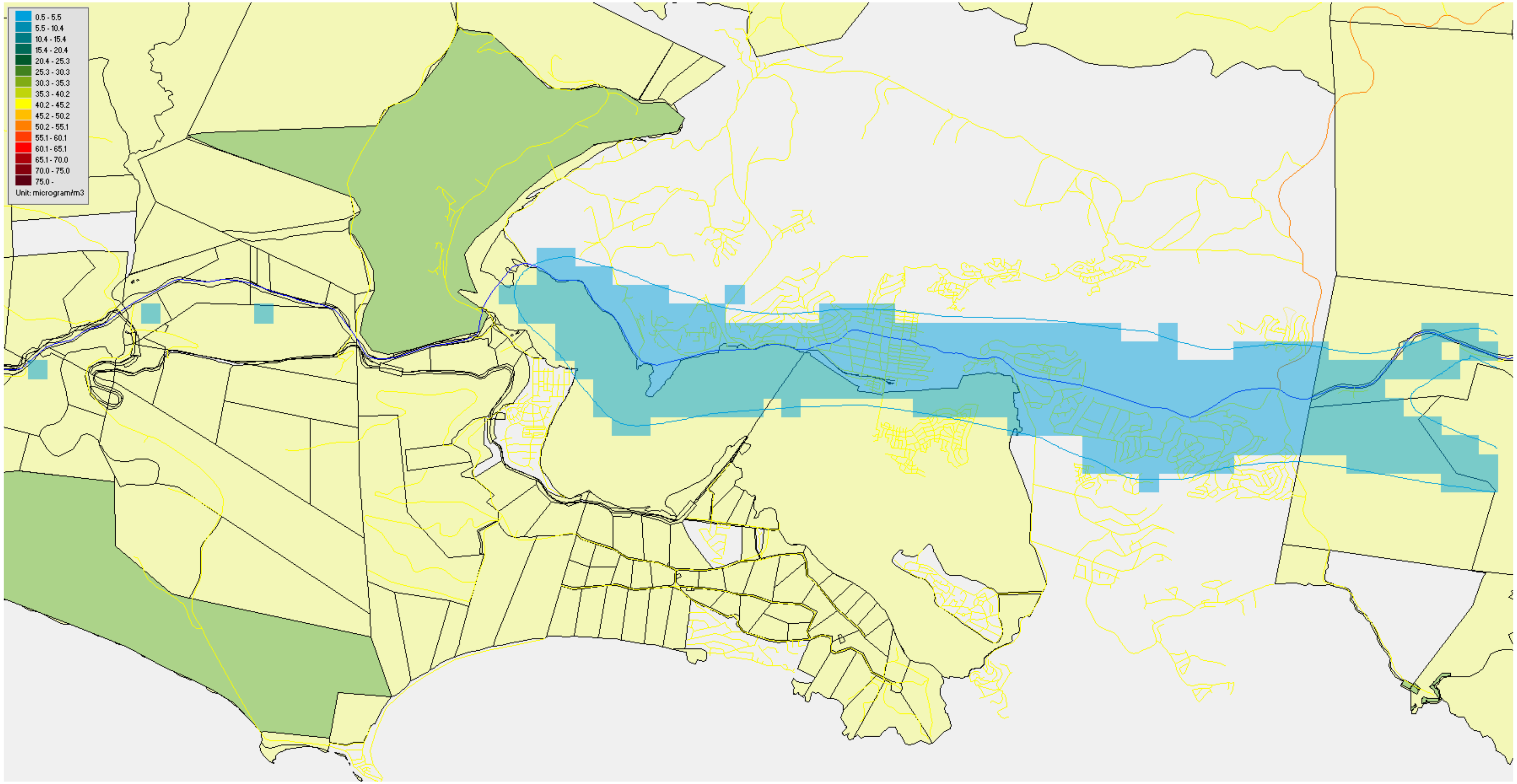

Figure 18: Knysna: 99-percentile PM10 Daily Averaged Concentrations

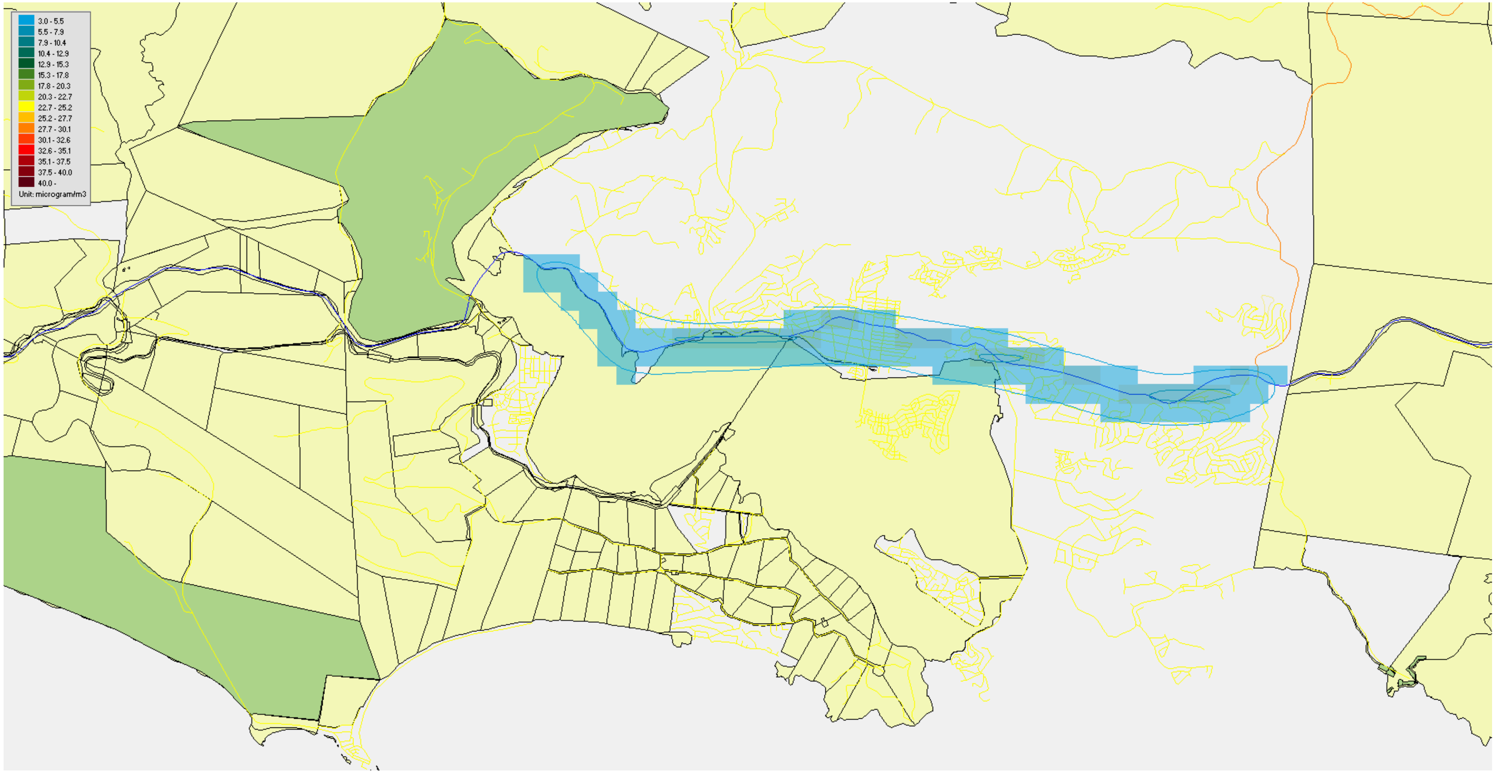

Figure 19: Knysna: Annual Average NO_2 Concentrations

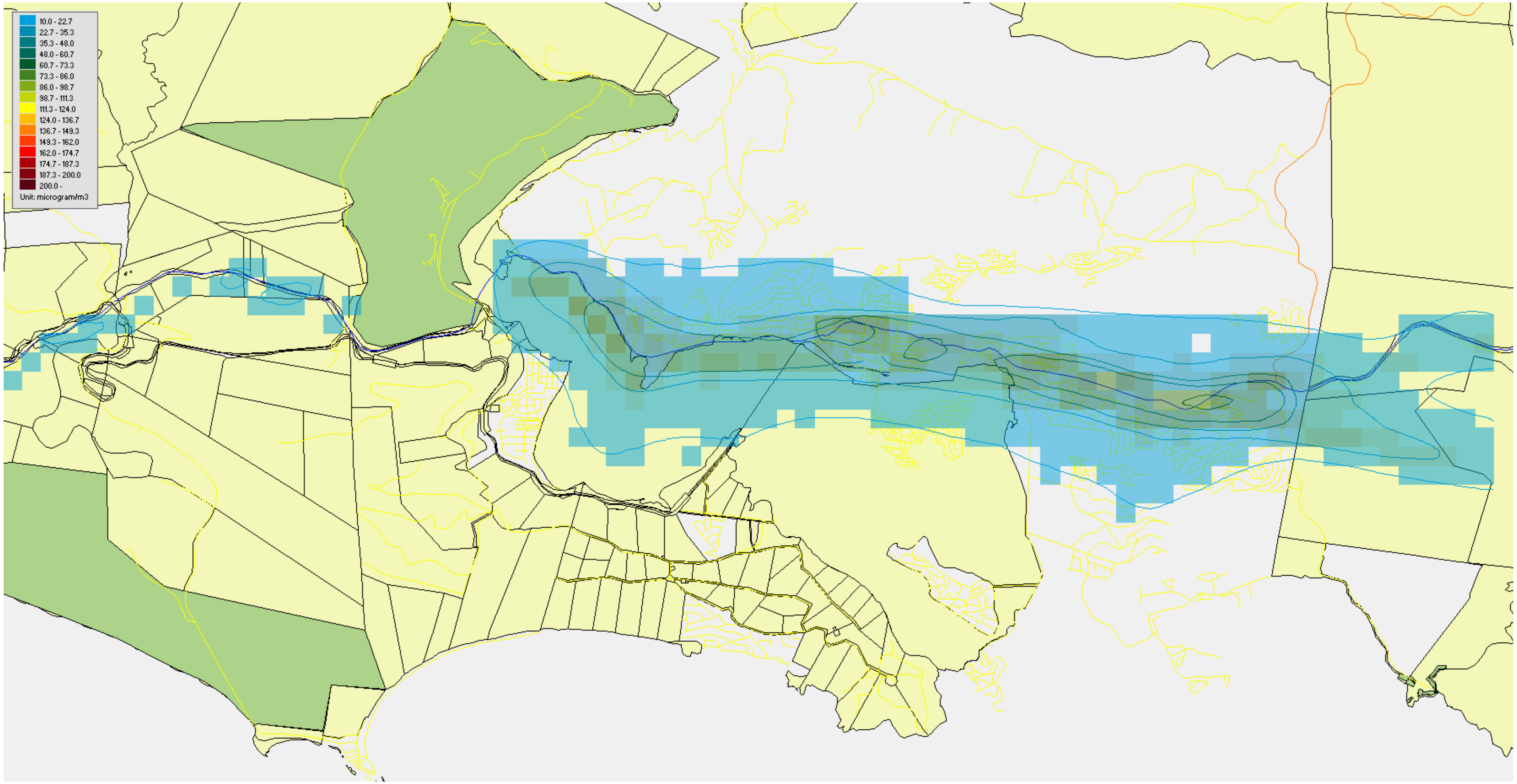

Figure 20: Knysna: 99-percentile NO_2 Concentrations

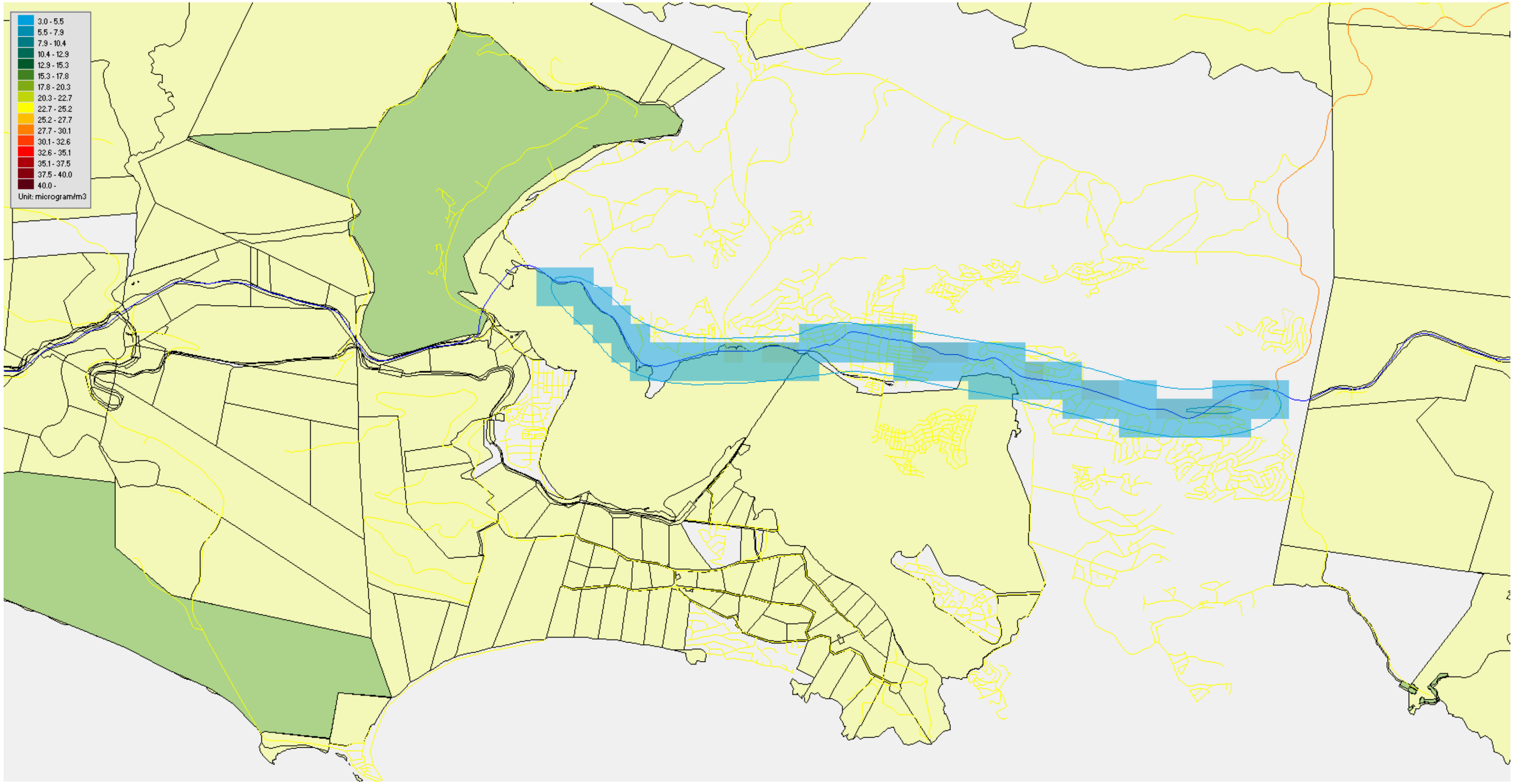

Figure 21: Knysna: 8-hour Average CO Concentrations

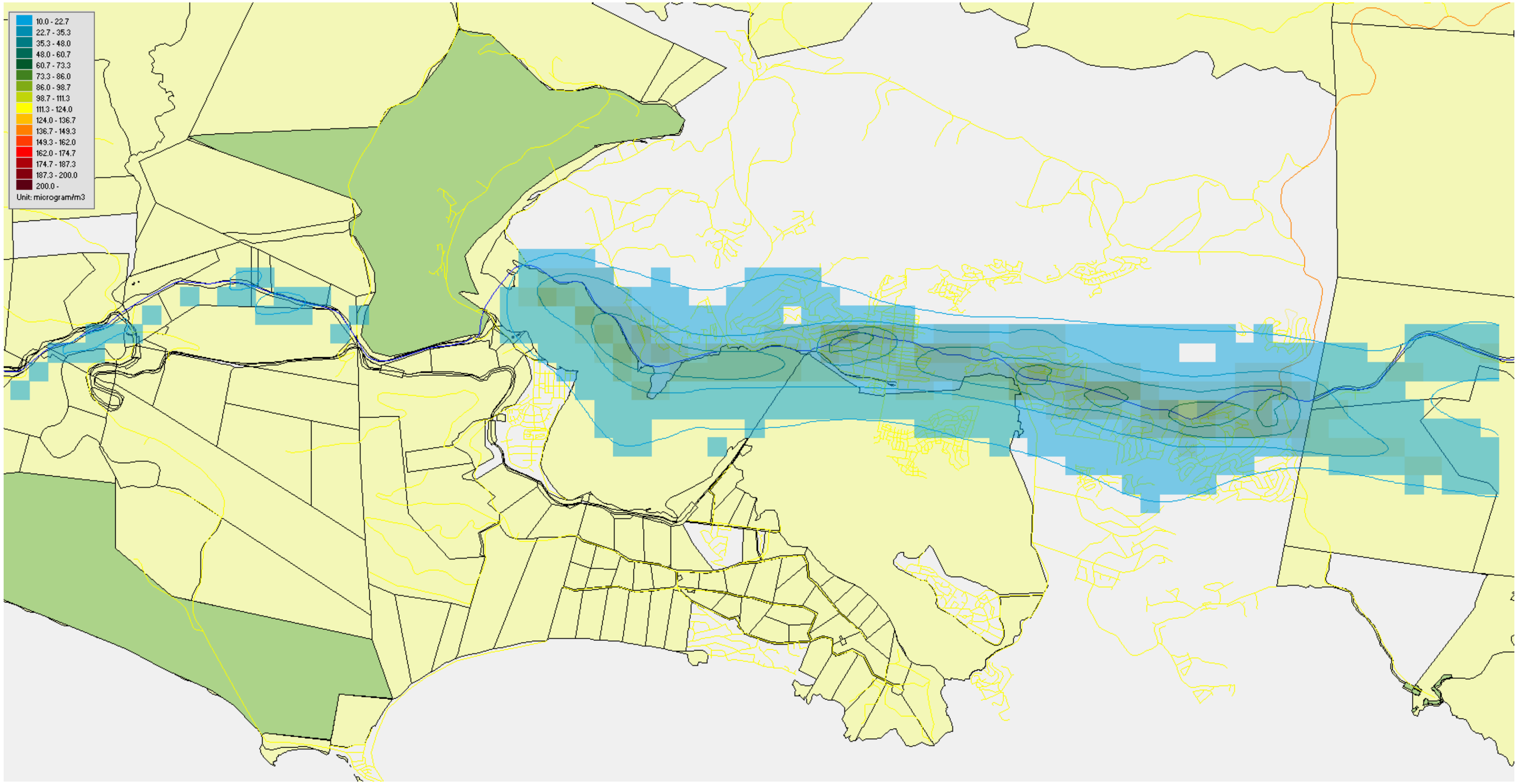

Figure 22: Knysna: 99-percentile CO Concentrations

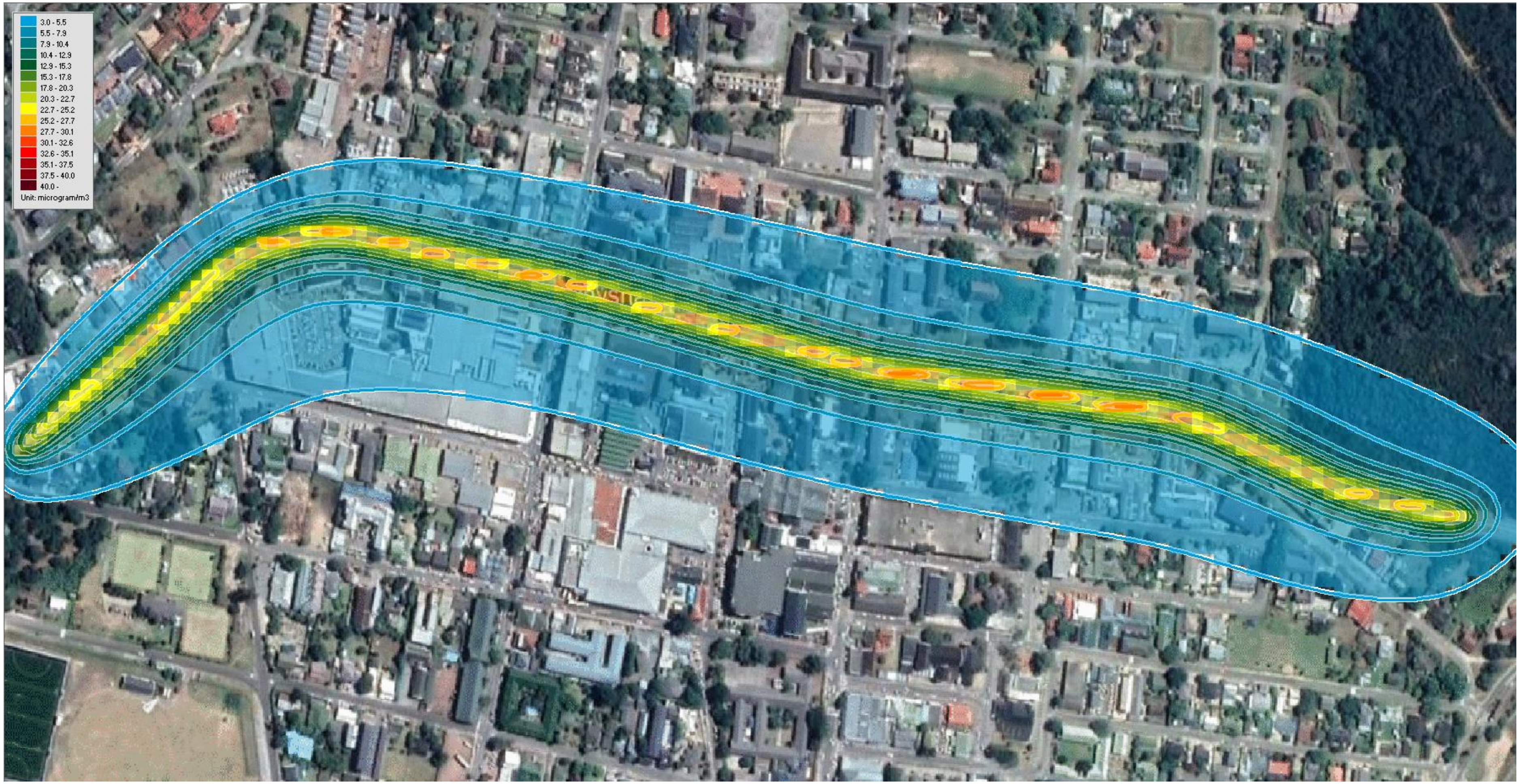

Figure 23: Knysna Main Road: Annual Average NO_2 Concentrations

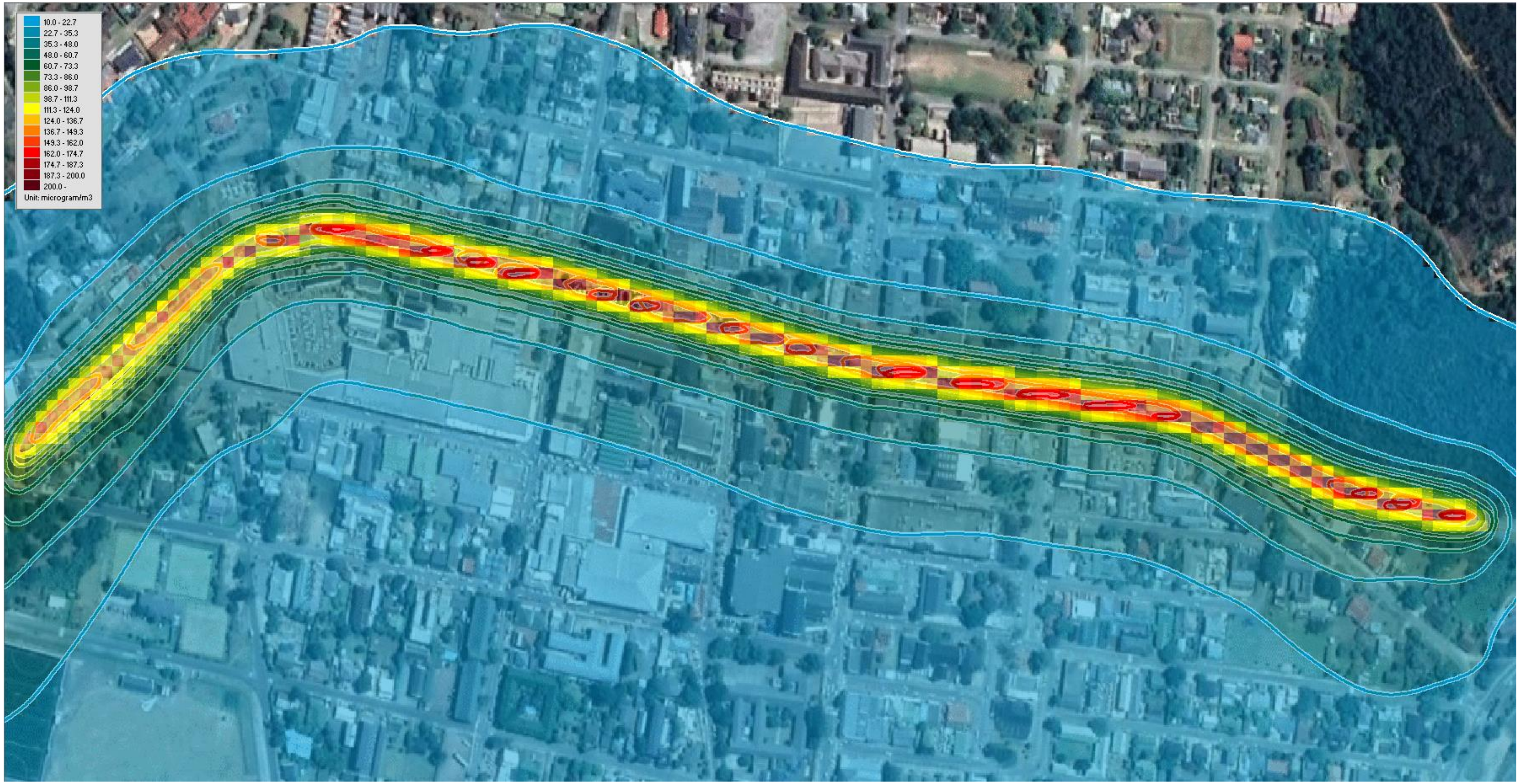

Figure 24: Knysna Main Road: 99-percentile NO_2 Concentrations

Except for Figures 23 and 24, the figures above show that the ground-level concentrations of PM10, SO_2 and CO are well below ambient air quality standards. This not surprising as there are very few sources of air pollutants in the area.

Figure 24 shows that high 99-percentile NO_2 concentrations may exist along virtually the whole length of Main Road in Knysna. This is primarily due to the high volume of traffic that flows through the town on the N2 national road.

The dispersion model estimates that the maximum annual average concentration of NO_2 will be approximately 28.6 µg/m^3 which is approximately 70% of the ambient air quality standard of 40 µg/m^3. The maximum 99-percentile NO_2 concentration will be approximately 216 µg/m^3 which is in excess of the ambient air quality standard of 200 µg/m^3.

Although LAQS is of the opinion that there is too much uncertainty in the estimated vehicle emissions to state categorically that the 99-percentile air quality standard for NO_2 will be exceeded, LAQS is of the opinion that the indications are potentially serious and should be investigated through a targeted air quality monitoring project.

7.3 GEORGE

The dispersion of pollutants from all sources located in the George area is shown graphically in Figures 25 to 34 below.

Figures 25 and 26 respectively show the annual average and 99-percentile 24-hour average ground-level concentrations of all PM10 emissions.

Figures 27 and 28 respectively show the annual average and 99-percentile ground-level concentrations of all sulphur dioxide (SO_2) emissions.

Figures 29 and 30 respectively show the annual average and 99-percentile ground-level concentrations for all nitrogen oxides (NO_2) emissions.

Figures 31 and 32 respectively show the 8-hour average and 99-percentile ground-level concentrations for all carbon monoxide (CO) emissions.

Figures 33 and 34 respectively show the annual average and 99-percentile ground-level concentrations of all odorous emissions

High estimated concentrations are discussed after the graphic results and summarised in Table 15 below.

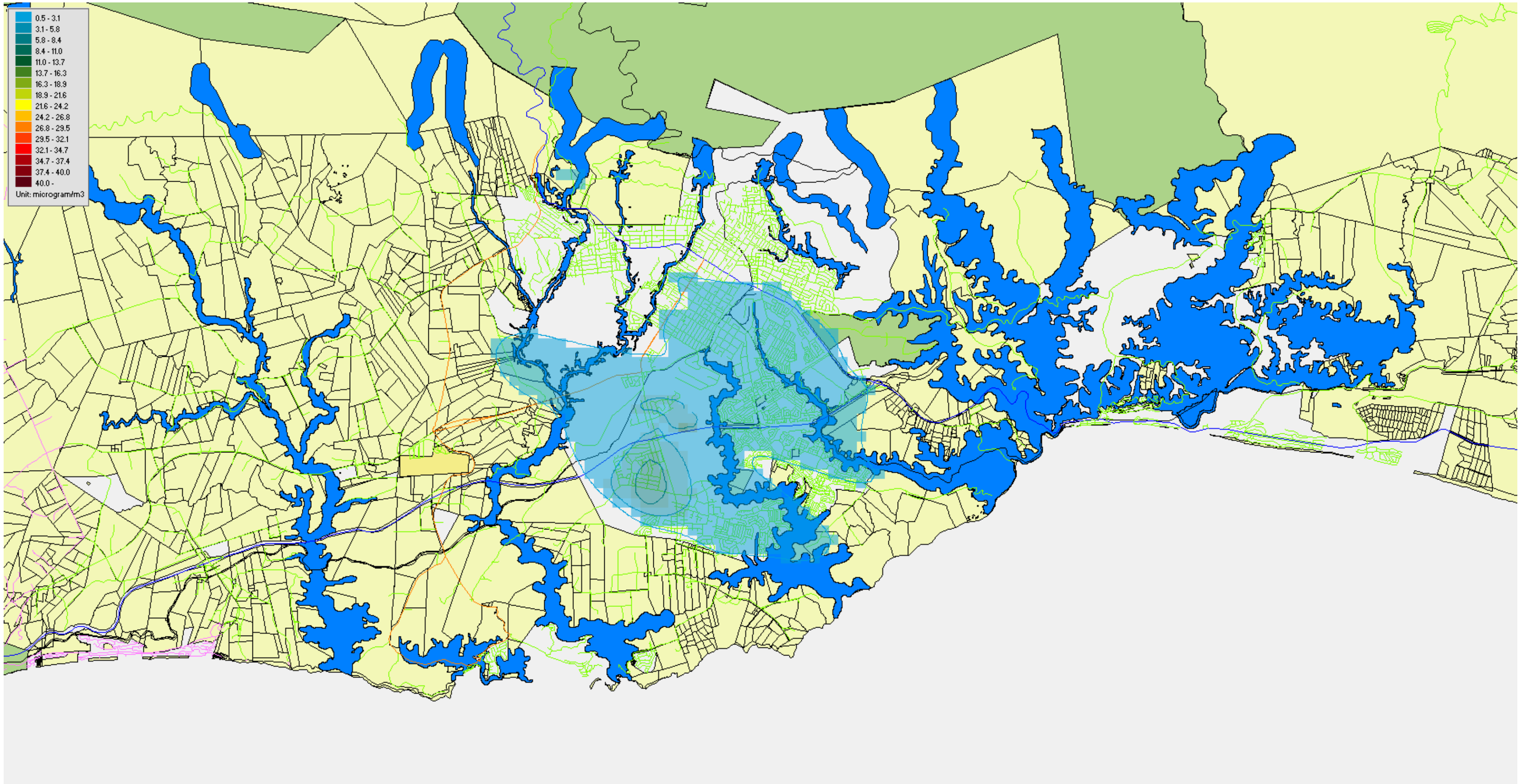

Figure 25: George: Annual Average PM10 Concentrations

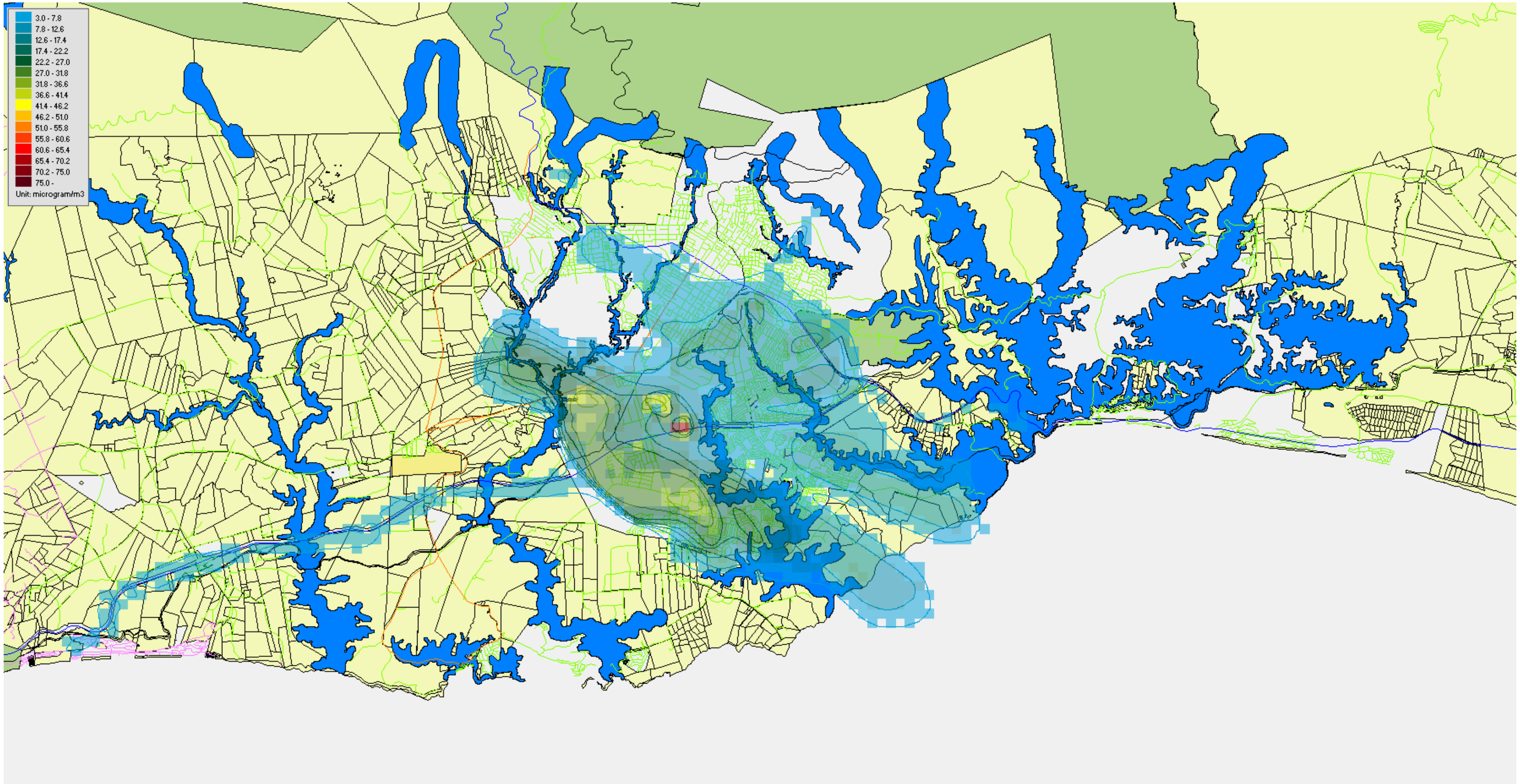

Figure 26: George: 99-percentile PM10 Daily Averaged Concentrations

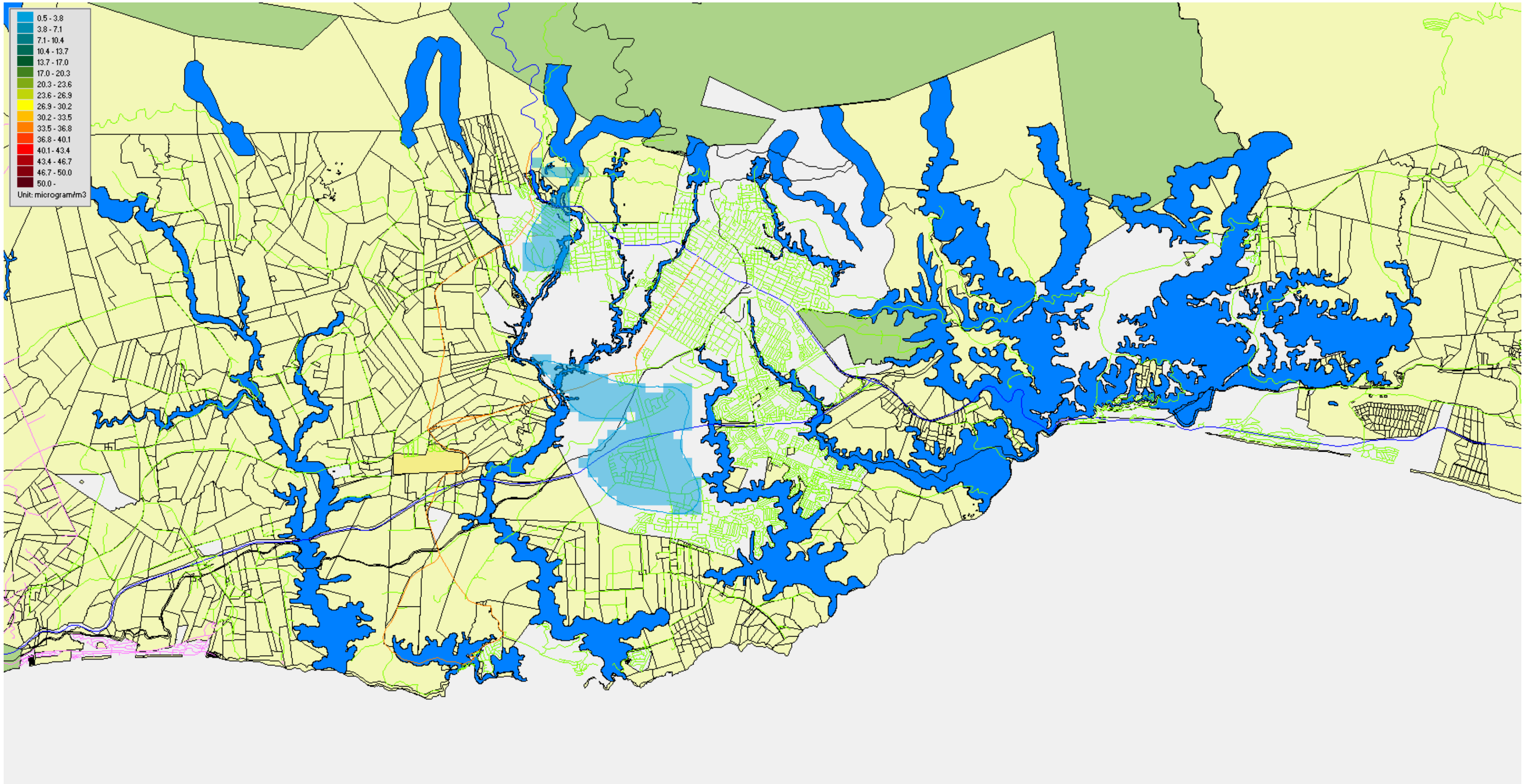

Figure 27: George: Annual Average SO_2 Concentrations

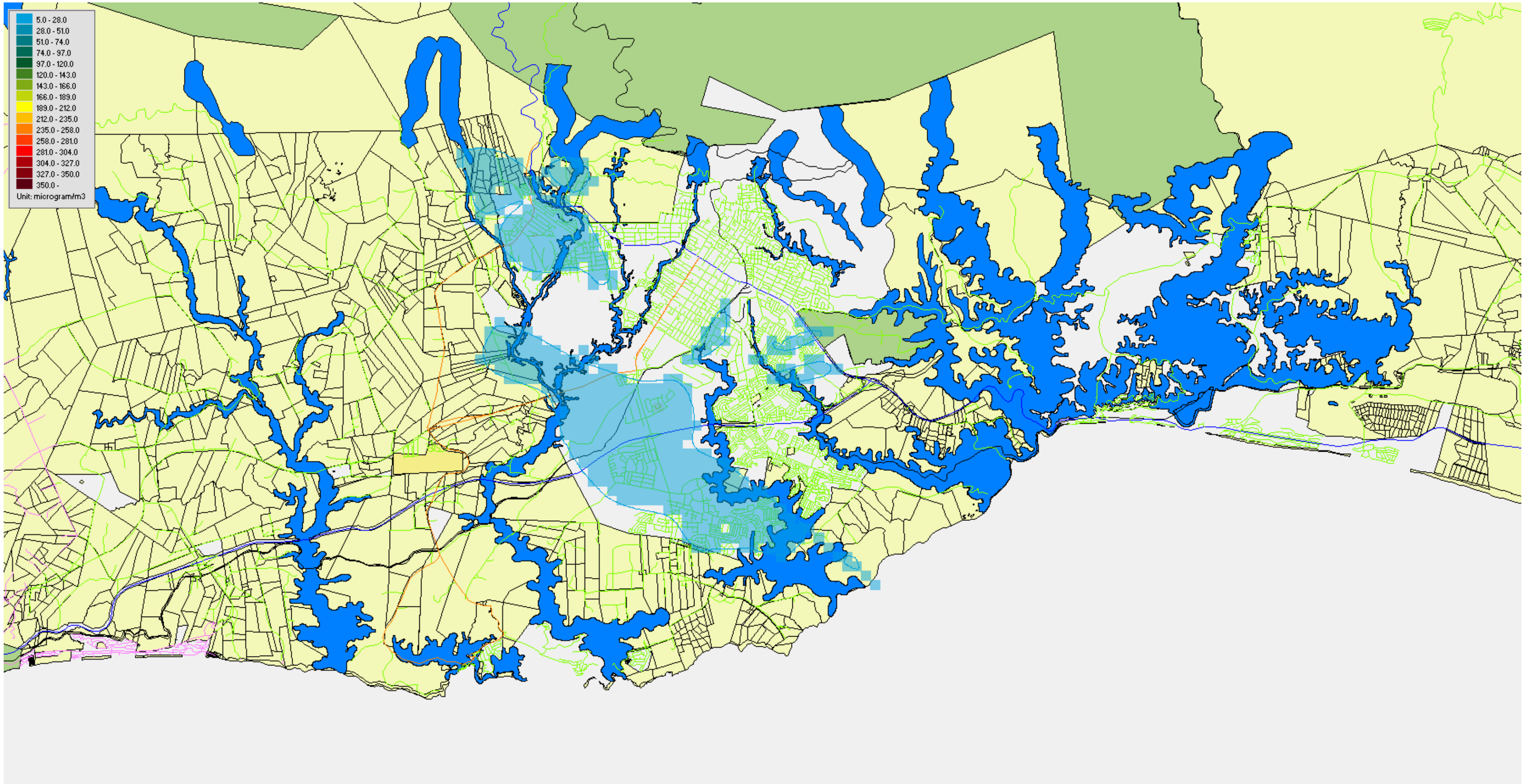

Figure 28: George: 99-percentile SO_2 Concentrations

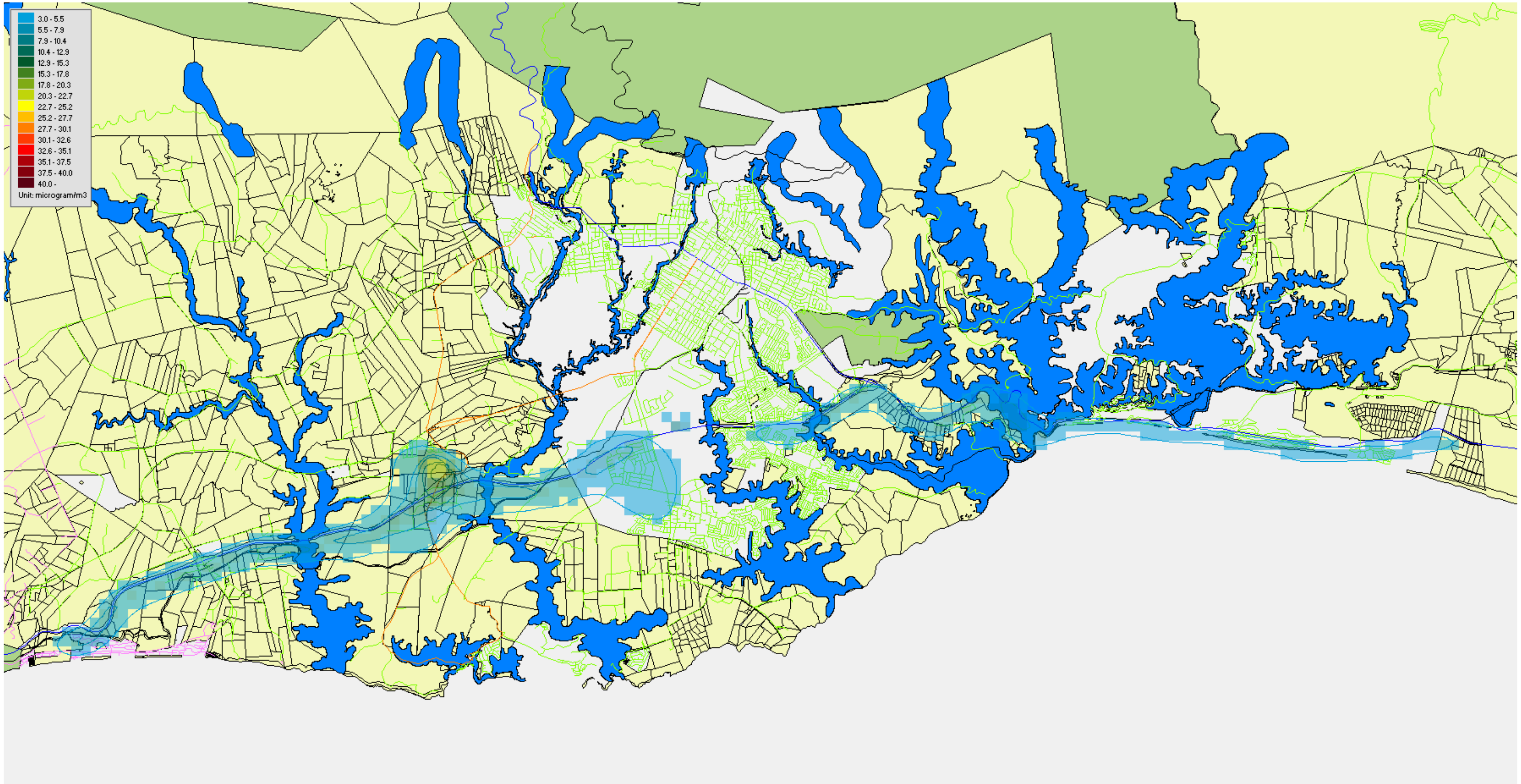

Figure 29: George: Annual Average NO_2 Concentrations

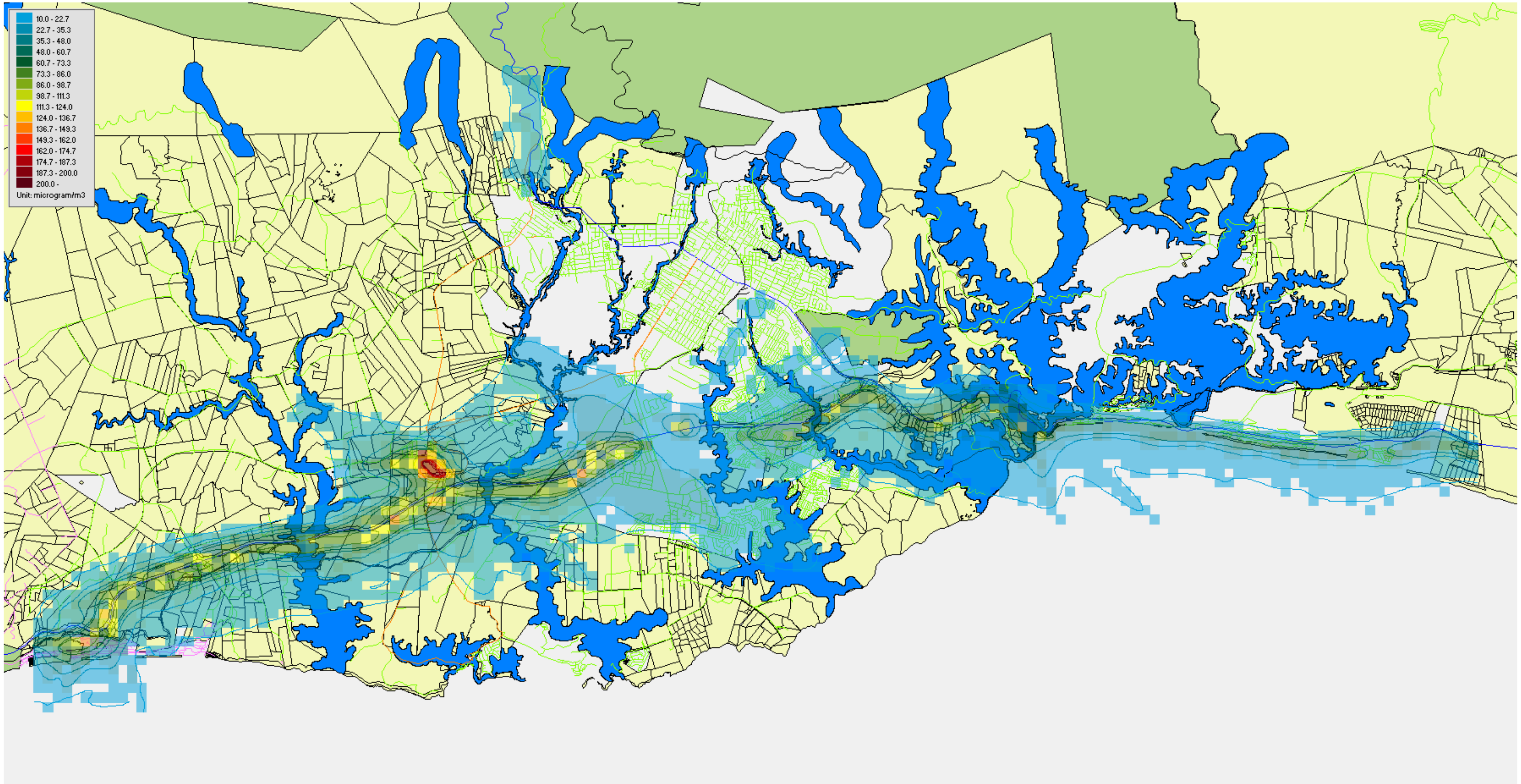

Figure 30: George: 99-percentile NO_2 Concentrations

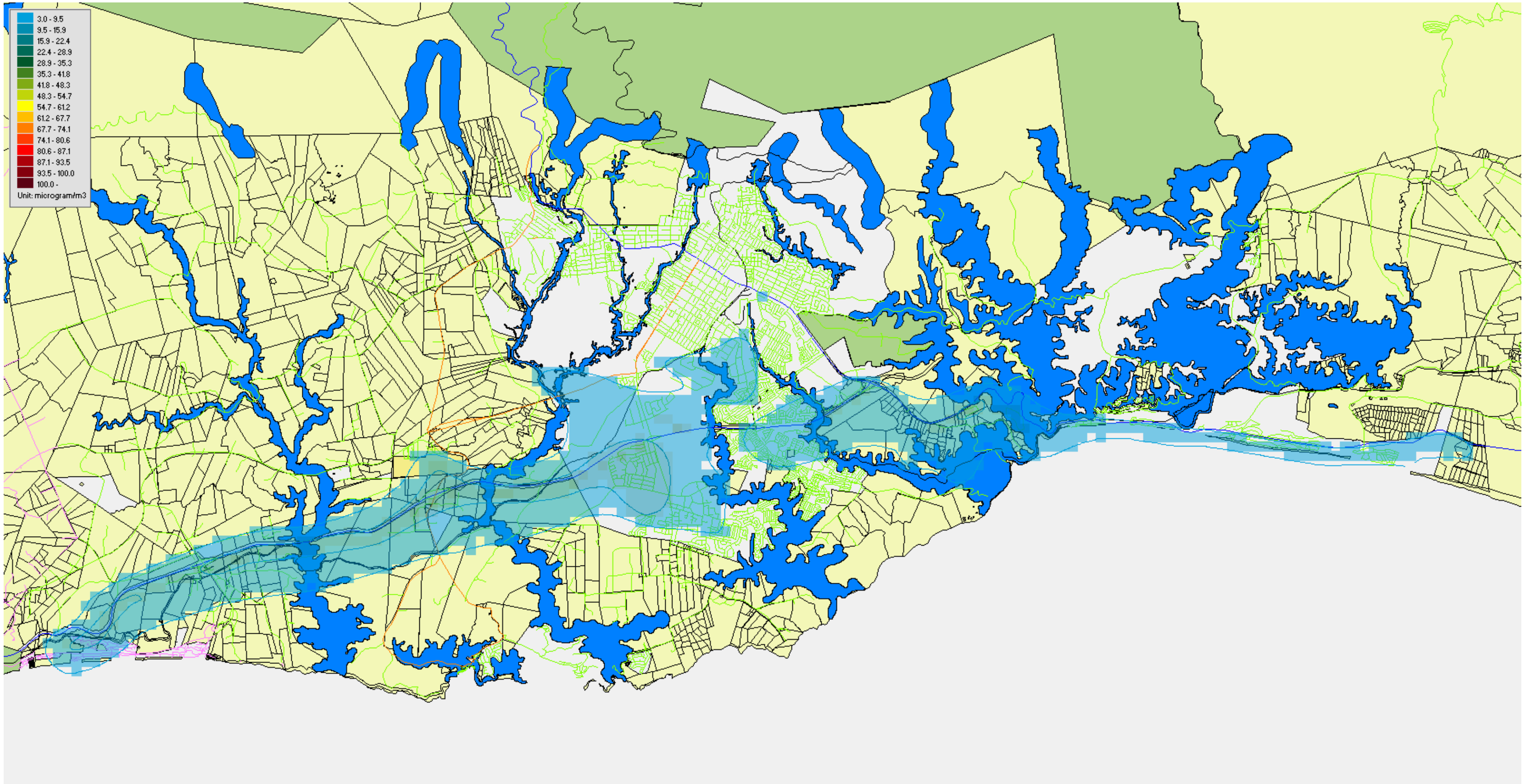

Figure 31: George: 8-hour Average CO Concentrations

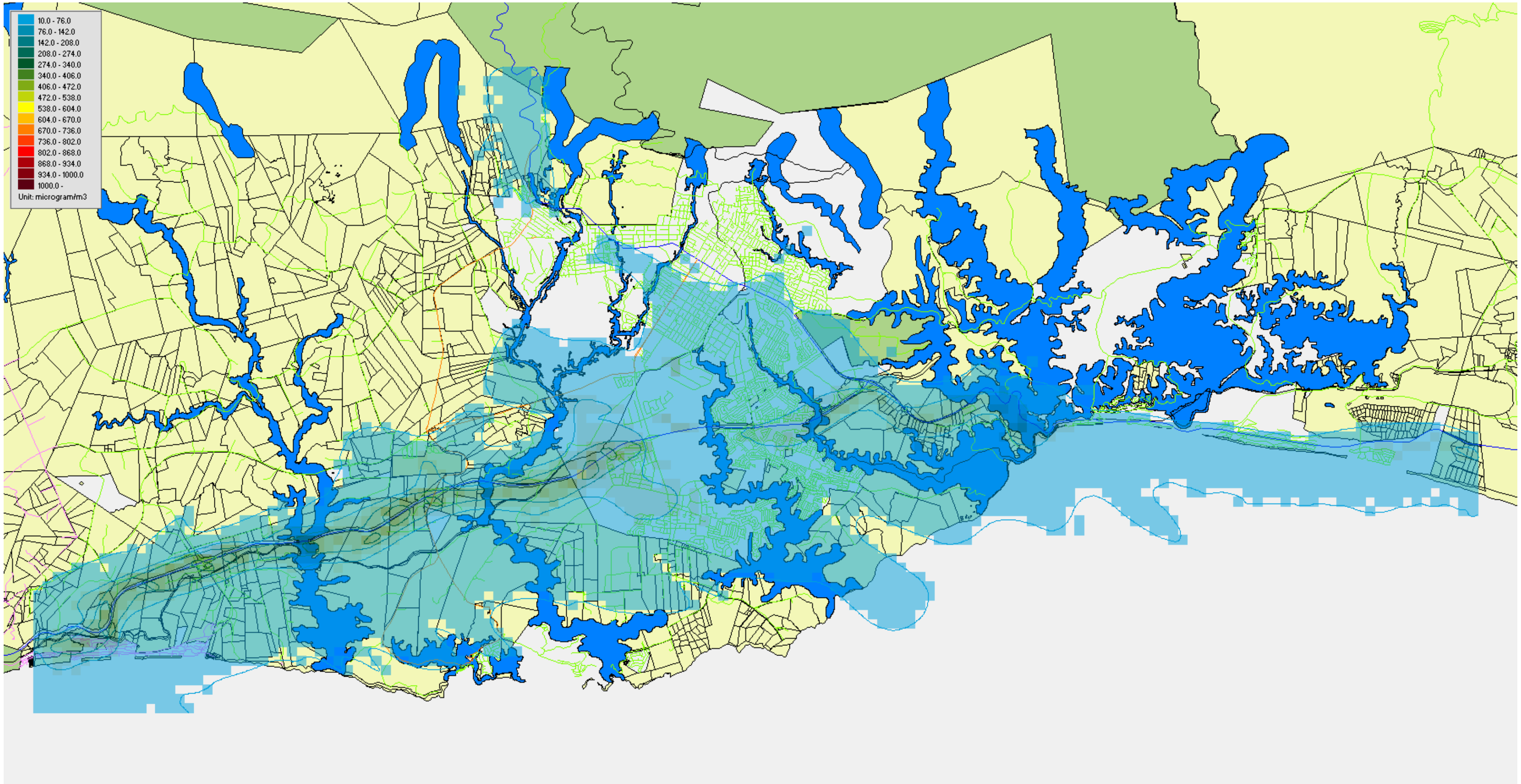

Figure 32: George: 99-percentile CO Concentrations

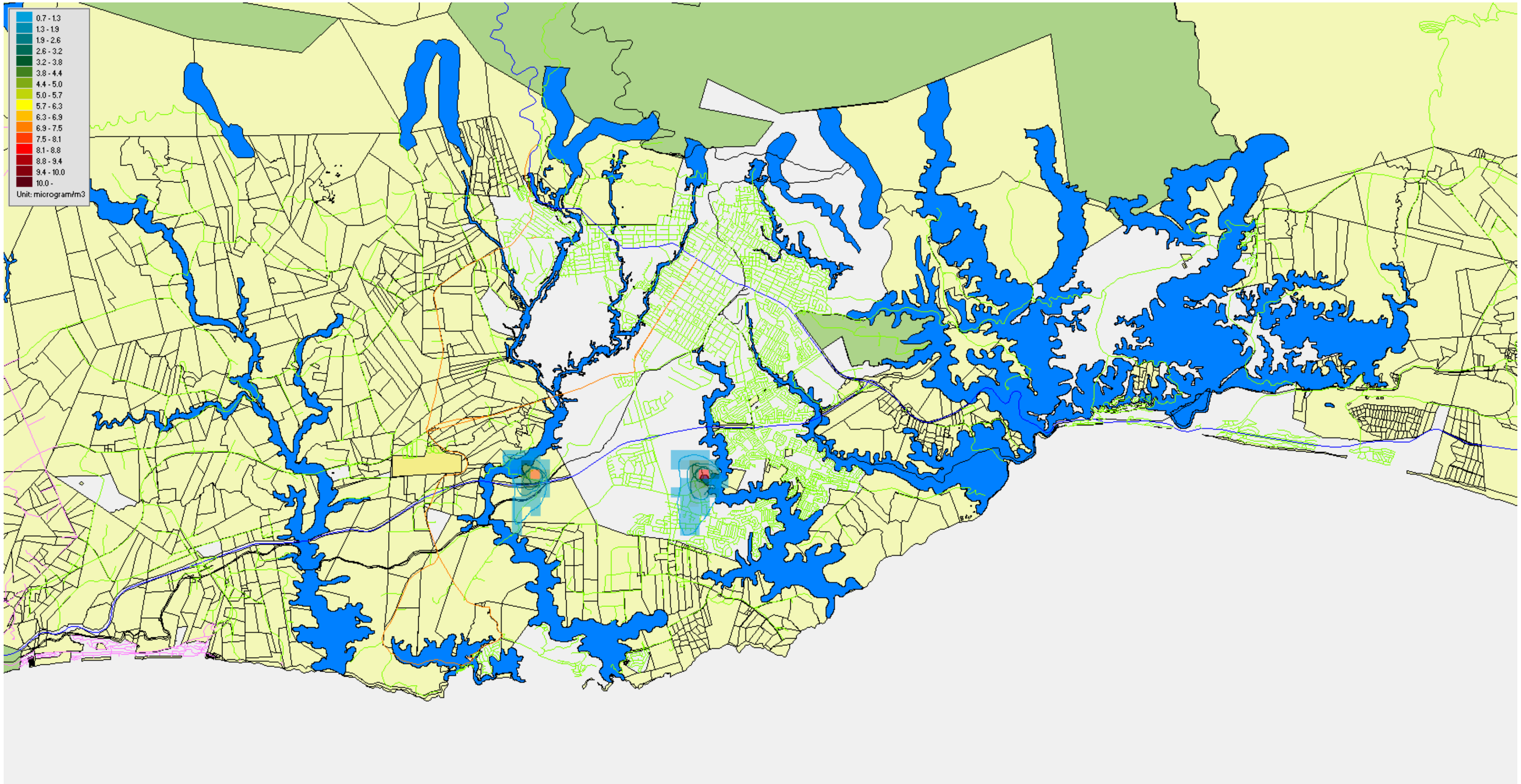

Figure 33: George: Annual Average Odour Concentrations

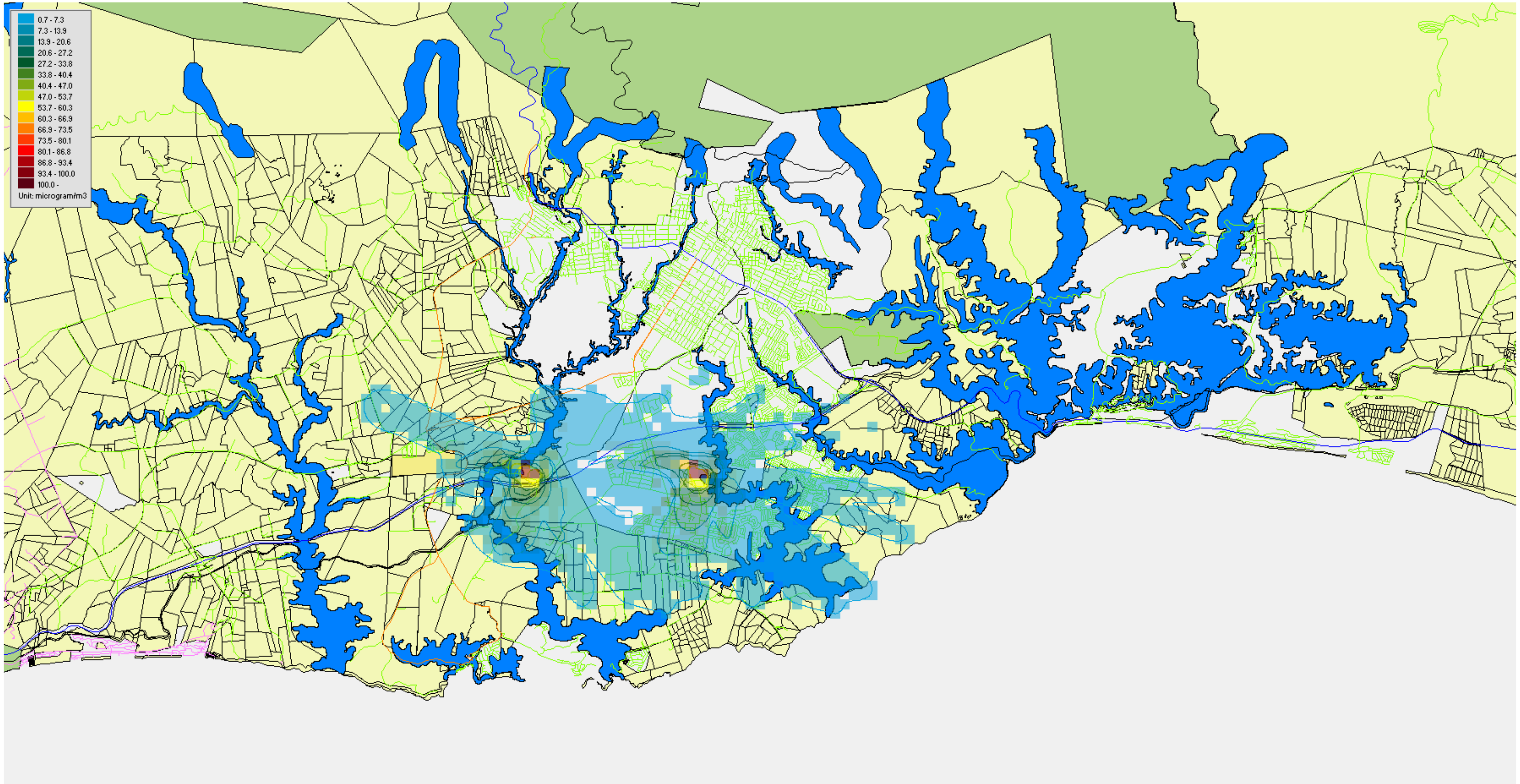

Figure 34: George: 99-percentile Odour Concentrations

As can be expected, the emissions from industries located in the industrial area immediately north of the N2 and east of York Street contribute the most to ground-level air pollutants in George.

While the estimated ground-level concentrations of most of the pollutants are well below the relevant ambient air quality standards, the dispersion model estimates that the 99-percentile ambient air quality standard for PM10 is estimated to be 76.6 $\mu g/m^3$ which is marginally higher than the air quality limit of 75 $\mu g/m^3$.

The dispersion model further estimates that the maximum 99-percentile air quality standard of 75 μ/m^3 may be exceeded marginally in the vicinity of the Airport where a maximum ground-level concentration of 77 μ/m^3 is estimated.

As is the case with NO_2 emissions in Knysna, there is too much uncertainty in the calculation of PM10 and NO_2 emissions from the various industries in the area to make a categorical statement to this effect. It is recommended that a dedicated PM10 monitoring program is set up to monitor the situation in the industrial area over a period of time.

7.4 MOSSEL BAY

The dispersion of pollutants from all sources is shown graphically in Figures 35 to 44 below.

Figures 35 and 36 respectively show the annual average and 99-percentile 24-hour average ground-level concentrations of all PM10 emissions.

Figures 37 and 38 respectively show the annual average and 99-percentile ground-level concentrations of all sulphur dioxide (SO_2) emissions.

Figures 39 and 40 respectively show the annual average and 99-percentile ground-level concentrations for all nitrogen oxides (NO_2) emissions.

Figures 41 and 42 respectively show the 8-hour average and 99-percentile ground-level concentrations for all carbon monoxide (CO) emissions.

Figures 43 and 44 respectively show the annual average and 99-percentile ground-level concentrations of all odorous emissions

High estimated concentrations are discussed after the graphic results and summarised in Table 15 below.

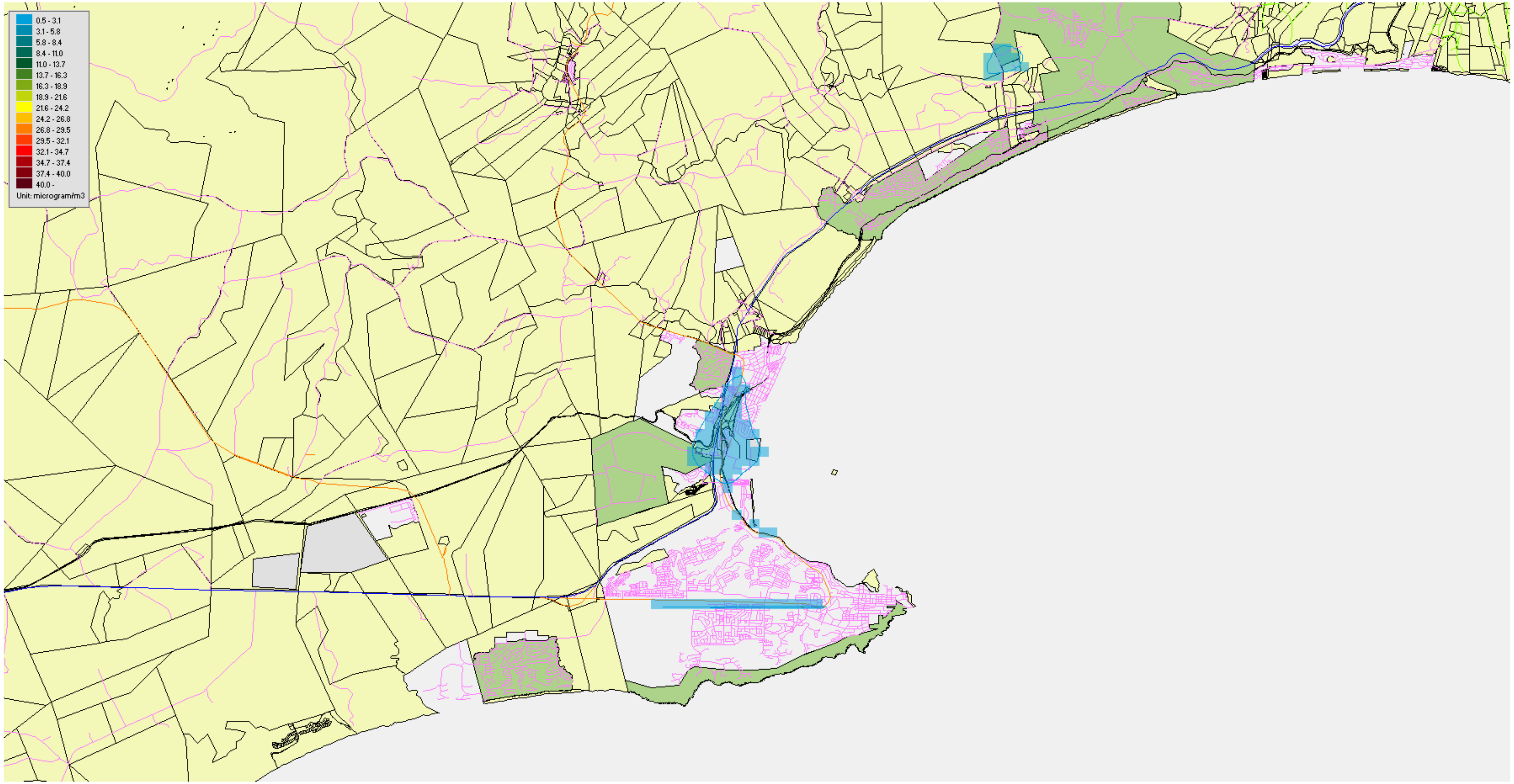

Figure 35: Mossel Bay: Annual Average PM10 Concentrations

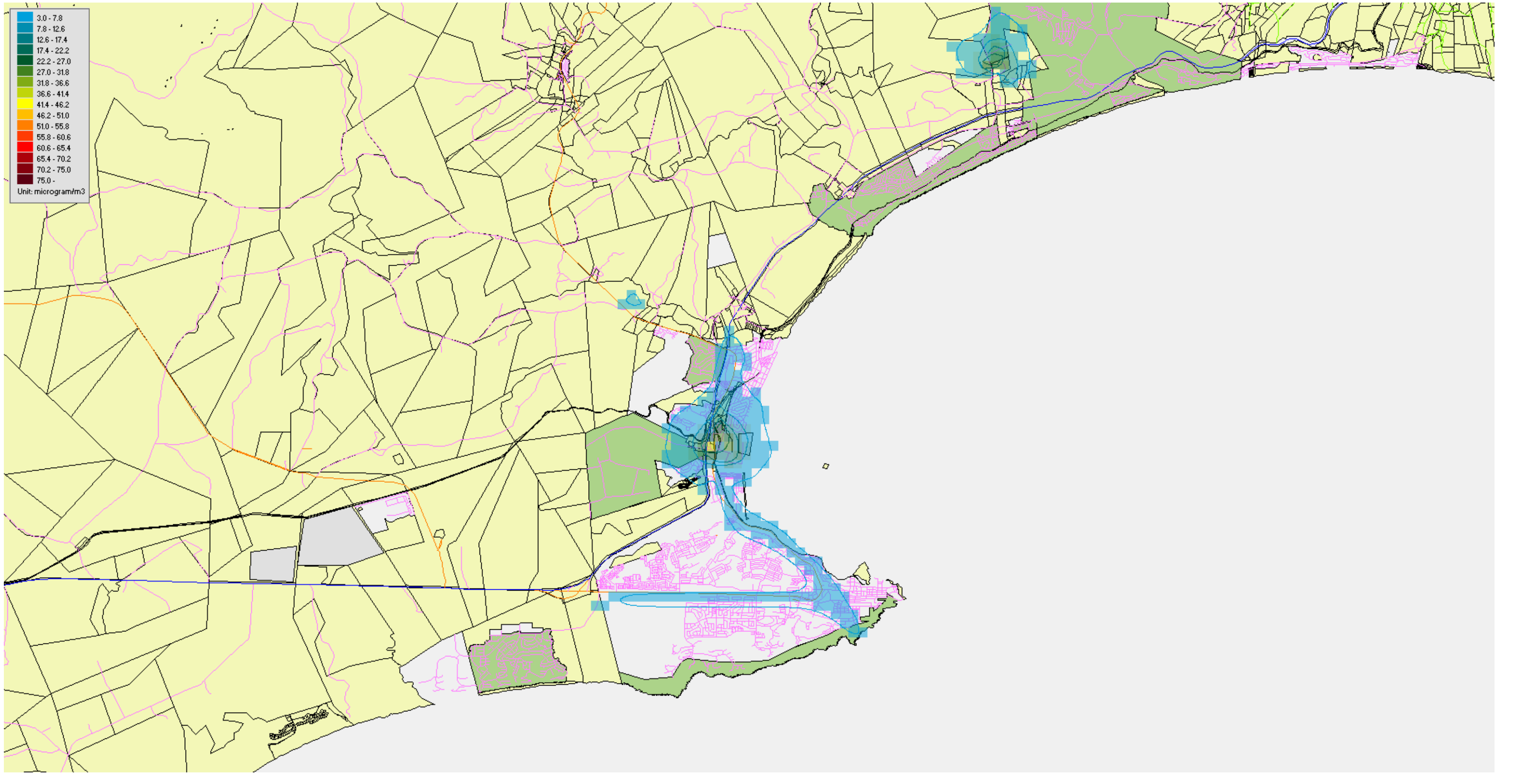

Figure 36: Mossel Bay: 99-percentile PM10 Daily Averaged Concentrations

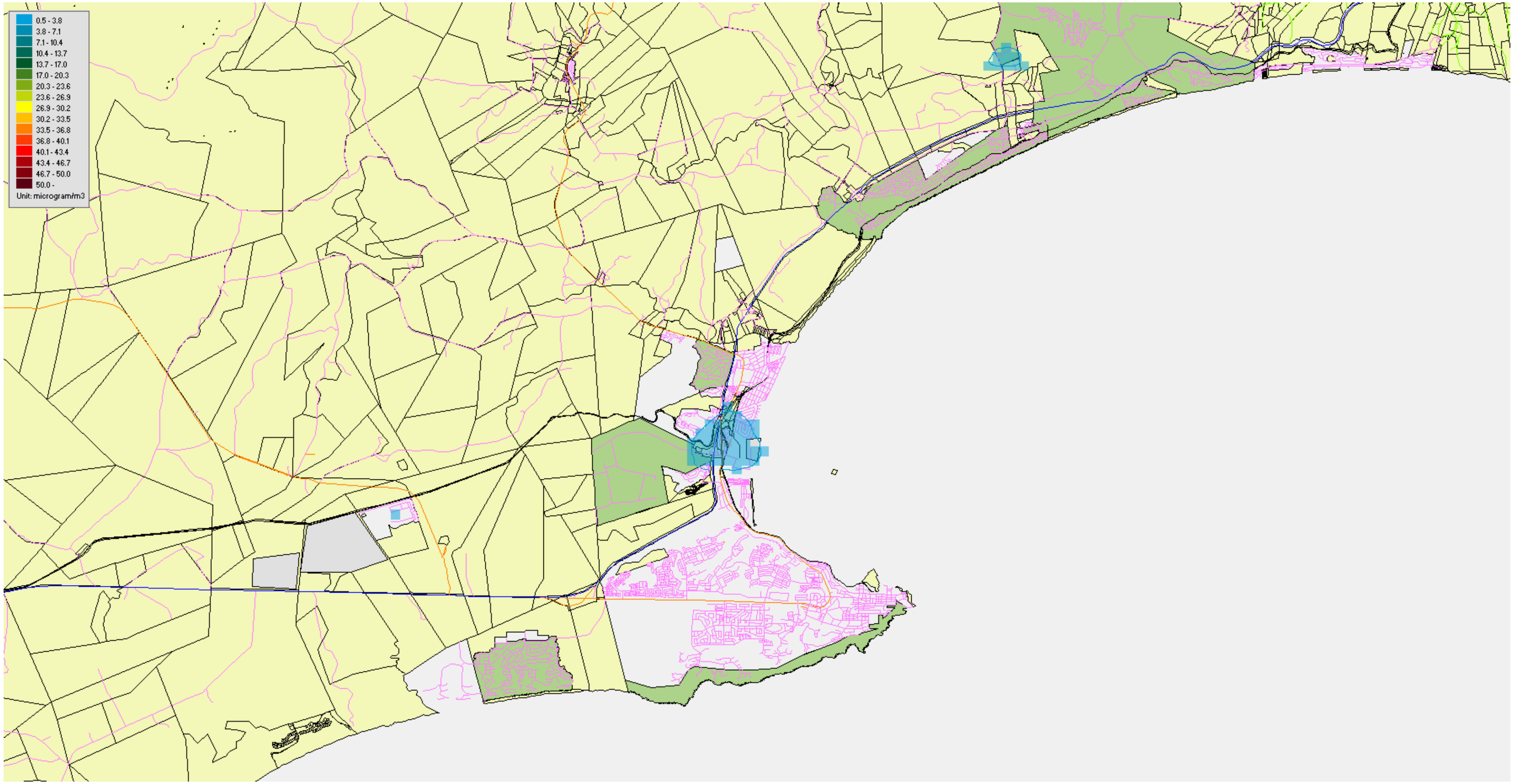

Figure 37: Mossel Bay: Annual Average SO_2 Concentrations

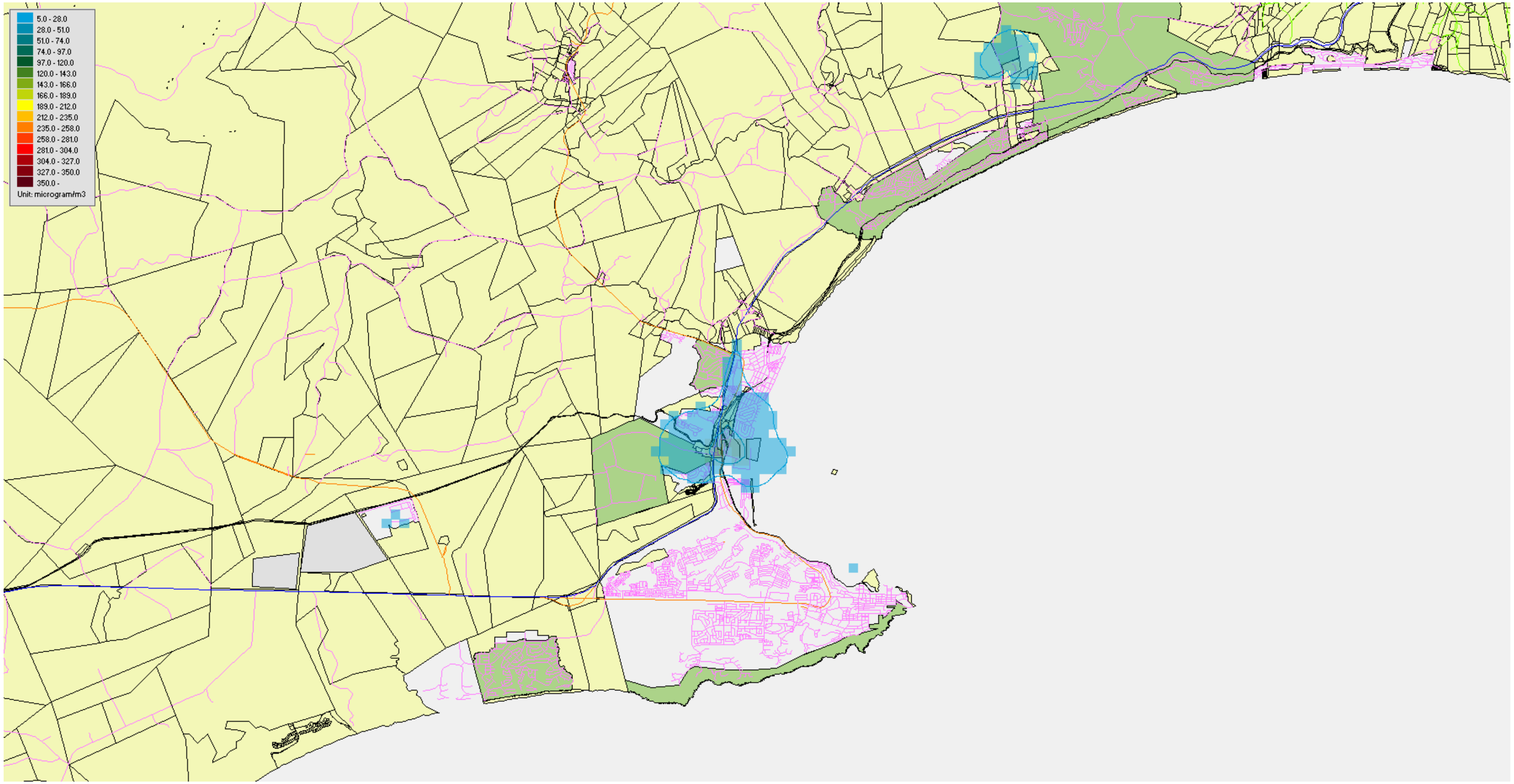

Figure 38: Mossel Bay: 99-percentile SO_2 Concentrations

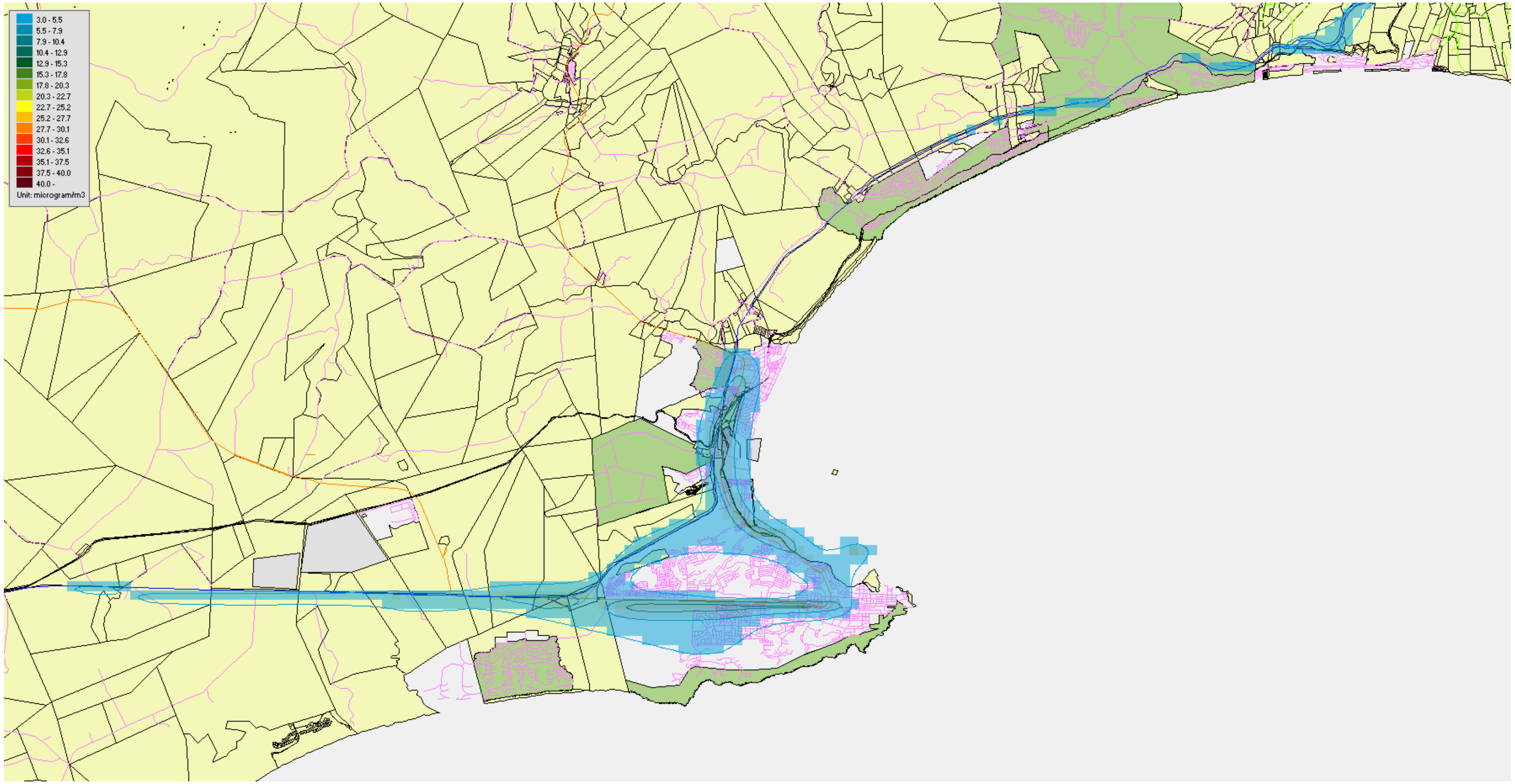

Figure 39: Mossel Bay: Annual Average NO_2 Concentrations

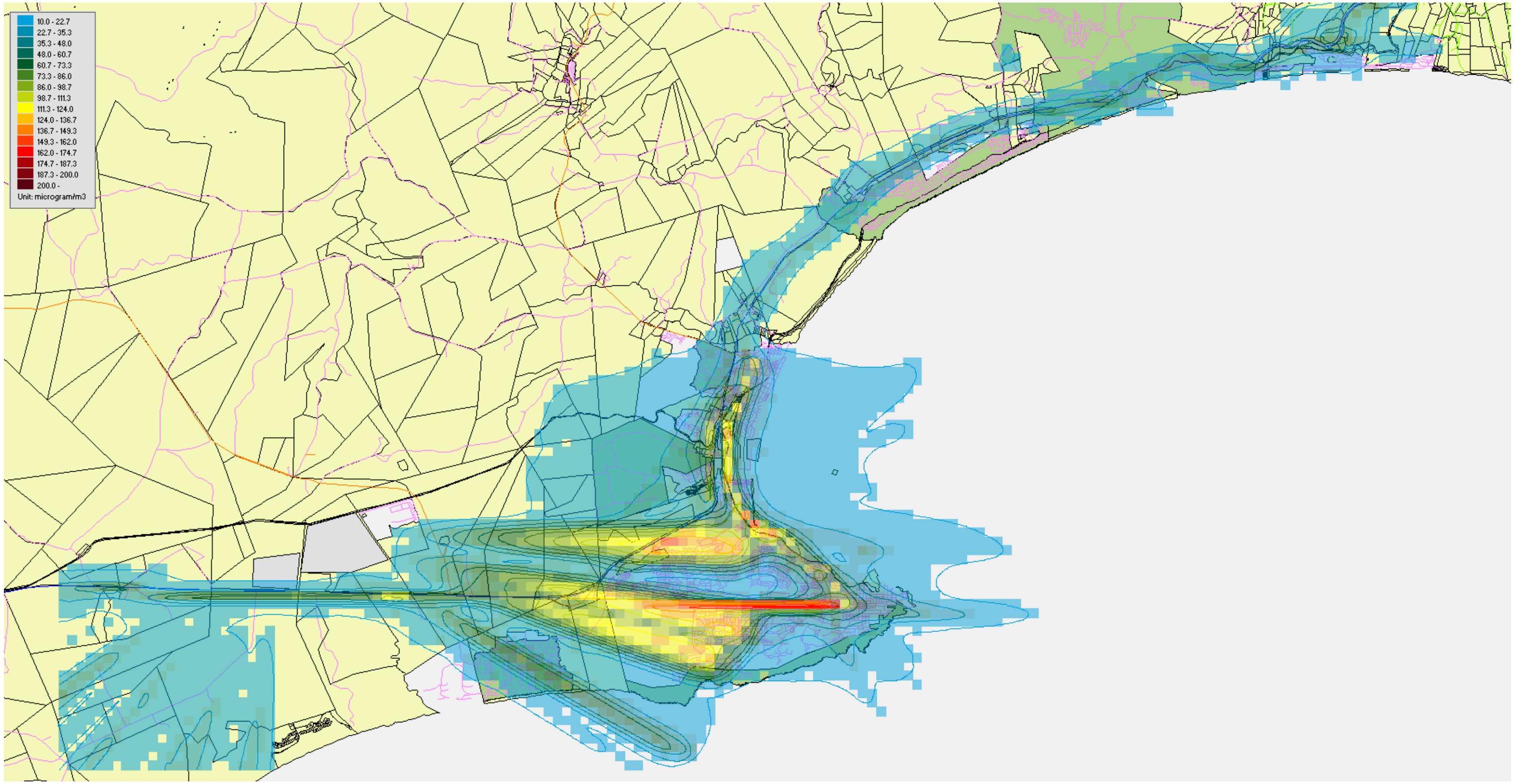

Figure 40: Mossel Bay: 99-percentile NO_2 Concentrations

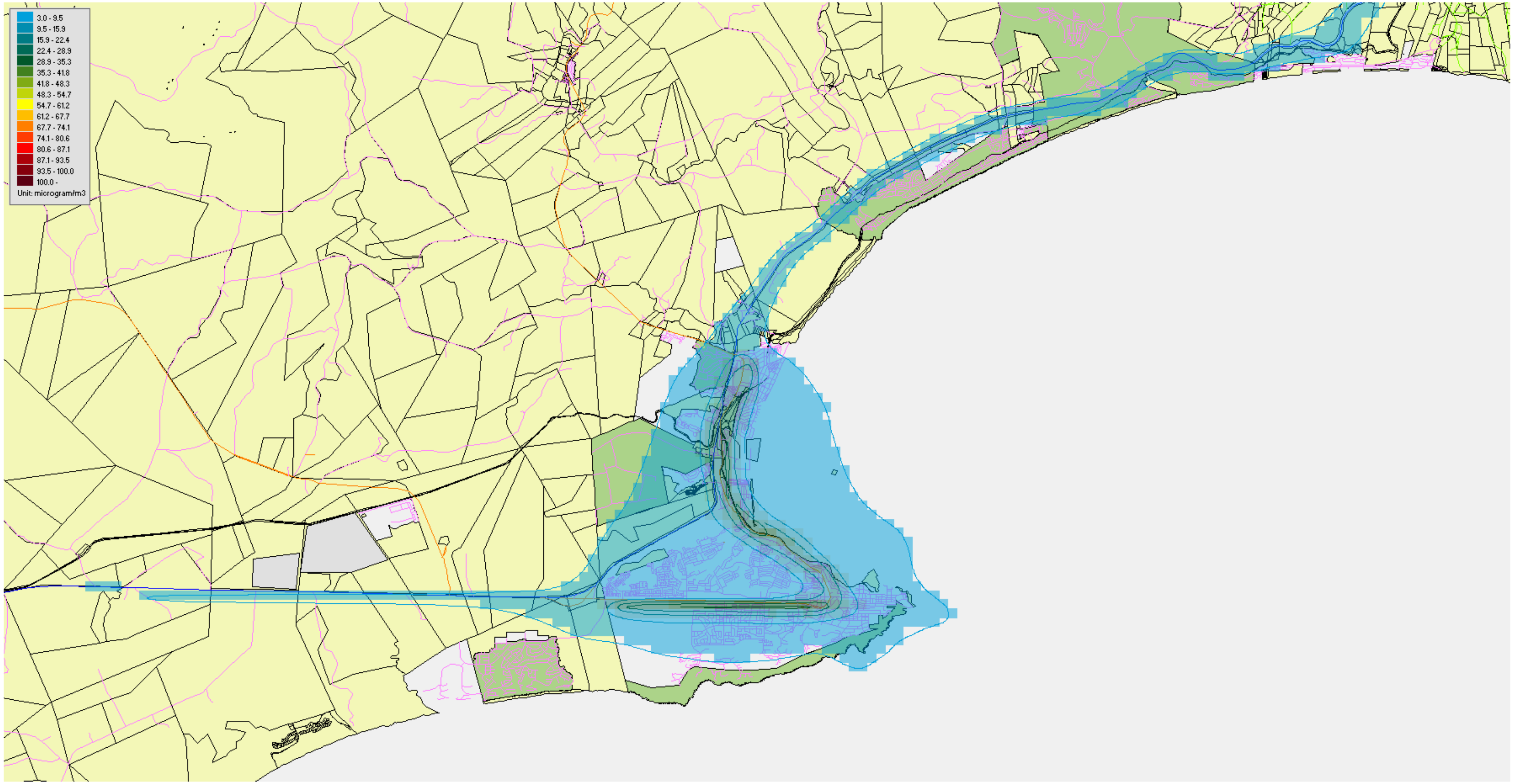

Figure 41: Mossel Bay: 8-hour Average CO Concentrations

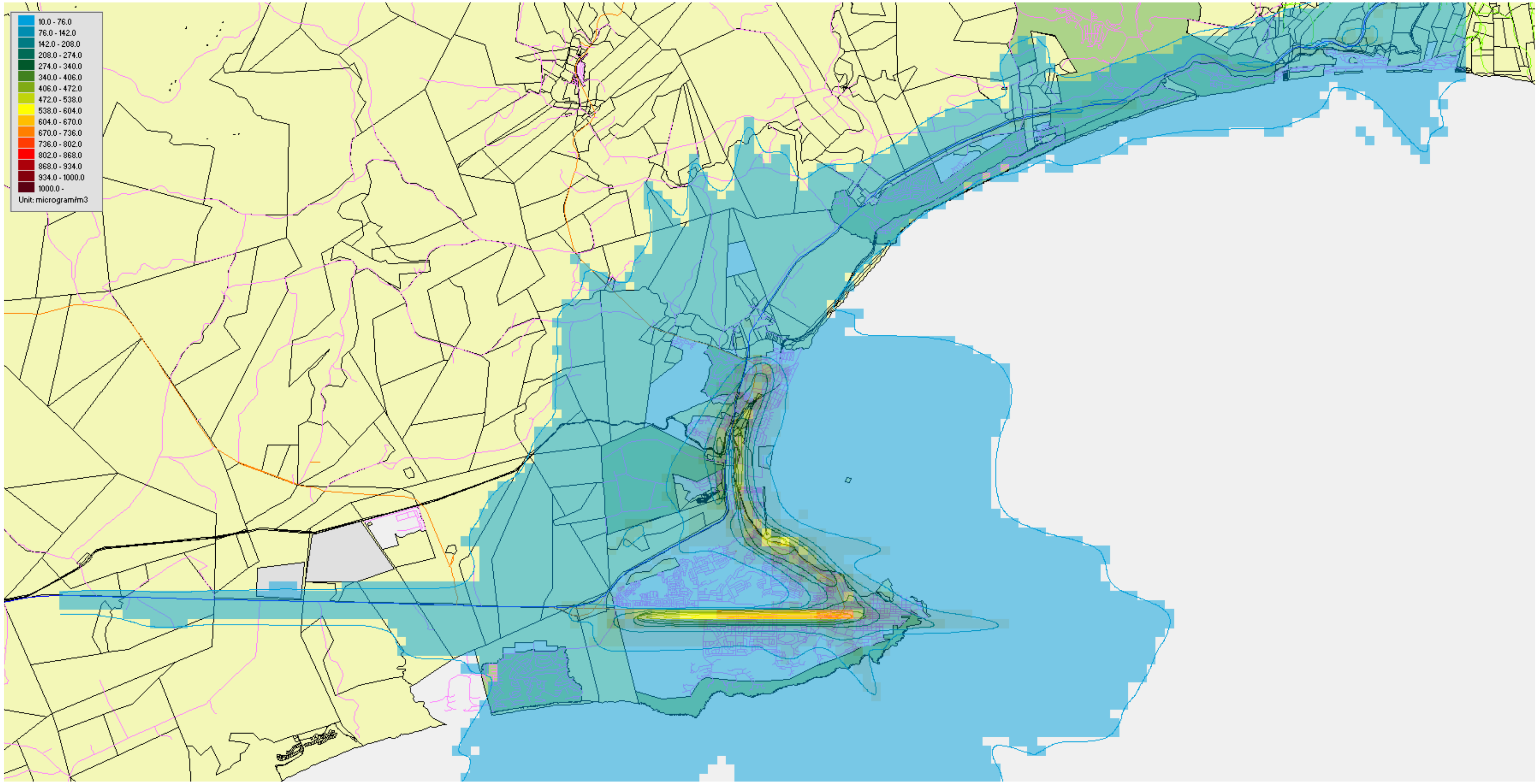

Figure 42: Mossel Bay: 99-percentile CO Concentrations

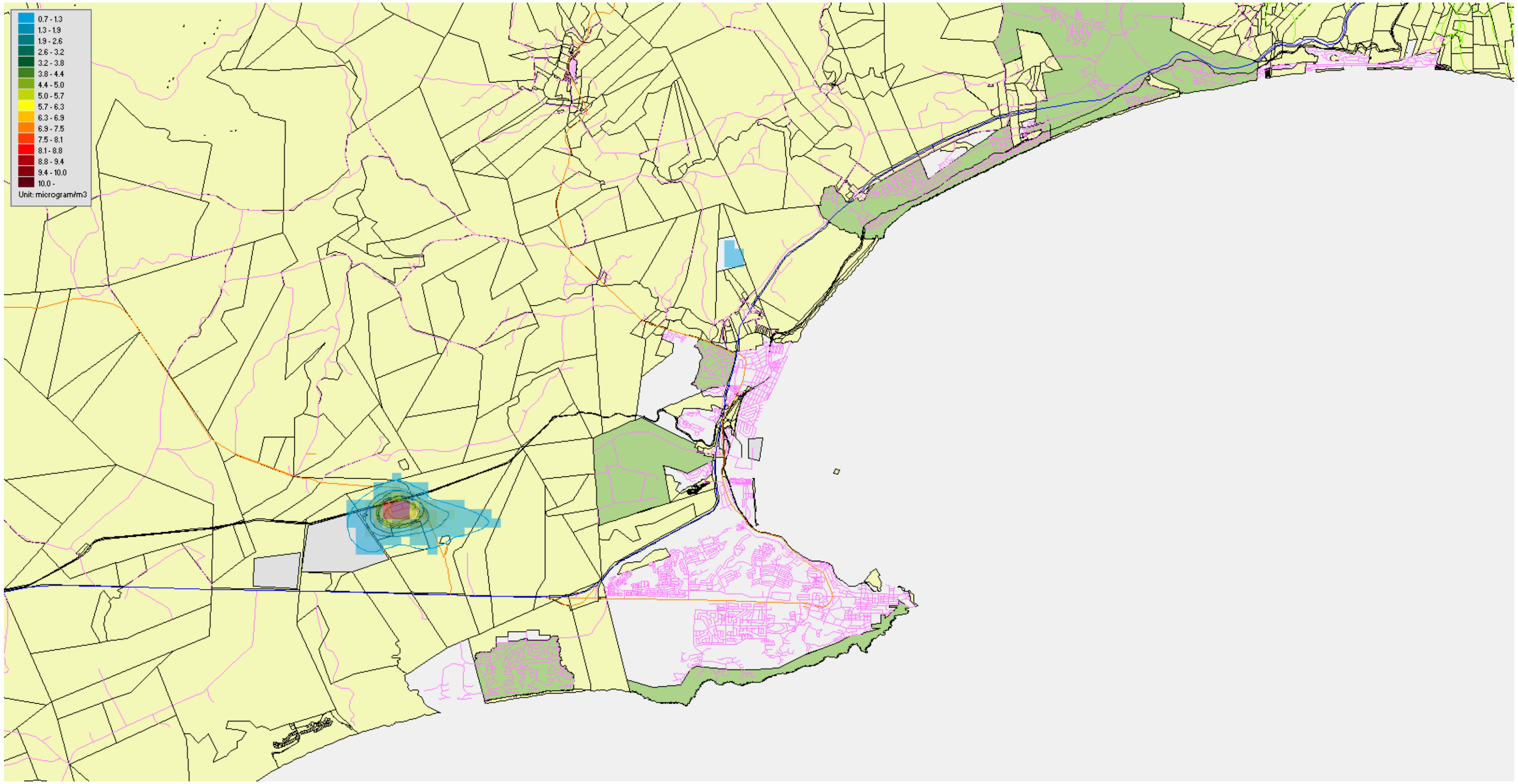

Figure 43: Mossel Bay: Annual Average Odour Concentrations

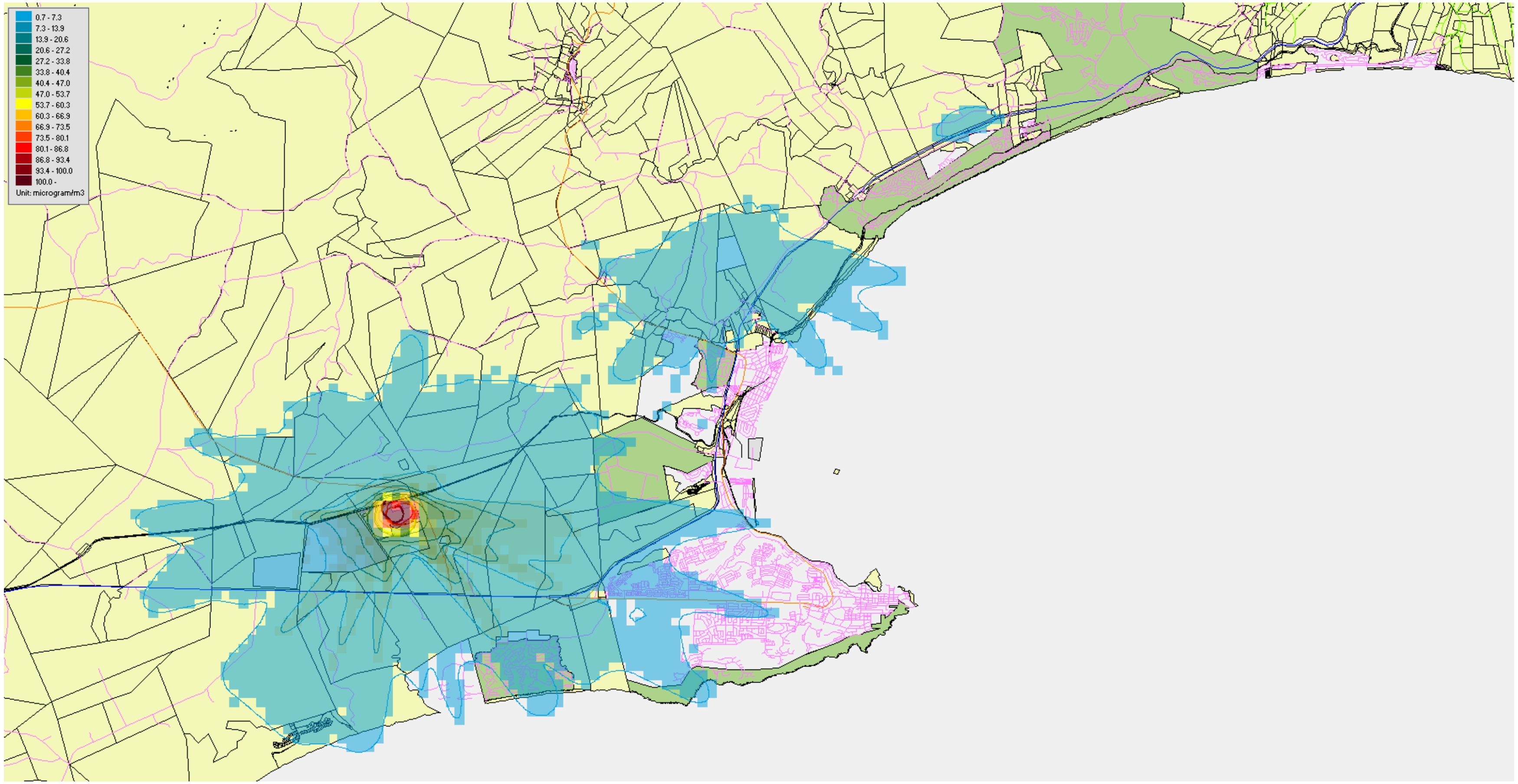

Figure 44: Mossel Bay: 99-percentile Odour Concentrations

The following information can be deduced from the isopleths shown in Figures 35 to 44 above:

-- The impact of vehicle related NO_2 emissions along the R102 past Voorbaai and towards Heiderand. The highest 99-percentile value estimated by the dispersion model is 176 µg/m^3 which is approximately 88% of the relevant ambient air quality standard of 200 µg/m^3.

-- As is known, the main sources of odorous emission are located in Mossdustria and the dispersion model estimates that odours will generally be detectable in and around that area. The 99-percentile simulation shows that odours could extend well to the south-east and south-west of Mossdustria and can cover Dana Bay and the western parts of Mossel Bay.

7.5 HESSEQUA

The dispersion of pollutants from all sources is shown graphically in Figures 45 to 54 below.

Figures 45 and 46 respectively show the annual average and 99-percentile 24-hour average ground-level concentrations of all PM10 emissions.

Figures 47 and 48 respectively show the annual average and 99-percentile ground-level concentrations of all sulphur dioxide (SO_2) emissions.

Figures 49 and 50 respectively show the annual average and 99-percentile ground-level concentrations for all nitrogen oxides (NO_2) emissions.

Figures 51 and 52 respectively show the 8-hour average and 99-percentile ground-level concentrations for all carbon monoxide (CO) emissions.

Figures 53 and 54 respectively show the annual average and 99-percentile ground-level concentrations of all odorous emissions

High estimated concentrations are discussed after the graphic results and summarised in Table 15 below.

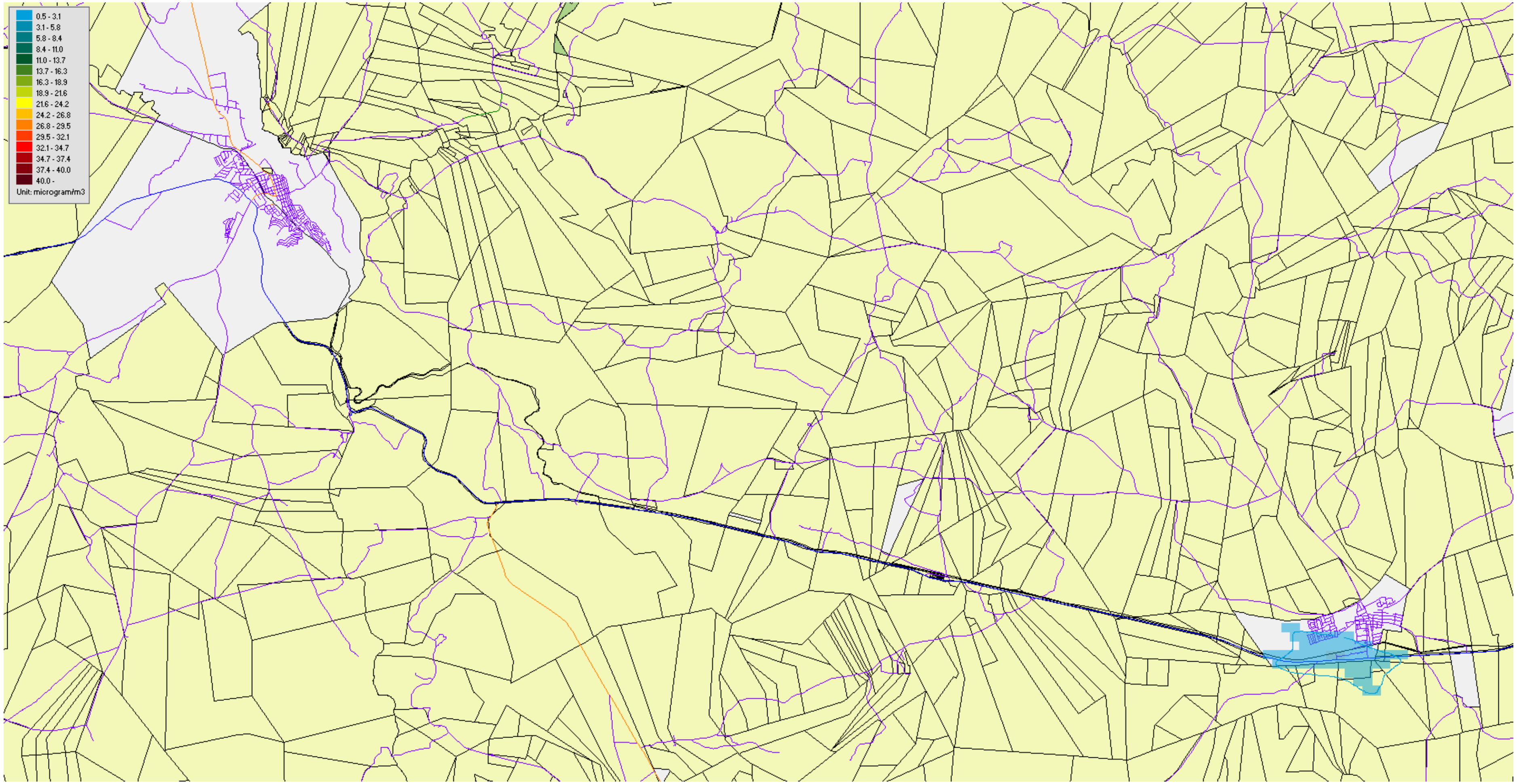

Figure 45: Hessequa: Annual Average PM10 Concentrations

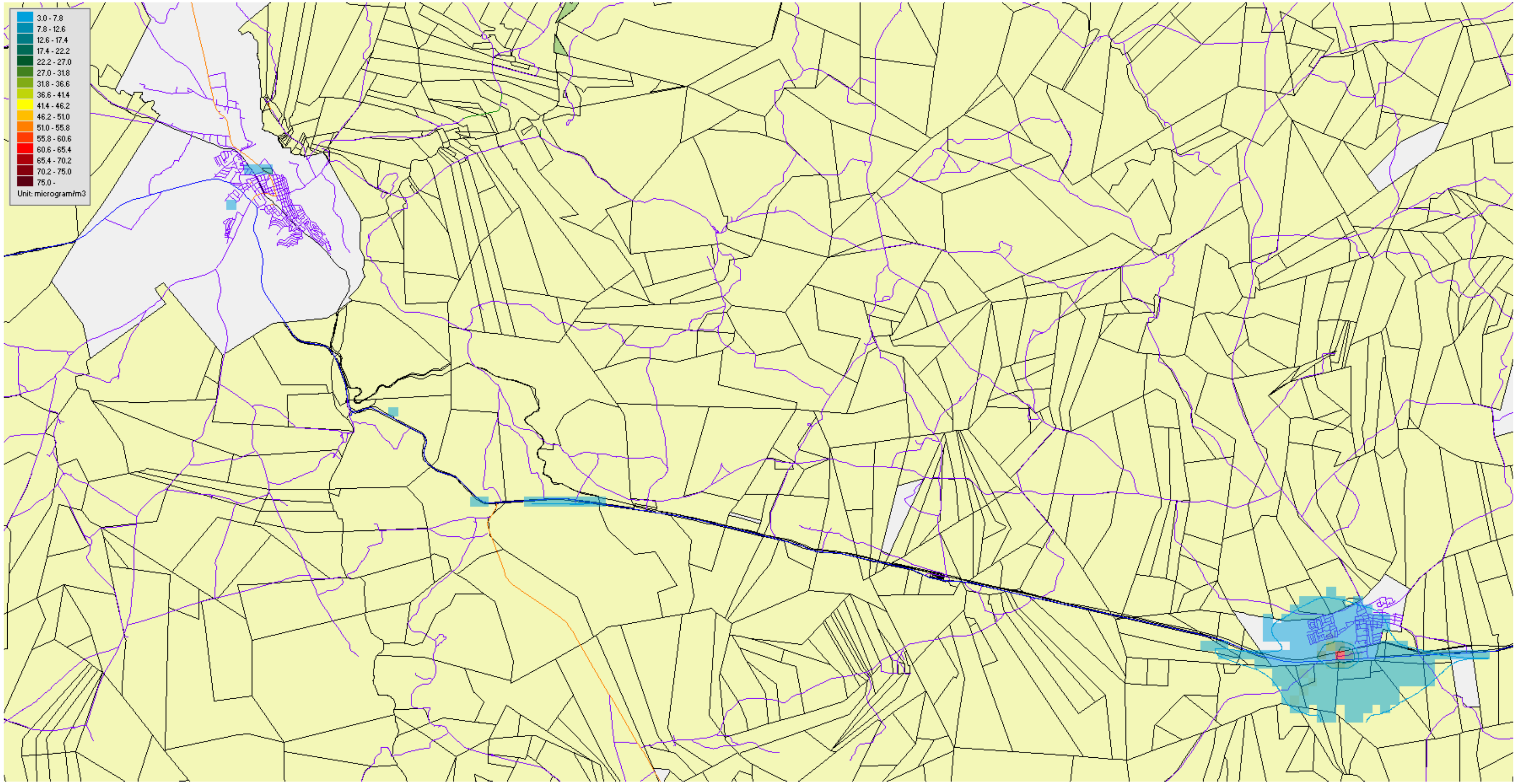

Figure 46: Hessequa: 99-percentile PM10 Daily Averaged Concentrations

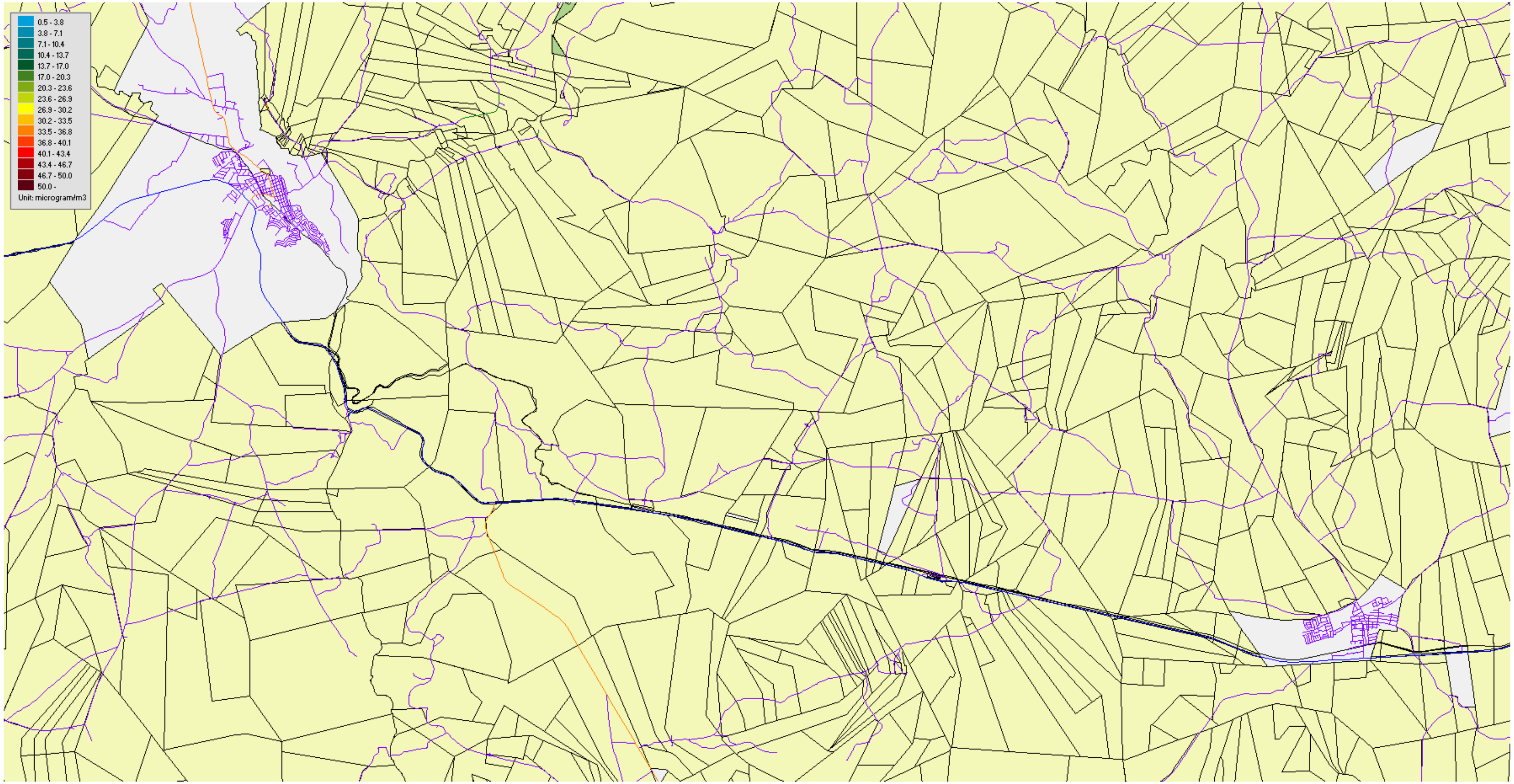

Figure 47: Hessequa: Annual Average SO_2 Concentrations

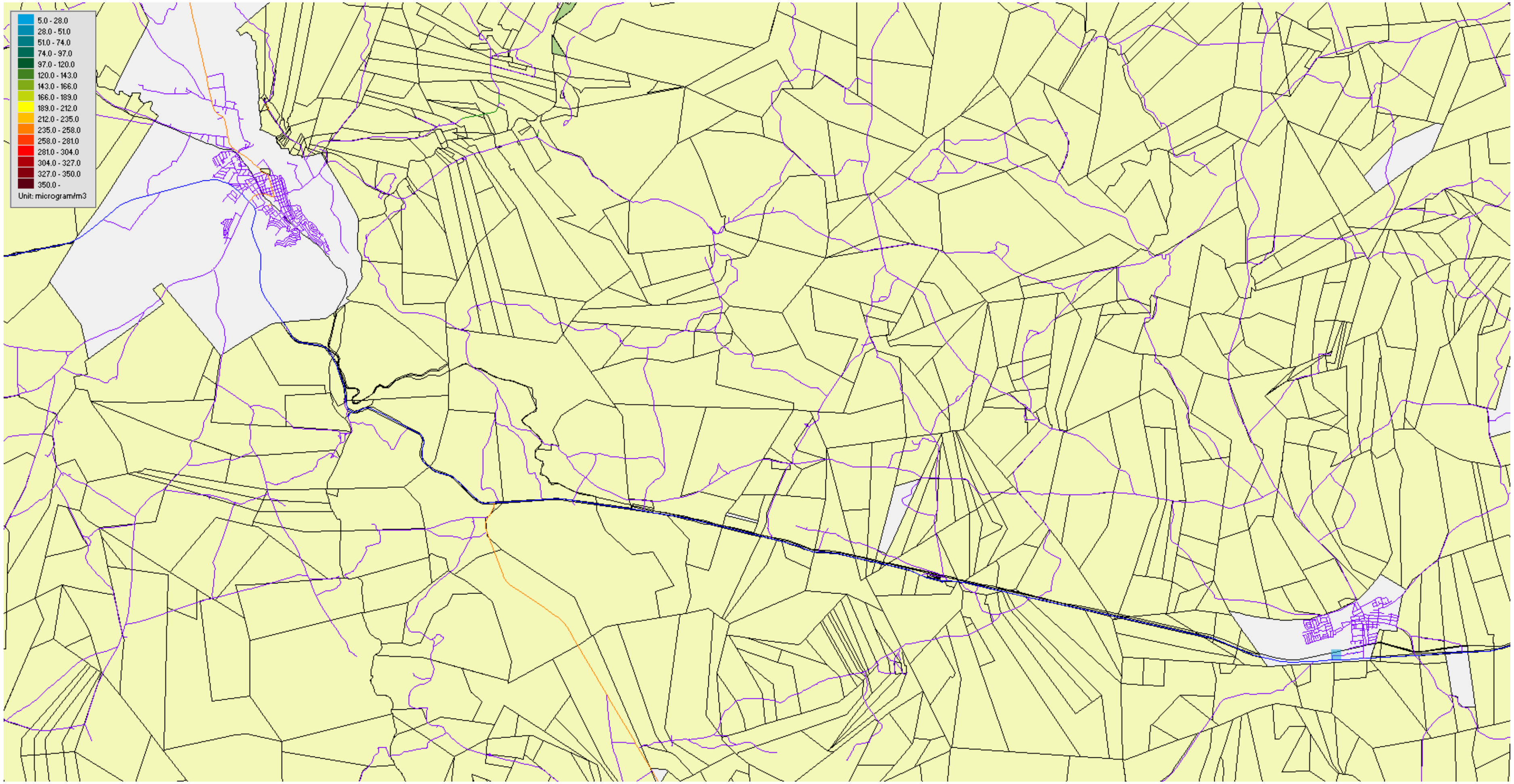

Figure 48: Hessequa: 99-percentile SO_2 Concentrations

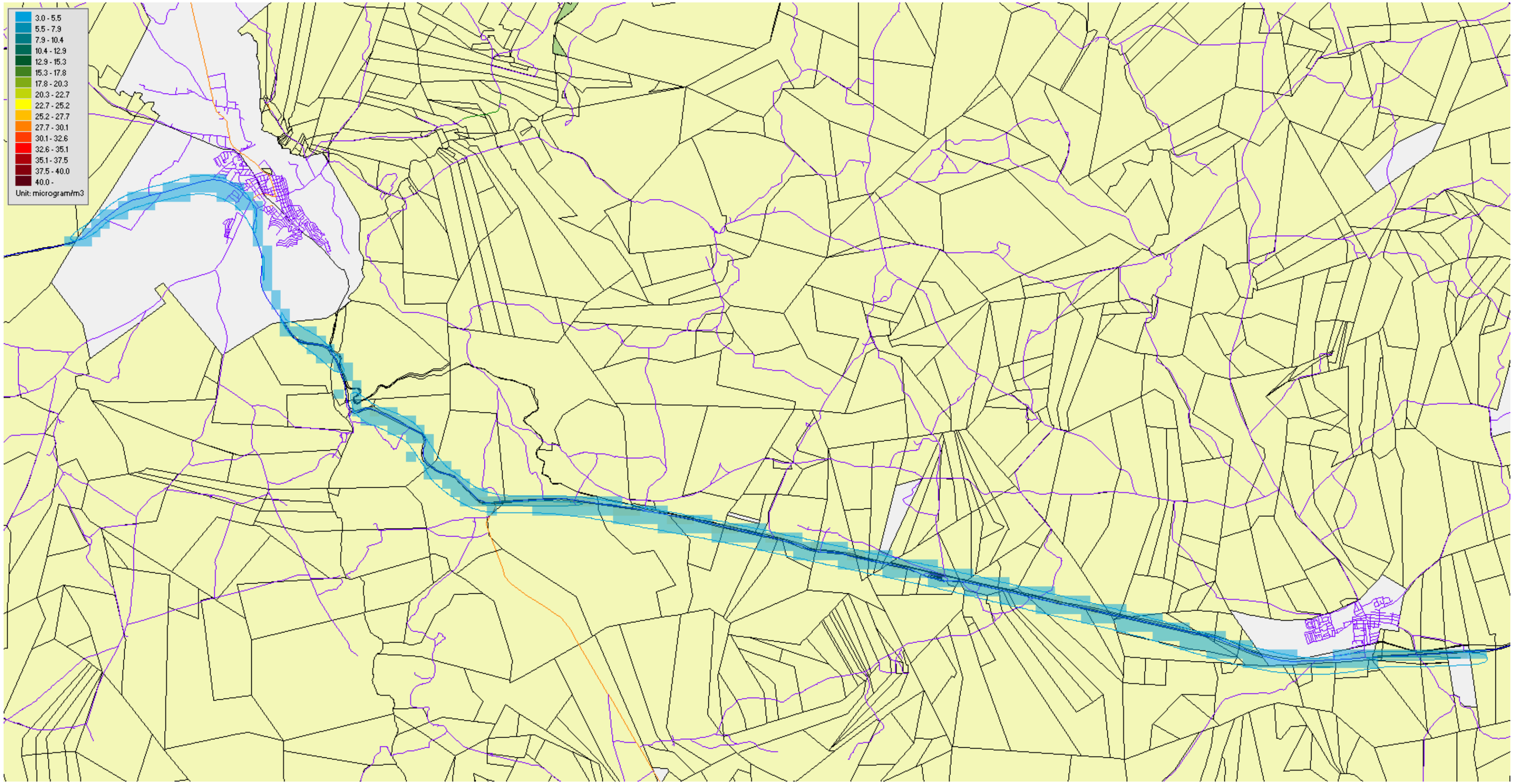

Figure 49: Hessequa: Annual Average NO_2 Concentrations

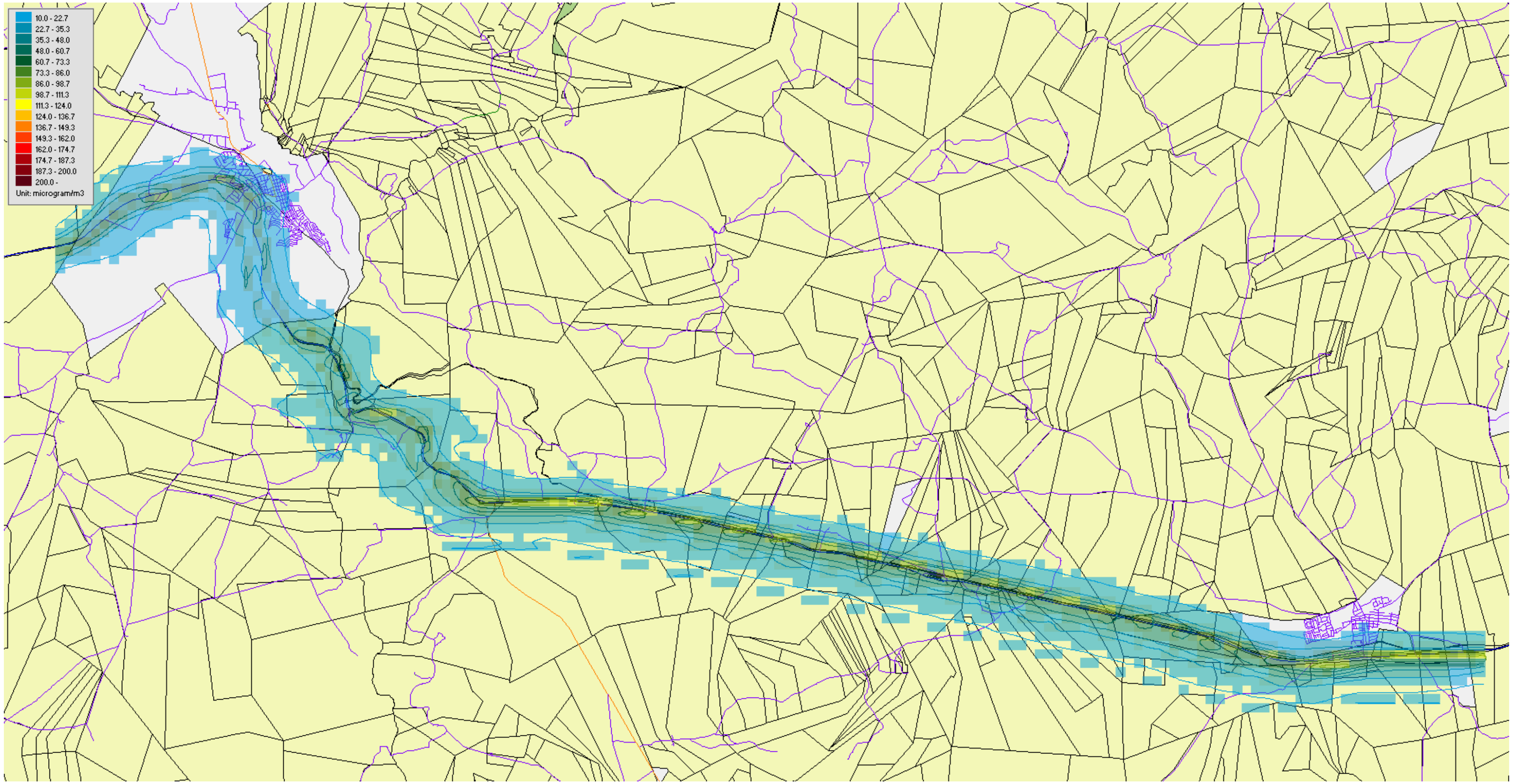

Figure 50: Hessequa: 99-percentile NO_2 Concentrations

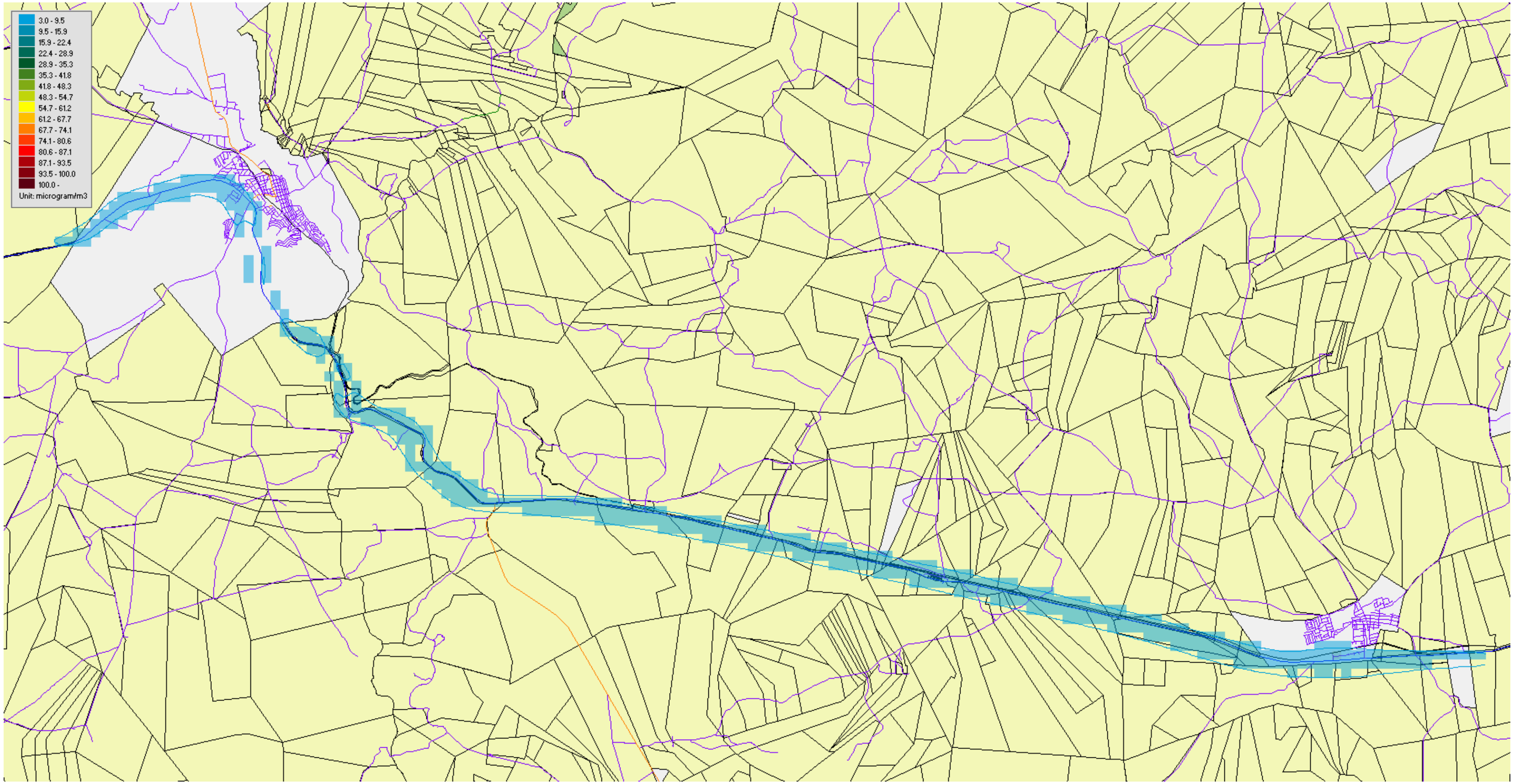

Figure 51: Hessequa: 8-hour Average CO Concentrations

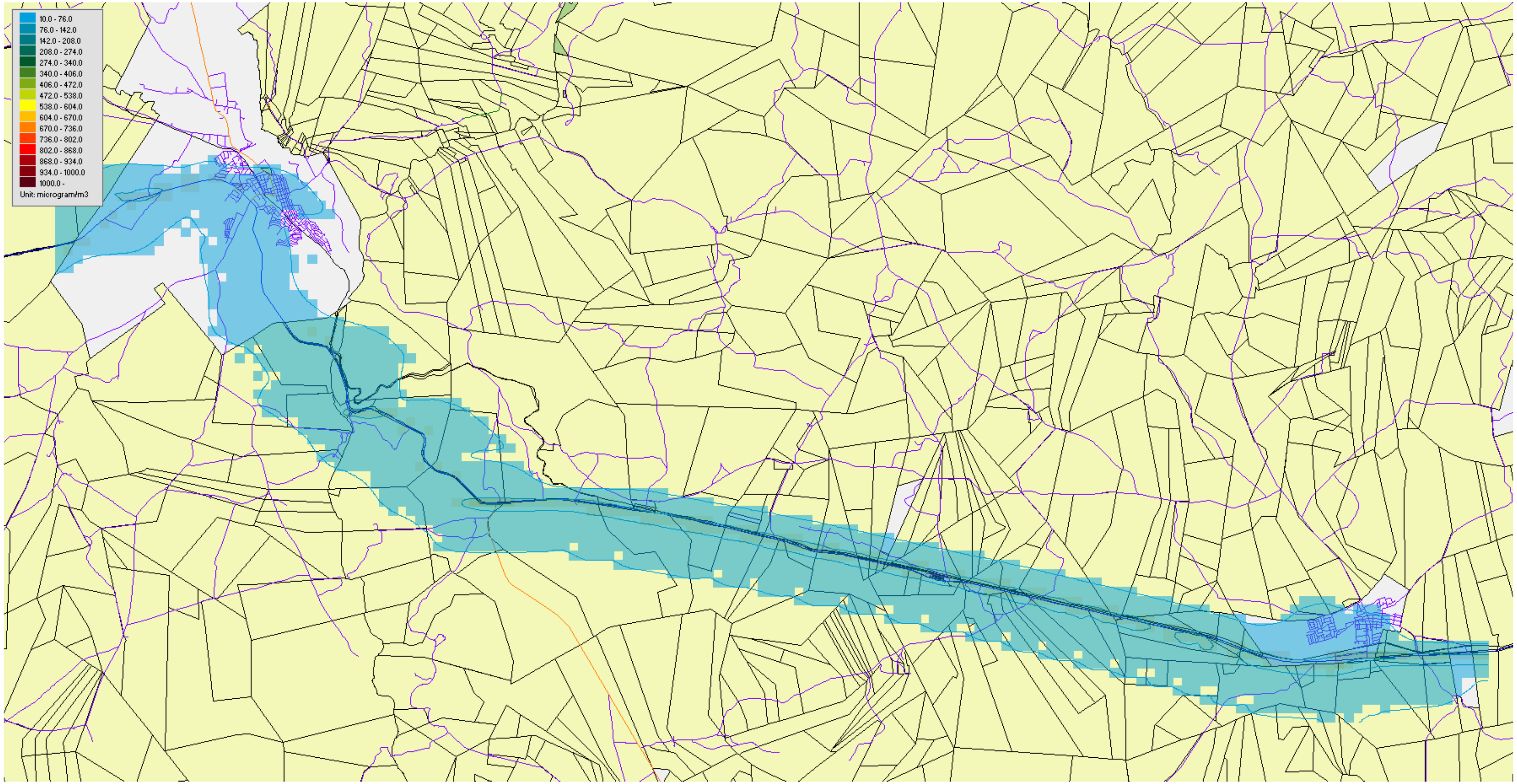

Figure 52: Hessequa: 99-percentile CO Concentrations

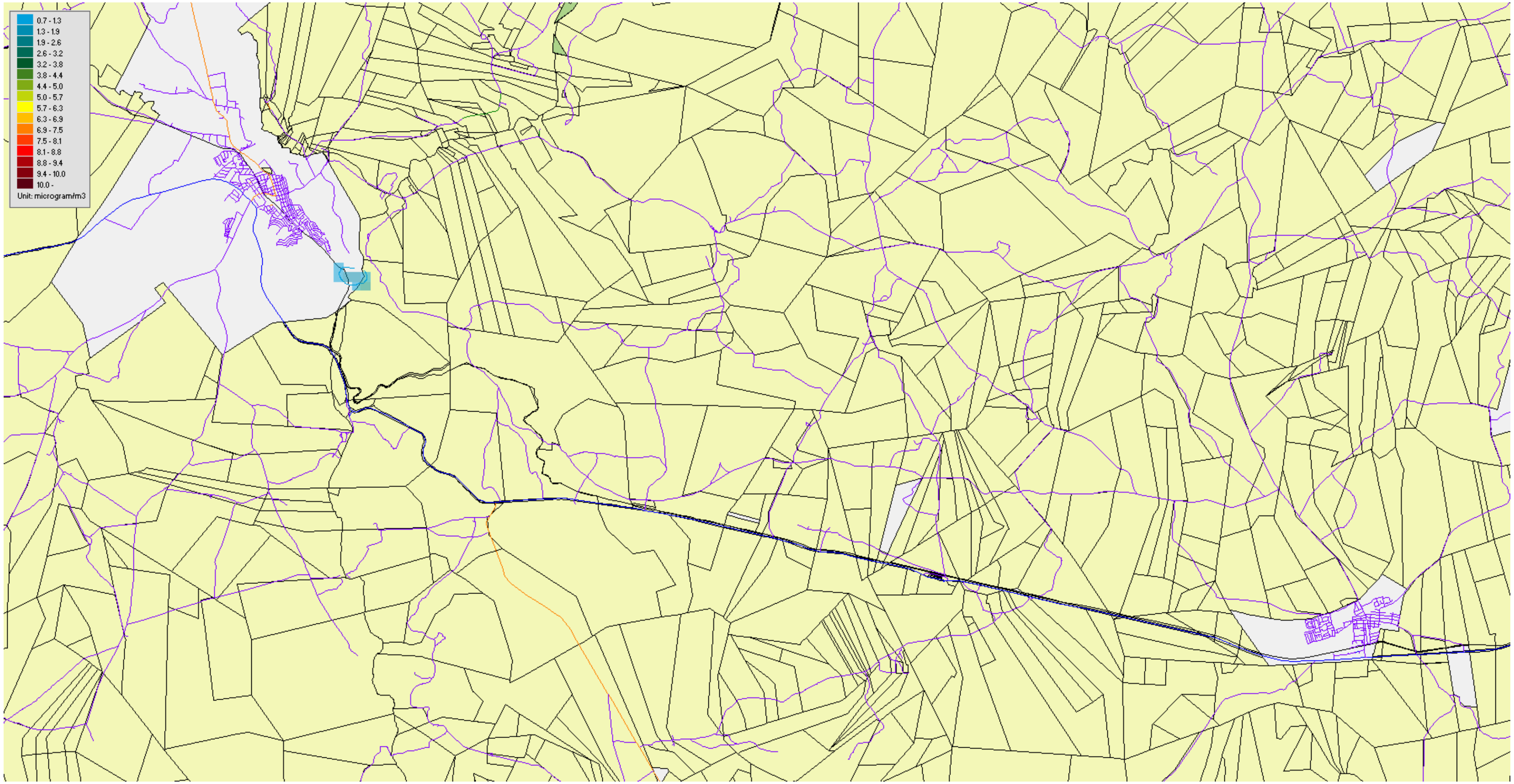

Figure 53: Hessequa: Annual Average Odour Concentrations

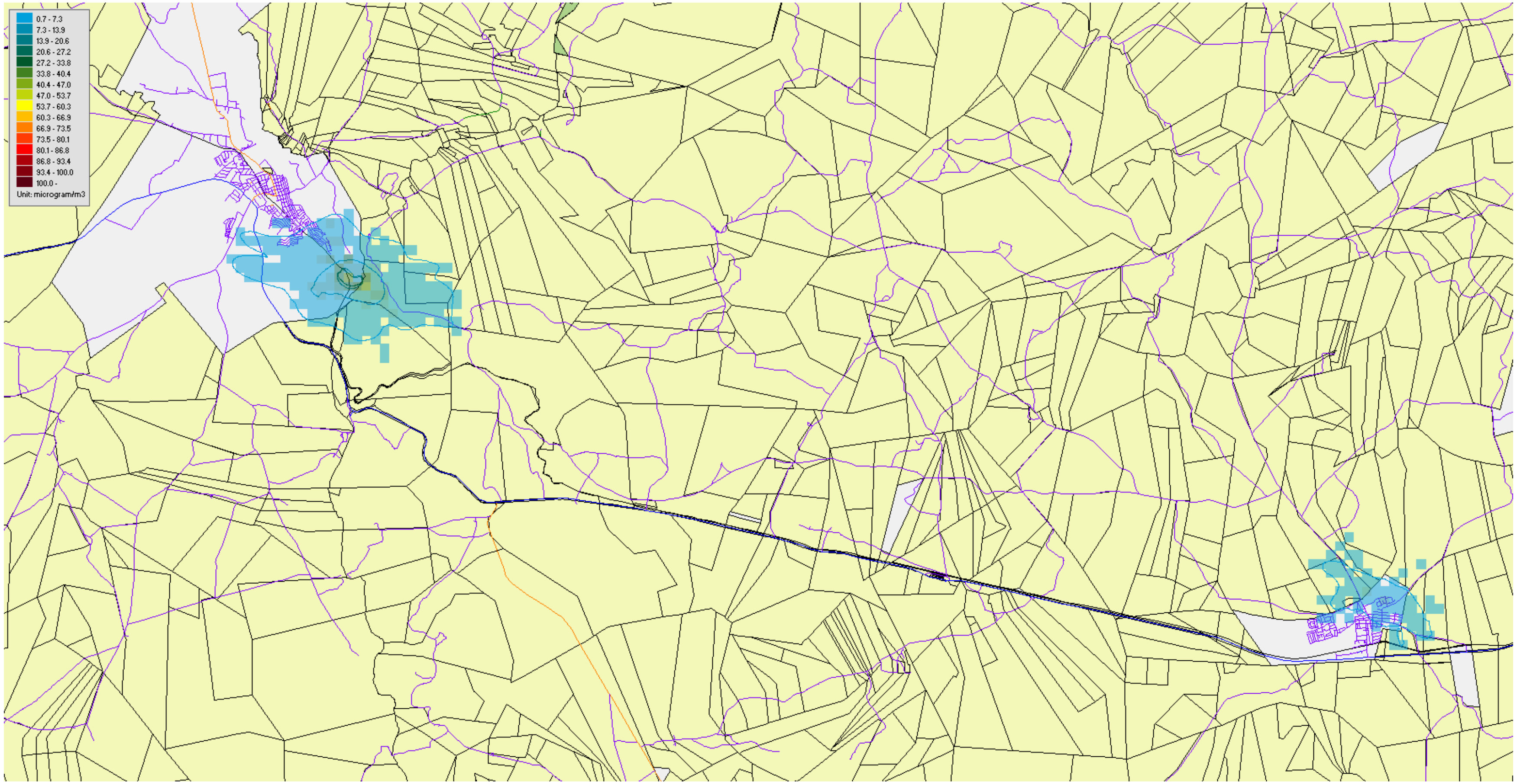

Figure 54: Hessequa: 99-percentile Odour Concentrations

Due to the low density of air pollutant sources in the Hessequa region, and the substantially lower traffic flows along the N2 national road, all of the estimated ground-level concentrations are well below the respective air quality standards.

There are no major sources of SO_2 and traffic sources are the main contributors to the modelled NO_2 and CO concentrations, but these concentrations are very low.

In general, no odours are expected in the region, although some creosote odours may be detected around Albertinia for 1% of the time.

7.6 KANNALAND

The dispersion of pollutants from all sources is shown graphically in Figures 55 to 64 below.

Figures 55 and 56 respectively show the annual average and 99-percentile 24-hour average ground-level concentrations of all PM10 emissions.

Figures 57 and 58 respectively show the annual average and 99-percentile ground-level concentrations of all sulphur dioxide (SO_2) emissions.

Figures 59 and 60 respectively show the annual average and 99-percentile ground-level concentrations for all nitrogen oxides (NO_2) emissions.

Figures 61 and 62 respectively show the 8-hour average and 99-percentile ground-level concentrations for all carbon monoxide (CO) emissions.

Figures 63 and 64 respectively show the annual average and 99-percentile ground-level concentrations of all odorous emissions

High estimated concentrations are discussed after the graphic results and summarised in Table 15 below.

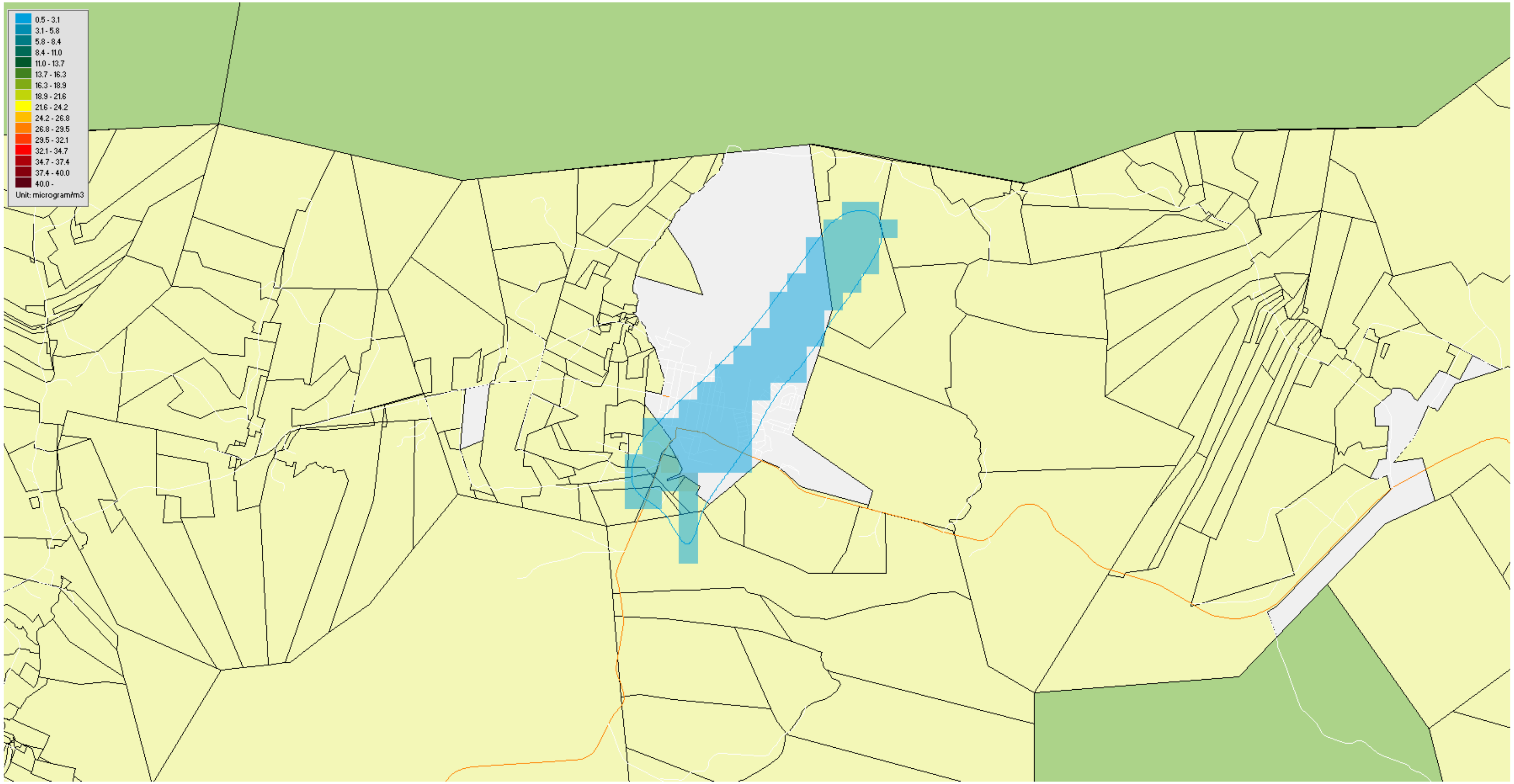

Figure 55: Kannaland: Annual Average PM10 Concentrations

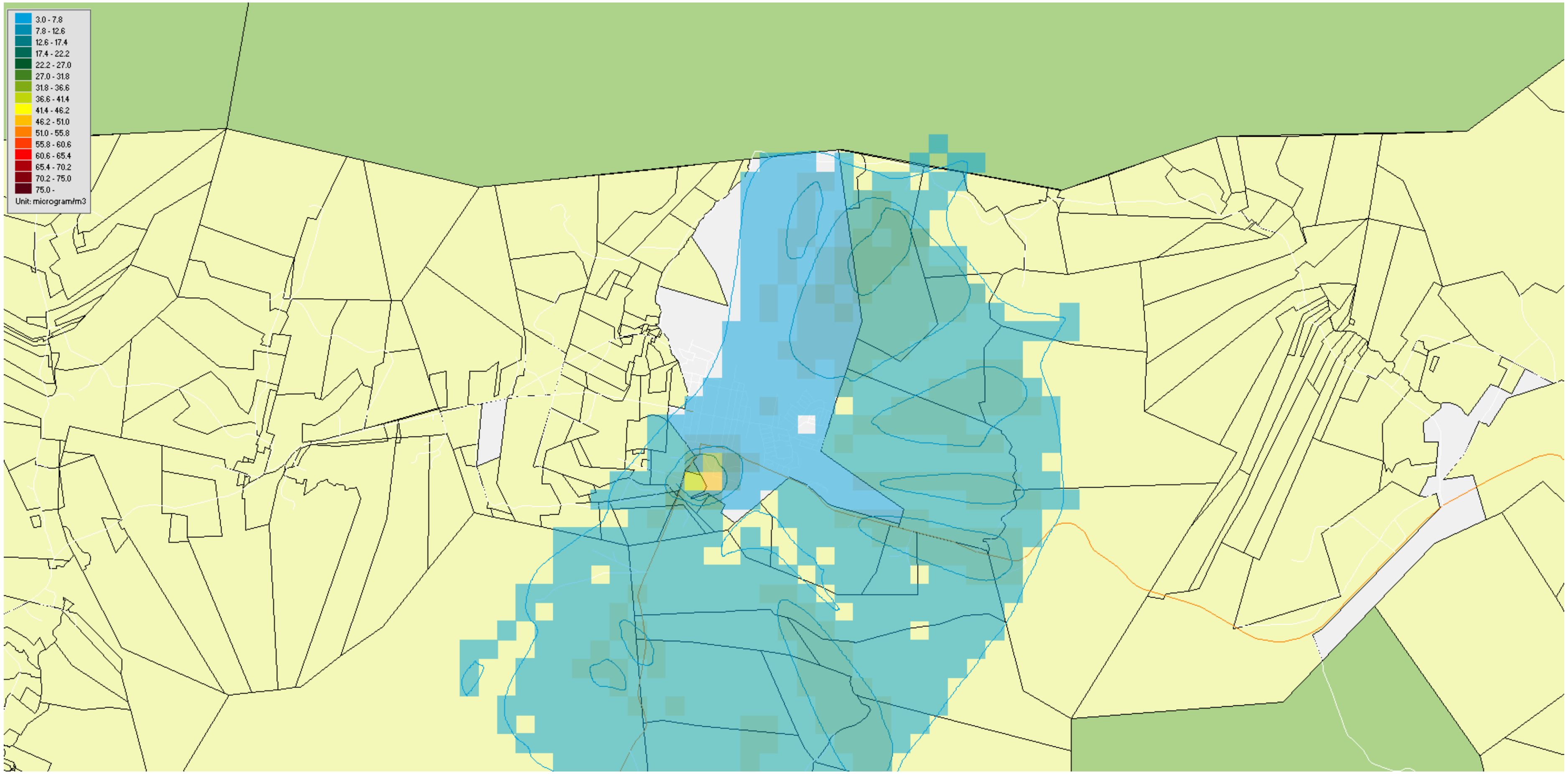

Figure 56: Kannaland: 99-percentile PM10 Daily Averaged Concentrations

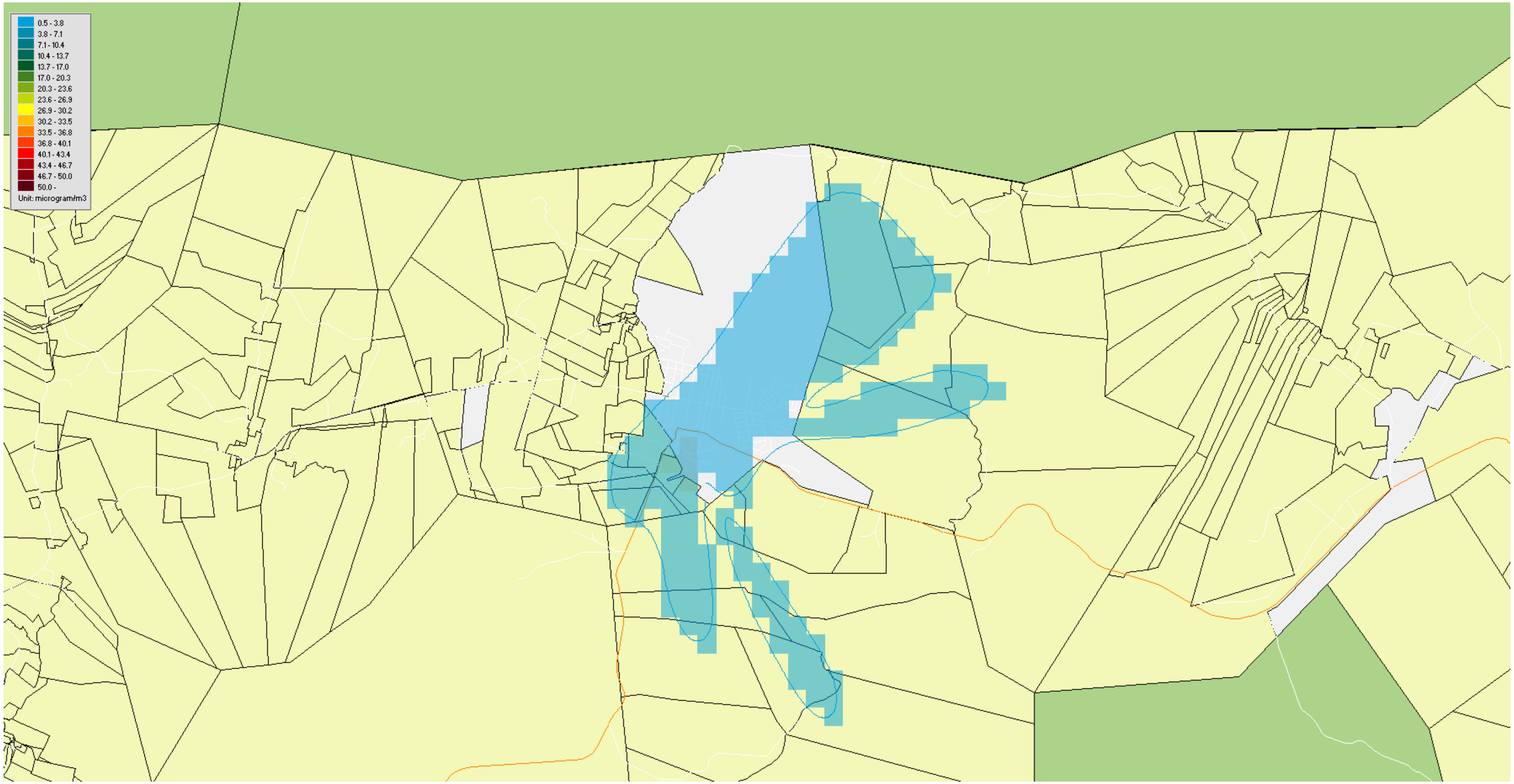

Figure 57: Kannaland: Annual Average SO_2 Concentrations

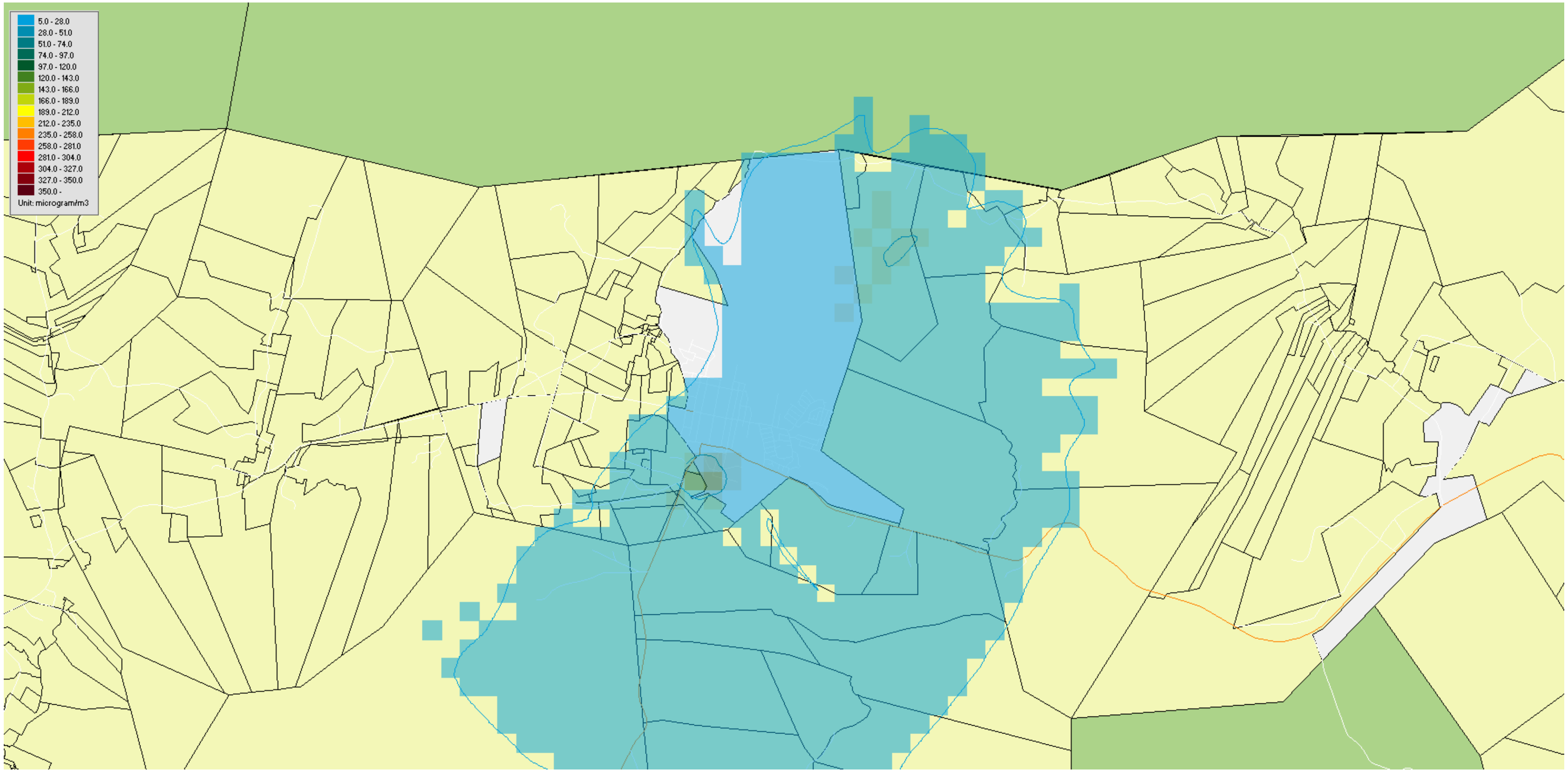

Figure 58: Kannaland: 99-percentile SO_2 Concentrations

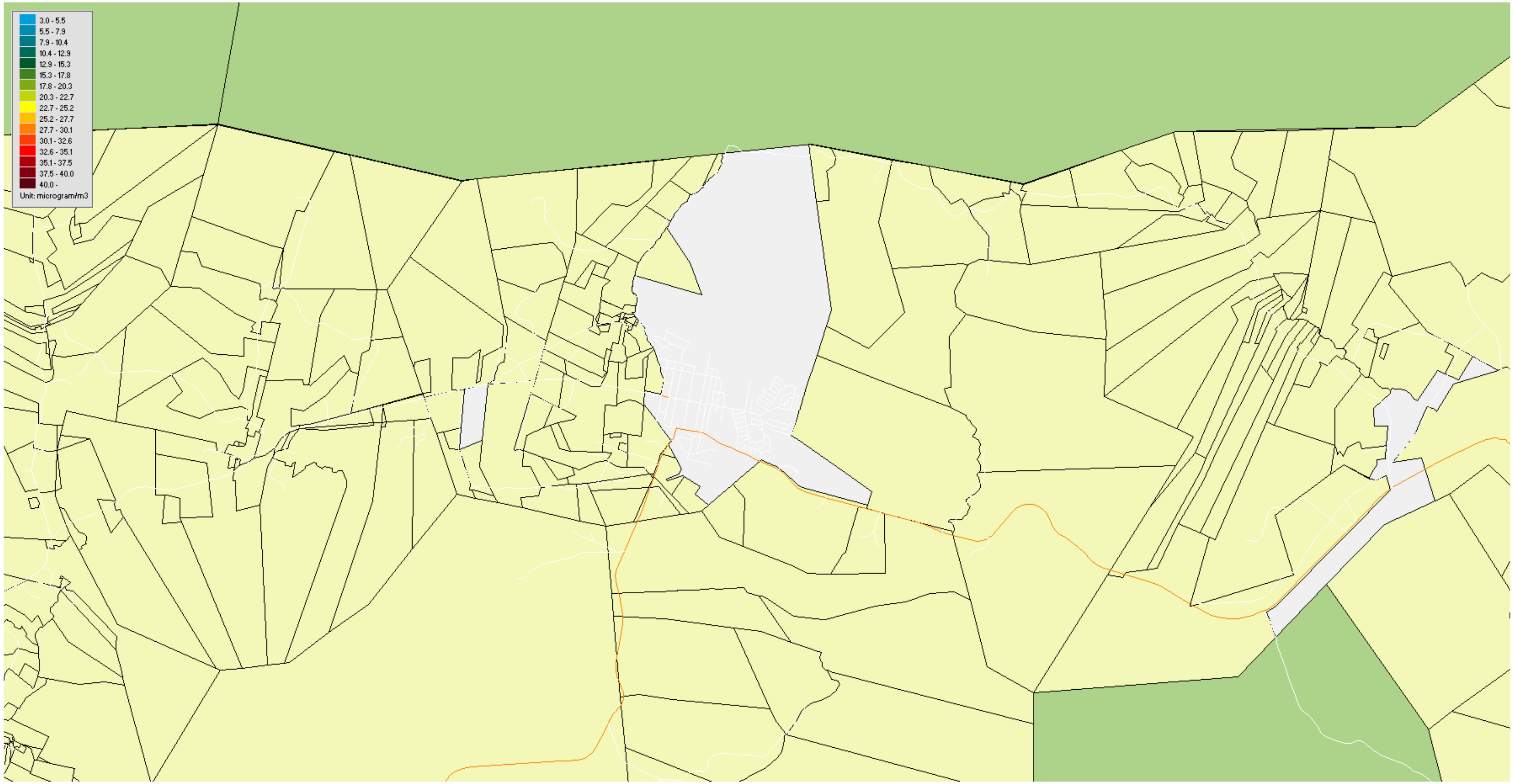

Figure 59: Kannaland: Annual Average NO_2 Concentrations

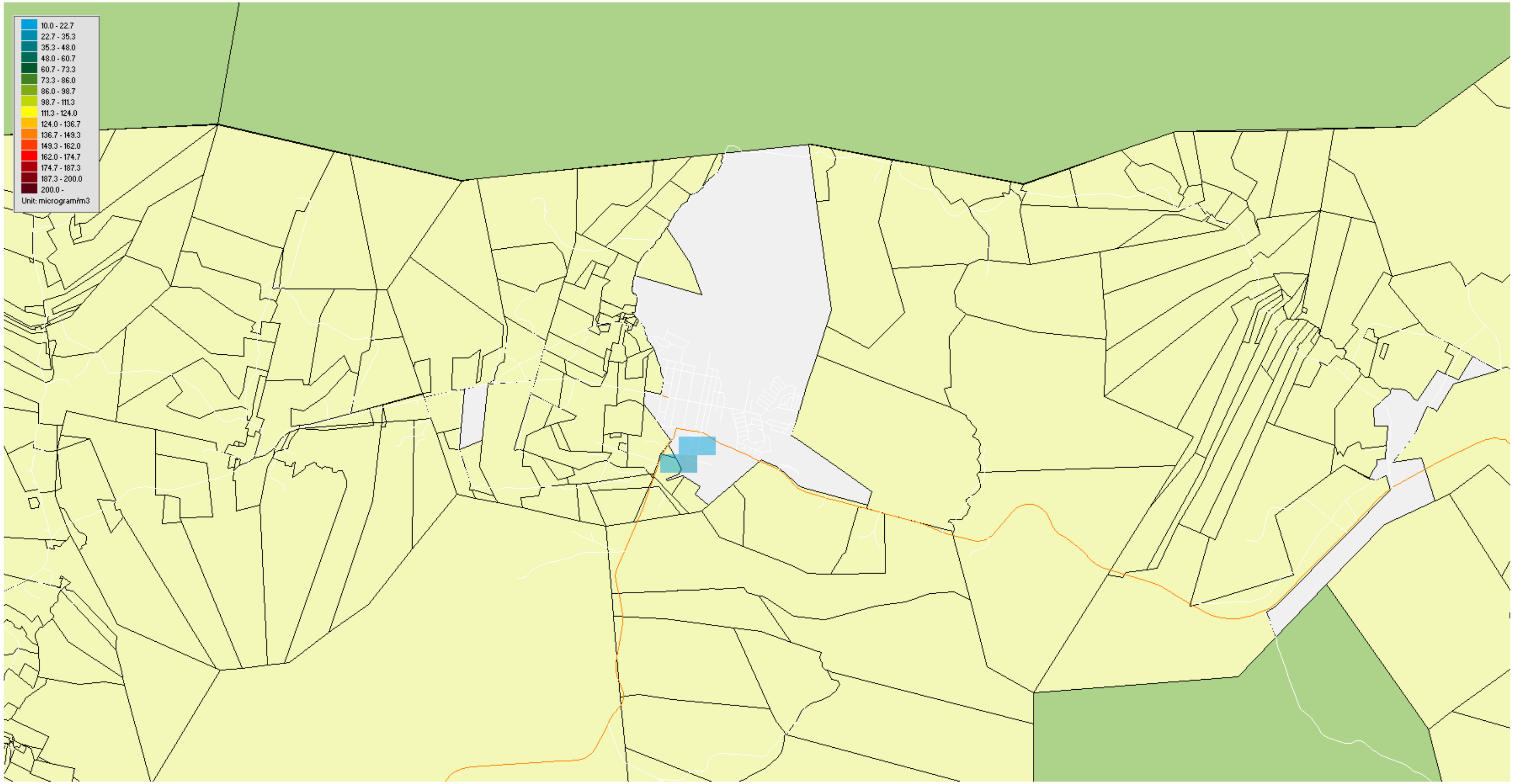

Figure 60: Kannaland: 99-percentile NO_2 Concentrations

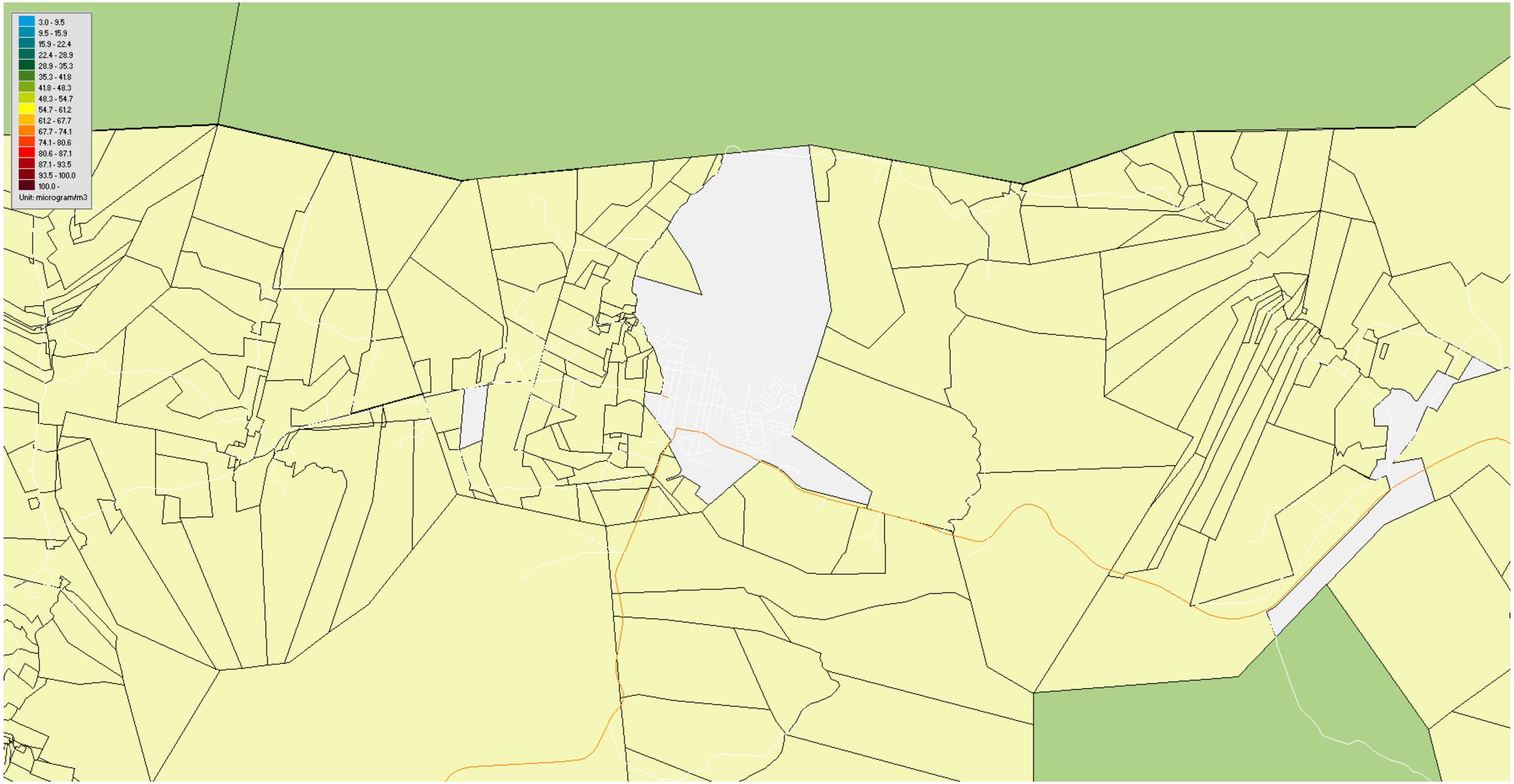

Figure 61: Kannaland: 8-hour Average CO Concentrations

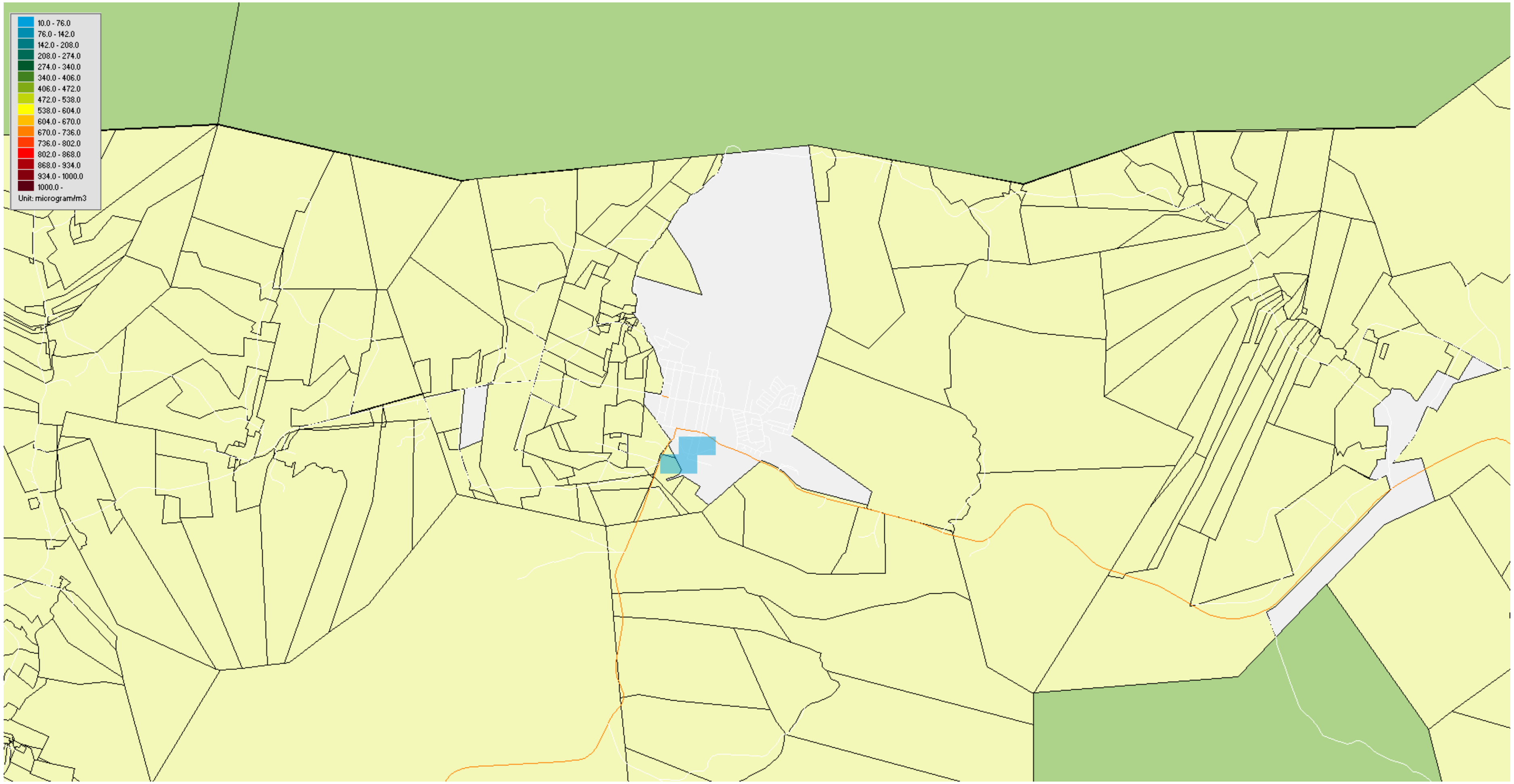

Figure 62: Kannaland: 99-percentile CO Concentrations

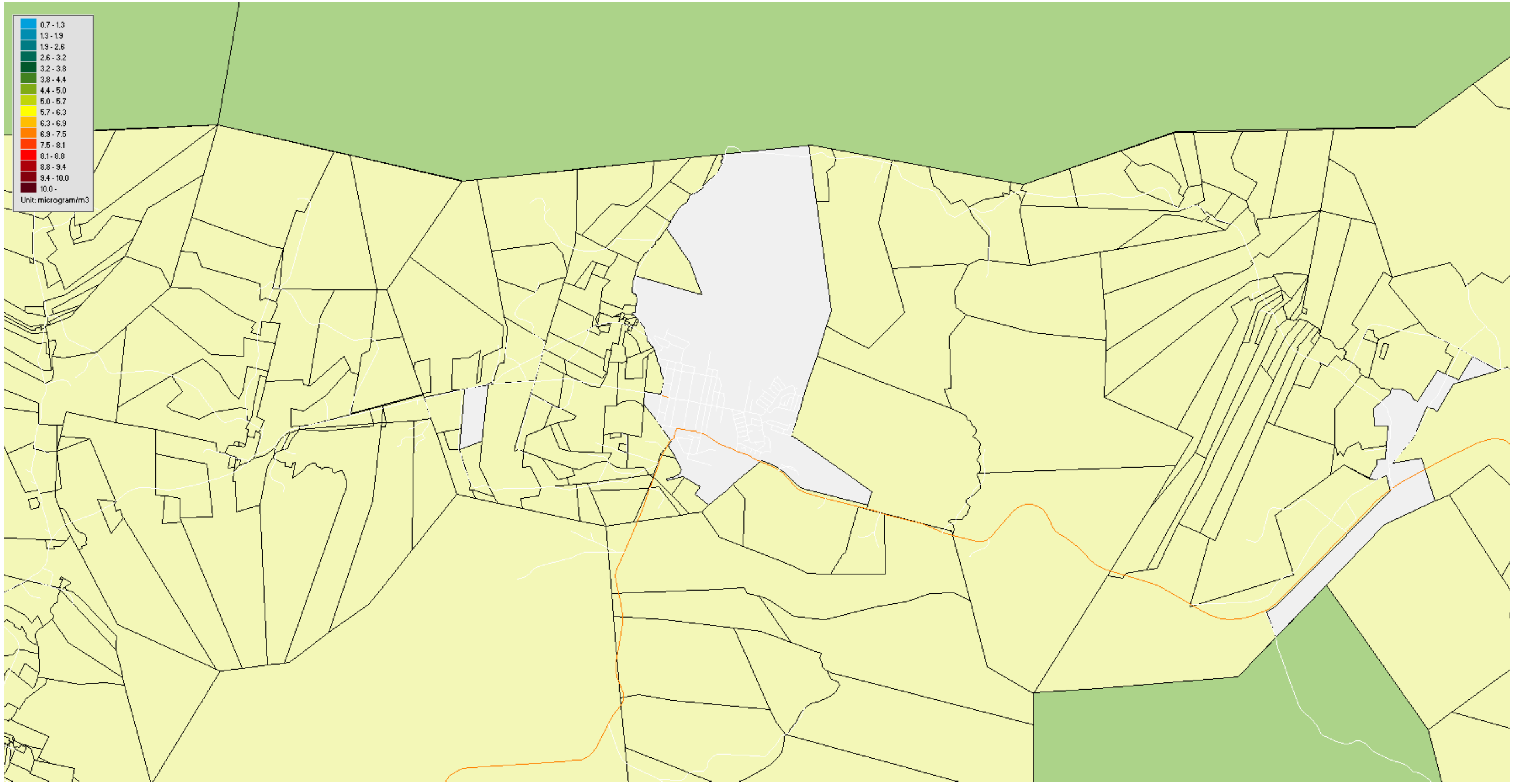

Figure 63: Kannaland: Annual Average Odour Concentrations

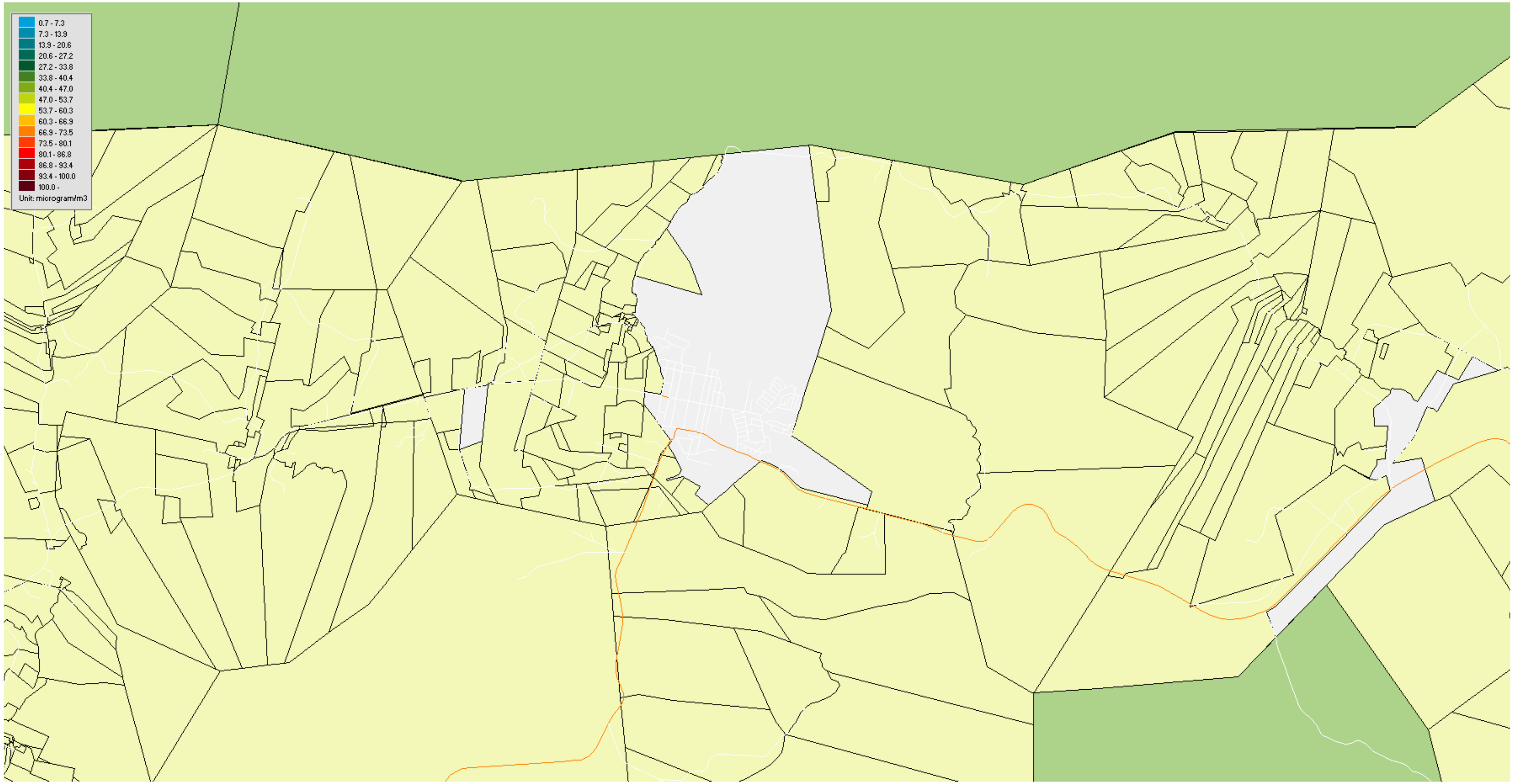

Figure 64: Kannaland: 99-percentile Odour Concentrations

The three industrial sources in Ladismith contribute jointly to the estimated ground-level concentrations of TPM, SO_2, NO_2 and CO in the area, although these concentrations are all well below the relevant air quality standards.

The small-scale wastewater treatment works is not regarded as a serious odour generator in the area.

7.7 OUDTSHOORN

The dispersion of pollutants from all sources in Oudtshoorn is shown graphically in Figures 65 to 74 below.

Figures 65 and 66 respectively show the annual average and 99-percentile 24-hour average ground-level concentrations of all PM10 emissions.

Figures 67 and 68 respectively show the annual average and 99-percentile ground-level concentrations of all sulphur dioxide (SO_2) emissions.

Figures 69 and 70 respectively show the annual average and 99-percentile ground-level concentrations for all nitrogen oxides (NO_2) emissions.

Figures 71 and 72 respectively show the 8-hour average and 99-percentile ground-level concentrations for all carbon monoxide (CO) emissions.

Figures 73 and 74 respectively show the annual average and 99-percentile ground-level concentrations of all odorous emissions

High estimated concentrations are discussed after the graphic results and summarised in Table 15 below.

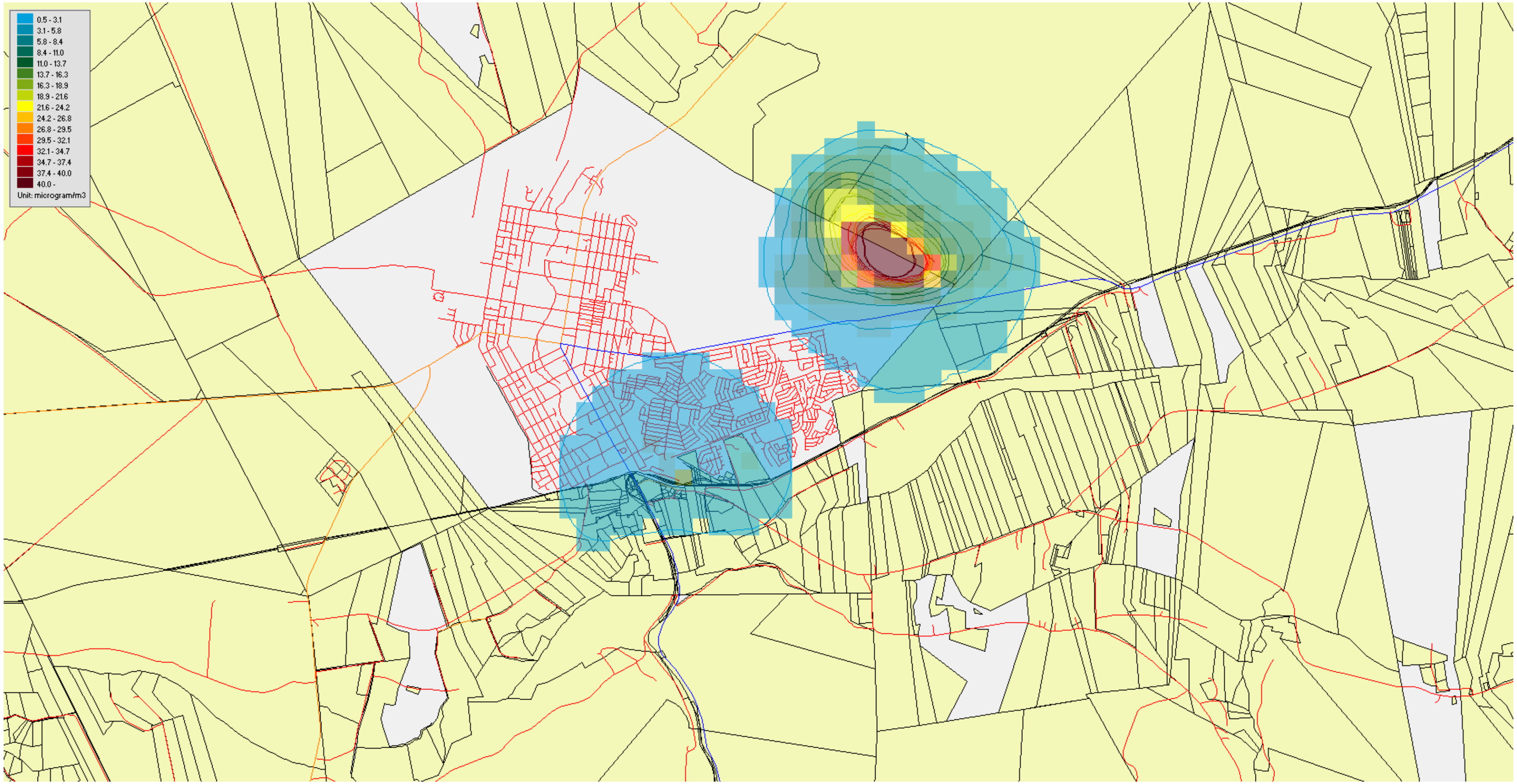

Figure 65: Oudtshoorn: Annual Average PM10 Concentrations

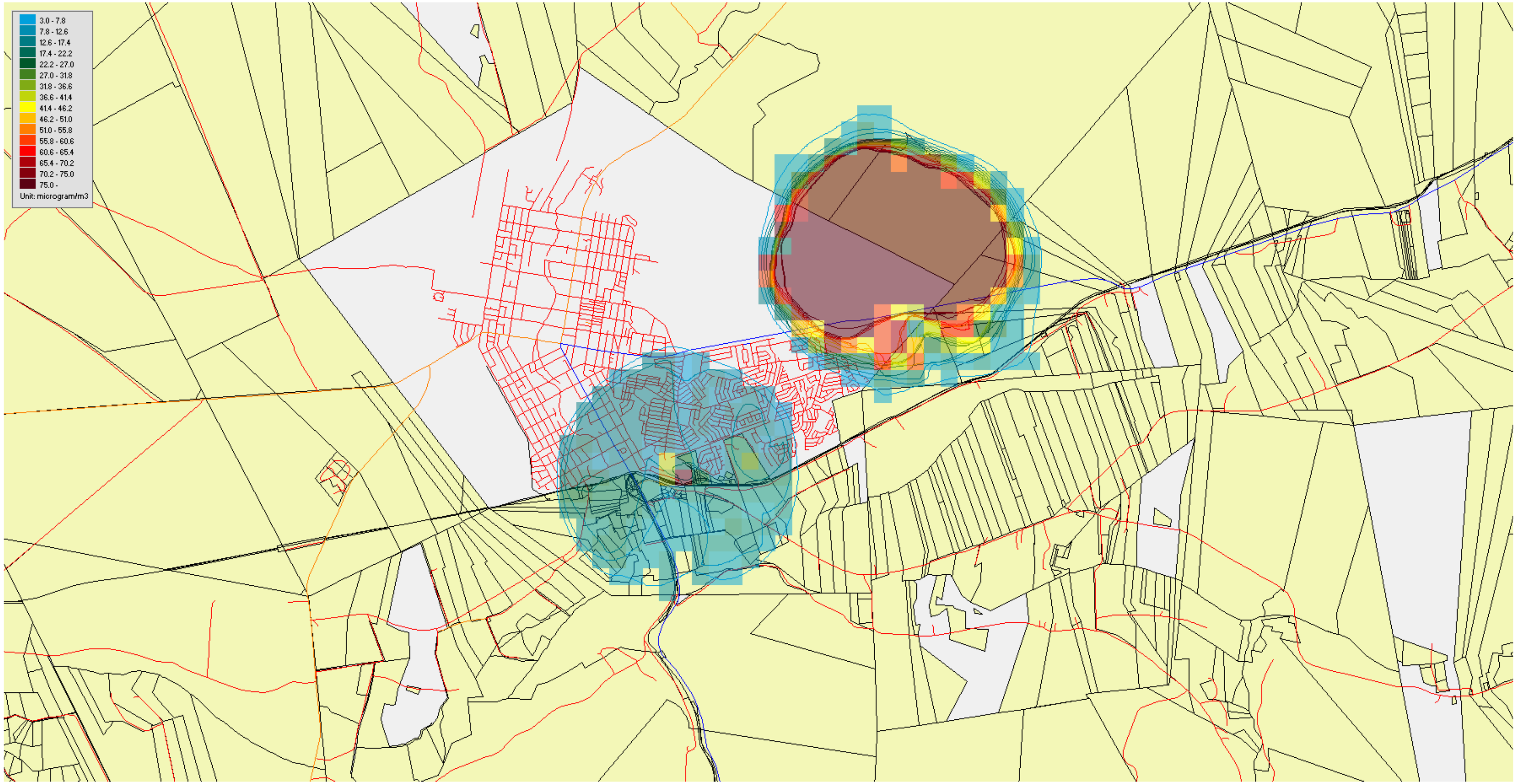

Figure 66: Oudtshoorn: 99-percentile PM10 Daily Averaged Concentrations

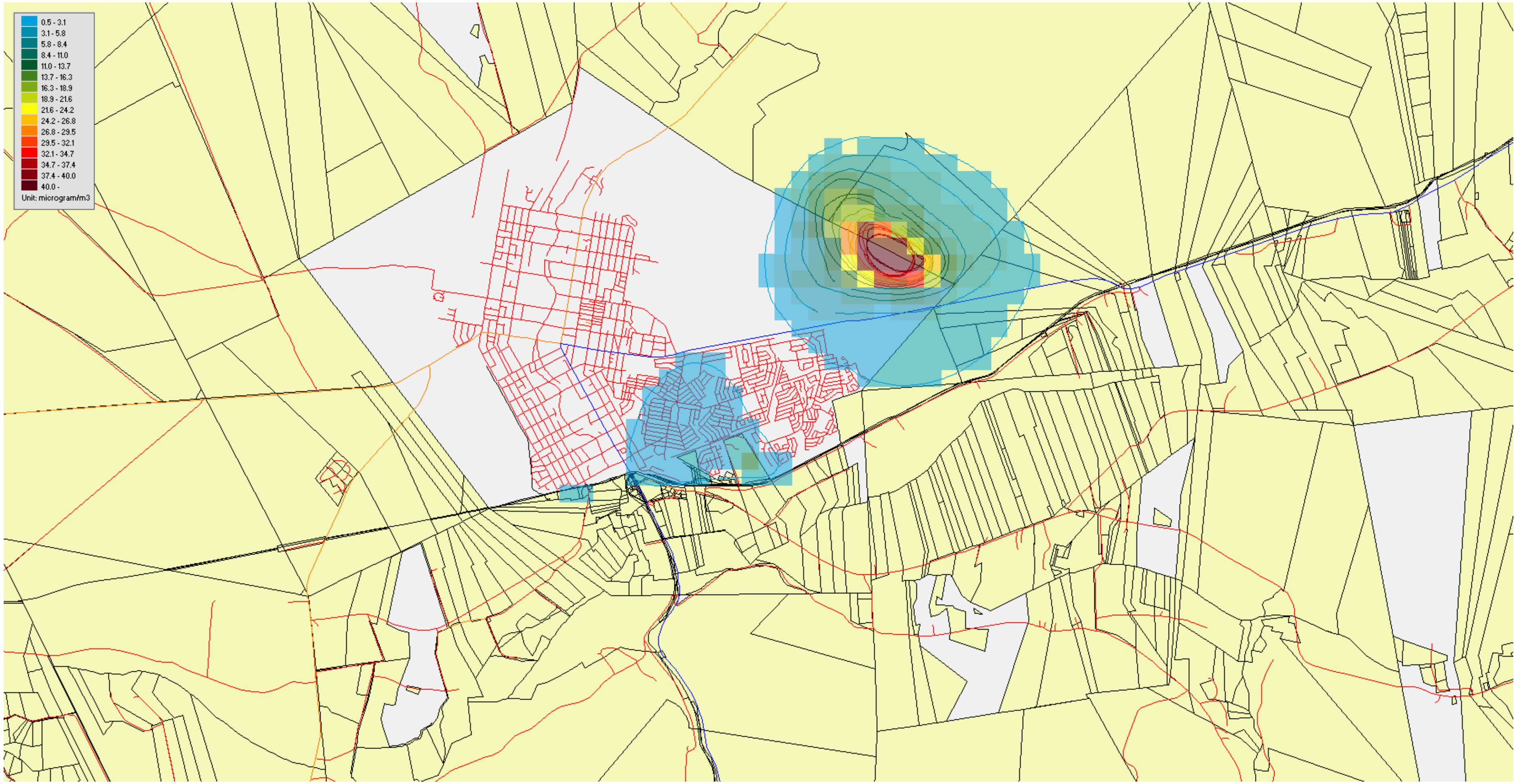

Figure 67: Oudtshoorn: Annual Average SO_2 Concentrations

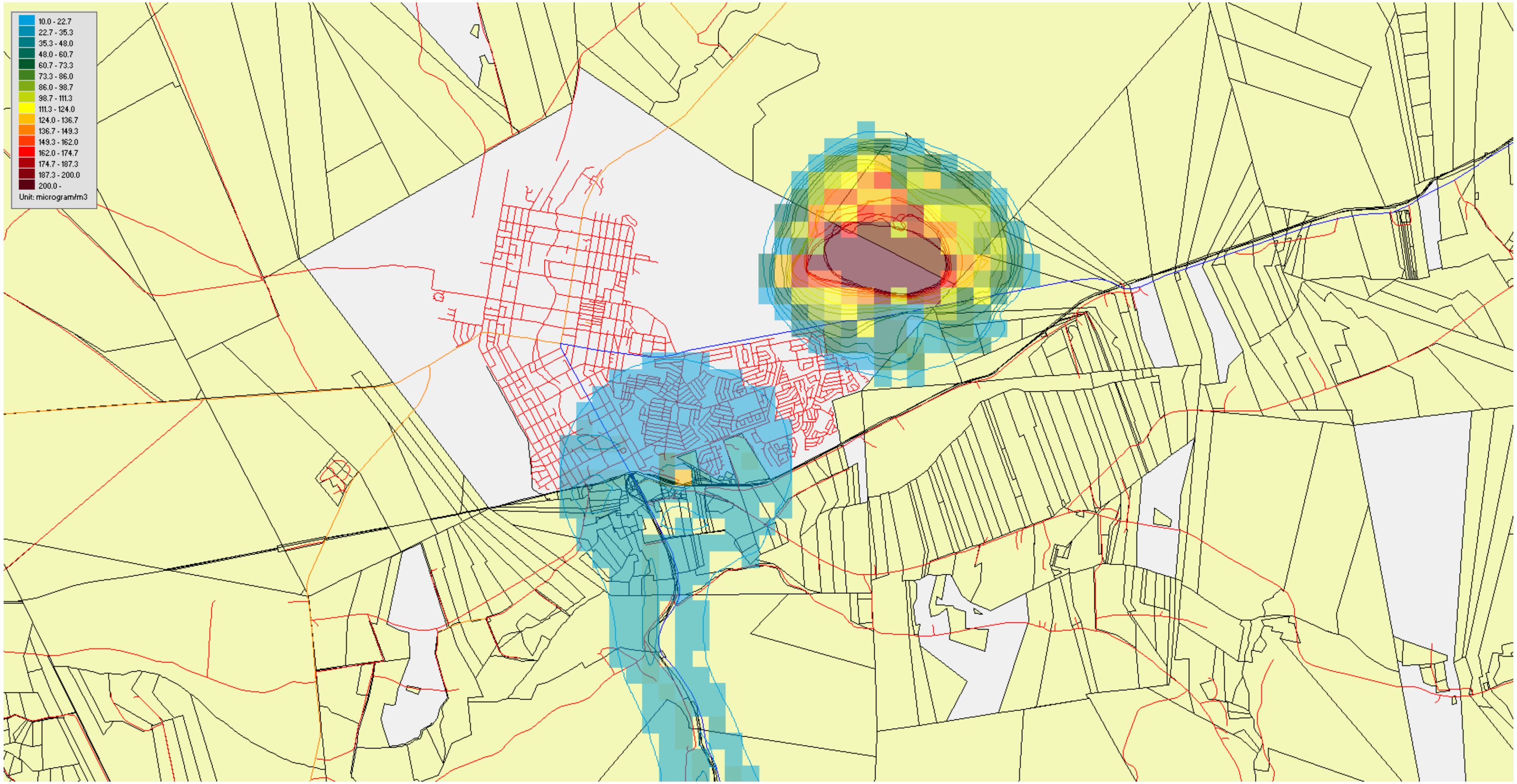

Figure 68: Oudtshoorn: 99-percentile SO_2 Concentrations

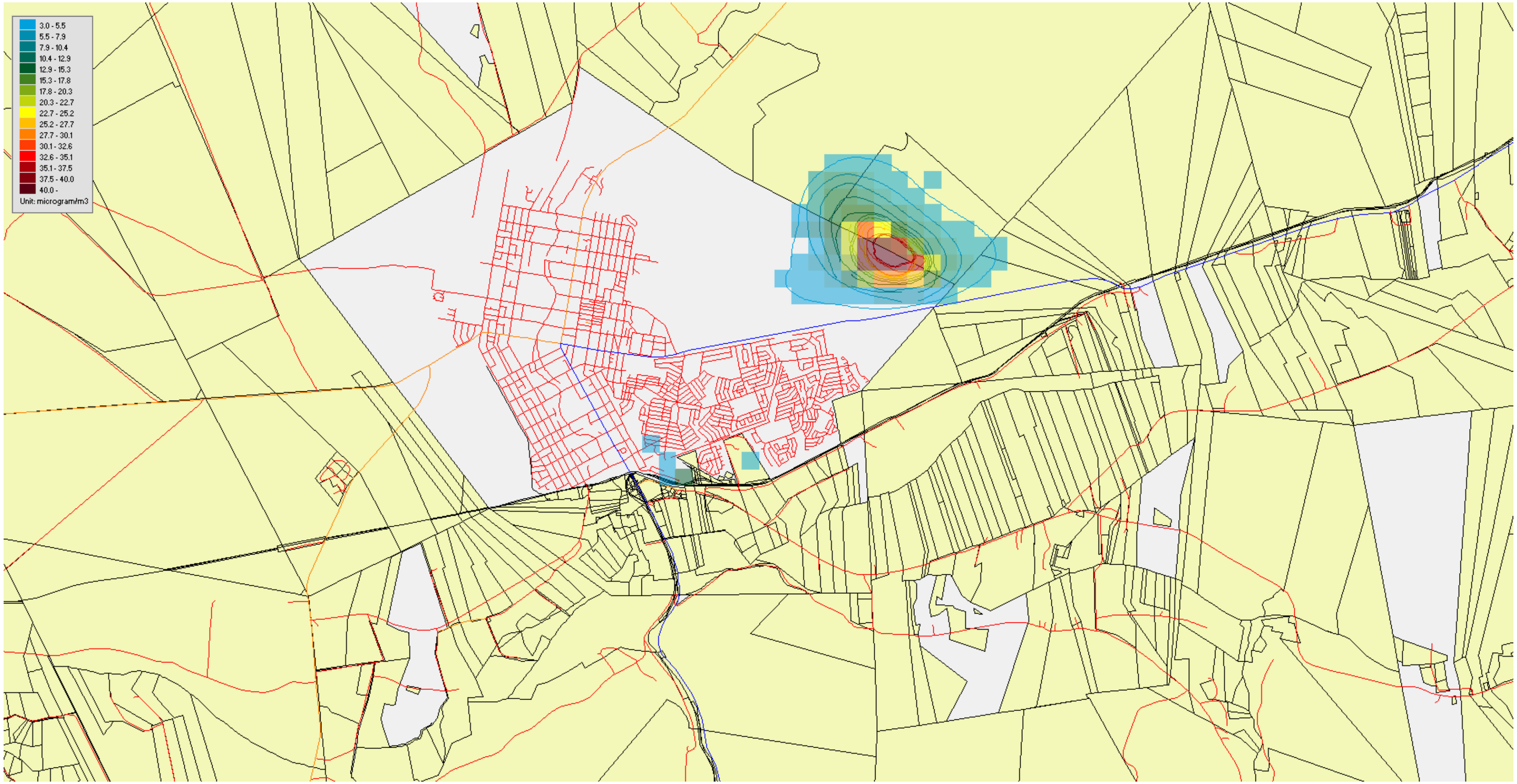

Figure 69: Oudtshoorn: Annual Average NO_2 Concentrations

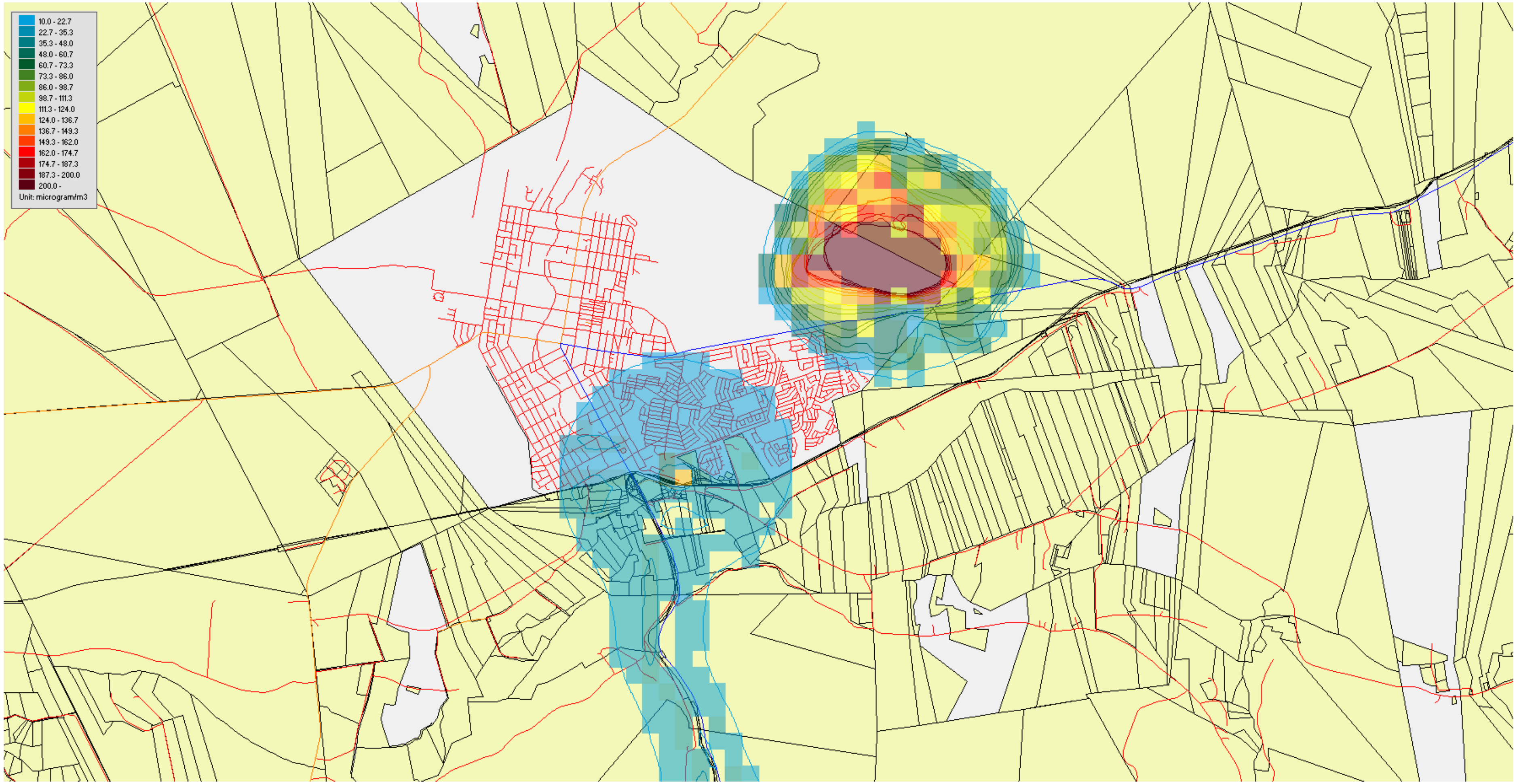

Figure 70: Oudtshoorn: 99-percentile NO_2 Concentrations

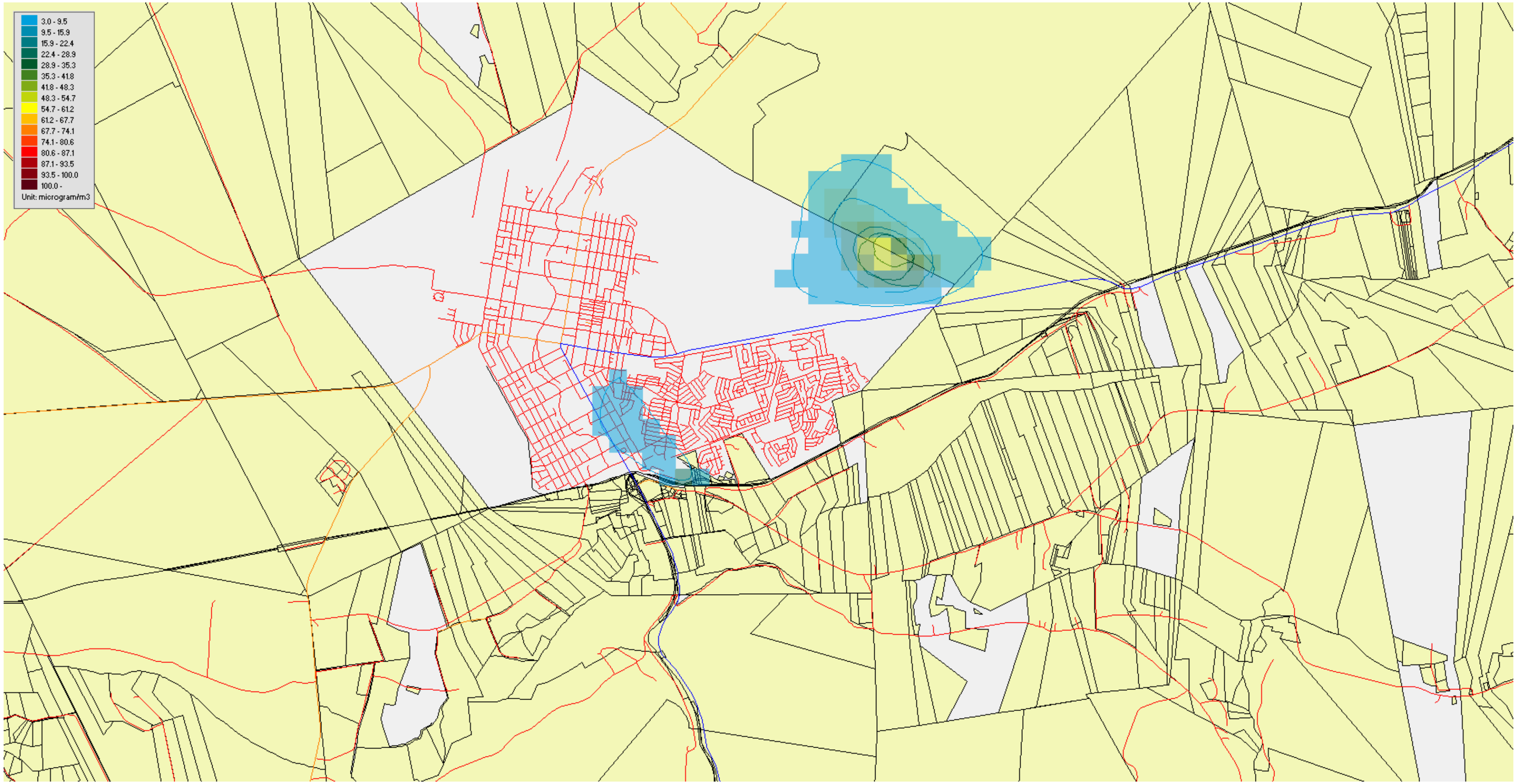

Figure 71: Oudtshoorn: 8-hour Average CO Concentrations

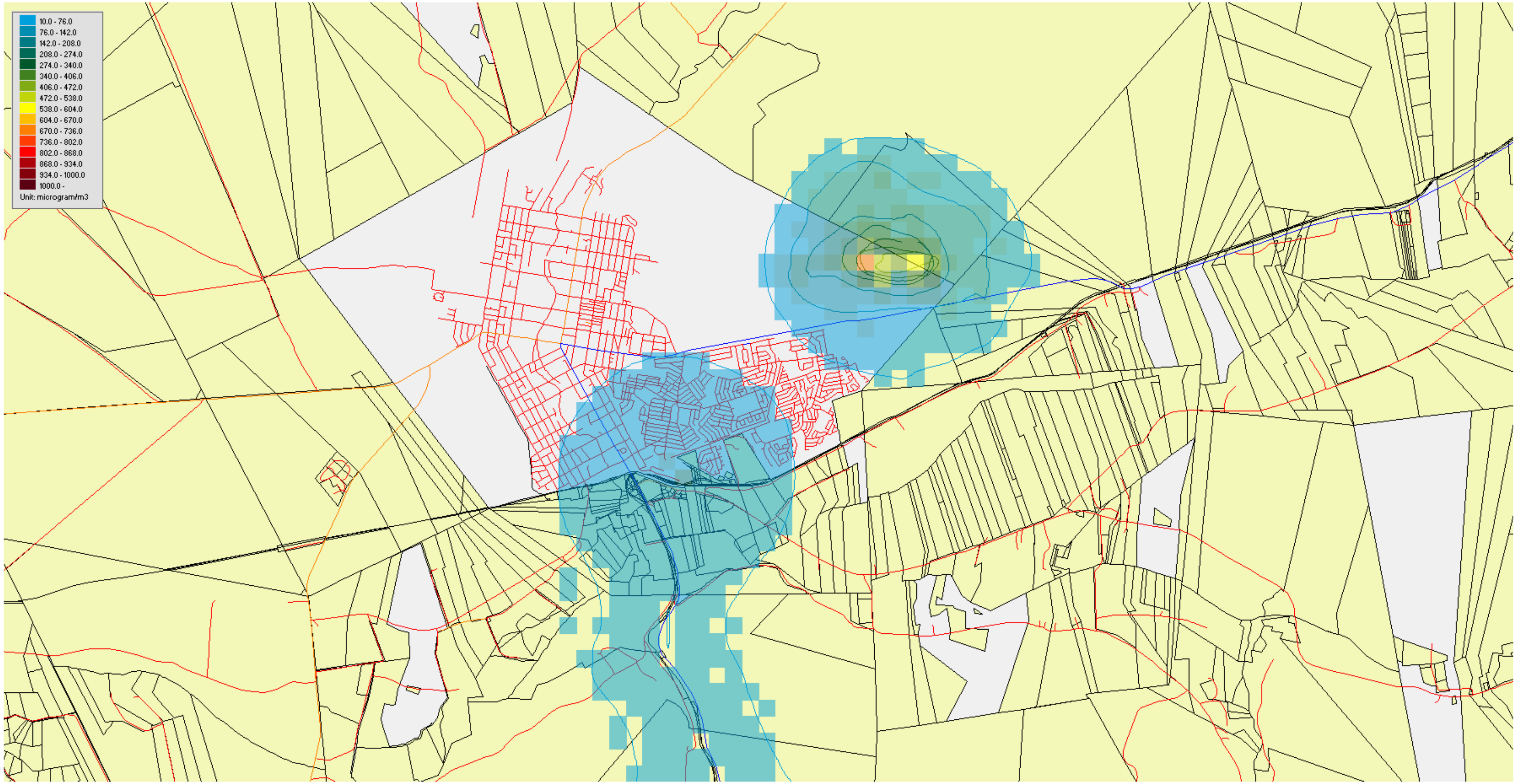

Figure 72: Oudtshoorn: 99-percentile CO Concentrations

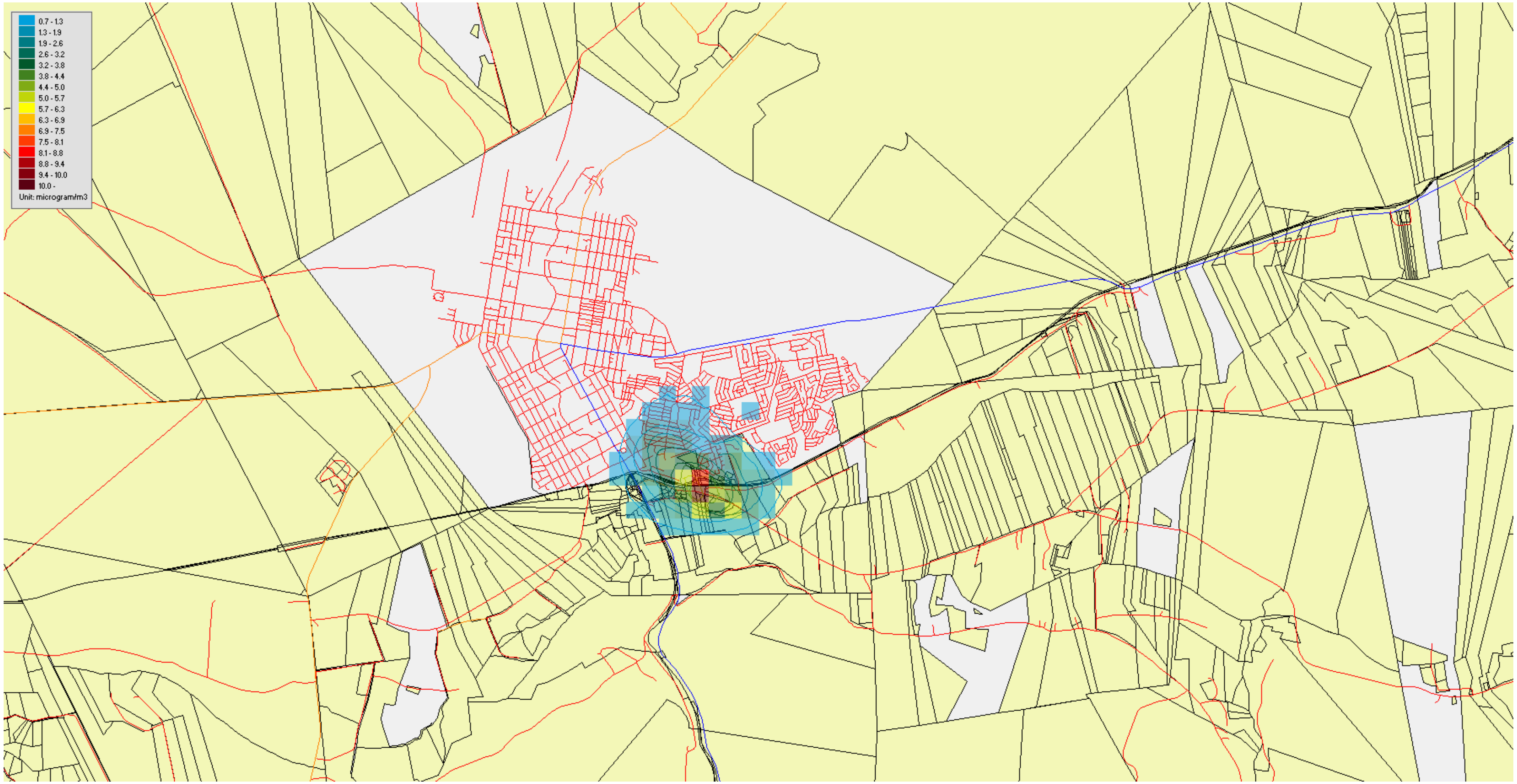

Figure 73: Oudtshoorn: Annual Average Odour Concentrations

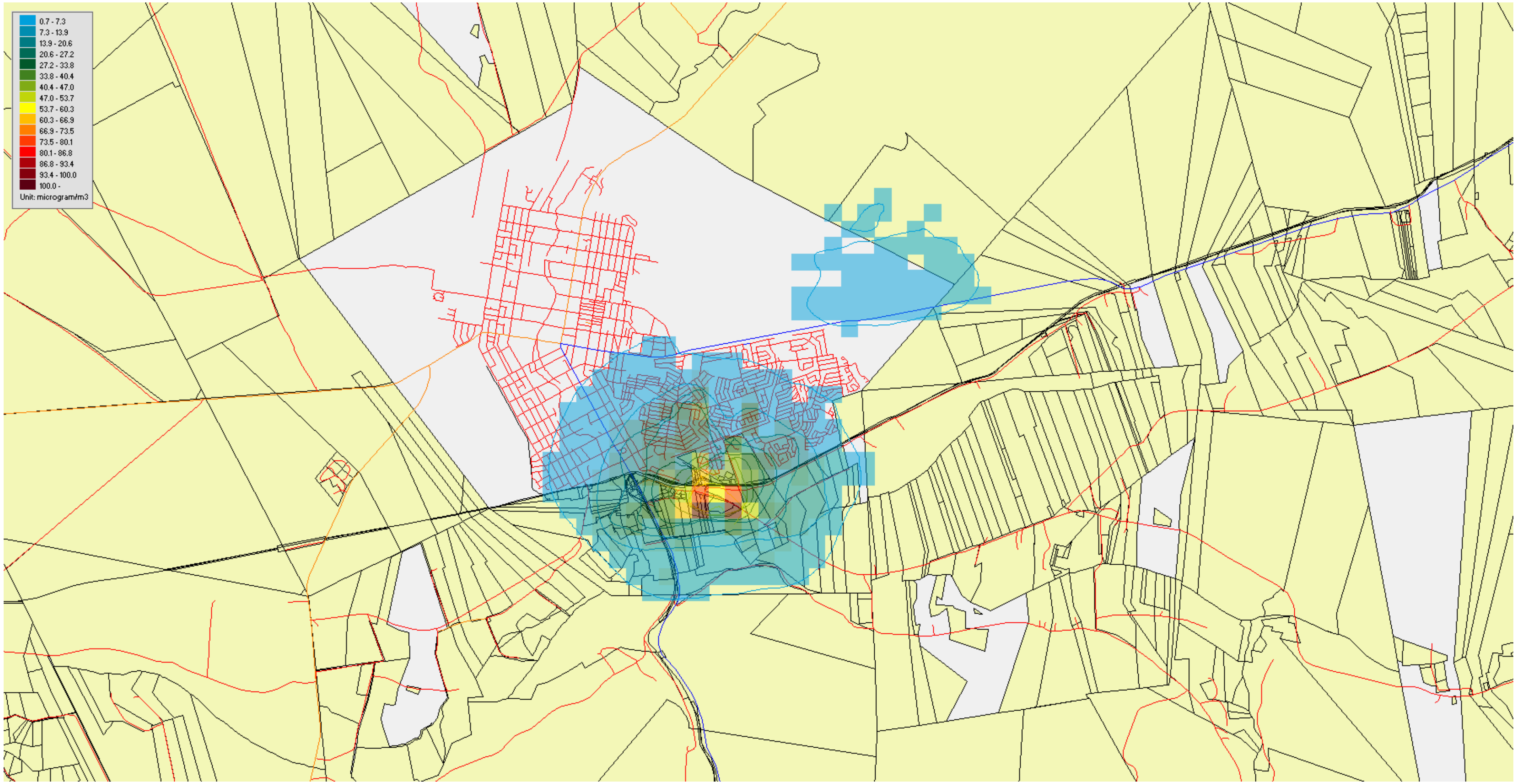

Figure 74: Oudtshoorn: 99-percentile Odour Concentrations

The following information can be deduced from the isopleths shown in the various figures above:

-- The dispersion model estimates that both the annual average and 99-percentile daily average ambient air quality standards of 40 µg/m^3 and 75 µg/m^3 respectively for PM10 will be exceeded by a substantial margin in a fairly large area surrounding Johnson Bricks' operations to the north-east of Oudtshoorn. The model estimates the maximum annual average concentration to be 106 µg/m^3 while the maximum 99-percentile daily average concentrations are estimated to be 955 µg/m^3.

-- The model further estimates that both the annual average and 99-percentile air quality standards of 50 µg/m^3 and 350 µg/m^3 respectively for SO_2 will also be exceeded by a significant margin in the same area. The model estimates the maximum annual average concentration to be 81 µg/m^3 while the maximum 99-percentile daily average concentrations is estimated to be 1 042 µg/m^3.

-- The model also estimates that both the annual average and 99-percentile air quality standards of 40 µg/m^3 and 200 µg/m^3, respectively for NO_2 will also be exceeded by a significant margin in the same area. The model estimates the maximum annual average concentration to be 65 µg/m^3 while the maximum 99-percentile daily average concentrations are estimated to be 836 µg/m^3.

-- As is known, the three major sources of odours to the south and south-east of Oudtshoorn, i.e. Klein Karoo International, PSP Timbers and the wastewater treatment works emit odours that are generally detectable in the southern part of Oudtshoorn, while the 99-perentile simulation shows that odours may be detected over a large part of the town.

7.4 SUMMARISED DATA

The ground-level concentrations of concern as estimated by the dispersion are summarised in Table 15 below.

Location & pollutant	Max annual avg.	Max 99-percentile	Where
Bitou			
PM10		121	Kurland
		56	Vantell
Knysna Main Road			
NO_2	28.6	216.3	
George			
PM10		76.6	Industrial area

NO_2		228	Airport
Mossel Bay			
NO_2		176	Heiderand
Oudtshoorn			
PM10	106	955	Johnson Bricks
SO_2	80.6	1042	
NO_2	64.6	836	

Table 15: Estimated Ground-level Concentrations of Concern, µg/m^3

8 DISCUSSION

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

8.1 RELIABILITY OF EMISSIONS DATABASE

8.1.1 Point Source Emissions

As is stated in Section 6.1, measured pollutant concentrations were used preferably in calculating annual emissions from various industrial sources included in this report. These sources are limited to those whom were issued with atmospheric emissions licenses (AELs) as such industries are obliged to have their emission quantified annually. The emissions calculated for these sources can be regarded as reliable, although the emission measurements only show emissions that occurred once per year and essentially only apply to the operating conditions that prevailed at the time of the tests.

Some of the pollutants included in this report were not measured in every case, e.g. CO from combustion sources, as the pollutants were not included as controlled substances in the AELs. In such cases LAQS calculated annual emissions from emission factors published by the USEPA in AP-42.

LAQS also made use of these emission factors for those industries that are not obliged to quantify emission annually. Emission factors predict emission based on an operating parameter, e.g. rate of production, fuel combustion rate, etc., and such information is not always known accurately. As a result the calculated annual emissions are not calculated accurately.

Furthermore, not all industries operate on the same daily, weekly and monthly schedule and others operate on variable schedules and variable production rates.

As a result there is a definite but unquantifiable uncertainty in the calculated point source emissions. Added to the fact that LAQS assumed all undefinable particulate emissions as PM10 emissions, the PM10 emissions used in the dispersion model is an overestimation of emissions as PM10 particles area subset of total particulate matter.

8.1.2 Area Source Emissions

Differentiation must be made between industrial area sources and non-industrial area sources.

Of the industrial area sources included in this study, only the H_2S emissions from the aeration dams treating Klein Karoo International's tannery were actually measured. Annual emissions from the rest were calculated from emission factors developed by the USEPA. As a result there is an unquantifiable degree of uncertainty associated with the calculated emissions.

AP-42 provides PM10 emission factors for various activities in brick making operations. GRDM provided the actual masses of bricks manufactured by the four works in GRDM (Kurland Bricks, Vantell Bricks, Spitskop Stene and Johnson Bricks) during 2018 and LAQS is of the opinion that emissions estimated from these operations have lower uncertainties as they are based on actual data.

Of the non-industrial area sources, emissions from landfill operations were estimated using the USEPA's Landfill Gas Emissions Model (Landgem). Landgem requires the date of commencement of a landfill site, the annual rate of municipal waste disposal since commencement and the estimated closure date of the site.

Of the sites included in this study, the mass of material disposed of during 2018 was made available, but not the annual masses since commencement of operations. To compensate LAQS estimated these masses using population growth rates published in GRDM's Integrated Waste Management Plan. There is, therefore, a degree of uncertainty in the estimated emissions from landfill sites.

Information about the quantitative emissions of odorous compounds from wastewater treatment works is extremely hard to find. LAQS based its calculations of the annual mass emission from these works on a single research paper with the result that there is a substantial degree of uncertainty in the estimated annual emission and odour impact on surrounding areas.

8.1.3 Line Sources

Road Traffic:

Accurate road traffic counts and average speeds of light and heavy motor vehicles on the national roads were provided by SANRAL, but only basic fleet composition data is available. As a result, LAQS made use of assumptions, based on its personal observations during daily travels. As emissions are directly related to the vehicle fleet composition, a degree of uncertainty in vehicle emission will result.

In addition, the state of servicing and repair of the vehicles that were counted by SANRAL is not known, nor the general age of the vehicle fleet. To compensate for this LAQS averaged emission factors for various fuel classes specified by the European Union. LAQS further assumed that the resulting averaged emission factors applied for all vehicles in a specific class, regardless of engine sizes. A further uncertainty factor would have been introduced in the equation.

Although the emission factors are reliable, the impact of the assumptions made by LAQS and its averaging calculations will have an unquantifiable degree of uncertainty in the outcome of the vehicle emissions data used.

Sea Traffic:

Accurate sea traffic data was provided by Mossel bay Harbour authorities. Accurate emissions factors developed by the European Union are also available. However, in calculating sea traffic emissions, the size of main and auxiliary engines on each ship in the dataset and the power used by each type of engine during the various harbour manoeuvres are not known and averaged data generated by the European Union was used in calculating annual emissions. As a result a degree of uncertainty exists in the calculated harbour emissions.

Airport:

Details of weekly commercial air traffic at George Airport were provided by the Airport authorities. Engine types used on each type of aircraft was obtained from literature. Emission factors for various aircraft manoeuvres for each type of aircraft engine applicable to this study were obtained from the International Civil Aviation Organisation. However, the duration of each applicable manoeuvre was estimated, resulting in a degree of uncertainty in the calculated annual emissions from George Airport.

8.2 METEOROLOGY DATABASE

LAQS procured the necessary meteorology data form Bitou, Knysna, George, Riversdale, Ladismith and Oudtshoorn from the Agriculture Research Council. Weather data for Mossel Bay was obtained from GRDM’s weather station located in Mossdustria.

The datasets cover the past three years, i.e. 2016, 2017 and 2018, thus meeting the requirements of GN R.533 and LAQS regards these sets as reliable. The wind distribution profile of each dataset is given in Figures 75 to 81 below.

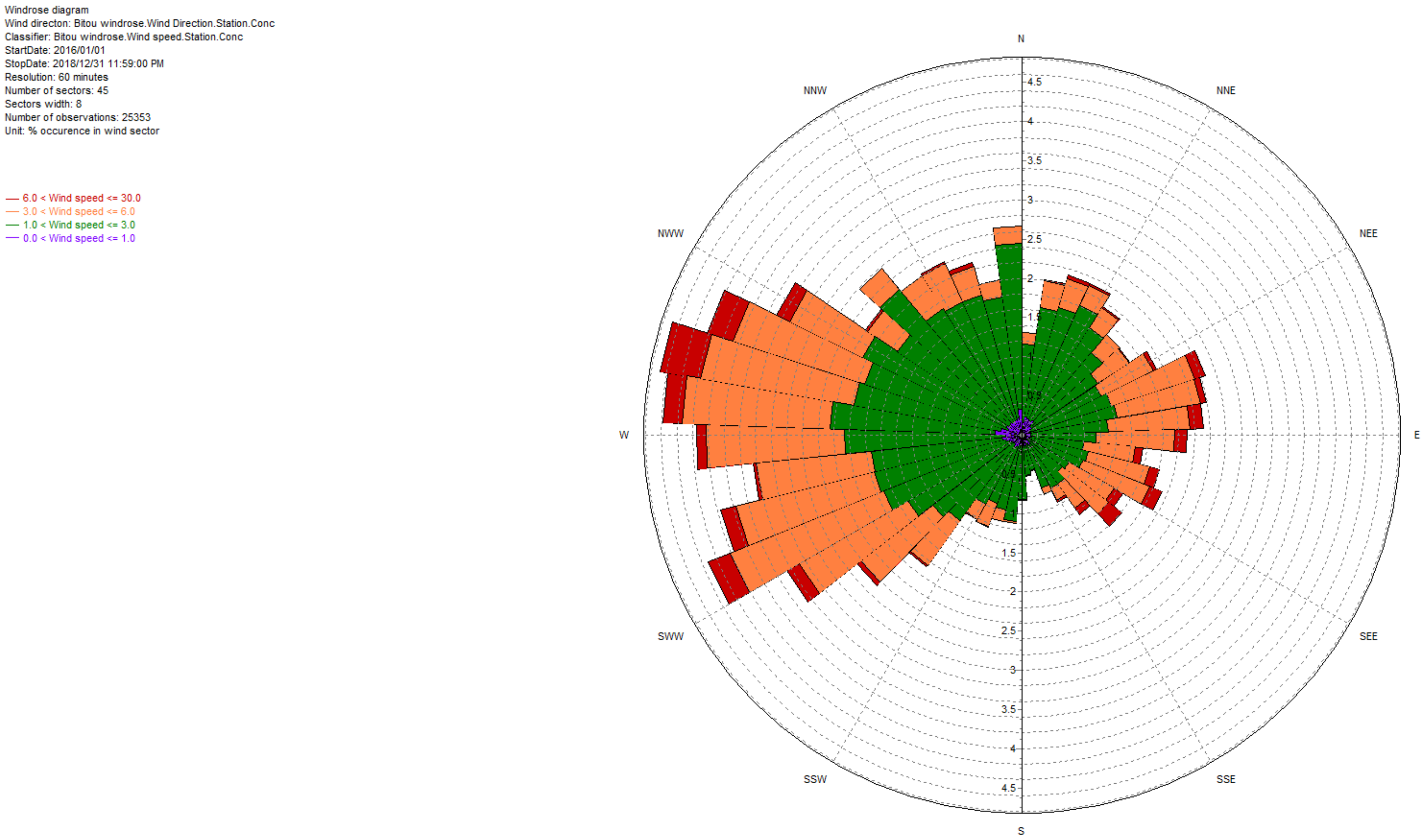

Figure 75: Bitou: Frequency of Wind Direction

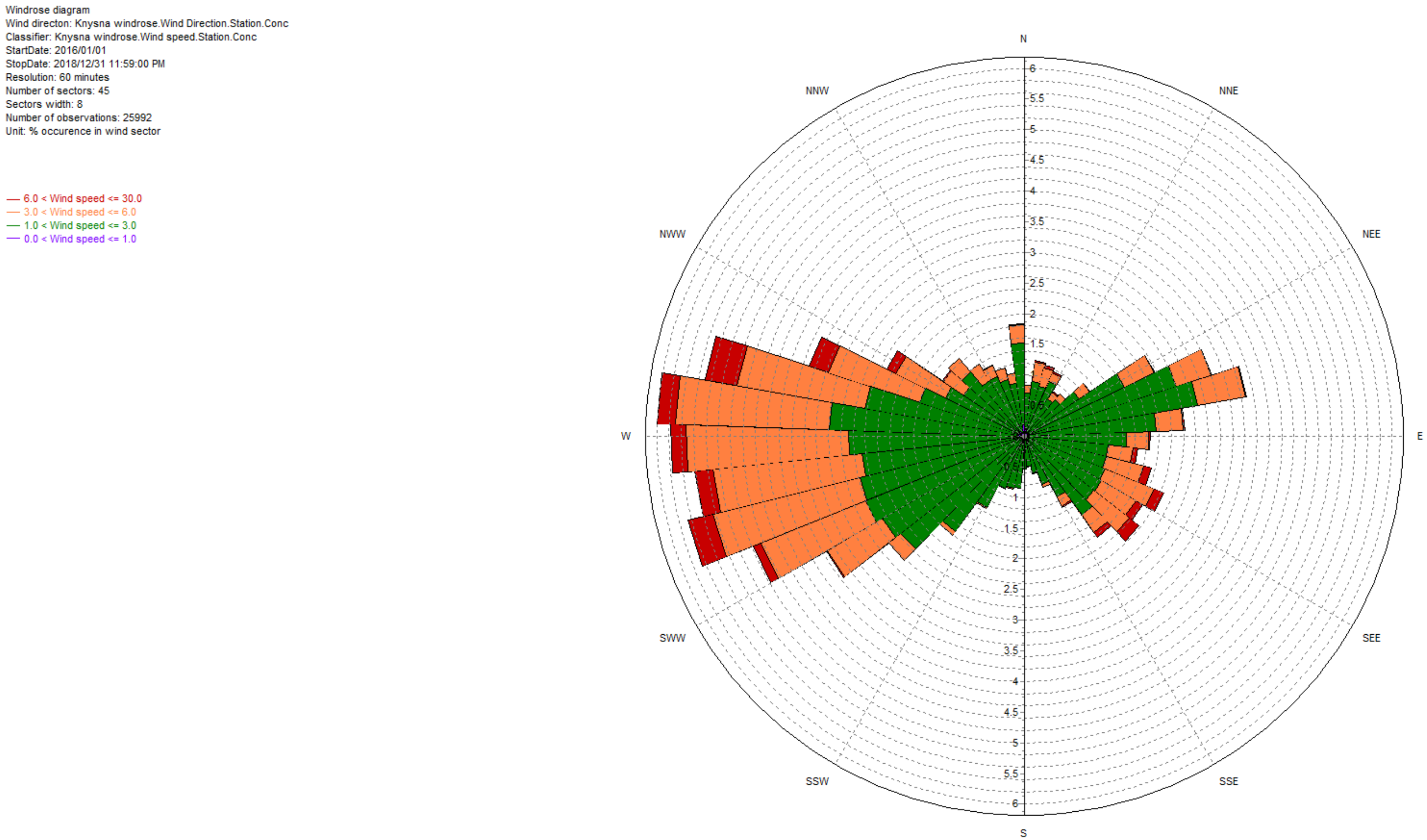

Figure 76: Knysna: Frequency of Wind Direction

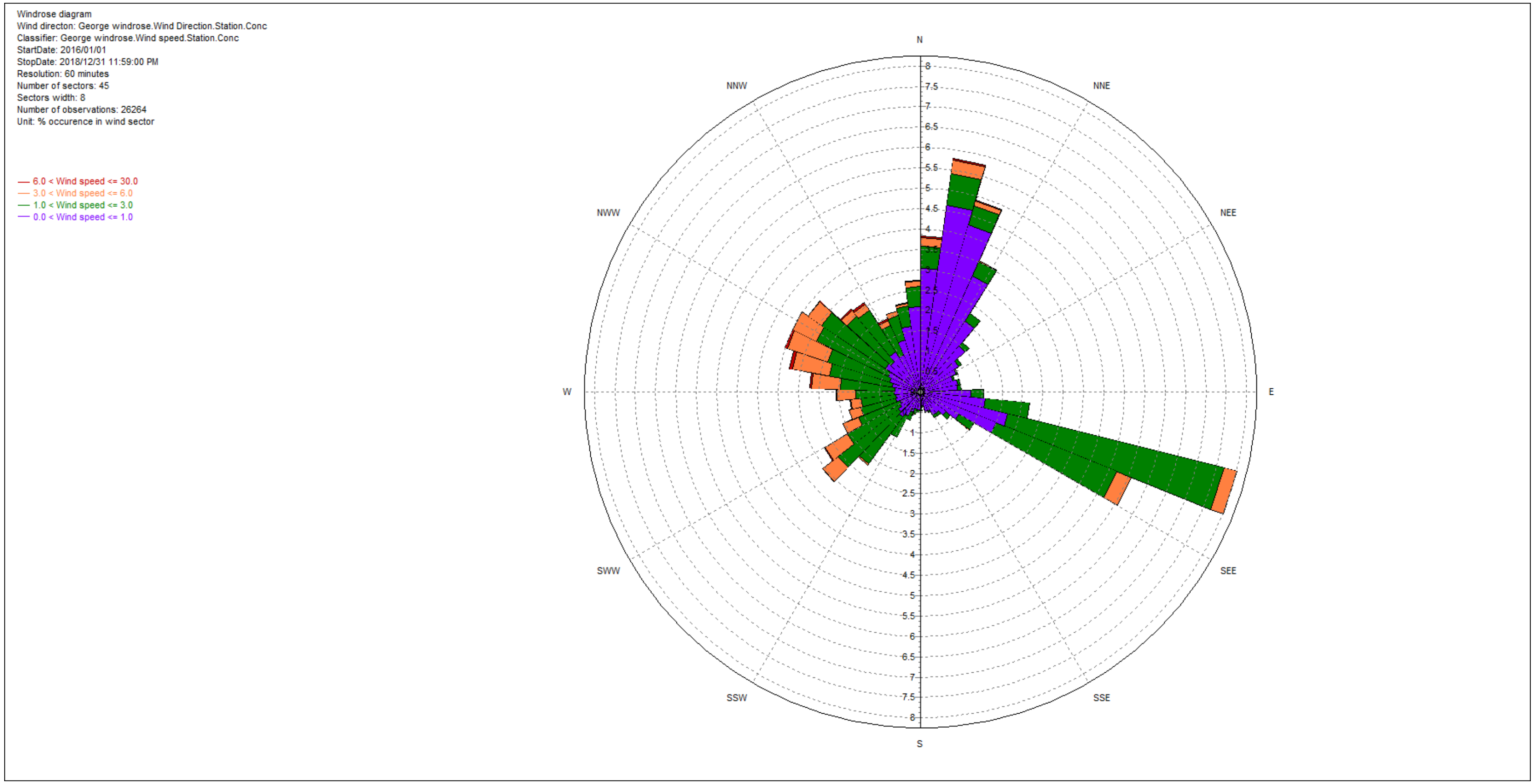

Figure 77: George: Frequency of Wind Direction

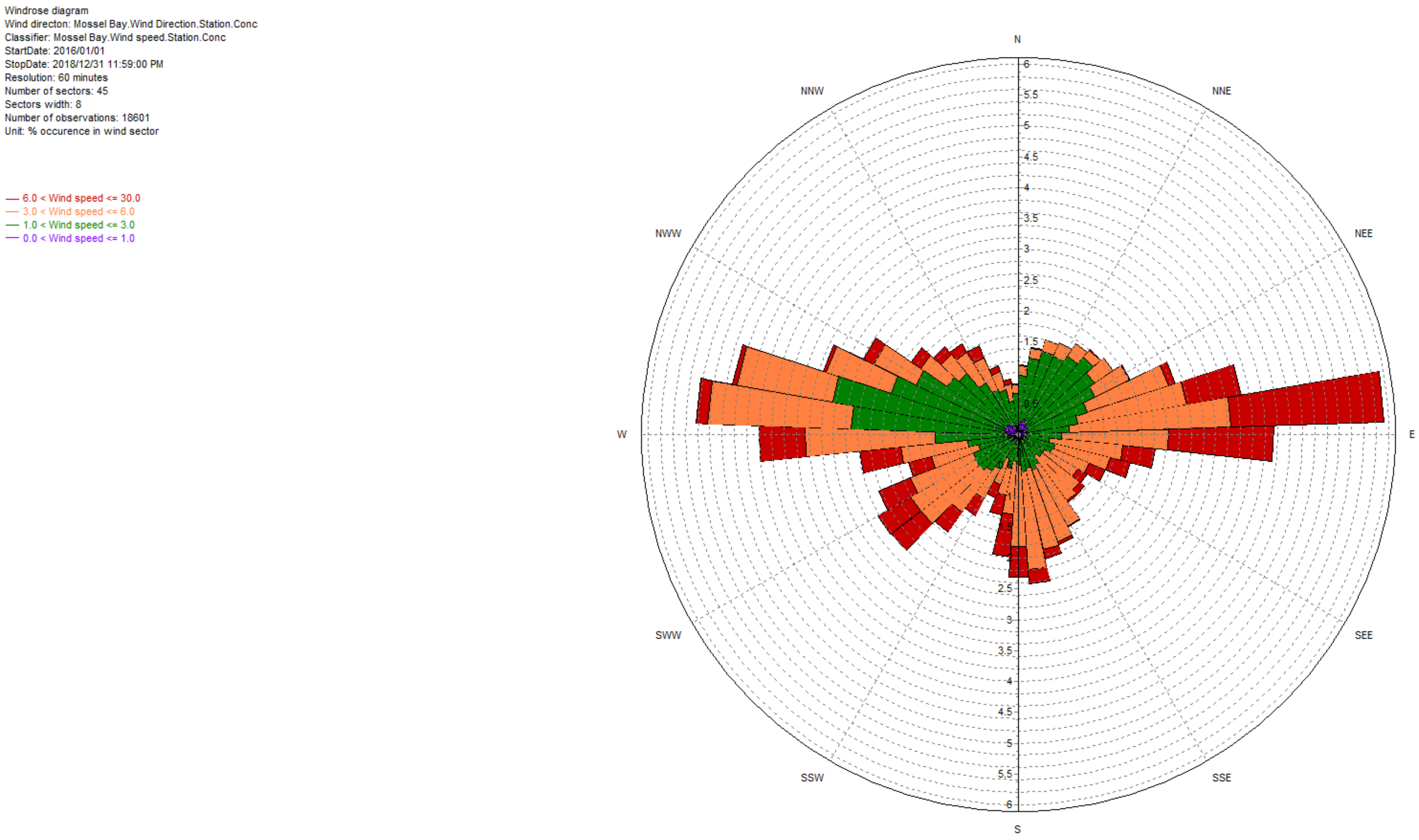

Figure 78: Mossel Bay: Frequency of Wind Direction

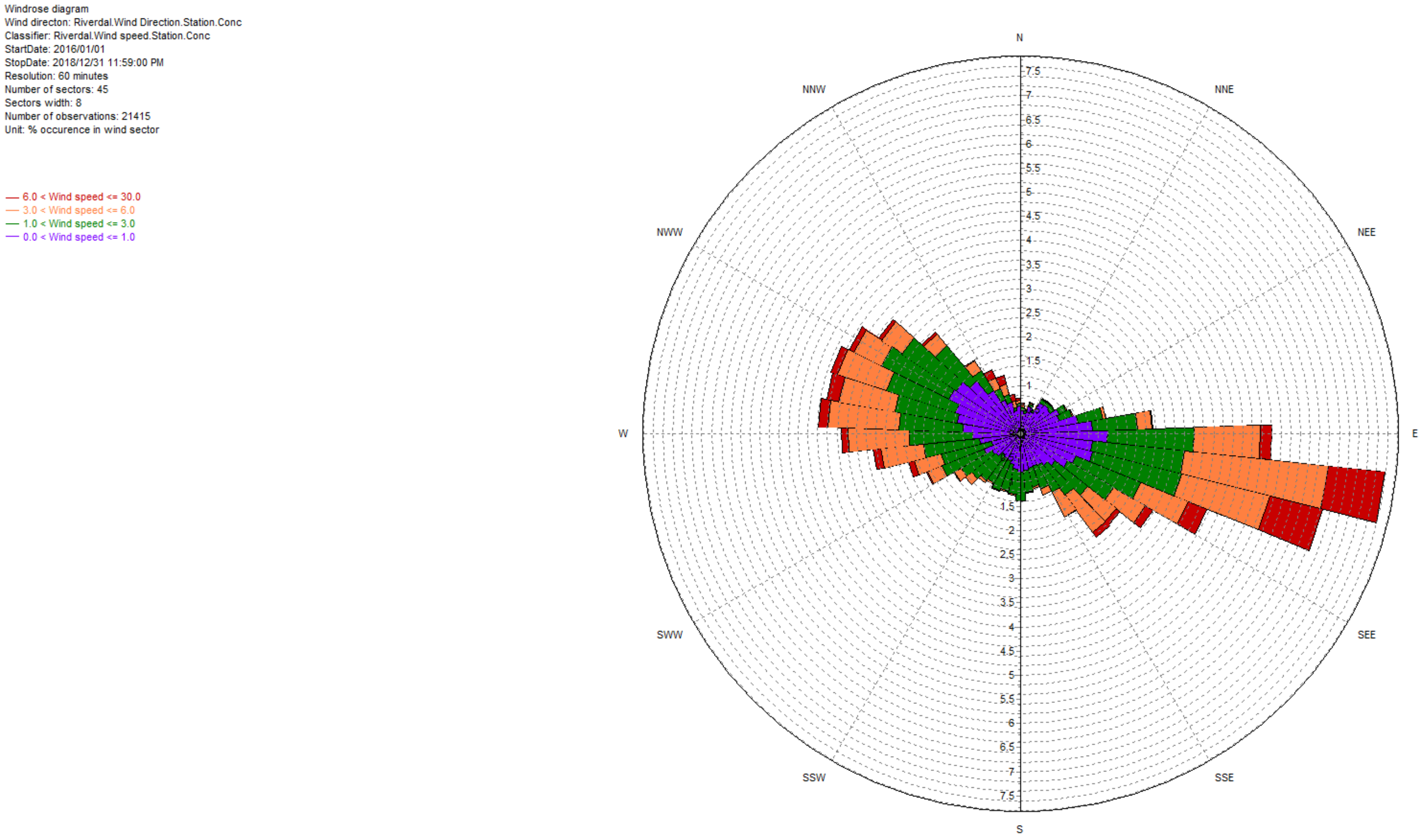

Figure 79: Riversdale: Frequency of Wind Direction

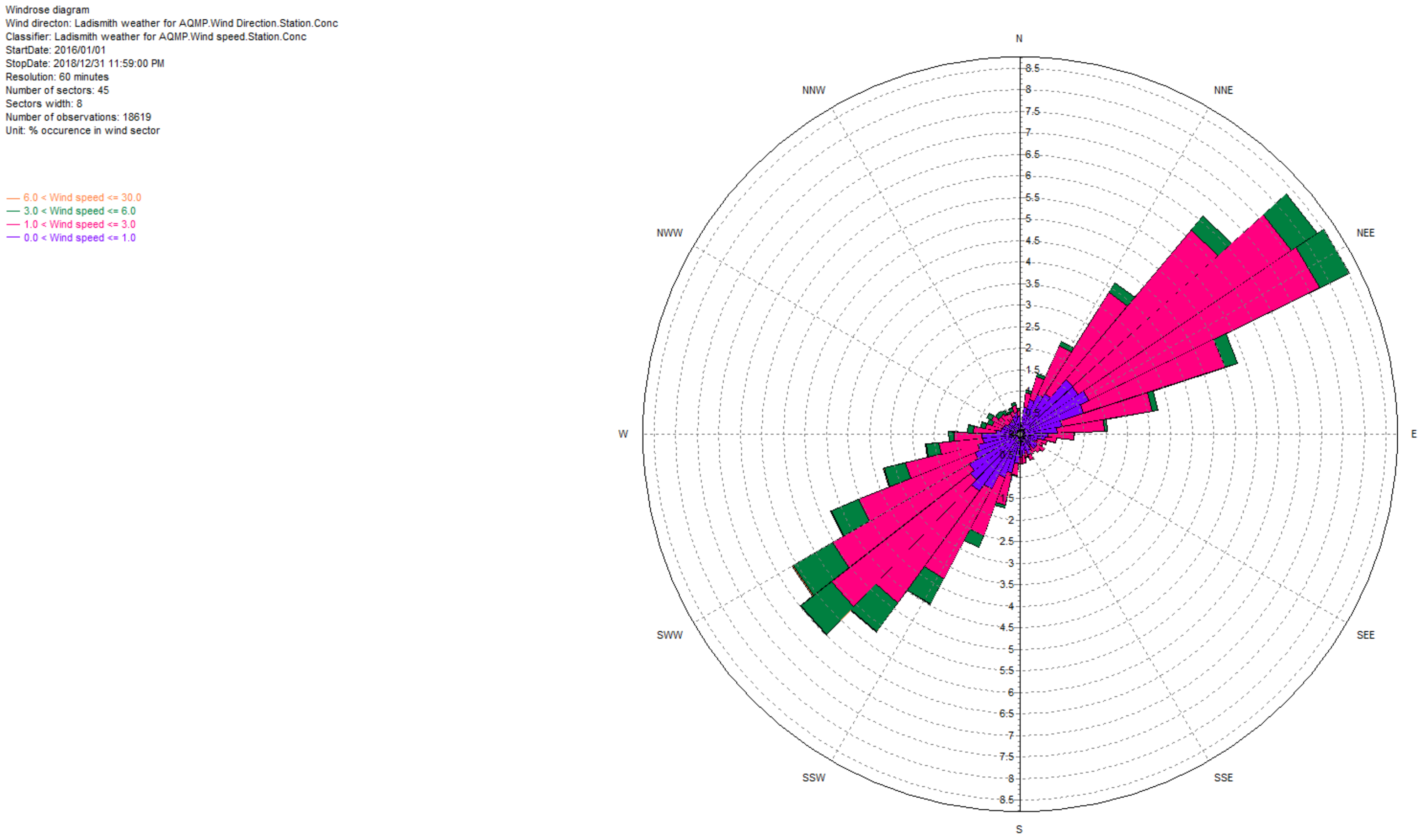

Figure 80: Ladismith: Frequency of Wind Direction

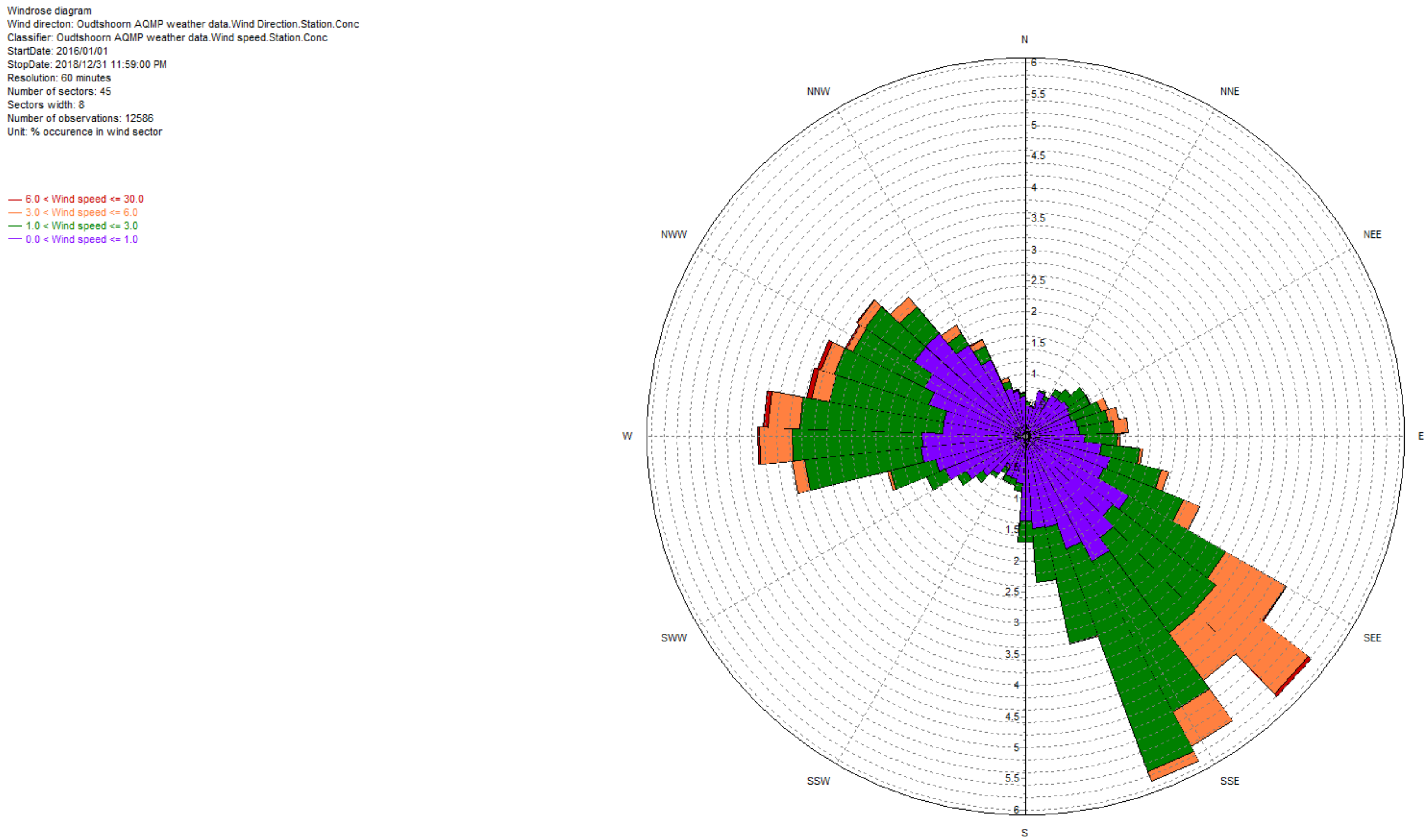

Figure 81: Oudtshoorn: Frequency of Wind Direction

8.3 DISPERSION MODEL

The user provides no direct data input to Planner. It uses Aermod, a USEPA-approved Gaussian plume dispersion model, which is also accepted as a suitable model in GN R.533. There is, therefore, no reason to doubt the reliability of the dispersion calculations.

9 SUMMARY

LAQS is of the opinion that the annual emissions of pollutants used in this study are overestimated for the following reasons:

-- Where no measured data was available annual emissions were estimated by means of emission factors. Emissions of pollutants were overestimated by using maximum fuel consumption rates and/or plant production rates instead of "normal" consumption / production rates. In some cases, however, actual production rates during 2018 were used to calculate annual emissions, e.g. the four brick manufacturers in the district.

-- Unless specific PM10 emission values were available, all particulate emissions were assumed to meet PM10 criteria, whereas PM10 particulates form a subset of total particulate matter (TPM).

-- Emissions of NO_2 were assumed to be equal to 80% of total NOx emissions in order to meet the requirements of GN R.533.

-- Averaged emission factors were used for motor vehicle emissions, regardless of engine size variations in each vehicle class.

-- Where possible ocean-going vessel routes were overestimated with the result that total annual emissions were overestimated.

LAQS followed this approach deliberately in order to create a conservative, or worst-case, scenario. Should such a scenario indicate that the impact on air quality is low, actual conditions would have an even lower impact on air quality.

The results of the dispersion modelling study show some areas of concern that need to be addressed in the revised air quality management plan.

10 RECOMMENDATIONS

10.1 KNYSNA

The results of the dispersion modelling study show that there is a possibility that the short-term air quality standard for NO_2 may be breached along Main Road in Knysna.

NO_2 affects human health as it affects, inter alia, lung function as it dissolves in tissue fluid to form nitrous and nitric acid.

Given the close proximity of shops to Main Road, the large number of pedestrian that frequent Main Road and the large number of motorists that make us of it, LAQS sees the high estimated NO_2 concentrations as a health threat that warrants further investigation.

As a result LAQS recommends that a dedicated air quality monitoring program is set up, using GRDM's Scentinel analyser. Such a monitoring program should be carried out in the following two phases:

-- Phase 1: Monitoring continuously during the months of June and July, i.e. mid-winter when poor dispersion conditions usually occur due to prevailing weather conditions

-- Phase 2: Monitoring continuously during the months of December and January when by far the highest vehicle flows through man Road occur.

10.2 BITOU

The dispersion model predicts that the short-term PM10 air quality standard may be exceeded in the vicinity of the two brick manufacturing operations, i.e. Kurland Bricks and Vantell Bricks, with the former having the greatest impact. It is fortuitous that both of these operations are active in areas of low population density.

It is likely that both of these operations carry our dust-fallout measurements as part of their AEL obligations, but dust fallout limits far exceed ambient air quality PM10 standards.

It is recommended that a PM10 monitoring program is set up to monitor on a daily basis. A MiniVol-type sampler will suffice. The monitoring program should be carried out for a period of one month during mid-winter and daily samples should be collected and analysed.

10.3 GEORGE

Similarly, it is recommended that a PM10 monitoring program is set up in the industrial area of George immediately to the north of the N2 as the dispersion model estimates high daily averaged concentrations in that area.

The monitoring program should also be carried out during mid-winter and daily samples of PM10 should be collected and analysed.

10.4 OUDTSHOORN

As is the case with Bitou, it is fortuitous that Johnson Bricks' operation is located in a remote area with low population density. Nevertheless, the dispersion model predicts that PM10, SO_2 and NO_2 emissions from this operation will exceed both the short-term and long-term air quality standards in a fairly large area around the site. According to the dispersion model these impacts are by far the greatest in the whole of the GRDM region.

It is recommended that a long-term passive sampling project is launched to monitor the ground-level concentrations of SO_2 and NO_2 at location that falls within the dispersion model's area of impact.

The passive gas monitoring activities should be supplemented with daily PM10 monitoring activities, using a MiniVol-type of sampler. PM10 sampling should be carried out over a period of one month during mid-winter.

10.5 MOSSEL BAY

While not as urgent as the others, it is recommended that a road-side monitoring program along the R102 in either Voorbaai or towards Heiderand is designed, using GRDM's Scentinel analyser. The dispersion model predicts that 99-percentile NO_2 concentrations are high and should be verified by the monitoring program.

The monitoring program should cover a period of two months over mid-winter.