

# Appendix F Air quality assessment





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# **DISPERSION MODELLING STUDY**

**FOR  
NATIONAL BIODIESEL (PTY) LTD  
AUSTRALIA**

**Report No. 204/08**

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# **DISPERSION MODELLING STUDY NATIONAL BIODIESEL (PTY) LTD**

## **1 INTRODUCTION**

Messrs National Biodiesel (Pty) Ltd (NB), a subsidiary of the National Biofuels Group (NBG), Pymble, NSW, Australia, is planning the installation of a soybean processing and biodiesel production facility in Port Kembla, New South Wales, Australia. The plant design is based on an identical plant under construction by NBG, located in the Coega Industrial Development Zone near Port Elizabeth, South Africa.

An air pollution dispersion modelling study is required as part of the environmental impact assessment of the proposed plant. As C&M Consulting Engineers (C&M) carried out a similar study on the identical plant in South Africa, NB commissioned C&M to carry out the study for the proposed plant in Port Kembla.

The planned operations will be carried out on land currently vacant, but bordered on the western side by large grain silos. Some vacant land adjoining the proposed site is used for the temporary storage of motor vehicles.

Figure 1 below shows the proposed plant layout relative to the silos and surrounding vacant areas.



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Figure 1: Site layout of Soybean-oil Extraction and Biodiesel plants



This report describes the software that was used and discusses the input data provided. The results of the study are given in both graphical form and summarised tabular format.

## **2 DISPERSION MODEL**

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

Mapper: A map manipulation tool

Emissioner: An extensive, relational emissions database

Envimet: A meteorological data management program

Planner: The actual dispersion model

Planner contains three different emission dispersion models, two of which are aimed at motor vehicle emissions and, therefore, not applicable to industrial plumes. The third dispersion model used in Planner is Aermol, the latest USEPA-approved industrial plume dispersion model. It is a Gaussian plume dispersion model.

### **2.1 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.



## 2.2 EMISSIONER

Emissioner is a comprehensive, relational emissions database that locates emission sources on fixed co-ordinates. Pollution sources are placed on the map by the user and the co-ordinates are automatically generated by Planner.

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. whole informal settlement areas
- Line sources, e.g. motor vehicle emissions

Of these, only point sources are of interest in this study.

When multiple sources are investigated, it is possible to add keywords to each source to uniquely identify it and to investigate plume dispersion from a single, or group of sources. In studying the plume dispersion from National Biodiesel's proposed facility keywords are not required.

## 2.3 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 reflect scaling of the boundary air layer. These are:

- Wind speed
- Wind direction
- Standard deviation of 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.

## 2.4 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 weather information about temperature, wind speed, wind direction, cloud cover, etc.
- True weather period, i.e. using weather data from a weather monitoring station to simulate air quality hour-by-hour based on observed weather data.
- 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 a statistical weather period simulation approach was used.

Planner makes use of three different dispersion models, two of which are aimed at motor vehicle emissions. Use is made of the Aermid Gaussian plume dispersion model for the purposes of calculating the dispersion of plume from point sources. Aermid is the latest USEPA-approved plume dispersion model.



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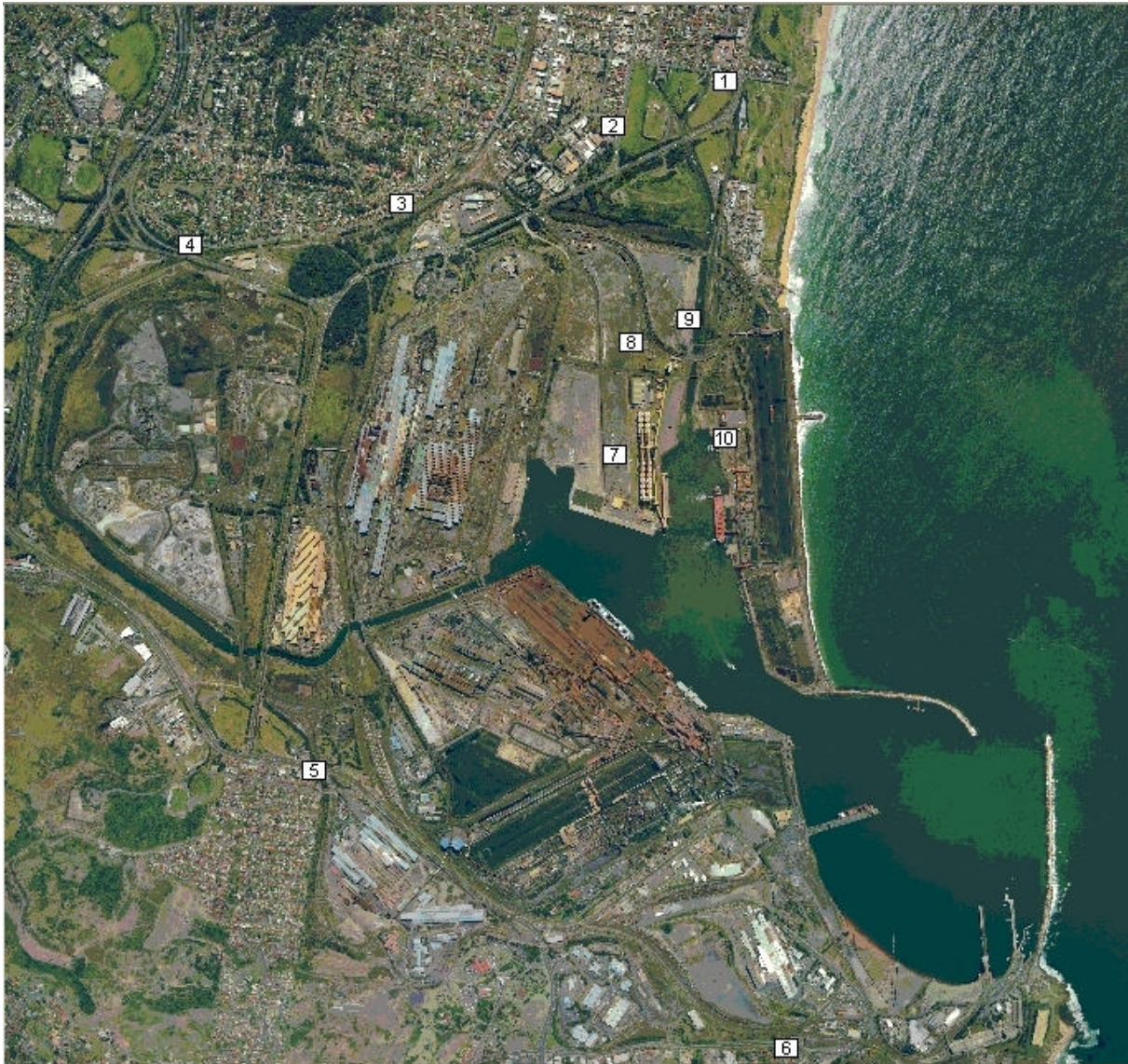
### **3 INPUT DATA**

#### **3.1 MAPPER**

A high-density bitmap image of the Port Kembla port and surrounding areas was provided by NB. The map shows the area where the plants will be operated, roads and surrounding suburbs in close proximity to the plant. The dimensions of the map area are approximately 5 km by 5 km. The map is shown in Figure 2 below.

The map also shows ten receptor points identified by white squares on the map. Six of these receptor points represent the closest residential areas that surround the proposed facility. These receptor points are located in the residential areas of:

- 1 Coniston
- 2 Coniston
- 3 Coniston
- 4 Mount St Thomas
- 5 Cringila
- 6 Port Kembla



**Figure 2: Map of Port Kembla harbour and surrounding area**  
(Image courtesy of Port Kembla Port Corporation)

The additional four receptor points were identified by NB in the inner harbour area and surrounding the site of the proposed operations. These points represent neighbouring port users and are shown in Figure 3 below.



**Figure 3: Location of inner harbour receptor points around the site**

The four receptor points are numbered from 7 to 10 and are referred to as Site SW, Site N, Site NE and Site E respectively further in this report.

### **3.2 EMISSIONER**

Compulsory information required for point source emissions are:

- Stack height
- Height of adjacent building that could influence plume behaviour
- Stack gas velocity or flow rate
- Stack gas temperature
- Stack internal and external diameters
- Definition of pollutants
- Emission rates of pollutants



Four point emission sources will exist once the plant is in operation. The four stacks and pollutants emitted are:

- Soybean-oil extraction plant stack - Hexane
- Extraction plant boiler stack – Nitrogen oxides
- Biodiesel plant stack - Methanol
- Biodiesel plant boiler stack – Nitrogen oxides

Pertinent data of the four stacks are given in Tables 1 and 2 below. As the plant is not currently in operation, maximum emissions guaranteed by the technology providers and/or maximum allowable emission rates were used. Typical industrial design specifications were used for gas-fired boiler information.

**Table 1: Stack and flue gas physical properties**

<b>Parameter</b>	<b>Extraction plant</b>	<b>Biodiesel plant</b>	<b>Gas-fired boiler</b>
Stack height, m	30	32	10
Stack ID, m	2.02	0.088	0.95
Stack OD, m	2.0	0.1	0.96
Flue gas velocity, m/s	11.1	2	11
Flue gas temperature, °C	35	35	200
Flow rate, Am <sup>3</sup> /s	34.8	0.012	7.58
Flow rate, Nm <sup>3</sup> /s	30.9	0.01	4.375
Oxygen content, %	21	21	3



**Table 2: Emissions from proposed facility**

Pollutant	Emission rate, g/s	Concentration mg/Am <sup>3</sup>	Corrected emissions, mg/Nm <sup>3</sup> at 3% O <sub>2</sub>	Regulation emissions, mg/Nm <sup>3</sup> at 3% O <sub>2</sub>
<b>Extraction plant</b>				
Hexane	2.2	63.1	(*)	na
<b>Bio-diesel plant</b>				
Methanol	0.002	178	(*)	na
<b>Boilers (per boiler)</b>				
NO <sub>2</sub>	1.36	202(**)	350	350

(\*): Flue gas stream is air with oxygen content of 21%. Conversion calculation not possible.

(\*\*): The maximum allowable NO<sub>2</sub> emission limit of 350 mg/Nm<sup>3</sup> at 3% O<sub>2</sub>, as determined by the Protection of the Environment Operations (Clean Air) Regulation 2002, was assumed to present a worst-case scenario. The value of 202 mg/Am<sup>3</sup> represents a conversion to actual stack temperature conditions.

na: not available

**Height of adjacent buildings:** The heights of the Extraction plant and Biodiesel plant are 28 and 30 metres respectively. The stacks serving these two plants protrude above roof height by approximately 2 metres. At heights of 10 metres each, the two boiler stacks are lower than then surrounding structures. The four stacks will, therefore, be regarded as wake-affected point sources.

**Output units:** Given an input of tons per annum, the output of Planner is in units of micrograms per cubic meter (µg/m<sup>3</sup>).



### 3.3 ENVIMET

A meteorological dataset was procured from the NSW EPA by NB. The data set was recorded at the Kembla Grange monitoring station approximately 8 km from the site of the proposed facility and included all five parameters that are essential for calculating a boundary layer scaling set. These are:

- Wind speed
- Wind direction
- Wind direction standard deviation
- Temperature
- Solar radiation

The data was recorded continuously for the period from 1 January 2006 to 31 December 2006. This data set was the most recent data range that has been subjected to the internal quality assurance procedure of the NSW EPA to ensure integrity of the meteorological data.

In calculating the boundary scaling parameters, Envimet uses a further parameter, referred to a “surface roughness”. Surface roughness is caused by tall trees, buildings, undulating countryside, etc., and affects the turbulence of ground-level winds. Generally, an extended water surface is regarded as having the lowest surface roughness while a city centre with many tall buildings will have the highest surface roughness.

A suitable surface roughness for the area was used.

### 3.4 PLANNER

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



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## 4 RESULTS

The results of the dispersion modelling study are given graphically in the Appendices attached. Three figures are provided for each of the pollutants involved. These figures are arranged as follows:

- Annual average concentration, expressed as an hourly concentration
- Maximum 1-hour average that could occur
- Estimated 95 percentile concentration, i.e. estimated worst conditions that would prevail for 5% of the time.

Graphic results of the dispersion of hexane from the Extraction plant are given in Appendix A below.

Graphic results of the dispersion of methanol from the Biodiesel plant are given in Appendix B below.

Graphic results of the dispersion of NO<sub>2</sub> from the two gas-fired boilers are given in Appendix C below.

The corresponding concentrations predicted at each of the 10 receptors are given in Tables 3, 4 and 5 below together with impact assessment criteria as given in Section 7 of "Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales".



**Table 3: Estimated concentrations of Hexane, mg/m<sup>3</sup>**

Receptor	Annual average	Maximum hourly	Hourly assessment criteria mg/m <sup>3</sup>	95 percentile
1 (Coniston)	0.9 x 10 <sup>-4</sup>	1.2 x 10 <sup>-2</sup>	3.2 (*)	0.5 x 10 <sup>-3</sup>
2 (Coniston)	1.1 x 10 <sup>-4</sup>	3.6 x 10 <sup>-2</sup>		0.4 x 10 <sup>-3</sup>
3 (Coniston)	0.6 x 10 <sup>-4</sup>	0.7 x 10 <sup>-2</sup>		0.3 x 10 <sup>-3</sup>
4 (Mt St Thomas)	0.3 x 10 <sup>-4</sup>	0.4 x 10 <sup>-2</sup>		0.1 x 10 <sup>-3</sup>
5 (Cringila)	0.8 x 10 <sup>-4</sup>	1.8 x 10 <sup>-2</sup>		0.2 x 10 <sup>-3</sup>
6 (Pt Kembla)	1.0 x 10 <sup>-4</sup>	1.8 x 10 <sup>-2</sup>		0.1 x 10 <sup>-3</sup>
7 (Site SW)	8.0 x 10 <sup>-4</sup>	1.9 x 10 <sup>-2</sup>		4.2 x 10 <sup>-3</sup>
8 (Site N)	5.3 x 10 <sup>-4</sup>	5.0 x 10 <sup>-2</sup>		2.5 x 10 <sup>-3</sup>
9 (Site NE)	5.4 x 10 <sup>-4</sup>	3.4 x 10 <sup>-2</sup>		3.3 x 10 <sup>-3</sup>
10 (Site E)	45 x 10 <sup>-4</sup>	3.7 x 10 <sup>-2</sup>		19 x 10 <sup>-3</sup>

(\*)Table 7.2b: Impact assessment criteria for individual toxic air pollutants (Victorian Government Gazette 2001) as given in Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales



**Table 4: Estimated concentrations of Methanol, mg/m<sup>3</sup>**

Receptor	Annual average	Maximum hourly	Hourly assessment criteria mg/m <sup>3</sup>	95 percentile
1 (Coniston)	$2.2 \times 10^{-7}$	$3.1 \times 10^{-5}$	3.0 (*)	$0.6 \times 10^{-6}$
2 (Coniston)	$2.5 \times 10^{-7}$	$3.2 \times 10^{-5}$		$0.7 \times 10^{-6}$
3 (Coniston)	$2.3 \times 10^{-7}$	$2.9 \times 10^{-5}$		$0.4 \times 10^{-6}$
4 (Mt St Thomas)	$1.5 \times 10^{-7}$	$2.0 \times 10^{-5}$		$0.05 \times 10^{-6}$
5 (Cringila)	$2.1 \times 10^{-7}$	$1.8 \times 10^{-5}$		$0.3 \times 10^{-6}$
6 (Pt Kembla)	$1.4 \times 10^{-7}$	$1.3 \times 10^{-5}$		$0.01 \times 10^{-6}$
7 (Site SW)	$7.0 \times 10^{-7}$	$2.8 \times 10^{-5}$		$2.9 \times 10^{-6}$
8 (Site N)	$32 \times 10^{-7}$	$13 \times 10^{-5}$		$17.7 \times 10^{-6}$
9 (Site NE)	$20 \times 10^{-7}$	$2.6 \times 10^{-5}$		$6.9 \times 10^{-6}$
10 (Site E)	$2.8 \times 10^{-7}$	$4.3 \times 10^{-5}$		$15.7 \times 10^{-6}$

(\*) Table 7.4a: Impact assessment criteria for individual odorous air pollutants (Victorian Government Gazette 2001) as given in Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales



**Table 5: Estimated concentrations of Nitrogen Oxides (as NO<sub>2</sub>), µg/m<sup>3</sup>**

Receptor	Annual average	Annual assess. Criteria µg/m <sup>3</sup>	Maximum hourly	Hourly assess. Criteria µg/m <sup>3</sup>	95 percentile
1 (Coniston)	0.14	62 (*)	4.2	246 (*)	0.85
2 (Coniston)	0.17		2.9		0.83
3 (Coniston)	0.12		18.9		0.58
4 (Mt St Thomas)	0.06		11.0		0.21
5 (Cringila)	0.09		10.1		0.29
6 (Pt Kembla)	0.05		2.5		0.17
7 (Site SW)	0.71		13.9		3.24
8 (Site N)	5.0		147		23.3
9 (Site NE)	3.0		22.7		12.8
10 (Site E)	7.4		85.2		33.1

(\*) Table 7.1: Impact assessment criteria for SO<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub>, Pb, PM<sub>10</sub>, TSP, deposited dust, CO and HF as given in of “Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales

As emission data is based on maximum design levels and/or maximum permissible pollutant concentrations, the outcome of the dispersion modelling study can be regarded as a worst-case scenario. As a result the dispersion modelling study was carried out as a Level 1 assessment, i.e. a screening-level dispersion modeling technique using worst-case input data (Section 2 of “Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales”.)

The results of the dispersion modelling study must be interpreted in conjunction with the relevant ambient air quality standards as defined in Section 7 of



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“Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales”.

## **5 DISCUSSION**

### **5.1 MODEL RELIABILITY**

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

#### **Mapper:**

A bitmap image of the relevant area was provided by NB. The bitmap image was of high-density and allowed sufficient zoom capacity without detail loss so that the locations of the four stacks could be placed accurately. As a result only a very low degree of uncertainty can be associated with the incorrect location of the point sources.

#### **Emissioner:**

The annual mass emission rates of pollutants used in the model are based on design criteria as supplied by NB. Where available, the maximum emission rate guaranteed by the technology providers was used in order to simulate expected worst-case conditions, thus allowing a Level 1 assessment approach to the dispersion modelling study.

Specific mention must be made of the approach to simulate emission of NO<sub>x</sub> from the two gas-fired boiler stacks. The expected maximum concentration of NO<sub>x</sub> expected in the flue gas is not known and C&M, therefore, accepted an



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emission rate of  $350 \text{ mg/Nm}^3$  at 3%  $\text{O}_2$  as this is the maximum allowable emission of  $\text{NO}_x$  from new gas-fired boilers.

Furthermore, C&M assumed that all of these emissions were  $\text{NO}_2$ , thus allowing direct comparison of the predicted ground-level concentrations with ambient air quality standards prevailing in New South Wales. These standards are a maximum hourly concentration of  $246 \text{ }\mu\text{g/m}^3$  (12 pphm) and an annual average concentration of  $62 \text{ }\mu\text{g/m}^3$  (3 pphm).

### **Envimet:**

A meteorological data set was procured from the NSW EPA by NB. The dataset contained hourly averaged data for the period from 1 January 2006 to 31 December 2006 and covered the necessary parameters required by Envimet to calculate a full set of boundary scaling parameters as required by Aermol.

The data was collected at the Kembla Grange monitoring station which is approximately 8 km from the proposed soybean processing and biodiesel production facility and is the closest monitoring station where reliable data is collected.

The dataset is of good quality with only a few isolated cases of missing data. Where possible, C&M applied linear interpolation techniques to fill missing data points using the approach that most meteorological parameters do not change drastically from hour to hour. A total of 20 hours, or 0.23% of the provided data, was modified in this manner.

Except for possible differences in wind profiles between Kembla Grange and the inner harbour at Port Kembla, the uncertainty in results due to linear interpolation of a few data points is regarded as negligible.

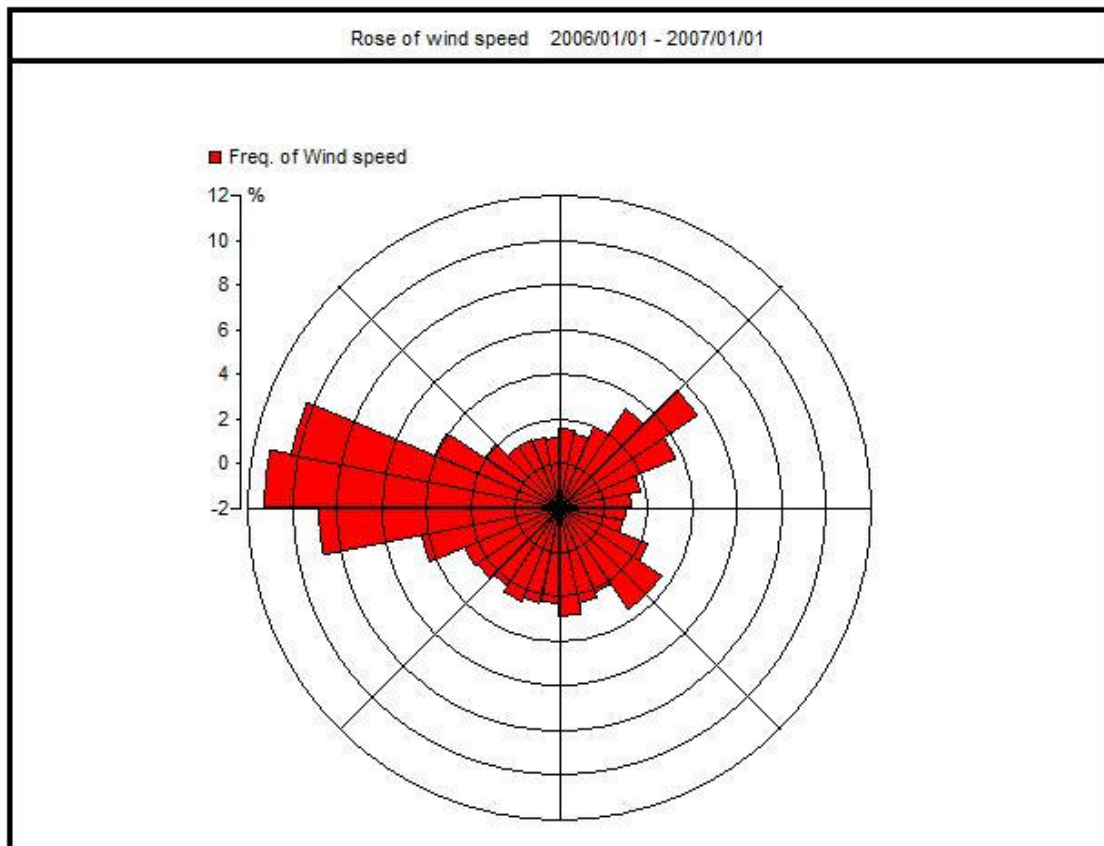
### **Planner:**



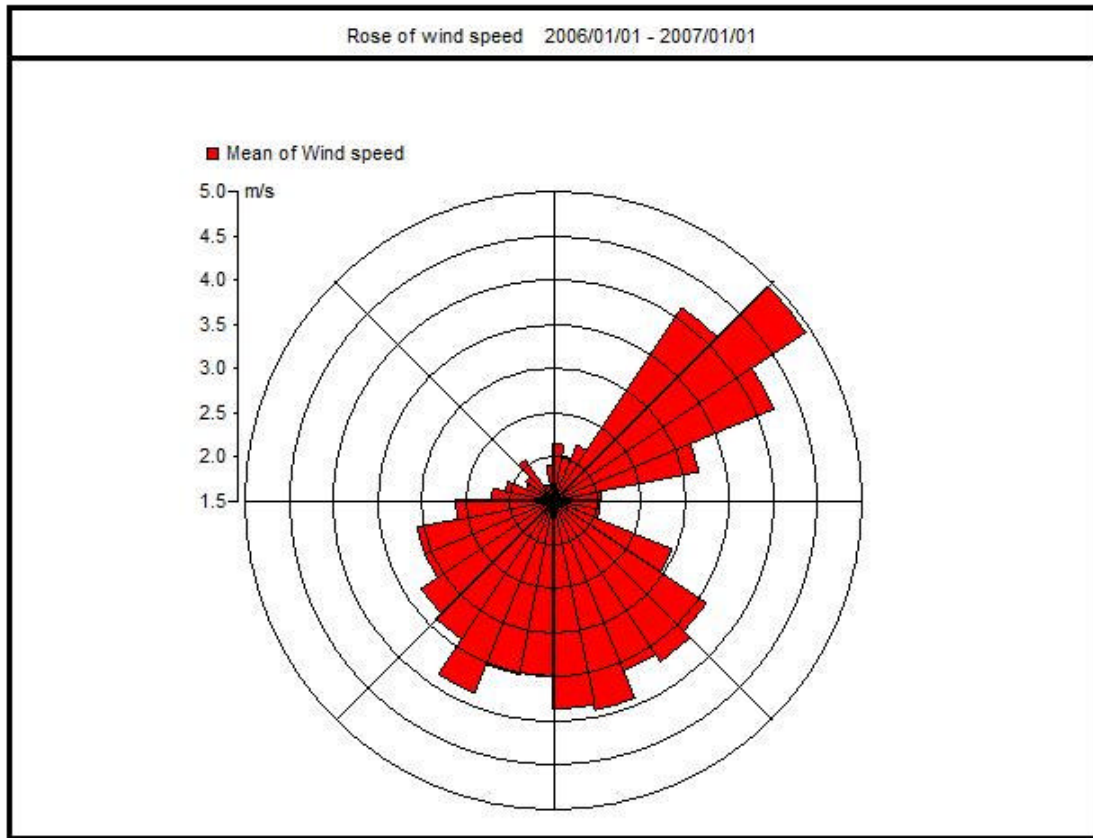
As was stated previously, the user provides no direct data input to Planner. As it uses the latest USEPA approved Gaussian plume dispersion model, Aermol, there is no reason to doubt the reliability of the dispersion calculations.

However, Aermol cannot compensate for the influence of the silos directly to the west of the soybean-oil extraction plant and directly south of the bio-diesel plant. Its bulk will affect the wind profile in the immediate vicinity and will, therefore, influence the dispersion of pollutants from the four stacks.

Figure 4 below shows the frequency of winds as a function of wind direction as measured at the Kembla Grange monitoring station. Figure 5 gives the mean wind speeds as a function of wind direction.



**Figure 4: Wind frequencies distribution**



**Figure 5: Mean wind speed distribution**

From these two figures it can be seen that the predominant wind direction is westerly (approximately 30% in total), but that the general wind speeds are relatively low (less than 3 m/s).

In principle the presence of the grain silos may have an effect on the wind profile and, therefore, the dispersion of pollutants to the east of the extraction plant and to the north from the bio-diesel plant. However, substantial openings exist between the various cells of the silos thus allowing free flow of air through the silo complex. This, together with the relatively low speeds of winds from the west, leads C&M to believe that the influence of the silos will be minimal.

Without a three-dimensional wind profile of the site it is not possible for Aermot to take this effect into account.



## 5.2 RESULTS

### 5.2.1 Hexane Emissions – Soybean-oil Extraction Plant

As was stated in Section 3.2 above, maximum emissions guaranteed by the technology providers were used as input data to the dispersion model in order to simulate worst case conditions.

Table 3 above shows the estimated concentrations of hexane at the various defined receptors as well as the relevant air quality impact assessment criteria.

The highest concentration was reported for receptor 10 which is located directly to the east of the soybean-oil extraction plant. While it is accepted that the presence of the silos would affect the dispersion from the extraction plant stack, the estimated maximum hourly concentration of  $4.5 \times 10^{-3} \text{ mg/m}^3$  is significantly lower than the assessment criteria of  $3.2 \text{ mg/m}^3$ .

Excluding any possible impact from the silos, the model estimates that the level of  $3.2 \text{ mg/m}^3$  will never be breached. Furthermore, the model estimates that the maximum concentration that can be expected is  $228 \text{ } \mu\text{g/m}^3$  ( $0.23 \text{ mg/m}^3$ ).

It must be pointed out that the mass emission rate of hexane used in the dispersion model represents a worst-case scenario. According to the technology provider the nominal value of emissions are expected to be significantly lower than the stated values (which represent a guaranteed upper-limit). The maximum emission levels may occur intermittently.

C&M regarded it as prudent to use the maximum emission rate as the frequency and duration of the “intermittent” emissions are not known and a reliable “average” emission rate cannot be calculated. It is safe to state that the predicted ground-level concentrations during “normal” emissions will be lower than the values reported in Table 3 above.



### **5.2.2 Methanol Emissions – Biodiesel plant**

Table 4 above shows the estimated concentrations of methanol at the various defined receptors as well as the relevant air quality impact assessment criteria.

While the impact assessment criteria is  $3 \text{ mg/m}^3$ , all of the predicted ground-level concentrations are in the order of nanograms per cubic metre ( $\text{ng/m}^3$ ), i.e. several orders of magnitude lower than the assessment criteria.

C&M is, therefore, of the opinion that the methanol emissions will not have any significant impact on the air quality in the surrounding area.

### **5.2.3 NOx Emissions – Two Gas-fired Boilers**

Table 5 above shows the estimated concentrations of NOx at the various defined receptors as well as the relevant air quality impact assessment criteria.

As was stated in Section 5.1 above, C&M attempted to simulate worst-case conditions by, firstly, assuming maximum allowable emissions and, secondly, that all of the NOx emissions will consist of NO<sub>2</sub>.

C&M extracted quarterly averages and hourly maximum concentrations of NO<sub>2</sub> measured at the Kembla Grange monitoring station from Quarterly Air Quality Monitoring Reports for 2006 as published by the New South Wales Department of Environment and Conservation.

The quarterly reports show quarterly average values in the range 0.5 to 0.7 pphm ( $8.2$  to  $14.4 \text{ } \mu\text{g/m}^3$ ) and hourly maxima in the range 2 to 4.9 pphm ( $41$  to  $100.5 \text{ } \mu\text{g/m}^3$ ). In determining the potential impact of the boiler emissions on air quality in the region, C&M used the highest quarterly average and hourly maximum values reported at the Kembla Grange monitoring station



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Table 5 above shows the incremental impact that NO<sub>x</sub> emissions from the two boilers will have on air quality in the surrounding area. The total impact as a result of these emissions and the existing NO<sub>x</sub> concentrations, as measured at the Kembla Grange monitoring station, are given in Table 6 below.

Section 5.1 gives the air quality standards for NO<sub>2</sub> as a maximum hourly concentration of 246 µg/m<sup>3</sup> (12 ppm) and an annual average concentration of 62 µg/m<sup>3</sup> (3 ppm). The standard values are shown in Table 6 as well.



**Table 6: Estimated total impact of NO<sub>x</sub> emissions from two gas-fired boilers**

Receptor	Average				Hourly Maxima			
	Estimated impact µg/m <sup>3</sup>	Existing impact µg/m <sup>3</sup> (*)	Total Impact µg/m <sup>3</sup>	Air quality standard µg/m <sup>3</sup>	Estimated impact µg/m <sup>3</sup>	Existing impact µg/m <sup>3</sup> (*)	Total Impact µg/m <sup>3</sup>	Air quality standard µg/m <sup>3</sup>
1	0.14	14.4	14.5	62	4.2	100.5	104.7	246
2	0.17		14.6		2.9		103.4	
3	0.12		14.5		18.9		119.4	
4	0.06		14.5		11.0		111.5	
5	0.09		14.5		10.1		110.6	
6	0.05		14.5		2.5		103	
7	0.71		15.1		13.9		114.4	
8	5.0		19.4		147		247.5	
9	3.0		17.4		22.7		123.2	
10	7.4		21.8		85.2		185.7	

(\*): Maximum values reported from Kembla Grange Monitoring Station



Table 6 shows that the predicted annual average concentrations of NO<sub>2</sub> are well below the standard annual average value of 62 µg/m<sup>3</sup>, the maximum predicted value being 21.8 µg/m<sup>3</sup>.

Except for receptor 8, i.e. Site NE, the maximum hourly values at all receptors are well below the standard hourly maximum value of 246 µg/m<sup>3</sup>.

It has been pointed out that a worst-case approach was followed in the dispersion modelling study. In the case of NO<sub>x</sub> emissions it was assumed that the emissions will be equal to the maximum legal limit of 350 mg/Nm<sup>3</sup> at 3% O<sub>2</sub>, but actual emissions are expected to be significantly less.

In addition it was assumed that all of the emissions were NO<sub>2</sub> and that no nitrogen monoxide (NO) is present in the flue gas. This approach implies that no compensation for conversion of NO to NO<sub>2</sub> in the atmosphere is required.

This approach is conservative. A significant part of the NO<sub>x</sub> in the flue gas will be present as NO. It is accepted that the NO will be converted to NO<sub>2</sub> in the atmosphere, but it is highly unlikely that it will occur from the time that it is emitted to the time that it reaches Receptor 8 as this receptor is in close proximity to both boiler stacks.

## 6 CONCLUSIONS

While the meteorological database provided by the NSW EPA is accurate and reliable, the emissions used for dispersion modelling purposes were based on maximum design and/or allowable emission levels. This ensured a worst-case approach to the study.

The dispersion model estimates that the ground-level concentration of hexane will be significantly less than the air quality impact assessment level prescribed by the New South Wales Government.



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The methanol emissions from the bio-diesel plant are very low and the outcome of the dispersion model clearly shows that the air quality impact is negligible.

While the dispersion model and measured maximum NO<sub>x</sub> levels at Kembla Grange show that the maximum air quality standard limit of 246 µg/m<sup>3</sup> may be exceeded at one receptor (NO<sub>x</sub> maximum hourly value for Receptor 8), C&M is of the opinion that the likelihood of such an event is low due to the fact that the NO<sub>x</sub> emissions were assumed to be a maximum and that all emissions were assumed to be NO<sub>2</sub>.



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## **APPENDIX A**

### **DISPERSION MODELLING RESULTS**

#### **HEXANE EMISSIONS**

#### **SOYBEAN-OIL EXTRACTION PLANT**



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Figure A.1: Hexane emissions: Annual average concentrations, Large scale map



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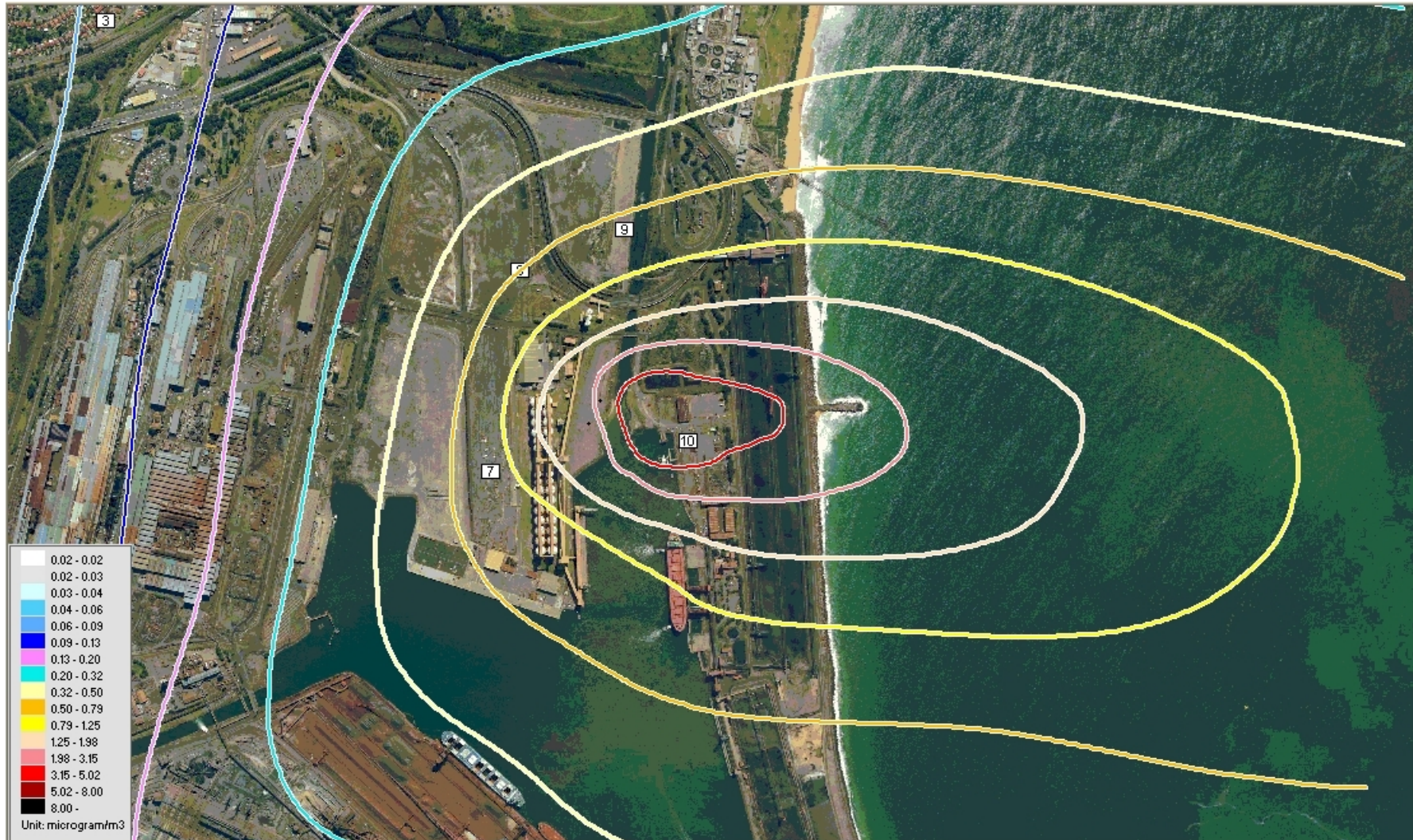


Figure A.2: Hexane emissions: Annual average concentrations, Small scale map



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Figure A.3: Hexane emissions: Maximum hourly concentrations, Large scale map



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Figure A.4: Hexane emissions: Maximum hourly concentrations, Small scale map



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CONSULTING ENGINEERS CC

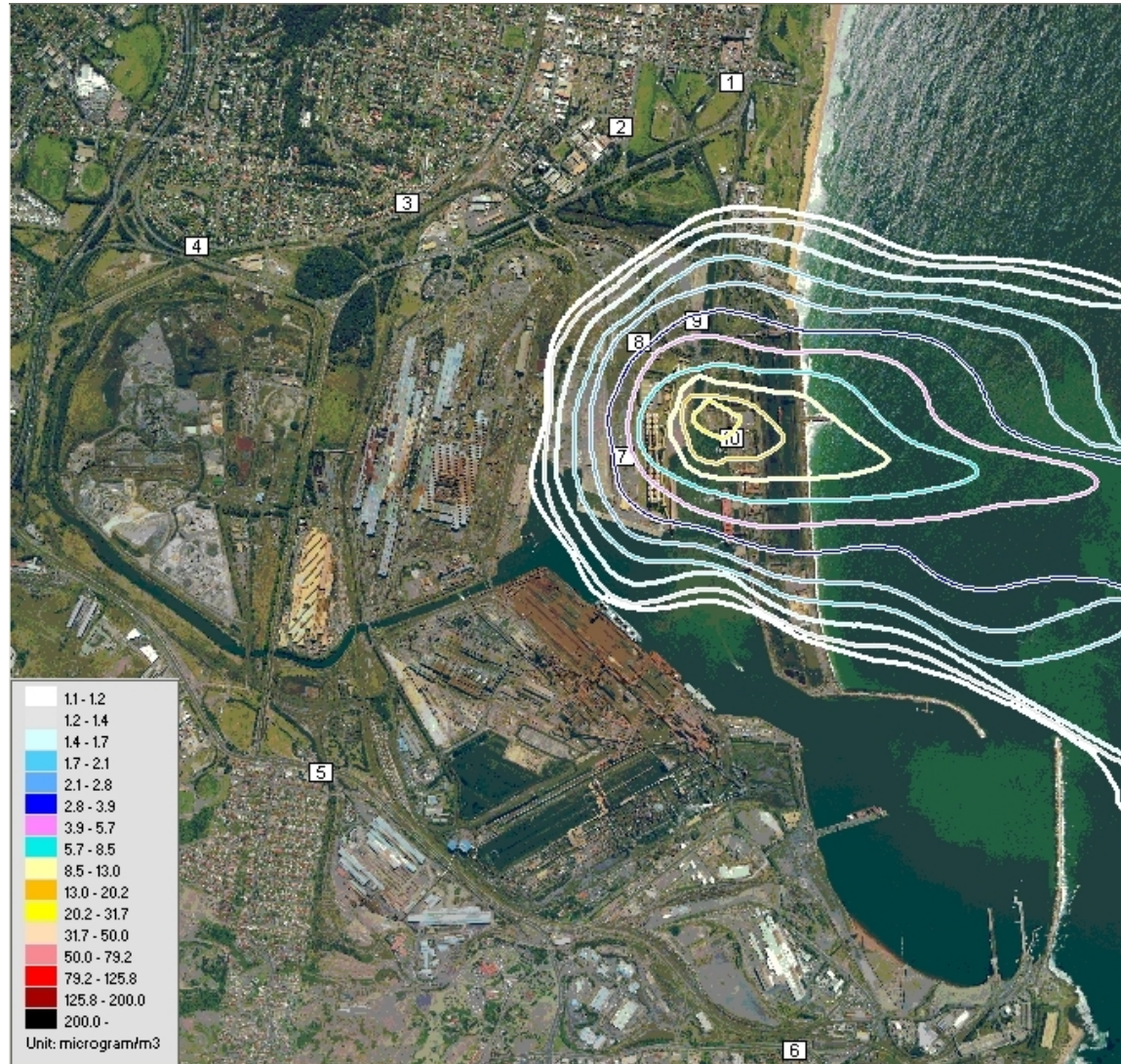


Figure A.5: Hexane emissions: 95 Percentile concentrations, Large scale map



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CONSULTING ENGINEERS CC

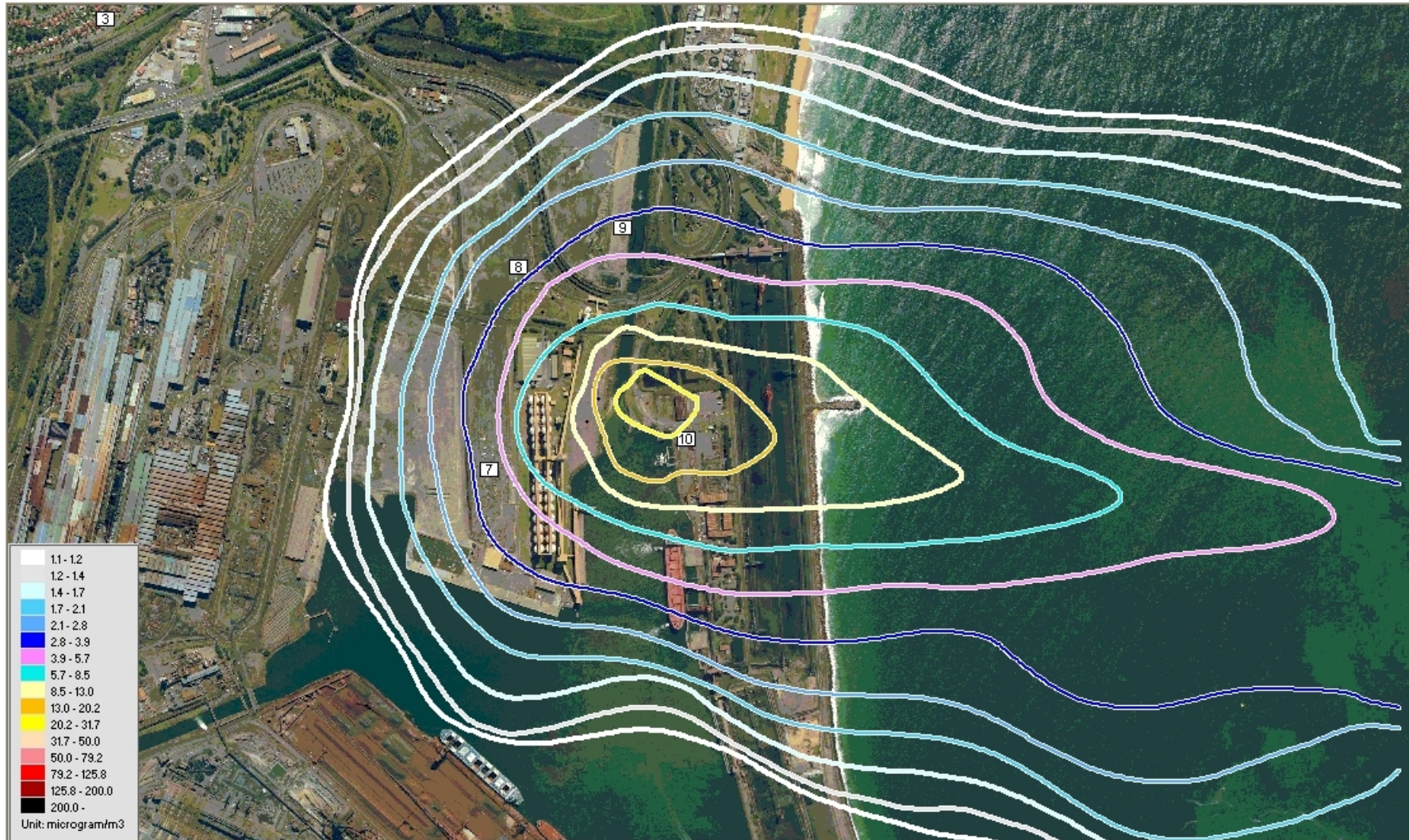


Figure A.6: Hexane emissions: 95 Percentile concentrations, Small scale map



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## **APPENDIX B**

### **DISPERSION MODELLING RESULTS**

#### **METHANOL EMISSIONS**

#### **BIODIESEL PLANT**



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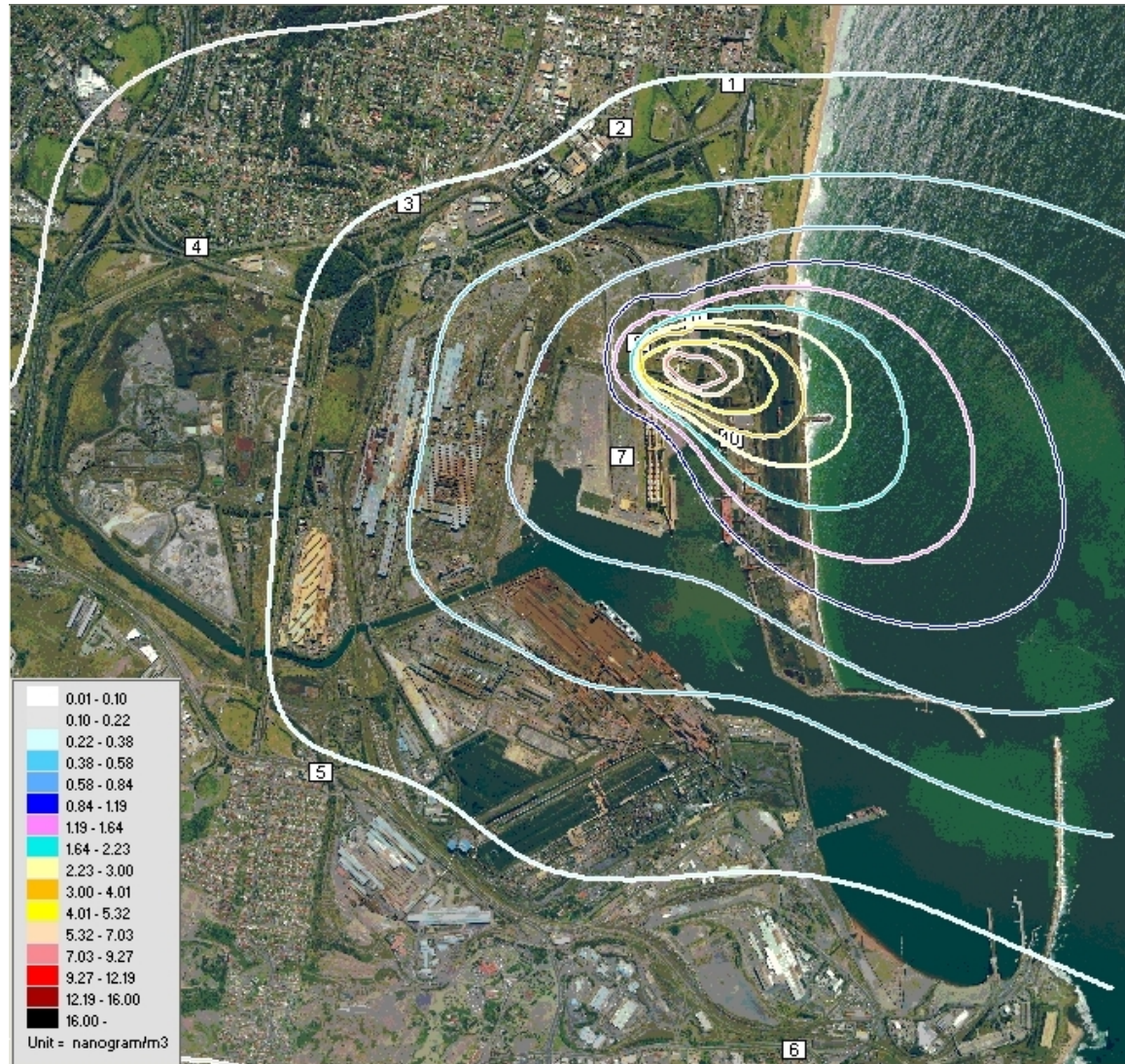


Figure B.1: Methanol emissions: Annual average concentrations, Large scale map



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CONSULTING ENGINEERS CC



Figure B.2: Methanol emissions: Annual average concentrations, Small scale map



RAADGEWENDE INGENIEURS BK  
CONSULTING ENGINEERS CC

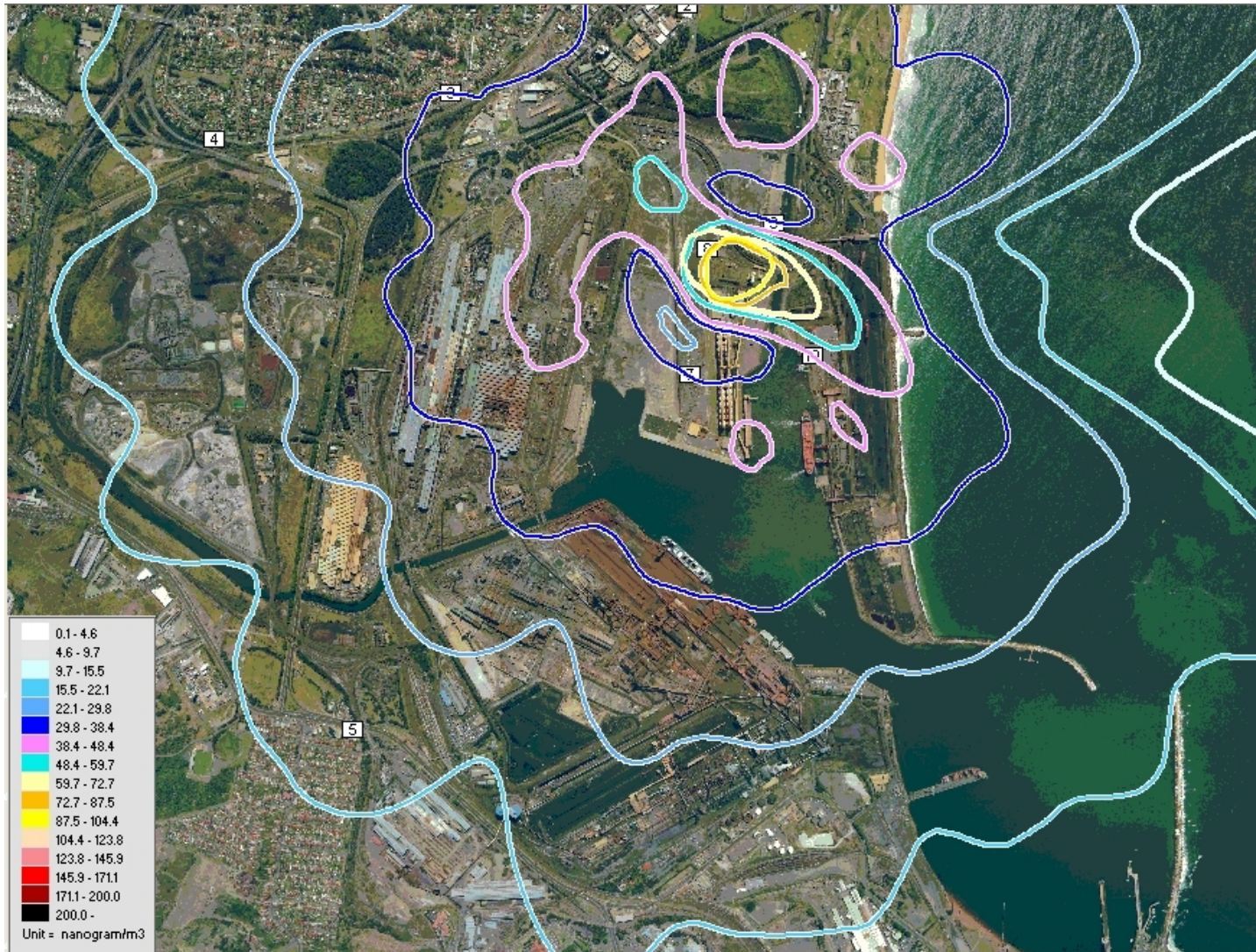


Figure B.3: Methanol emissions: Maximum hourly concentrations, Large scale map



RAADGEWENDE INGENIEURS BK  
CONSULTING ENGINEERS CC

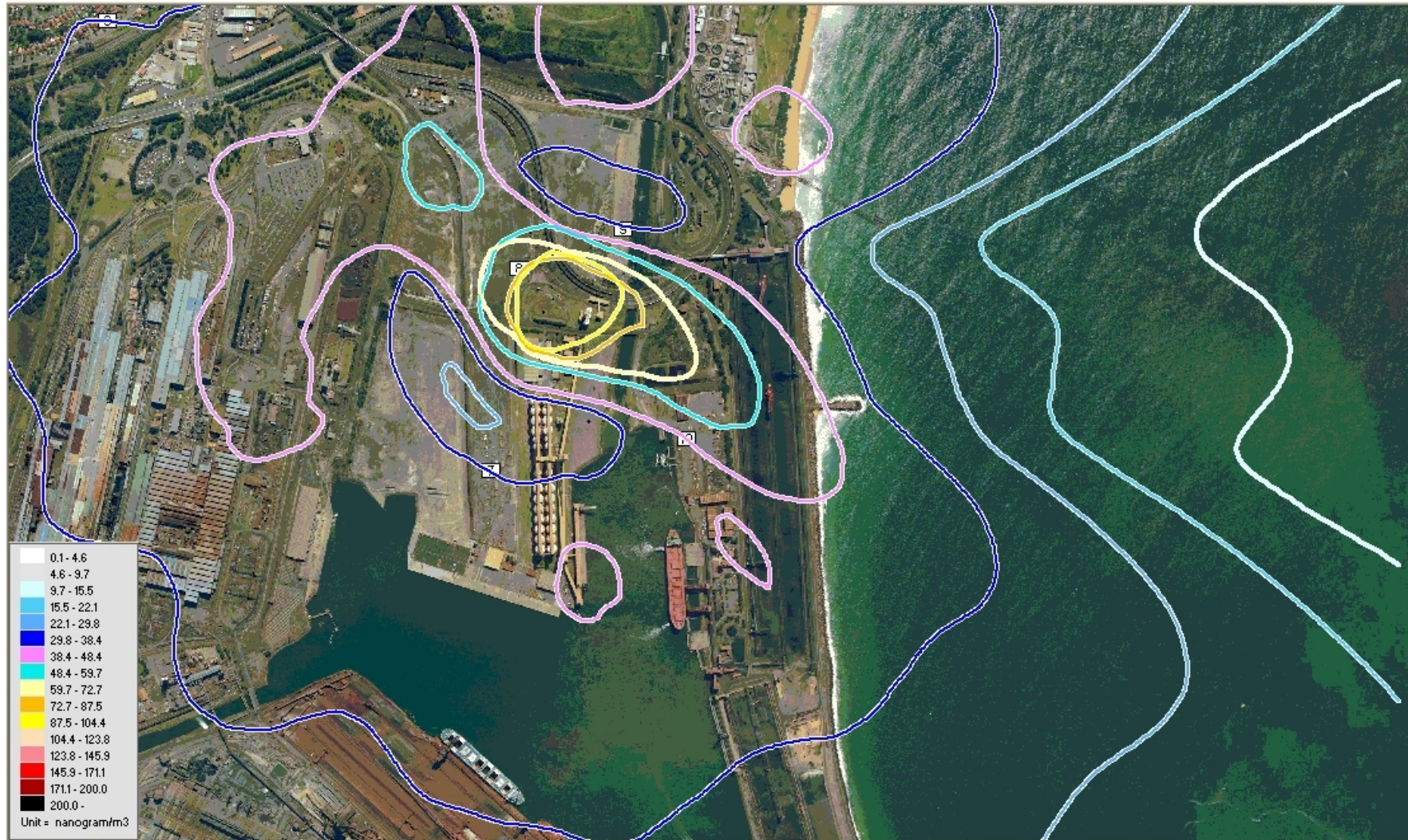


Figure B.4: Methanol emissions: Maximum hourly concentrations, Small scale map



RAADGEWENDE INGENIEURS BK  
CONSULTING ENGINEERS CC

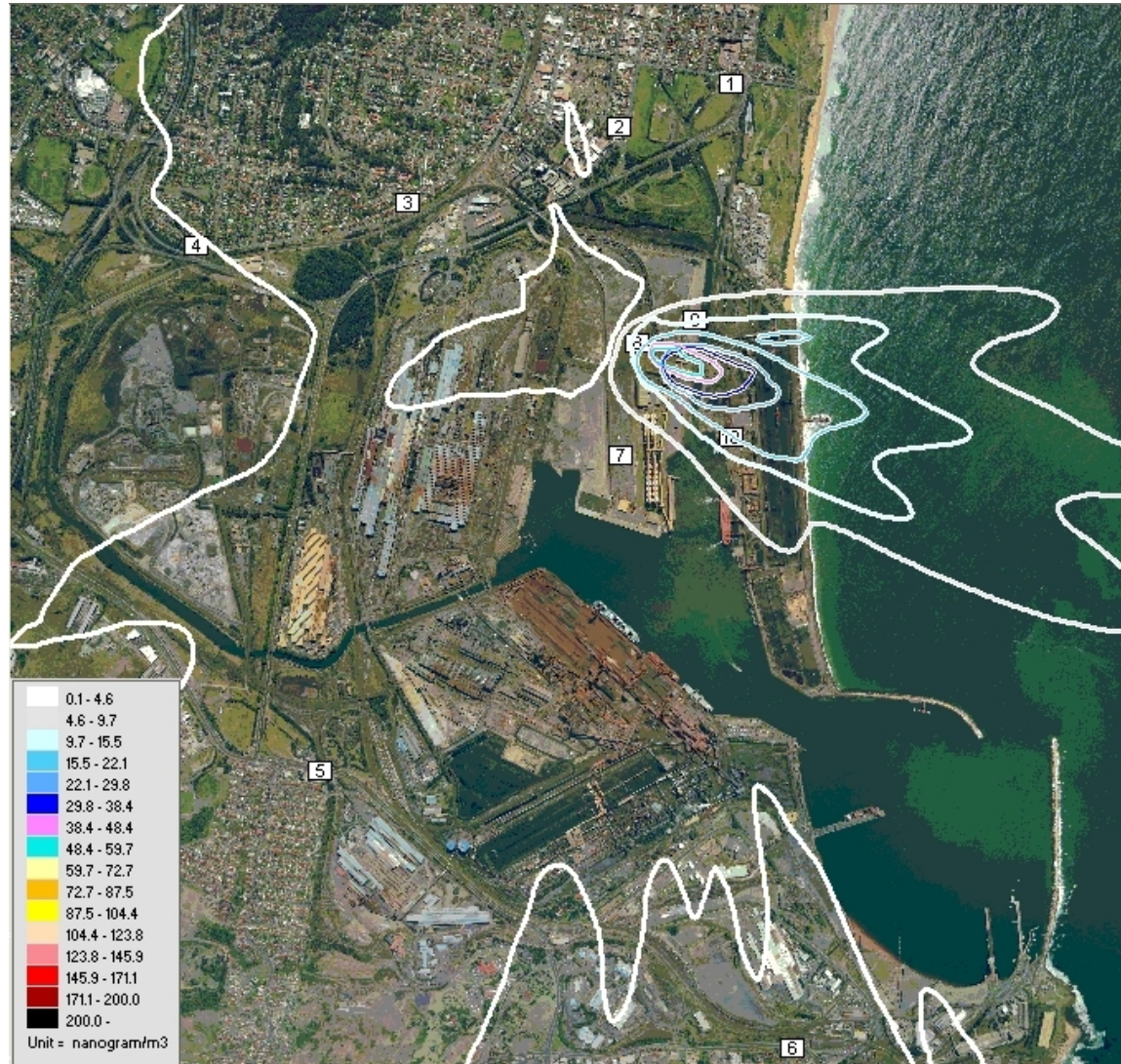


Figure B.5: Methanol emissions: 95 Percentile concentrations, Large scale map



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Figure B.6: Methanol emissions: 95 Percentile concentrations, Small scale map



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## **APPENDIX C**

### **DISPERSION MODELLING RESULTS**

#### **NO<sub>x</sub> EMISSIONS**

#### **TWO GAS-FIRED BOILERS**



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CONSULTING ENGINEERS CC

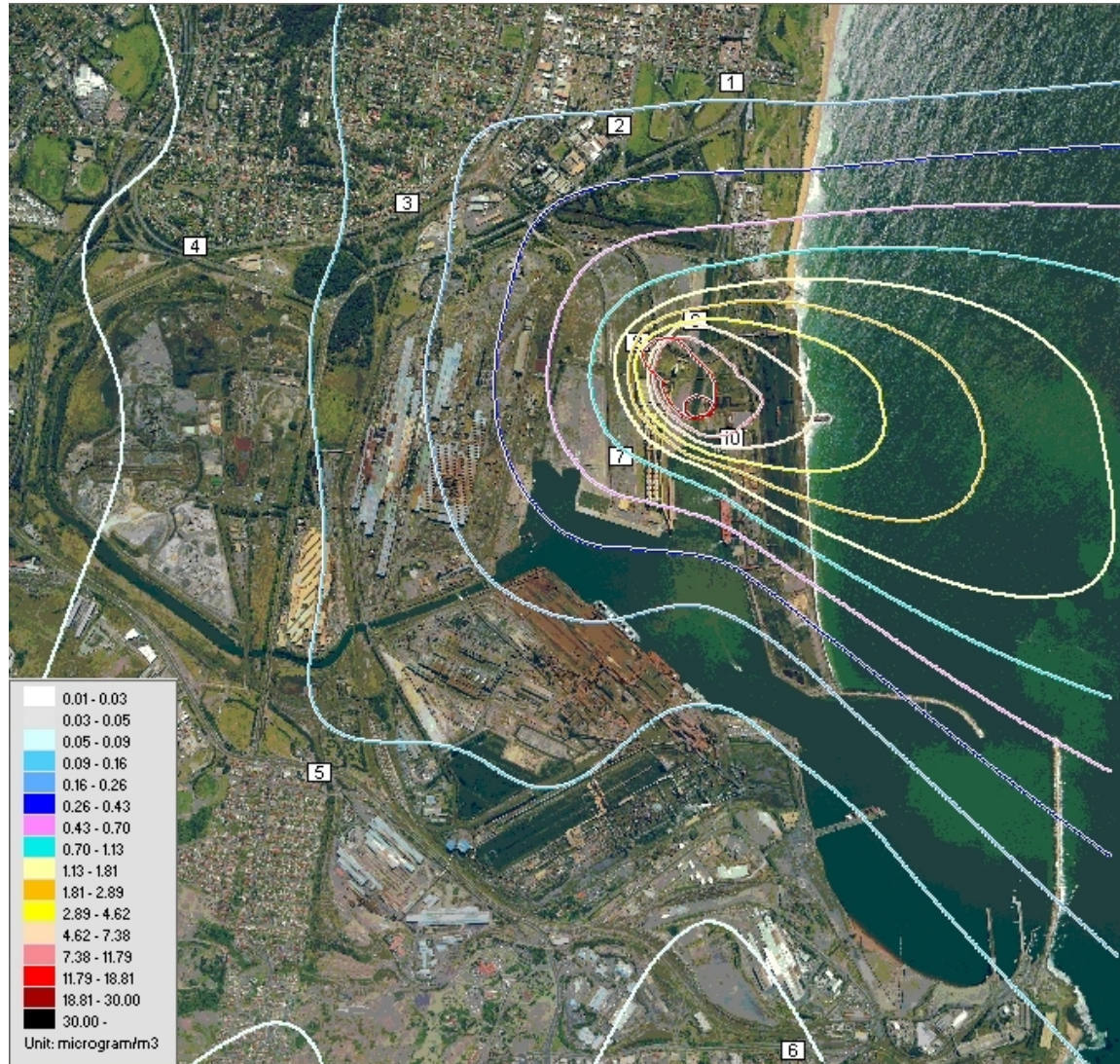


Figure C.1: NO<sub>x</sub> emissions: Annual average concentrations, Large scale map



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Figure C.2: NOx emissions: Annual average concentrations, Small scale map



RAADGEWENDE INGENIEURS BK  
CONSULTING ENGINEERS CC

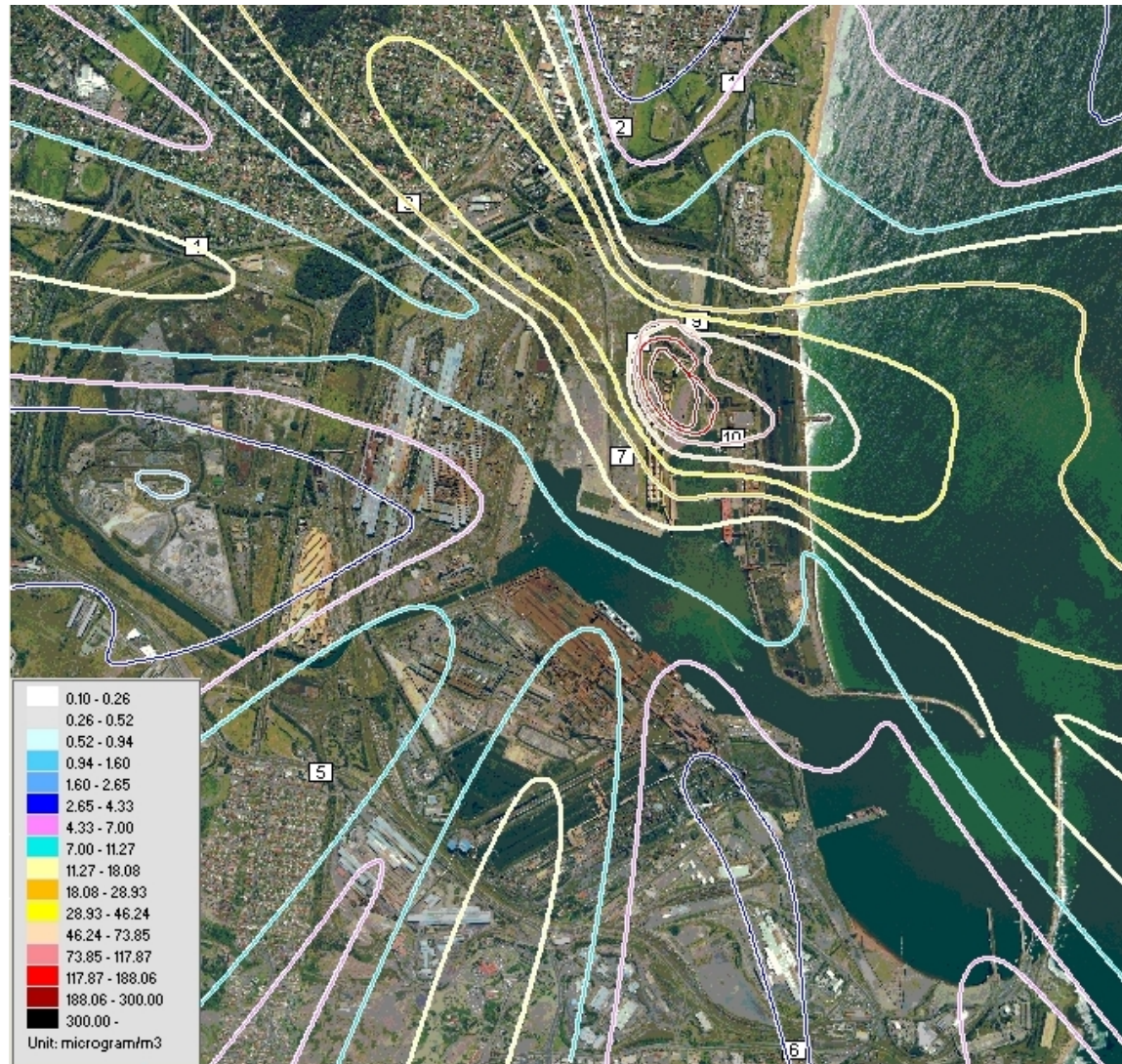


Figure C.3: NOx emissions: Maximum hourly concentrations, Large scale map



Figure C.4: NOx emissions: Maximum hourly concentrations, Small scale map



RAADGEWENDE INGENIEURS BK  
CONSULTING ENGINEERS CC

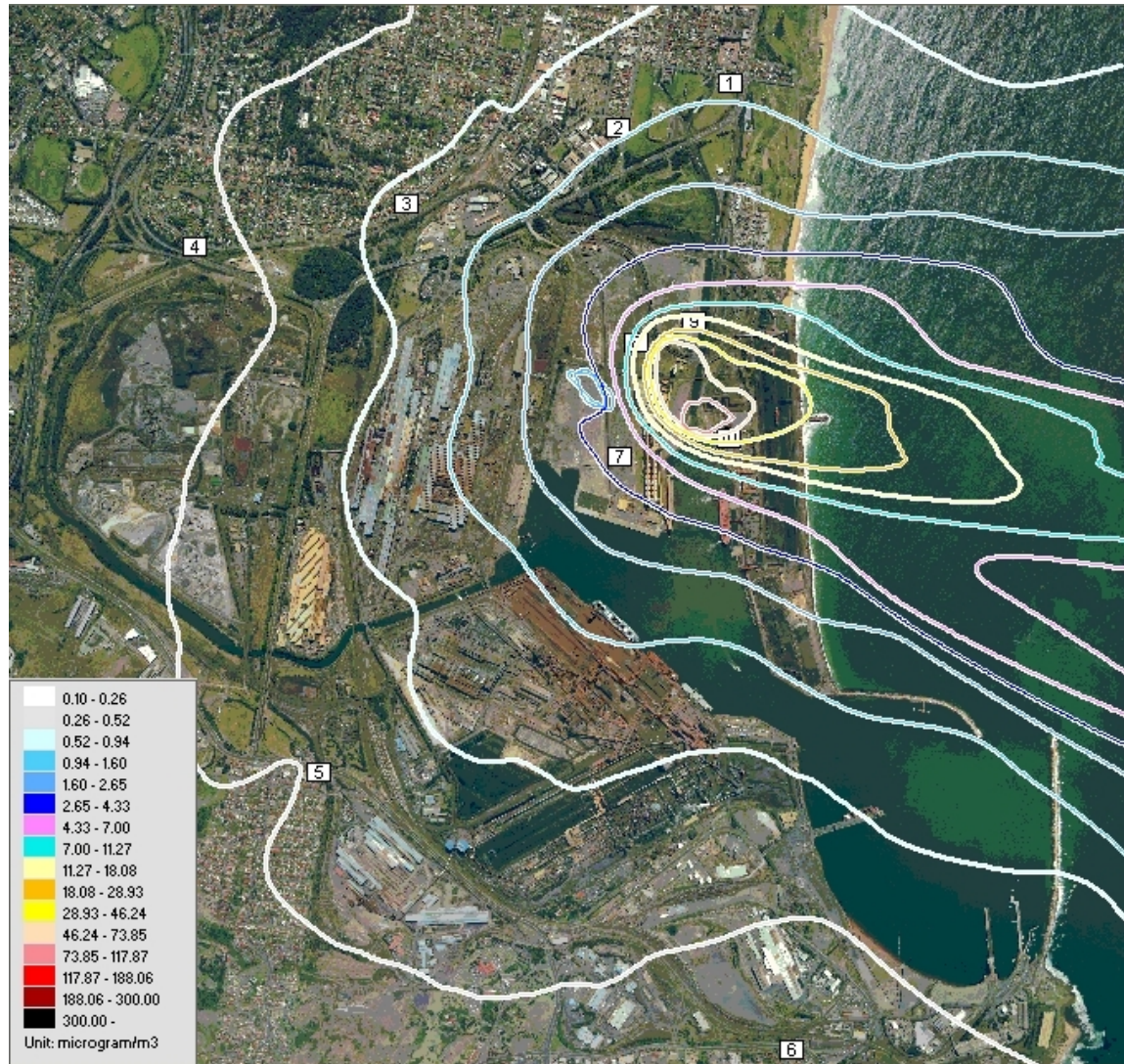


Figure C.5: NO<sub>x</sub> emissions: 95 Percentile concentrations, Large scale map

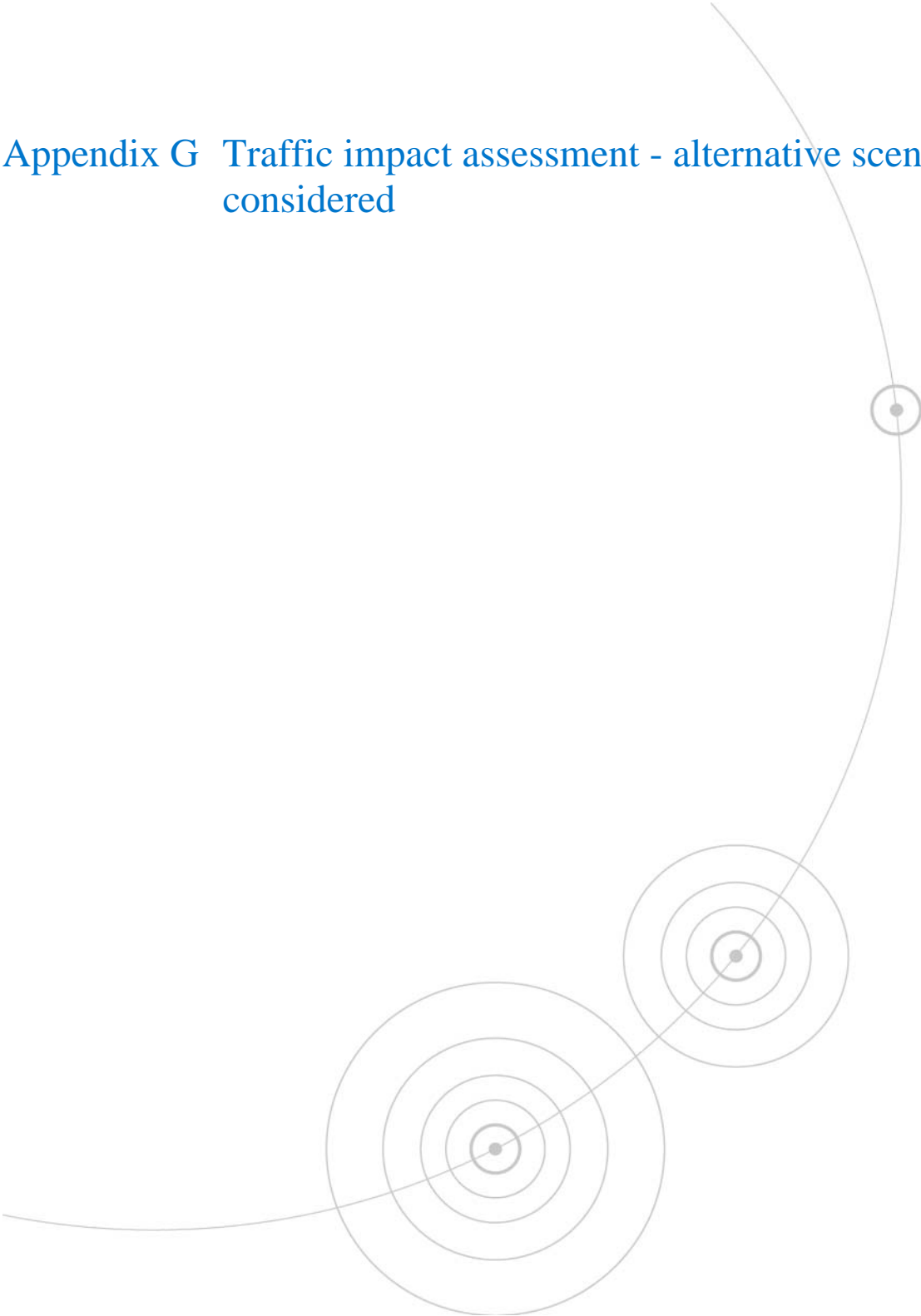


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Figure C.6: NO<sub>x</sub> emissions: 95 Percentile concentration, Small scale map

# Appendix G Traffic impact assessment - alternative scenarios considered



## Scenario 1

Raw material	Annual quantity (mt)	Transport method	Load per vessel (mt)		Vessels per year		Vessels per day		Vessels per hour	
			Min	Max	Min	Max	Min	Max	Min	Max
<b>Inbound</b>										
Soybeans	1273600	Ship	35000	40000	31.84	36	0.087	0.100	0.004	0.005
	100000	Train	960	1200	83	104	0	0	0	0
Hexane	816	Road truck	30	45	18	27	0.050	0.075	0.002	0.003
Methanol	24000	Ship	1500	1500	16	16	0.044	0.044	0.002	0.002
Caustic soda (50%)	825.0	Road truck	30	45	213	320	0.584	0.877	0.027	0.040
Sodium methylate (30%)	5000									
Sulphuric acid (98%)	75									
Hydrochloric acid (36%)	3000									
Phosphoric acid (80%)	450									
Activated carbon	75.0									
Citric acid	175									
Silica	750	Road truck	30	45	17	25	0.046	0.068	0.002	0.003
Bleaching earth	3750	Road truck	30	45	83	125	0.228	0.342	0.010	0.016
<b>Outbound</b>										
Product	Annual quantity (mt)	Transport method	Load per vessel (mt)		Vessels per year		Vessels per day		Vessels per hour	
			Min	Max	Min	Max	Min	Max	Min	Max
Soybean meal	180000	Ship (NZ)	20000	25000	7	9	0.020	0.025	0.001	0.001
	600000	Ship (AU)	10000	20000	30	60	0.082	0.164	0.004	0.007
	278400	Train	960	1200	232	290	0.636	0.795	0.029	0.036
	33000	Road truck	30	45	733	1100	2.009	3.014	0.091	0.137
Biodiesel	250000	Road truck	30	45	5556	8333	15.221	22.831	0.692	1.038
Glycerine	25450	Road truck	30	45	566	848	1.549	2.324	0.070	0.106

<b>SUMMARY</b>						
<b>Inbound vessels</b>						
	Min ship	Max ship	Min rail	Max rail	Min truck	Max truck
Per year	48	52	83	104	331	497
Per day	0.131	0.144	0.23	0.29	0.9	1.4
Per hour	0.006	0.007	0.010	0.013	0.041	0.062
<b>Outbound vessels</b>						
	Min ship	Max ship	Min rail	Max rail	Min truck	Max truck
Per year	37	69	232	290	6854	10282
Per day	0.102	0.189	0.6	0.8	18.8	28.2
Per hour	0.005	0.009	0.029	0.036	0.854	1.280
<b>Total inbound &amp; outbound vessels</b>						
	Min ship	Max ship	Min rail	Max rail	Min truck	Max truck
Per year	85	121	315	394	7186	10779
Per day	0.233	0.333	0.9	1.1	19.7	29.5
Per hour	0.011	0.015	0.039	0.0	0.895	1.3

<b>Vessel loads (mt)</b>	
Min	Max
<b>SHIPS</b>	
<b>Handymax SB in</b>	
35000	40000
<b>Methanol</b>	
1500	1500
<b>Mini-bulker SBM AU</b>	
10000	20000
<b>Soybean oil</b>	
10000	10000
<b>Mini-bulker SBM NZ</b>	
20000	25000
<b>RIAL CARRIAGE</b>	
32	40
<b>ROAD TRUCK</b>	
30	45
<b>Carriages per train</b>	
30	

<b>Checks</b>	
Sum of raw materials	1412516
Sum of products	1366850
<b>Inbound</b>	
Max load X Min Movem	1412516
Min load X Max Movem	1412516
<b>Outbound</b>	
Max load X Min Movem	1366850
Min load X Max Movem	1366850

Raw material	Amount needed	Units	Amount used for calculations
Soybeans (Imported)	1273600	mt	1273600
Soybeans (Domestic)	100000	mt	100000
Soybean oil (Imported)	0	mt	0
Soybean oil (Domestic)	0	mt	0
Hexane	816	mt	816
Methanol	96	kg/mt biodiesel	96
Caustic soda (50%)	3	kg/mt biodiesel	3
Caustic soda (50%)	0.3	kg/mt biodiesel	0.3
Sodium methylate (30%)	20	kg/mt biodiesel	20
Sulphuric acid (98%)	0.3	kg/mt biodiesel	0.3
Hydrochloric acid (36%)	12	kg/mt biodiesel	12
Phosphoric acid (80%)	1.3-1.8	kg/mt biodiesel	1.8
Activated carbon	0.3	kg/mt biodiesel	0.3
Citric acid	0.7	kg/mt biodiesel	0.7
Silica	1-3	kg/mt biodiesel	3
Bleaching earth	8-15	kg/mt biodiesel	15

## Scenario 2

Raw material	Annual quantity (mt)	Transport method	Load per vessel (mt)		Vessels per year		Vessels per day		Vessels per hour	
			Min	Max	Min	Max	Min	Max	Min	Max
<b>Inbound</b>										
Soybeans	137360	Truck	30	45	3052	4579	8	13	0.380	0.570
	1236240	Train	960	1200	1030	1288	2.8	3.5	0.128	0.160
Hexane	816	Road truck	30	45	18	27	0.050	0.075	0.002	0.003
Methanol	24000	Ship	1500	1500	16	16	0.044	0.044	0.002	0.002
Caustic soda (50%)	825.0	Road truck	30	45	213	320	0.584	0.877	0.027	0.040
Sodium methylate (30%)	5000									
Sulphuric acid (98%)	75									
Hydrochloric acid (36%)	3000									
Phosphoric acid (80%)	450									
Activated carbon	75.0									
Citric acid	175	Road truck	30	45	17	25	0.046	0.068	0.002	0.003
Silica	750									
Bleaching earth	3750	Road truck	30	45	83	125	0.228	0.342	0.010	0.016
<b>Outbound</b>										
Product	Annual quantity (mt)	Transport method	Load per vessel (mt)		Vessels per year		Vessels per day		Vessels per hour	
			Min	Max	Min	Max	Min	Max	Min	Max
Soybean meal	180000	Ship (NZ)	20000	25000	7	9	0.020	0.025	0.001	0.001
	600000	Ship (AU)	10000	20000	30	60	0.082	0.164	0.004	0.007
	278400	Train	960	1200	232	290	0.636	0.795	0.029	0.036
	33000	Road truck	30	45	733	1100	2.009	3.014	0.091	0.137
Biodiesel	250000	Road truck	30	45	5556	8333	15.221	22.831	0.692	1.038
Glycerine	25450	Road truck	30	45	566	848	1.549	2.324	0.070	0.106

<b>SUMMARY</b>						
<b>Inbound vessels</b>						
	Min ship	Max ship	Min rail	Max rail	Min truck	Max truck
Per year	16	16	1030	1288	3384	5076
Per day	0.044	0.044	2.8	3.5	9.3	13.9
Per hour	0.002	0.002	0.128	0.160	0.421	0.632
<b>Outbound vessels</b>						
	Min ship	Max ship	Min rail	Max rail	Min truck	Max truck
Per year	37	69	232	290	6854	10282
Per day	0.102	0.189	0.6	0.8	18.8	28.2
Per hour	0.005	0.009	0.029	0.036	0.854	1.280
<b>Total inbound &amp; outbound vessels</b>						
	Min ship	Max ship	Min rail	Max rail	Min truck	Max truck
Per year	53	85	1262	1578	10238	15358
Per day	0.146	0.233	3.5	4.3	28.1	42.1
Per hour	0.007	0.011	0.157	0.2	1.275	1.9

<b>Vessel loads (mt)</b>	
Min	Max
<b>SHIPS</b>	
<b>Handymax SB in</b>	
35000	40000
<b>Methanol</b>	
1500	1500
<b>Mini-bulker SMB AU</b>	
10000	20000
<b>Soybean oil</b>	
10000	10000
<b>NZ SBM out</b>	
20000	25000
<b>RIAL CARRIAGE</b>	
32	40
<b>ROAD TRUCK</b>	
30	45
<b>Carriages per train</b>	
30	

<b>Checks</b>	
Sum of raw materials	1412516
Sum of products	1366850
<b>Inbound</b>	
Max load X Min Movem	1412516
Min load X Max Movem	1412516
<b>Outbound</b>	
Max load X Min Movem	1366850
Min load X Max Movem	1366850

Raw material	Amount needed	Units	Amount used for calculations
Soybeans (Imported)	0	mt	0
Soybeans (Domestic)	1373600	mt	1373600
Soybean oil (Imported)	0	mt	0
Soybean oil (Domestic)	0	mt	0
Hexane	816	mt	816
Methanol	96	kg/mt biodiesel	96
Caustic soda (50%)	3	kg/mt biodiesel	3
Caustic soda (50%)	0.3	kg/mt biodiesel	0.3
Sodium methylate (30%)	20	kg/mt biodiesel	20
Sulphuric acid (98%)	0.3	kg/mt biodiesel	0.3
Hydrochloric acid (36%)	12	kg/mt biodiesel	12
Phosphoric acid (80%)	1.3-1.8	kg/mt biodiesel	1.8
Activated carbon	0.3	kg/mt biodiesel	0.3
Citric acid	0.7	kg/mt biodiesel	0.7
Silica	1-3	kg/mt biodiesel	3
Bleaching earth	8-15	kg/mt biodiesel	15

### Scenario 3

Raw material	Annual quantity (mt)	Transport method	Load per vessel (mt)		Vessels per year		Vessels per day		Vessels per hour	
			Min	Max	Min	Max	Min	Max	Min	Max
<b>Inbound</b>										
Soybeans	1373600	Ship	35000	40000	34.34	39	0.094	0.108	0.004	0.005
	0	Train	960	1200	0	0	0	0	0	0
Hexane	816	Road truck	30	45	18	27	0.050	0.075	0.002	0.003
Methanol	24000	Ship	1500	1500	16	16	0.044	0.044	0.002	0.002
Caustic soda (50%)	825.0	Road truck	30	45	213	320	0.584	0.877	0.027	0.040
Sodium methylate (30%)	5000									
Sulphuric acid (98%)	75									
Hydrochloric acid (36%)	3000									
Phosphoric acid (80%)	450									
Activated carbon	75.0									
Citric acid	175									
Silica	750	Road truck	30	45	17	25	0.046	0.068	0.002	0.003
Bleaching earth	3750	Road truck	30	45	83	125	0.228	0.342	0.010	0.016
<b>Outbound</b>										
Product	Annual quantity (mt)	Transport method	Load per vessel (mt)		Vessels per year		Vessels per day		Vessels per hour	
			Min	Max	Min	Max	Min	Max	Min	Max
Soybean meal	180000	Ship (NZ)	20000	25000	7	9	0.020	0.025	0.001	0.001
	600000	Ship (AU)	10000	20000	30	60	0.082	0.164	0.004	0.007
	278400	Train	960	1200	232	290	0.636	0.795	0.029	0.036
	33000	Road truck	30	45	733	1100	2.009	3.014	0.091	0.137
Biodiesel	250000	Road truck	30	45	5556	8333	15.221	22.831	0.692	1.038
Glycerine	25450	Road truck	30	45	566	848	1.549	2.324	0.070	0.106

<b>SUMMARY</b>						
<b>Inbound vessels</b>						
	Min ship	Max ship	Min rail	Max rail	Min truck	Max truck
Per year	50	55	0	0	331	497
Per day	0.138	0.151	0.00	0.00	0.9	1.4
Per hour	0.006	0.007	0.000	0.000	0.041	0.062
<b>Outbound vessels</b>						
	Min ship	Max ship	Min rail	Max rail	Min truck	Max truck
Per year	37	69	232	290	6854	10282
Per day	0.102	0.189	0.6	0.8	18.8	28.2
Per hour	0.005	0.009	0.029	0.036	0.854	1.280
<b>Total inbound &amp; outbound vessels</b>						
	Min ship	Max ship	Min rail	Max rail	Min truck	Max truck
Per year	88	124	232	290	7186	10779
Per day	0.240	0.340	0.6	0.8	19.7	29.5
Per hour	0.011	0.015	0.029	0.0	0.895	1.3

<b>Vessel loads (mt)</b>		
Min	Max	
<b>SHIPS</b>		
<b>Handymax SB in</b>		
35000	40000	
<b>Methanol</b>		
1500	1500	
<b>Mini-bulker SBM AU</b>		
10000	20000	
<b>Soybean oil</b>		
10000	10000	
<b>Mini-bulker SBM NZ</b>		
20000	25000	
<b>RIAL CARRIAGE</b>		
32	40	
<b>ROAD TRUCK</b>		<b>Carriages per train</b>
30	45	30

<b>Checks</b>	
Sum of raw materials	1412516
Sum of products	1366850
<b>Inbound</b>	
Max load X Min Movem	1412516
Min load X Max Movem	1412516
<b>Outbound</b>	
Max load X Min Movem	1366850
Min load X Max Movem	1366850

Raw material	Amount needed	Units	Amount used for calculations
Soybeans (Imported)	1373600	mt	1373600
Soybeans (Domestic)	0	mt	0
Soybean oil (Imported)	0	mt	0
Soybean oil (Domestic)	0	mt	0
Hexane	816	mt	816
Methanol	96	kg/mt biodiesel	96
Caustic soda (50%)	3	kg/mt biodiesel	3
Caustic soda (50%)	0.3	kg/mt biodiesel	0.3
Sodium methylate (30%)	20	kg/mt biodiesel	20
Sulphuric acid (98%)	0.3	kg/mt biodiesel	0.3
Hydrochloric acid (36%)	12	kg/mt biodiesel	12
Phosphoric acid (80%)	1.3-1.8	kg/mt biodiesel	1.8
Activated carbon	0.3	kg/mt biodiesel	0.3
Citric acid	0.7	kg/mt biodiesel	0.7
Silica	1-3	kg/mt biodiesel	3
Bleaching earth	8-15	kg/mt biodiesel	15