ODOUR MONITORING IRELAND LTD

Unit 32 De Granville Court, Dublin Rd, Trim, Co. Meath

Tel: +353 46 9437922
Mobile: +353 86 8550401
E-mail: info@odourireland.com
www.odourireland.com

DISPERSION MODELLING ASSESSMENT OF TOTAL PARTICULATES FROM NAMED EMISSION POINTS A2-1 AND A2-6 LOCATED IN PANDA WASTE LTD, BEAUPARC BUSINESS PARK, NAVAN, CO. MEATH.

PERFORMED BY ODOUR MONITORING IRELAND ON THE BEHALF OF O CALLAGHAN MORAN CONSULTING ENGINEERS LTD.

REPORT PREPARED BY:	Dr. Brian Sheridan
REPORT VERSION:	Document Ver.1
ATTENTION:	Mr. Jim O Callaghan
DATE:	13th Oct 2017
REPORT NUMBER:	2017961(1)

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Document Amendment Record

Client: ***Panda Waste Ltd***

Title: Dispersion modelling assessment of Total particulates from named emission points A2-1 and A2-6 located in Panda Waste Ltd, Beauparc Business Park, Navan, Co. Meath.

Project Number: 2017961(1)			**DOCUMENT REFERENCE:** Dispersion modelling assessment of Total particulates from named emission points A2-1 and A2-6 located in Panda Waste Ltd, Beauparc Business Park, Navan, Co. Meath.		
2017961(1)	Document for review	B.A.S.	JMC	B.A.S	13/10/2017
Revision	**Purpose/Description**	**Originated**	**Checked**	**Authorised**	**Date**

EXECUTIVE SUMMARY

Odour Monitoring Ireland Ltd was commissioned by O Callaghan Moran Consulting Engineers to perform an air quality dispersion modelling assessment of the proposed emissions from 2 emission points A2-1 and A2-6 located in Panda Waste Ltd, Beauparc Business Park, Navan, Co. Meath. Proposed emission limit values based on levels contained in BAT were utilised within the dispersion model. Volume flow rates utilised were based on typical figures examined on these proposed buildings in previous assessment reports. These were utilised within the dispersion modelling assessment in order to ascertain the risk associated with Total Particulates emission limit from these emission points A2-1 and A2-6. Total particulates emission rates were utilised in conjunction with source characteristics within the dispersion modelling assessment. This was used to assess compliance with SI180 of 2011 and EU Directive 2008/50/EC.

Dispersion modelling assessment was performed utilising AERMOD Prime (16216r) dispersion model. Five years of hourly sequential meteorological data from Dublin Airport (2011 to 2015 inclusive) was used within the dispersion model (Worst case year 2015). The total mass limit emission rate of Total particulates matter as PM_{10} was inputted with source characteristics for the proposed operations into the dispersion model in order to assess compliance with SI180 of 2011 and 2008/50/EC CAFÉ directive on air quality.

The following conclusions are drawn from the study:

1. The assessment was carried out to provide information in line with relevant information for investigation of downwind impact from a facility. This information can be used to assess the potential impact risk associated with facilitating a mass emission rate of Total particulate matter as PM_{10} on the surrounding environment.
2. Specific dispersion modelling was performed for Particulate matter (as Pm_{10}).
3. With regard to Total particulates as $PM_{10/2.5}$, the maximum GLC+Baseline at worst case sensitive receptors at or beyond the boundary of the facility for Total particulates as PM_{10} is 26.25 $\mu g/m^3$ for the maximum 24-hour mean concentration at the 90.40th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is less than or equal to 47.5% of the impact criterion for emissions from the combined A2-1 and A2-6 operations. An annual average was also generated to allow comparison with the SI 180 of 2011 and Directive 2008/50/EC for Total particulates as $PM1_{10}$ and $PM_{2.5}$. The maximum predicted annual average + baseline ground level concentration at worst case sensitive receptors at or beyond the boundary of the facility for PM_{10} and $PM_{2.5}$ are 19.25 and 15 $\mu g/m^3$, respectively. When compared, the annual average PM_{10} and $PM_{2.5}$ air quality impact is less than or equal to 52 and 40% of the impact criterion for emissions from the combined A2-1 and A2-2 operations.

1. Introduction and scope

1.1 Introduction

Odour Monitoring Ireland Ltd was commissioned by O Callaghan Moran Consulting Engineers to perform a dispersion modelling assessment of proposed Total particulates air emissions from emission point A2-1 and A2-6 located in Panda Waste Ltd facility, Beauparc Business Park, Navan, Co. Meath.

The assessment allowed for the examination of proposed short and long term ground level concentrations (GLC's) of Total particulates as PM10/2.5 as a result of combined operations of A2-1 and A2-6 located in the facility.

Predicted dispersion modelling GLC's were compared to regulatory / guideline ground level limit values for Total particulates contained in SI180 of 2011 and Directive 2008/50/EC.

The materials and methods, results, discussion of results and conclusions are presented within this document.

1.2 Scope of the work

The main aims of the study included:

- Calculation of proposed total mass emission rate of Total particulates from the proposed emission points A2-1 and A2-6 for use within a dispersion modelling assessment.
- Dispersion modelling assessment of Total particulates emission limits values in accordance with EPA guidance AG4.
- Assessment of whether the predicted ground level concentrations of Total particulates from the emission points is in compliance with ground level concentration limit values at receptors in the vicinity of the facility (as taken from SI 180 of 2011 and Directive 2008/50/EC).

1.3 Model assumptions

The approach adopted in this assessment is considered a worst-case investigation in respect of Total particulates emissions to the atmosphere from the proposed operation of the emission points A2-1 and A2-6. These predictions are therefore most likely to over estimate the GLC that may actually occur for each modelled scenario. These assumptions are summarised and include:

- Emissions to the atmosphere from the proposed operations were assumed to occur 24 hours each day / 7 days per week, 365 days per year, 100% output for all sources.

- Five years of hourly sequential meteorological data from Dublin Airport 2011 to 2015 inclusive was used in the modelling screen which will provide statistical significant results in terms of the short and long term assessment. All years were presented for data analysis while the worst case year 2015 was used for contour presentation. This is in keeping with current national and international recommendations (EPA Guidance AG4). In addition, AERMOD incorporates a meteorological pre-processor AERMET PRO. The AERMET PRO meteorological pre-processor requires the input of surface characteristics, including surface roughness (z0), Bowen Ratio and Albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. The values of Albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated land etc.) and vary with seasons and wind direction. The assessment of appropriate land-use type was carried out to a distance of 10km from the meteorological station for Bowen Ratio and Albedo and to a distance of 1km for surface roughness in line with USEPA recommendations. This was performed on the Dublin Airport file for the specific area around Panda Waste Ltd as recommended in AG4.

- Maximum GLC's at receptors beyond the facility boundary and also at or beyond the facility boundary + Background were compared with relevant air quality limits values.
- All emissions were assumed to occur at maximum potential emission concentration and mass emission rates for each scenario and were assumed to occur for 24 hours per day, 365 days per year.
- AERMOD Prime (16216r) dispersion modelling was utilised throughout the assessment in order to provide the most conservative dispersion estimates.
- All building wake affects that could occur within the site were assessed within the dispersion model using the Prime algorithm and appropriate site maps.
- It is assumed in the dispersion that all assessed emission points will operate continuously throughout the year so this assessment is considered worst case with respect to emissions and ground level concentrations.

2. Materials and methods

This section describes the materials and methods used throughout the dispersion modelling assessment.

2.1 Dispersion modelling assessment

2.1.1 Atmospheric dispersion modelling of air quality: What is dispersion modelling?

Any material discharged into the atmosphere is carried along by the wind and diluted by wind turbulence, which is always present in the atmosphere. This process has the effect of producing a plume of air that is roughly cone shaped with the apex towards the source and can be mathematically described by the Gaussian equation. Atmospheric dispersion modelling has been applied to the assessment and control of emissions for many years, originally using Gaussian form ISCST 3. Once the compound emission rate from the source is known, ($g\ s^{-1}$), the impact on the vicinity can be estimated. These models can effectively be used in three different ways:

- Firstly, to assess the dispersion of compounds;
- Secondly, in a "reverse" mode, to estimate the maximum compound emissions which can be permitted from a site in order to prevent air quality impact occurring;
- And thirdly, to determine which process is contributing greatest to the compound impact and estimate the amount of required abatement to reduce this impact to within acceptable levels (McIntyre et al. 2000).

In this latter mode, models have been employed for imposing emission limits on industrial processes, control systems and existing facilities and processes (Sheridan et al., 2002).

Any dispersion modelling approach will exhibit variability between the predicted values and the measured or observed values due to the natural randomness of the atmospheric environment. A model prediction can, at best, represent only the most likely outcome given the apparent environmental conditions at the time. Uncertainty depends on the completeness of the information used as input to the model as well as the knowledge of the atmospheric environment and the ability to represent that process mathematically. Good input information (emission rates, source parameters, meteorological data and land use characteristics) entered into a dispersion model that treats the atmospheric environment simplistically will produce equally uncertain results as poor information entered into a dispersion model that seeks to simulate the atmospheric environment in a robust manner. It is assumed in this discussion that pollutant emission rates are representative of maximum emission events, source parameters accurately define the point of release and surrounding structures, meteorological conditions define the local atmospheric environment and land use characteristics describe the surrounding natural environment. These conditions are employed within the dispersion modelling assessment therefore providing good confidence in the generated predicted exposure concentration values.

2.1.2 Atmospheric dispersion modelling of air quality: dispersion model selection

The AERMOD model was developed through a formal collaboration between the American Meteorological Society (AMS) and U.S. Environmental Protection Agency (U.S. EPA). AERMOD is a Gaussian plume model and replaced the ISC3 model in demonstrating compliance with the National Ambient Air Quality Standards (Porter et al., 2003) AERMIC (USEPA and AMS working group) is emphasizing development of a platform that includes air turbulence structure, scaling, and concepts; treatment of both surface and elevated sources; and simple and complex terrain. The modelling platform system has three main components: AERMOD, which is the air dispersion model; AERMET, a meteorological data pre-processor; and AERMAP, a terrain data pre-processor (Cora and Hung, 2003).

AERMOD is a Gaussian steady-state model which was developed with the main intention of superseding ISCST3 (NZME, 2002). The AERMOD modeling system is a significant departure from ISCST3 in that it is based on a theoretical understanding of the atmosphere rather than depend on empirical derived values. The dispersion environment is characterized by turbulence theory that defines convective (daytime) and stable (nocturnal) boundary layers instead of the stability categories in ISCST3. Dispersion coefficients derived from turbulence theories are not based on sampling data or a specific averaging period. AERMOD was especially designed to support the U.S. EPA's regulatory modeling programs (Porter at al., 2003)

Special features of AERMOD include its ability to treat the vertical in-homogeneity of the planetary boundary layer, special treatment of surface releases, irregularly-shaped area sources, a three plume model for the convective boundary layer, limitation of vertical mixing in the stable boundary layer, and fixing the reflecting surface at the stack base (Curran et al., 2006). A treatment of dispersion in the presence of intermediate and complex terrain is used that improves on that currently in use in ISCST3 and other models, yet without the complexity of the Complex Terrain Dispersion Model-Plus (CTDMPLUS) (Diosey et al., 2002).

Input data from stack emissions, and source characteristics were used to construct the basis of the modelling scenarios.

2.2 Air quality impact assessment criteria

The predicted air quality impact from the operation of the existing and proposed emission points for each scenario is compared to relevant air quality objectives and limits. Air quality standards and guidelines referenced in this report include:

- SI 180 of 2011 – Air Quality Standards Regulations 2011.
- EU limit values laid out in the Directive on Air Quality 2008/50/EC.

Air quality is judged relative to the relevant Air Quality Standards, which are concentrations of pollutants in the atmosphere, which achieve a certain standard of environmental quality. Air quality Standards are formulated on the basis of an assessment of the effects of the pollutant on public health and ecosystems.

In general terms, air quality standards have been framed in two categories, limit values and guideline values. Limit values are concentrations that cannot be exceeded and are based on WHO guidelines for the protection of human health. Guideline values have been established for long-term precautionary measures for the protection of human health and the environment. European legislation has also considered standard for the protection of vegetation and ecosystems.

The relevant air quality standards for the proposed emission limits from the existing sources A2-1 and A2-6 are presented in *Table 2.1*.

2.2.1 Air Quality Guidelines value for Classical air pollutant Total Particulates

Table 2.1 illustrates the guideline and limit values for classical air quality pollutants in Ireland.

Table 2.1. EU and Irish Limit values laid out in the SI 180 of 2011 and 2008/50/EC.

POLLUTANT	Objective			
	Concentration	Maximum No. Of exceedences allowed	Exceedence expressed as percentile	Measured as
Particulates (PM10) (2008/50/EC and SI180 of 2011)	50 µg m^{-3} 40 µg m^{-3}	35 times in a year None	90.40th percentile --	24 hour mean Annual mean
Particulates (PM2.5) (2008/50/EC and SI180 of 2011)	25 µg m^{-3} – Stage 1 20 µg m^{-3} – Stage 2	None None	-- --	Annual mean Annual mean

2.3 Existing Baseline Air Quality

The EPA has been monitoring national Air quality from a number of sites around the country. This information is available from the EPA's website. The values presented for Total particulates as $PM_{10, 2.5}$ give an indication of expected immissions of this pollutant are listed in *Table 2.1*. *Table 2.2* illustrates the baseline data expected to be obtained from a Zone D area for this classical air pollutant. The existing facility would be considered to be located in a Zone D area according to the EPA's classification of zones for air quality (www.epa.ie). Traffic and industrial related emissions would be low to low / medium.

Table 2.2. Baseline air quality data used to assess air quality impact criterion in a number of Zone D region.

Baseline Values Zone D EPA Report 2014	Total Particulates (PM_{10}) Annual average (µg/m^3)	Total Particulates ($PM_{2.5}$) Annual average (µg/m^3)
Castlebar	12	-
Claremorris	10	5
Enniscorthy	22	-
Kilkitt	9	-
Longford	**--**	**13**
Average	**13.25**	**9**

Notes: [1] denotes taken from Air quality in Ireland 2014 – Key indicators of ambient air quality, www.epa.ie.

2.4 Meteorological data

Five years of hourly sequential meteorological data was chosen for the modelling exercise (i.e. Dublin Airport 2011 to 2015 inclusive). A schematic wind rose and tabular cumulative wind speed and directions of all five years are presented in *Section 7*. All five years of met data was screened to provide more statistical significant result output from the dispersion model. The worst case year 2015 was used for contour presentation. This is in keeping with national and international recommendations on quality assurance in operating dispersion models and will provide a worst case assessment of predicted ground level concentrations based on the input emission rate data. Surface roughness, Albedo and Bowen ratio were assessed and characterised around Dublin Airport met station for AERMET Pro processing for the Panda Waste site.

2.5 Terrain data

Topography effects were accounted for within the dispersion modelling assessment utilising topographical data obtained from OSI Ireland. 10 m spaced XYZ column format data was post processed in Aermap. This allowed for the appropriate scaling of receptor in the vicinity of the facility.

2.6 Building wake effects

Building wake effects are accounted for in modelling scenarios through the use of the Prime algorithm (i.e. **all** building features located within the facility were assessed and the effects of same on plume grounding and dispersion including the new buildings on site) as this can have a significant effect on the compound plume dispersion at short distances from the source and can significantly increase GLC's in close proximity to the facility. All building structures and stack heights and orientations were inputted into the dispersion model in order to allow for wake effects to be taken in to account in the calculations.

3. Results

This section describes the results obtained from the dispersion modelling assessment of emissions from the proposed operation located in Panda Waste Ltd facility. All input data and source characteristics were developed in conjunction with engineering drawings and source characteristics for the emission point supplied by OCM.

3.1. Dispersion model input data – Source characteristics and input data

Table 3.1 illustrates the source characteristics utilised within the dispersion model for the named emission points. Grid reference location, stack height (A.G.L), maximum volume flow and temperature of the emission point(s) are presented within this table for reference purposes.

Table 3.1. Source characteristics for emission points A2-1 and A2-6 located in Panda Waste Ltd.

Emission point identity	Proposed emission point – A2-1	Proposed emission point – A2-6
X cord(m)	297516.9	297422.9
Y cord (m)	269223.8	269108.4
Finish floor level (m)	71.50	70
Stack height (m)	15	14
Temp (K)	293.15	293.15
Efflux velocity (m)	18.76	15.72
Stack tip dia. dimensions (m)	1.40	1.50
Worst case building height next source (m)	14	13
Stack orientation (m)	Vertical	Vertical
Volumetric airflow rate (Am^3/hr wet)	100,000	103,960
Total particulates flue gas conc. (mg/Am^3)	10	10
Total particulates mass emission rate (g/s)	0.2778	0.2887

3.2 Dispersion modelling assessment

AERMOD Prime (16216r) was used to determine the overall ground level impact of the proposed emissions points A2-1 and A2-6 operating 24/7/365 days per year. These computations give the relevant GLC's at each 20 and 100-meter X Y Cartesian grid receptor location that is predicted to be exceeded for the specific air quality impact criteria. Receptor elevations were established at 1.80 m height above ground (normal breathing zone). A total Cartesian receptors gird of 1,748 points was established within the dispersion model giving grid coverage of 12.25 km sq. centred on the facility.

Five years of hourly sequential meteorological data from Dublin Airport (Dublin Airport 2011 to 2015 inclusive) was screened with the worst case year 2015 been used for contour presentation. Tabular data for this worst case year. Source characteristics as detailed in *Table 3.1* (including emission data contained in *Table 3.1*) were inputted into the dispersion model.

Various averaging intervals were chosen to allow direct comparison of predicted GLC's with the relevant pollutant air quality assessment criteria as outlined in *Table 2.1*. In particular, 24-hour, percentile and annual average GLC's of the pollutants were calculated at distances from the site. Relevant percentiles of these GLC's were also computed for comparison with the relevant Air Quality Standards.

For modelling classical air pollutants and in order to obtain the predicted environmental concentration (PEC), background data was added to the process emissions. In relation to the annual averages, the ambient background concentration was added directly to the process concentration.

3.3 Dispersion modelling scenarios

Three distinct scenarios were assessed within the dispersion model. The output data was analysed to calculate the following (excluding background):

Ref Scenario 1: Predicted Total particulates as PM10 emission contribution of all relevant exhaust stack of exhaust emission points to plume dispersal at the 90.4th percentile of an 24 hour average for an Total particulates as PM10 concentration of less than or equal to 5 µg/m^3 for 5 years of screened hourly sequential meteorological data (worst case year Dublin Airport 2015) (*see Figure 6.2*).

Ref Scenario 2: Predicted Total particulates as PM_{10} emission contribution of all relevant exhaust emission points to plume dispersal for the Annual average for an Total particulates as PM_{10} concentration of less than or equal to 2.0 µg/m^3 for 5 years of screened hourly sequential meteorological data (worst case year Dublin Airport 2015) (*see Figure 6.3*).

Ref Scenario 3: Predicted Total particulates as $PM_{2.5}$ emission contribution of all relevant exhaust emission points to plume dispersal for the Annual average for an Total particulates as $PM_{2.5}$ concentration of less than or equal to 2.0 µg/m^3 for 5 years of screened hourly sequential meteorological data (worst case year Dublin Airport 2015) (*see Figure 6.4*).

4. Results and Discussion of results

This section will describe the results obtained throughout the study.

AERMOD GIS Pro Prime (Ver. 16216r) was used to determine the overall air quality impact of proposed emission point operations at Panda Waste Ltd for new mass emission rates. *Table 4.1* illustrates the tabular concentration results at the worst case receptor location at or beyond the facility boundary.

Predicted GLC's presented within these tables will allow for comparison with SI 180 of 2011 and Directive 2008/50/EC guideline and limit values.

4.1 Assessment of air quality impacts for pollutants from named emission points.

Table 4.1 presents the comparison between model predictions at the worst case receptor location at or beyond the facility boundary for Total particulates and the maximum percentage value of the air quality impact criterion.

Table 4.1. Predicated combined baseline and ground level concentration of named pollutant at worst case sensitive receptor at or beyond the facility boundary for Dublin 2015.

Receptor identity Yr. 2012	Scenario 1 - 90.4%ile Total Particulates (µg/m^3)	Scenario 2 - Total particulates Annual average (µg/m^3)	Scenario 3 - Total particulates (as PM2.5) Annual average (µg/m^3)
Max predicted value at or beyond the facility boundary	13	6	6
Average Baseline conc. level (EPA Report 2014)	13.25	13.25	9
Max value + Baseline value (µg/m^3)	26.25	19.25	15
Air quality limit value (µg/m^3)	50	40	25
% of impact criterion (human health)	**47.50**	**51.88**	**40**

Notes:
Max predicted value for 90.4%ile Total Particulates, Annual average Total Particulates (as PM10/2.5) Annual average Oxides of nitrogen at location 297484, 269131

As can be observed in *Tables 4.1*, the predicted maximum averaging ground level concentration and baseline concentration at each receptor location and worst case value at or beyond the facility boundary are within the guideline / limit value for each pollutant assessed.

4.1.1 Total particulates as PM10 and PM2.5

The results for the potential air quality impact for dispersion modelling of Total particulates based on the emission rates in *Table 3.1* are presented in *Tables 4.1.* Results are presented for the maximum predicted percentile emission regime. As can be observed in *Table 4.1,* the maximum GLC+Baseline at the worst case sensitive receptors at or beyond the boundary of the facility for Total particulates as PM10 is 26.25 $\mu g/m^3$ for the maximum 24-hour mean concentration at the 90.40th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is less than or equal to 47.50% of the impact criterion for emissions from the combined existing emission point operations utilising the new mass emission rates for Total particulates as PM10.

An annual average was also generated to allow comparison with the SI 180 of 2011 and Directive 2008/50/EC for Total particulates as PM10 and PM2.5. The maximum predicted annual average + baseline ground level concentration at the nearest worst case sensitive receptor at or beyond the boundary of the facility for Total particulates as PM10 and PM2.5 is 19.25 and 15 $\mu g/m^3$. When compared, the annual average Total particulates as PM10 and 2.5 air quality impact is less than or equal to 52 and 40% of the impact criterion for emissions from the combined existing emission point operations utilising the new mass emission rates for Total particulates as PM2.5.

Table 4.2 presents the predicted ground level concentrations at each of the identified sensitive receptors.

Table 4.2. Predicted GLC's of Total particulates at each identified sensitive receptor.

Receptor identity	X coordinate (m)	Y coordinate (m)	90.4%ile Total particulates conc. as PM10 (µg/m3) - Yr 2015	Annual average Total particulates as PM10 conc (µg/m3) - Yr 2015	Annual average Total particulates as PM2.5 conc (µg/m3) - Yr 2015
R1	297498.3	269436.6	1.48	0.45	0.45
R2	297573.5	269493.2	1.82	0.57	0.57
R3	297654.7	269498.3	2.46	0.78	0.78
R4	297395.3	269510.8	1.11	0.30	0.30
R5	297355.4	269515	1.17	0.33	0.33
R6	297281.2	269519.7	1.25	0.36	0.36
R7	297299.3	269380.5	1.86	0.52	0.52
R8	297744.7	269499.2	2.32	0.76	0.76
R9	297629.6	268891.5	1.26	0.33	0.33

5. Conclusions

Odour Monitoring Ireland was commissioned by OCM to perform a desktop dispersion modelling study in order to assess the potential Total particulates air quality impact associated with combined proposed A2-1 and A2-6 operations at Panda Waste facility located in Navan, Co Meath. Following a detailed desktop review and dispersion modelling assessment, it was demonstrated that no significant Total Particulates impact will not occur as a result of operating the emission points with proposed emission limit values to limit values stated in Table 3.1.

The following conclusions are drawn from the study:

1. The assessment was carried out to provide information in line with relevant information for investigation of downwind impact from a facility. This information can be used to assess the potential impact risk associated with facilitating an increased mass emission rate of Total particulate matter as PM_{10} on the surrounding environment.
2. Specific dispersion modelling was performed for Particulate matter (as Pm_{10}).
3. With regard to Total particulates as $PM_{10/2.5}$, the maximum GLC+Baseline at worst case sensitive receptors at or beyond the boundary of the facility for Total particulates as PM_{10} is 26.25 µg/m^3 for the maximum 24-hour mean concentration at the 90.40th percentile. When combined predicted and baseline conditions are compared to the SI180 of 2011 and Directive 2008/50/EC, this is less than or equal to 47.5% of the impact criterion for emissions from the combined A2-1 and A2-6 operations. An annual average was also generated to allow comparison with the SI 180 of 2011 and Directive 2008/50/EC for Total particulates as $PM1_{10}$ and $PM_{2.5}$. The maximum predicted annual average + baseline ground level concentration at worst case sensitive receptors at or beyond the boundary of the facility for PM_{10} and $PM_{2.5}$ are 19.25 and 15 µg/m^3, respectively. When compared, the annual average PM_{10} and $PM_{2.5}$ air quality impact is less than or equal to 52 and 40% of the impact criterion for emissions from the combined A2-1 and A2-2 operations.

6. *Appendix I* - Air dispersion modelling contour plots (Process contribution only).

These contour plots are for illustrative purposes only. The pollutant contour values were selected for illustrative purposes only to allow for graphical representation of dispersion from the identified source.

6.1 Site layout drawing and location of proposed emission points.

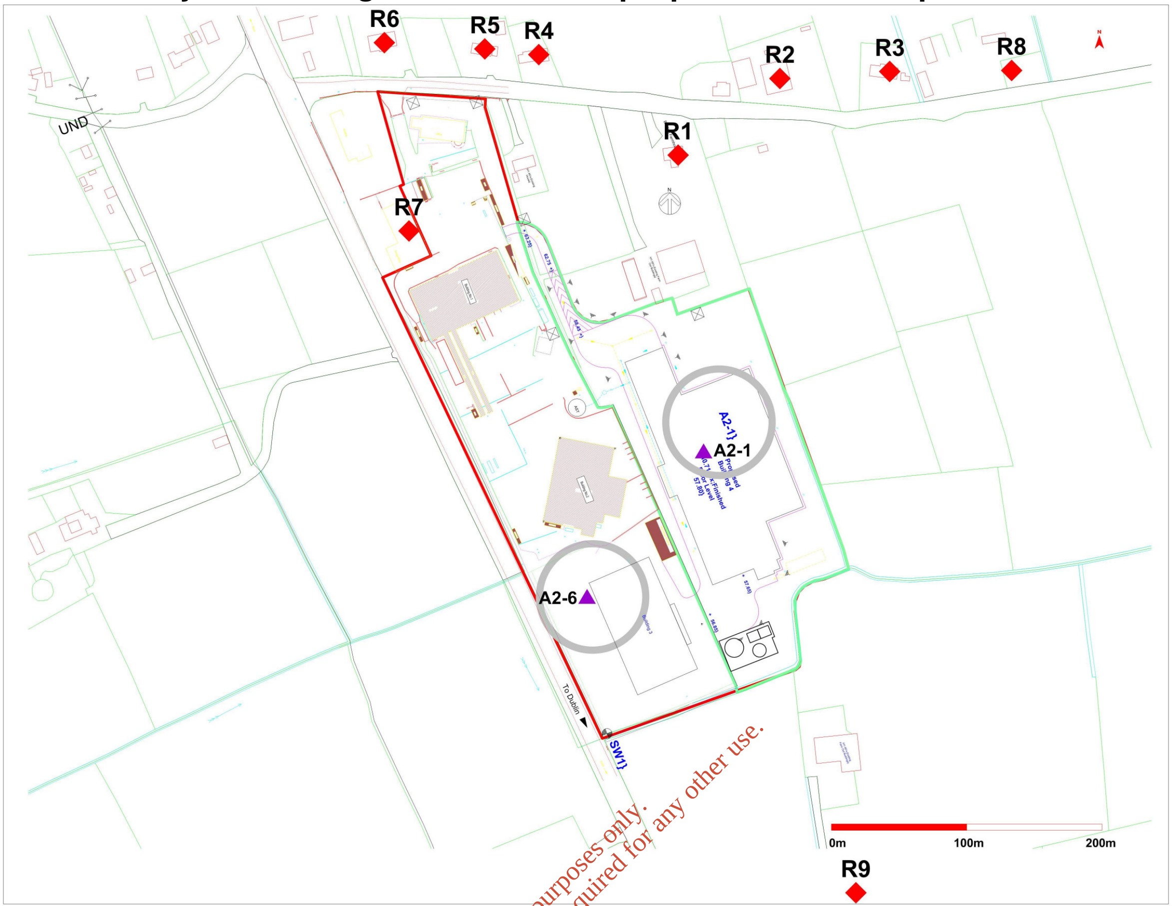

Figure 6.1. Plan view facility layout drawings for proposed emission points (A2-1 and A2-6)).

6.2 Total particulates contours.

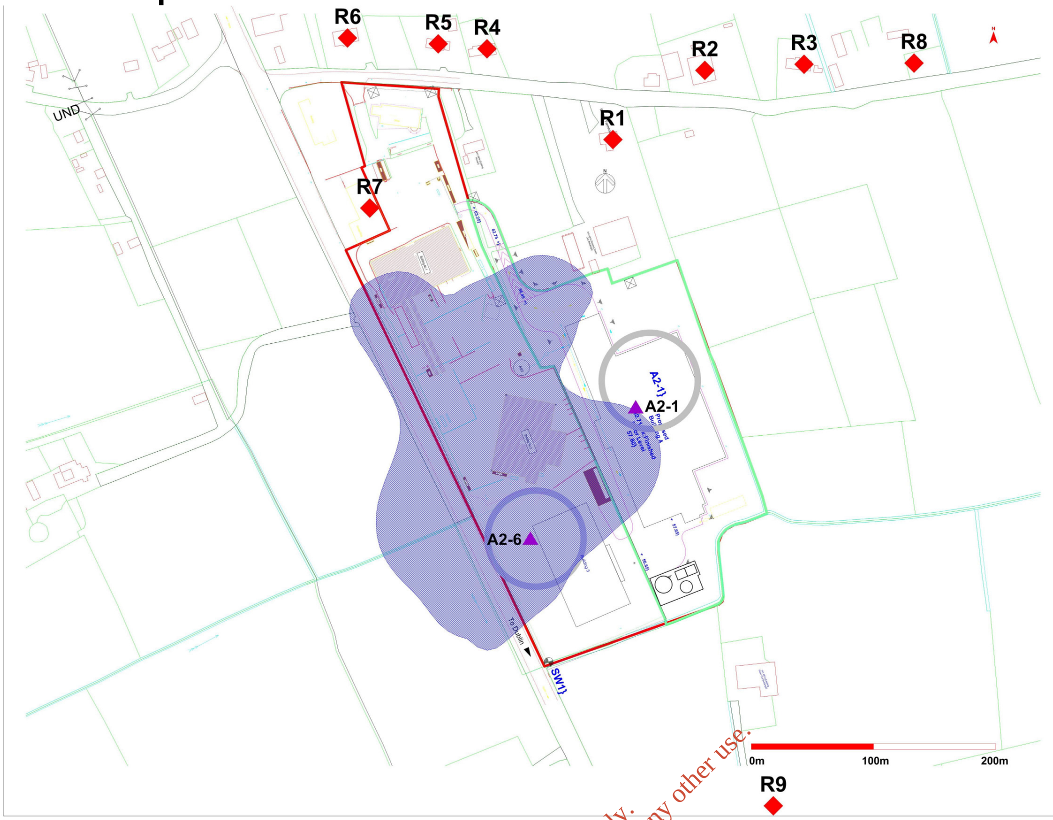

Figure 6.2. Predicted Total particulates as PM_{10} ground level concentration impact contribution of cumulative proposed emissions from all named emission points for the 24 hour 90.40th %ile ground level concentration of ≤ 5.0 µg/m^3 (▬▬) for worst case meteorological year Dublin Airport 2015.

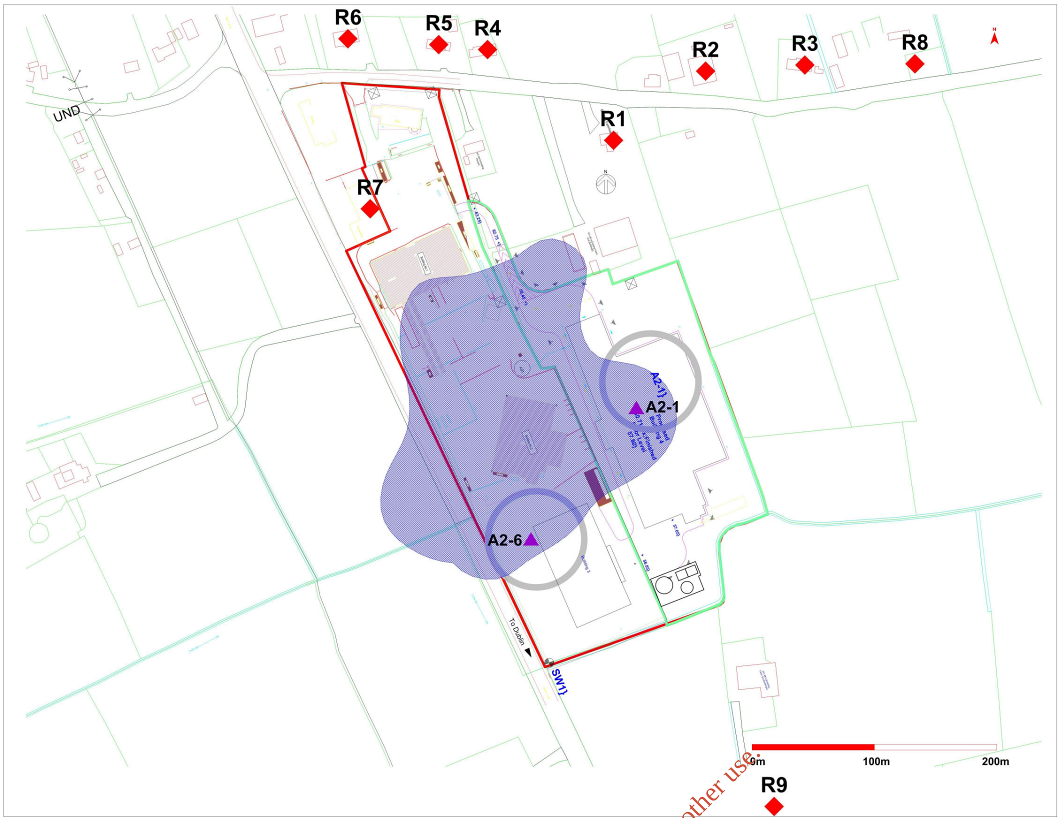

Figure 6.3. Predicted Total particulates as PM_{10} ground level concentration impact contribution of cumulative proposed emissions from all named emission points for the Annual average ground level concentration of ≤ 2.0 µg/m^3 ( ) for worst case meteorological year Dublin Airport 2015.

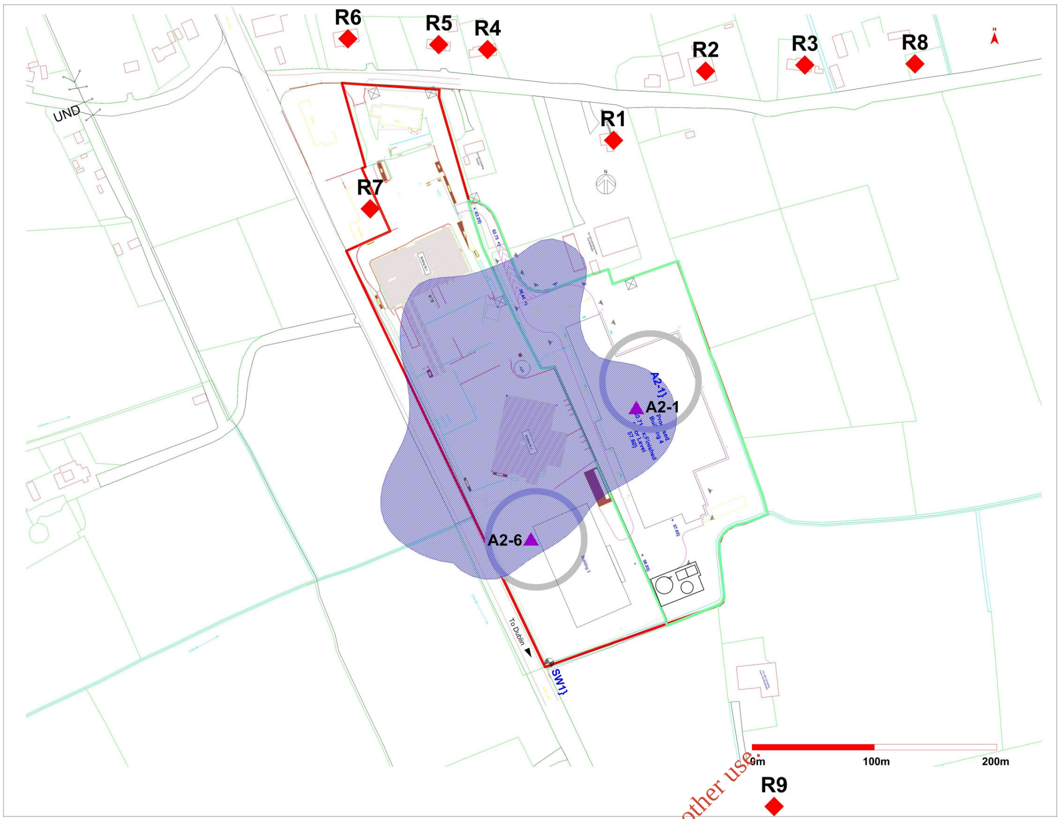

Figure 6.4. Predicted Total particulates as $PM_{2.5}$ ground level concentration impact contribution of cumulative proposed emissions from all named emission points for the Annual average ground level concentration of ≤ 2.0 µg/m^3 ( ) for worst case meteorological year Dublin Airport 2015.

7. *Appendix II* - Meteorological data used within the Dispersion modelling study.

Meteorological file Dublin Airport 2011 to 2015 inclusive

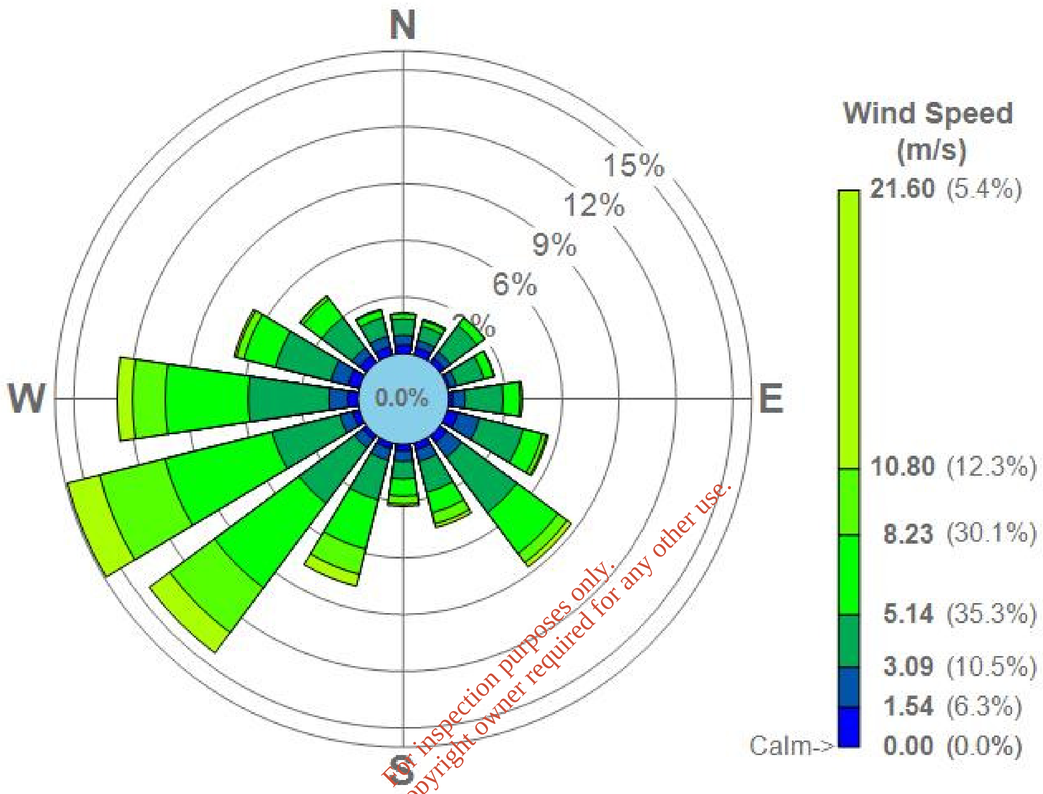

Figure 7.1. Schematic illustrating windrose for meteorological data used for atmospheric dispersion modelling – Dublin Airport 2011 to 2015 inclusive.

Table 7.1. Cumulative wind speed and direction for meteorological data used for atmospheric dispersion modelling Dublin Airport 2011 to 2015 inclusive.

Cumulative Wind Speed Categories							
Relative Direction	**> 1.54**	**>3.09**	**>5.14**	**>8.23**	**> 10.80**	**< 10.80**	**Total**
0	0.47	0.51	0.86	0.29	0.01	0.00	2.13
22.5	0.40	0.40	0.77	0.30	0.07	0.00	1.94
45	0.30	0.41	1.74	0.50	0.02	0.00	2.96
67.5	0.13	0.37	1.49	0.54	0.03	0.00	2.56
90	0.22	0.65	2.00	0.91	0.10	0.00	3.88
112.5	0.57	1.18	2.39	1.03	0.23	0.09	5.49
135	0.47	0.96	3.64	2.69	0.60	0.29	8.65
157.5	0.37	0.63	1.68	1.12	0.59	0.21	4.61
180	0.35	0.53	0.94	0.91	0.42	0.12	3.28
202.5	0.31	0.63	2.16	2.68	1.38	0.65	7.80
225	0.25	0.57	3.65	5.56	2.95	1.35	14.32
247.5	0.36	0.70	3.69	5.83	3.56	1.76	15.90
270	0.54	1.00	4.25	4.38	1.74	0.81	12.72
292.5	0.62	0.94	3.00	1.72	0.42	0.13	6.82
315	0.47	0.50	2.00	1.22	0.19	0.03	4.41
337.5	0.46	0.56	1.02	0.42	0.04	0.00	2.49
Total	**6.28**	**10.54**	**35.26**	**30.11**	**12.33**	**5.43**	**99.95**
Calms	**--**	**-**	**-**	**-**	**-**	**-**	**0.05**
Missing	**-**	**-**	**-**	**-**	**-**	**-**	**0.00**
Total	**-**	**-**	**-**	**-**	**-**	**-**	**100.00**

8. *Appendix III* - Checklist for EPA requirements for air dispersion modelling reporting

Table 8.1. EPA checklist as taken from their air dispersion modelling requirements report.

Item	Yes/No	Reason for omission/Notes
Location map	Section 6	-
Site plan	Section 6	-
List of pollutants modelled and relevant air quality guidelines	Yes	-
Details of modelled scenarios	Yes	-
Model description and justification	Yes	-
Special model treatments used	Yes	-
Table of emission parameters used	Yes	-
Details of modelled domain and receptors	Yes	-
Details of meteorological data used (including origin) and justification	Yes	-
Details of terrain treatment	Yes	-
Details of building treatment	Yes	-
Details of modelled wet/dry deposition	N/A	-
Sensitivity analysis	N/A	Five years of hourly sequential data used from nearest valid met station-Dublin 2011 to 2015 inclusive. Worst case year was Year 2015.
Assessment of impacts	Yes	Pollutant emissions assessment from process identified.
Model input files	No	DVD can be sent upon request. Files are a total of 4.60 GB in size.