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Xtratherm Limited

Liscarton Industrial Estate, Kells Rd, Mullaghard, Navan, Co. Meath, C15 NP79

Air Dispersion Model Report
Part of Additional Information Requested by the EPA
Model for A2-1 and A2-2

Project: EPA Licence Review

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Executive Summary

AXIS environmental services were commissioned to carry out an air dispersion model for Xtratherm Limited, Liscarton Industrial Estate, Kells Rd, Mullaghard, Navan, Co. Meath. Xtratherm require a model to predict dispersion of parameters from the existing A2-1 and A2-2 at the installation as part of an EPA licence application.

An air dispersion modelling exercise involving the AERMOD dispersion software was conducted to predict the impact of emissions on ambient air quality in the surrounding environment from the installation.

The assessment identified two point sources of air pollution from process operations at their licensed and existing locations.

The contribution of mobile source emissions both on and off the facility were not considered as part of the modelling project, moreover the emissions from these sources were considered as part of the background concentration value for general parameters measured by the EPA where such data was available.

Building and terrain effects were included as part of the modelling analysis, and the meteorological data set was defined using wind speed and direction from Dublin Airport Met Station which is located approximately 42km south east of the installation. Five years of met data was used in the model to estimate worst case ground level concentrations during the period (2013 to 2017). This was the closest and most appropriate station with the required meteorological data in any annual period used.

A receptor grid system was determined using a multi-tier grid system that extended out to 10km from the proposed boundary line. This included a 100 metre resolution inner grid, a 500 metre middle grid and a 1000m outer grid to 10km from the boundary. Special receptors including nearby houses and amenities were included as part of the receptor network.

With all the input files established, the air dispersion model was executed. The model was run using the rural option based on the Auer (1978) Land Use categories.

Table 1-1 Summary of Input Parameters

Parameter	Units	A2-1	A2-2
Total Organic Carbon	g/s	0.83[Note 1]	0.14[Note 1]
Total Organic Carbon	mg/m^3	150 [Note 1]	50 [Note 1]
MDI	g/s	0.00033	N/a
MDI	mg/m^3	0.1	N/a
Stack height	meter	12.7	10.5
Stack diameter	meter	0.58	0.26
Exit temperature	^OC	30	30
Exit velocity	m/s	14.2	7.0
Exit flow rate	Nm^3/hr	12,000	1,200
Vertical or Horizontal	-	Vertical	Vertical
Chinese Cap or None	-	None	None

Note 1: Maximum emission applies to existing ELVs in the current licence which are requested in the licence review for the new licence of 150 mg/m^3 above a mass flow threshold of 3 kg/hour, which is equivalent to 0.83 g/s;
Note 2: TOC consists of varying concentrations of Iso-pentane and Cyclopentane.

Table 1-2 summarises the results of the model for the installation, and their comparisons with the ambient air quality standards (AQS). The air quality standards currently applicable in Ireland are the ambient standards EU 2008/50/EC, Clean air for Europe (CAFÉ) Directive. As there is no AQS defined for total volatile organic compounds, iso-pentane or cyclopentane reference was made to the EPA guidance note for applicable environmental assessment levels (EALs).

The EPA 2019 AG4 guidance note outlines the following relevant information: *"When modelling unidentified / semi-quantified mixtures of volatile organic compounds (VOCs), a worst-case approach may be to assume that all emissions are in the form of benzene. Where this indicates an exceedance of the EU ambient air quality standard, a more detailed assessment will be required in order to determine the main constituents of the mixture and thereafter to assess whether compliance is being achieved with the relevant standards or guideline values for these constituents".*

As no limits exist in legislation, a breakdown of the solvents that could be emitted from these emission points were assessed. The EALs for each compound were determined by use of the EPA guidance note and the 2020 Code of practice for the Safety, Health and Welfare at Work (Chemical Agents) Regulations (2001-2015) and the Safety, Health and Welfare at Work (Carcinogens) Regulations (2001-2019). The VOCs in the emissions consist of a combination of iso-pentane and cyclopentane. As the mixture is defined, it is appropriate to assess the emissions against the adjusted 2020 Code of practice limits. For a worst case scenario, it was assumed that all emissions were in the form of Cyclopentane which has lower EALs.

Table 1-2 Summary of Model Results

Pollutant	Averaging Period	Impact from site ($\mu g.m^{-3}$)	Background ($\mu g.m^{-3}$)Note 1	Combined Result ($\mu g.m^{-3}$)	EAL ($\mu g.m^{-3}$)Note 2
Total Organic Carbon	1 hour	408	4.61	412.6	5,160,000Note 3
Total Organic Carbon	Annual	13.4	0.23	13.63	17,200
MDI	1 hour	0.19	-	0.19	7
MDI	Annual	0.005	-	0.005	0.2

Note 1: The EPA have limited background data for TOC in Zone D areas in 2019, no information on MDI;
Note 2: The Environmental Assessment Level quoted is from the 2020 for the Safety, Health and Welfare at Work (Chemical Agents) Regulations (2001-2015) and the Safety, Health and Welfare at Work (Carcinogens) Regulations (2001-2019); following the rules required by the EPA Guidance Note AG4:2019 Appendix J;
Note 3: 3 times the 8 hour time weighted average for cyclopentane;
Note 4: A factor of 100 is applied to the 8-hour occupational exposure level for cyclopentane.

The model has predicted that assuming the worst case emissions from the facility the ground level concentration of organic compounds would be below the EAL as applied Appendix J of the EPA guidance note AG4 given the following conditions:

- A2-1 and A2-2 were releasing at maximum flow rate;
- A2-1 and A2-2 were releasing at maximum mass emissions;
- Combined with worst case meteorological data for dispersion (taken 5 years of met data into account).

1. Introduction

Xtratherm Limited requested AXIS environmental services to complete an air dispersion model as part of an investigation into the impact of emission points at the installation on the local environment.

The air dispersion model analysis is being undertaken to determine the impact of specific air pollutants from the facility on the ambient air quality. A determination was also made whether a significant air quality impact would be created based on the incremental contribution of the facility to the cumulative air quality impact.

This report describes the air dispersion modelling analysis for:

- Total Organic Carbon (TOC), which is a combination of Isopentane and Cyclopentane;
- MDI (Methylene diphenyl diisocyanate).

Modelled ground level concentrations were then compared against any relevant limits applied in the CAFÉ directive for Ambient Air Quality Standards, limits applied by the Environmental Protection Agency Guidance Note AG4 Environment Assessment Levels (EAL's).

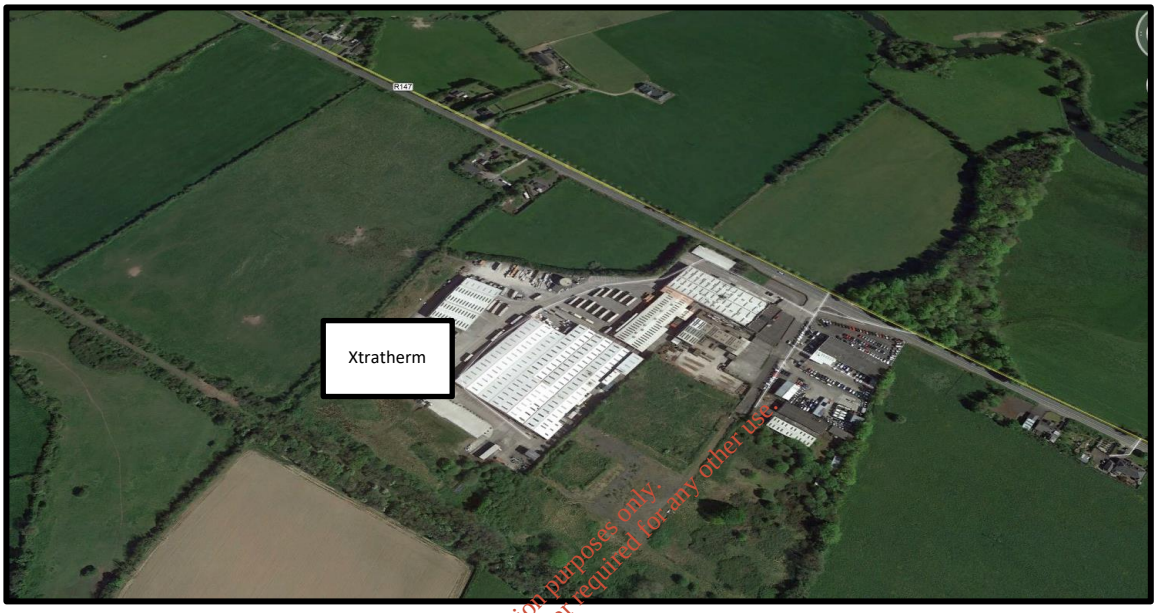
TOC is a total of gaseous solvents (referenced as carbon, propane equivalent) that are emitted from the installation. MDI is a compound used in manufacturing products on the chemical laydown line. For the purpose of this study, ground level concentrations in the local environment have been assessed against the Environmental Assessment Levels required by the EPA in the guidance note AG4.

The cumulative air quality impact analysis from background concentrations are also required by the EPA Guidance Note AG4. The EPA does not have published data for organic compounds in Navan and its environs. There was data available for organic compounds in a Zone D location in 2019 which has been used in this report to determine the cumulative impact.

2. Process Description and Air Pollutant Sources

The emission points are existing emission points in the licence currently listed as A2-1 and A2-2. Both stacks are located side by side at the installation. A2-1 extracts organics and MDI from the chemical laydown line, while A2-2 is a room extract.

Fig 2-1: Location Map (Source: Google Earth)



2.1 Air Emissions

Table 2-1: Summary of Emissions

Emission Point Reference No:	Chemical Laydown A2-1	Foaming Agent Room A2-2	Units
Location:	Laydown	Laydown	-
Volume to be emitted:	12,000	1,200	Nm^3/hour
Minimum Discharge Height:	12.7	10.5	m
Total Organics (as C)	150 at mass flow of greater than 3 kg/hour	50 at mass flow of greater than 0.5 kg/hour	mg/Nm^3
MDI	0.1	N/a	mg/Nm^3

3. Air Dispersion Modelling Methodology

3.1 Modelling Approach

The assessment methodology for the air dispersion modelling exercise follows the guidance specified by the Environmental Protection Agency, AG4, Air Dispersion Modelling from Industrial Installations Guidance Note, December 2019.

One of the detailed models recommended in the document is AERMOD. The model of selection was the Breeze AERMOD/ISC which is designed to estimate pollutant concentrations and deposition from an industrial source complex. The latest version of AERMOD 19191 (Version 9.1.0.16 Pro Plus) with the most current version of the AERMOD terrain pre-processor (AERMAP) was used on this assessment.

3.2 Building Downwash

The emissions sources at the facility were evaluated in terms of the proximity to nearby structures. All buildings located reasonably close to the point sources on the property were included in the modelling analysis. Breeze guidance would suggest that any building within 100 metres of the point source should be included.

The purpose of the downwash evaluation was to determine if stack discharges may become caught in the turbulent wakes generated by these structures. AERMOD incorporates the Plume Rise Model Enhancements (PRIME) algorithms for estimating enhanced plume growth and restricted plume rise for plumes affected by building wakes.

Direction specific structure dimensions and the dominant downwash structure parameters used as input to AERMOD were determined using the BREEZE®BPIPP software, developed by Trinity Consultants, Inc. The software incorporates the algorithms of the U.S. EPS's sanctioned SPIP PRIME (BPIPP). The software creates the downwash input cards that were used in AERMOD.

3.3 Dispersion Options

AERMOD was utilised using the regulatory default option.

3.4 Receptor Grid Selection

Ground level concentrations were calculated for receptors covering a region that extends 10km from all edges of the boundary line. As per the guidance note, receptors inside the site boundary would not be assessed in the model. Sensitive discrete receptor locations were located at a local private residence's closest to the installation boundary.

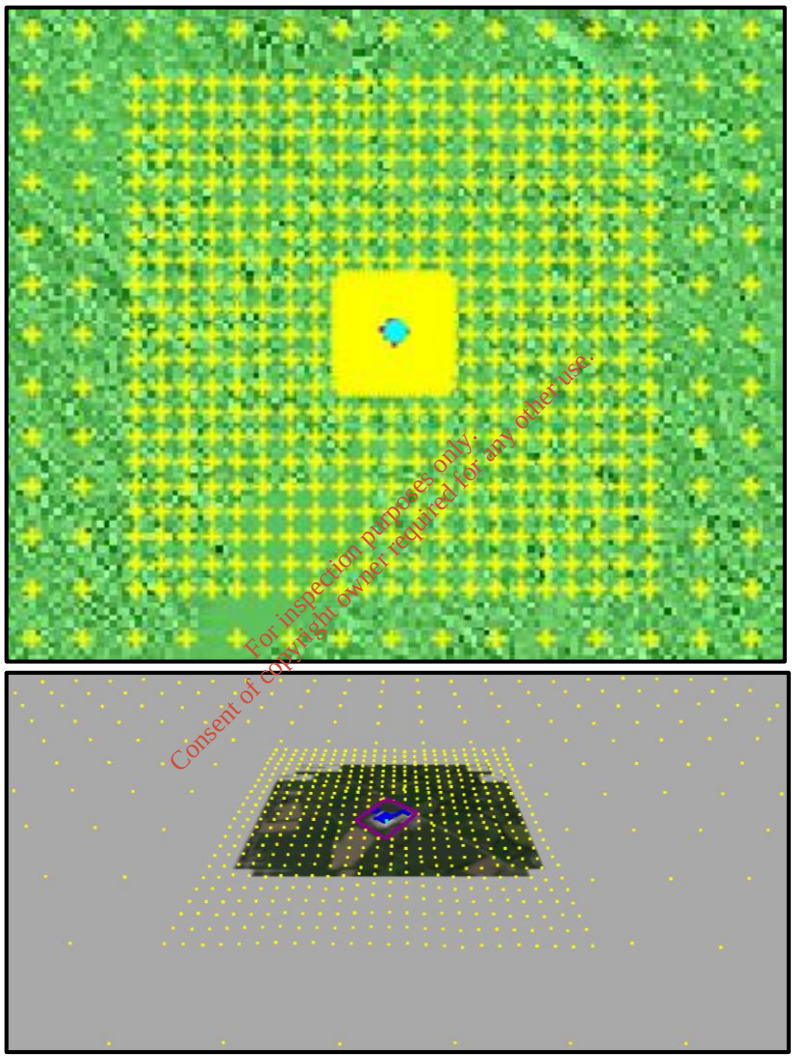
Fig 3-2: Property Boundary

- The property boundary line is a discrete receptor grid with receptors spaced at 10m intervals along the property line. All receptors inside the property line have been removed from the model run;
- The inner grid contains 100 m resolution spaced receptors extending to 1,000 m from the property line;
- The middle grid contains 500 m resolution spaced receptors extending to 5,000m from the property line;
- The outer grid contains 1000 m resolution spaced receptors extending to 10,000m from the property line.

3.5 Terrain

The terrain elevation for each modelled building, source and receptor was determined using Digital Terrain Model (DTM) Data from the Ordinance Survey of Ireland (OSI). The terrain height for each modelled source, building and receptor was calculated using the AERMOD terrain pre-processor AERMAP. AERMAP computes the terrain height from the digital terrain elevations surrounding the modelled receptors, sources and buildings. It also computes the hill height scale required for the receptors.

Fig 3-3: Terrain Data and Receptor Grid



3.6 Meteorological Options

The facility is located in an area designated by the EPA as Zone D, just outside Navan which would be designed as Zone C. The closest met station to the proposed site with suitable and adequate data for the model was Dublin Airport. Five years of data was obtained from 2013 – 2017 for this location. The met station is located approximately 42km south east of the installation.

There are two types of meteorological files used in this model, a file containing surface scalar parameters and a file containing vertical profiles. Both data filters for the surface and mixing heights were used to generate the meteorological files required by the AERMOD dispersion model, using the AERMET meteorological pre-processor programme. This AERMET programme has three stages to process the data. The first stage extracts met data and assesses data quality through a series of quality assessment checks. The second stage merges all data available for 24 hours periods and writes these data together in a single intermediate file. The third and final stage reads the merged met data and estimates the necessary boundary layer parameters for dispersion calculations by AERMOD.

The AERMOD model requires hourly surface data values for wind speed, wind direction, temperature, rainfall, relative humidity, pressure, cloud cover, ceiling height and solar radiation and at least once daily mixing height data.

The wind rose for the respective years modelling is included in the table below. The wind rose shows the most predominant wind direction blows from south west indicating that the emission plumes will mainly be dispersed in the opposing direction.

The met station has less than 10% of missing data, calculated by the model programme as 2.93% which complies with the EPA guideline requirements. The guidelines also require that the model run would have greater than 90% data coverage on a seasonal basis. The calculated coverage during this run was 99.3%.

Figure 3-1 Met Data

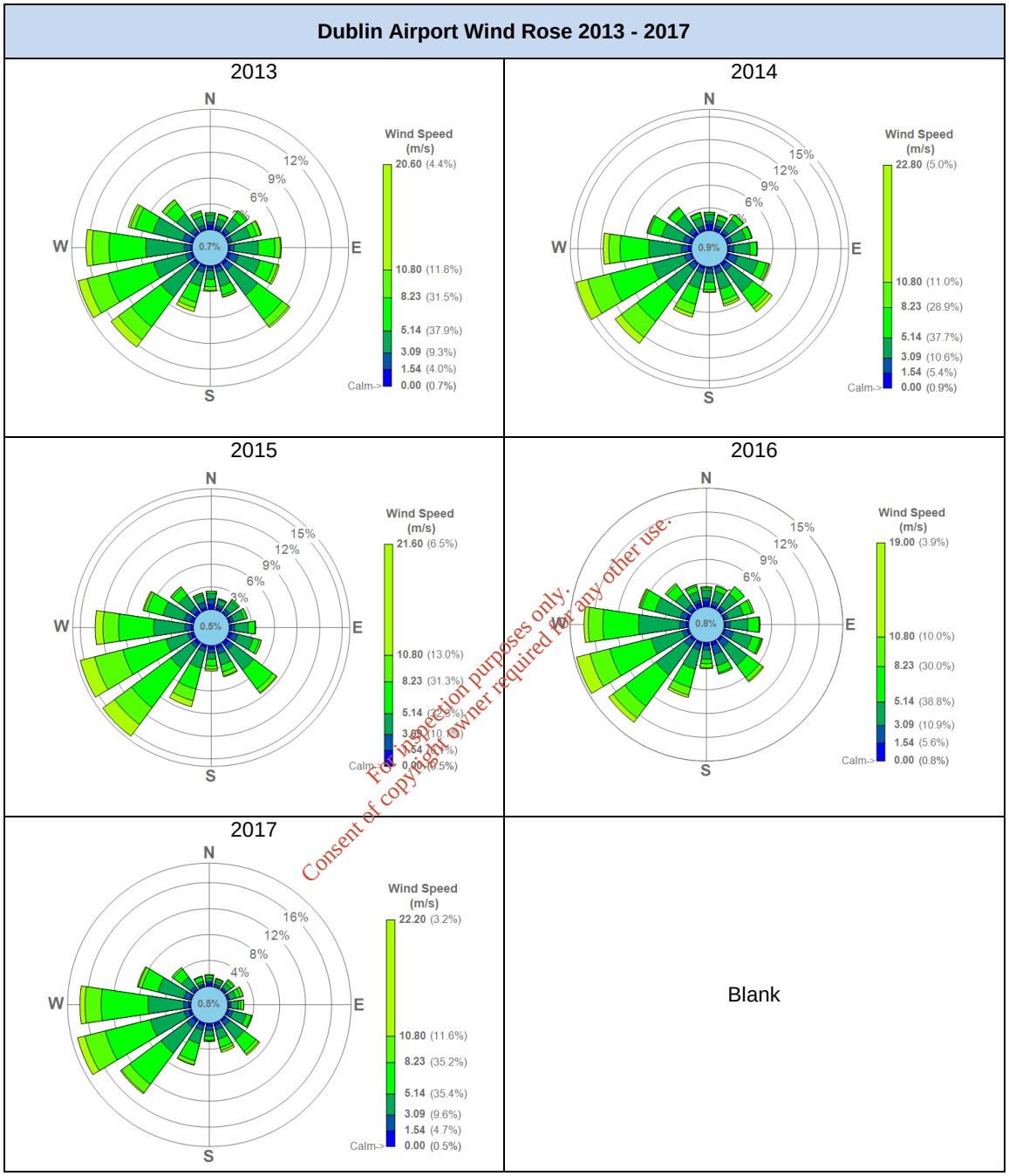


Table 3-1: Met Data Summary (2013 – 2017)

Direction \ Speed	<= 1.54	<= 3.09	<= 5.14	<= 8.23	<= 10.80	> 10.80	Total
0.0	0.5	0.3	0.6	0.4	0.1	0.0	1.8
22.5	0.1	0.3	0.5	0.3	0.1	0.0	1.4
45.0	0.2	0.3	0.9	0.5	0.2	0.0	2.0
67.5	0.2	0.2	1.0	0.7	0.4	0.1	2.6
90.0	0.2	0.3	1.1	0.4	0.5	0.0	2.5
112.5	0.2	0.7	2.1	0.8	0.2	0.0	4.0
135.0	0.3	0.8	2.7	2.3	0.5	0.2	6.9
157.5	0.4	0.7	1.5	1.3	0.5	0.3	4.7
180.0	0.4	0.7	0.9	0.6	0.2	0.1	2.8
202.5	0.4	0.8	2.1	2.7	0.6	0.1	6.8
225.0	0.4	1.1	5.0	6.0	1.6	0.2	14.2
247.5	0.4	0.8	5.4	7.2	3.3	1.2	18.1
270.0	0.3	0.8	5.5	7.3	2.5	0.8	17.1
292.5	0.2	1.0	4.1	2.6	0.6	0.2	8.6
315.0	0.3	0.5	1.7	1.5	0.3	0.0	4.3
337.5	0.2	0.3	0.4	0.7	0.1	0.0	1.8
Total	4.7	9.6	35.4	35.2	11.6	3.2	99.5
Calm							**0.46**
Missing							**0.00**
Total							**100.00**

4. Model Inputs

4.1 Emissions from the Facility

A critical step for conducting air dispersion modelling is to quantify the emissions from the various sources at the facility. The emission rate for A2-1 was obtained from the existing licence conditions. The limit imposed was a maximum concentration of 150 mg/m^3 for TOC above a threshold of 3 kg/hr. MDI has a concentration limit of 0.1 mg/m^3. The details for A2-2 were taken from the licence application with a proposed limit of 50 mg/m^3 TOC when a mass threshold of 0.5 kg/hr has been surpassed.

Table 4-1 outlines the source information data determined for the facility. The emission rate was based on the maximum emission rate from A2-1 and A2-2.

Table 4-1: Source Information Data

Source ID	Type	Description	X Co-ord. m	Y Co-ord. m	Elevation metres	Height metres	Diameter Metres	Exit Temp. (^{O}C)
A2-1	Point Source	Chemical Laydown	649108.2	5949303.2	57.12	12.7	0.58	30
A2-2	Point Source	Foam Blowing Agent	649108.1	5949305.7	56.71	10.5	0.26	30

Table 4-2: Emission Rates

Source ID	Exit Volume, (m^3/hr)	Exit Velocity, (m/s)	Moisture Content (%)	TOC (g/s)	MDI (g/s)	Stack Layout	Chinese Cap
A2-1	12,000	14.2	1	0.83[Note 1]	0.00033	Vertical	None
A2-2	1,200	7.0	1	0.14[Note 2]	None	Vertical	None

Note 1: Based on an emission of 3kg/hour;
Note 2: Based on an emission of 0.5kg/hour.

4.2 Existing Baseline Air Quality Data

When modelling the release of pollutants it is important to consider the existing parameters present in the environment and at what concentration. The Process Contribution (PC) should be added to the Background Concentration (BC) to obtain the Predicted Environmental Concentration (PEC), which is the figure used for final assessment with the appropriate legislative limits.

The EPA manages the National Ambient Air Quality Network and routinely monitors ambient air quality at c. 33 locations in Ireland. The data is collected and collated for publication in the Annual Air Quality Reports.

The EPA have divided the country into zones for assessment and management of air quality. Zone A is the Dublin conurbation, Zone B is the Cork conurbation with Zone C comprising 23 large towns in Ireland with a population >15,000. Zone D is the remaining area of Ireland.

The number of monitoring locations required is dependent on population size and whether ambient air quality concentrations exceed the upper assessment threshold, are between the upper and lower assessment thresholds, or are below the lower assessment threshold.

Table 4-3: Background Data for Zone D

Table A 13 Summary statistics for daily ozone precursor VOCs concentrations at Longford in 2018

	Benzene	Toluene	Ethylbenzene	m- and p-Xylene	o-Xylene
(µg/m³)			Zone C		
Annual mean[23]	0.21	0.36	0.08	0.20	0.28
Median	0.10	0.21	0.04	0.12	0.07
% data capture	83	83	83	83	83
Hourly max	2.38	5.85	2.93	6.22	5.23

Source: EPA Air Quality in Ireland 2019 Report.

5. Model Results

With the various sources identified, a model domain established of 10km from the site boundary and centred in the middle of the proposed facility, the necessary input files created, model predictions were made for the emissions for averaging periods of 1 hour and annual averages. Additional information was obtained from the Environmental Protection Agency Guidance Note AG4 for ground level concentrations for parameters not listed under the CAFE Directive.

Model impacts were run for point sources alone and combined with EPA ambient air quality data published under the national ambient air quality monitoring programme for a predicted environmental concentration.

The following assumptions have been made in this model:

- The site is in operation 24 hours per day, 365 days per year;
- The point sources are emitting continuously and consistently at maximum proposed emission limit values;
- 5 years of met data have been used from the closest Met station which is representative of met conditions at this site;
- The maximum ground level concentration for the appropriate reporting value was recorded outside the boundary of the facility.

5.1 Total Organic Carbon Dispersion Results

Table 5-1.1: Annual Results

Receptors	Year	Model Result	Background Note 1	Cumulative	Limit	Compliance Statement
		Process Contribution (PC)	Average of Annual Mean for Zone D EPA monitoring stations	Predicted Environmental Concentration (PEC)	Note 2	
		ug.m^{-3}	ug.m^{-3}	ug.m^{-3}	ug.m^{-3}	
Annual Average	2013	7.02	0.23	7.25	17,200	Compliant
	2014	10.1		10.33		Compliant
	2015	10.2		10.43		Compliant
	2016	11.2		11.43		Compliant
	2017	13.4		13.63		Compliant

Note 1: Background data is for VOC concentrations determined in Zone D averaged in 2019;
Note 2: The limit has been obtained from the EPA Guidance Note AG4:2019 Appendix J for the more hazardous substance for a conservative limit.

Fig 5-1: Annual Contour Plot Process Contribution

Contours (ug/m^3)

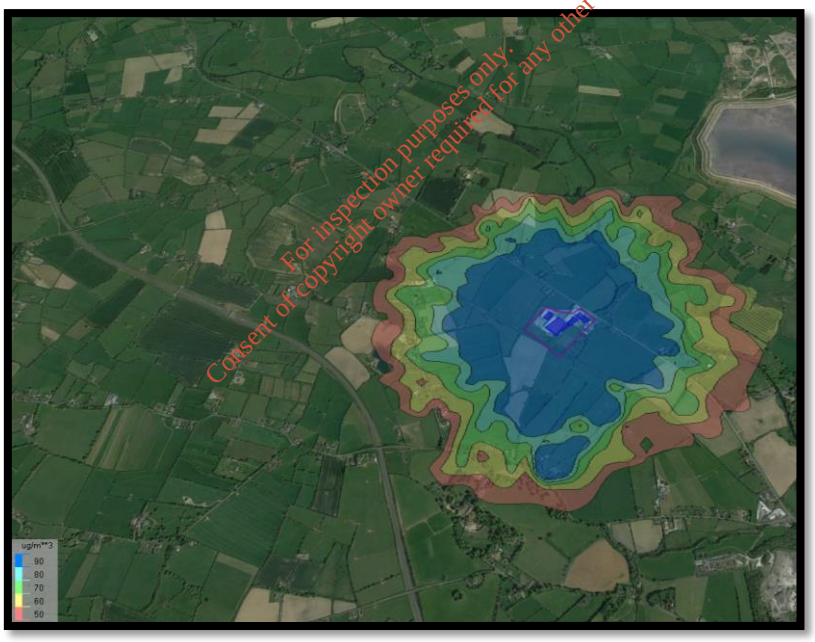
2	4	6	8	10

Table 5-1.2: 1 Hour Results

Receptors	Year	Model Result	Background Note 1	Cumulative	Limit	Compliance Statement
		Process Contribution (PC)	Average of Annual Mean for Zone D EPA monitoring stations	Predicted Environmental Concentration (PEC)	Note 2	
		ug.m^{-3}	ug.m^{-3}	ug.m^{-3}	ug.m^{-3}	
1 Hour Result	2013	269	4.61	273.6	5,160,000	Compliant
	2014	298		302.6		Compliant
	2015	408		412.6		Compliant
	2016	363		367.6		Compliant
	2017	276		280.6		Compliant

Note 1: Background data is for VOC concentrations determined in Zone D averaged in 2019;
Note 2: The limit has been obtained from the EPA Guidance Note AG4:2019 Appendix J for the more hazardous substance for a conservative limit.

Fig 5-2: 1 Hour Contour Plot Process Contribution



Contours (ug/m^3)

	50		60		70		80		90

5.2 MDI Dispersion Results

Table 5-2.1: Annual Results

Receptors	Year	Model Result	Background Note 1	Cumulative	Limit	Compliance Statement
		Process Contribution (PC)	Average of Annual Mean for Zone D EPA monitoring stations	Predicted Environmental Concentration (PEC)	Note 2	
		ug.m^{-3}	ug.m^{-3}	ug.m^{-3}	ug.m^{-3}	
Annual Average	2013	0.004	None	0.004	0.2	Compliant
	2014	0.004		0.004		Compliant
	2015	0.005		0.005		Compliant
	2016	0.004		0.004		Compliant
	2017	0.004		0.004		Compliant

Note 1: There is no background data for MDI;
Note 2: The limit has been obtained from the EPA Guidance Note AG4:2019 Appendix J for isocyanates.

Fig 5-3: Annual Contour Plot Process Contribution

Contours (ug/m^3)

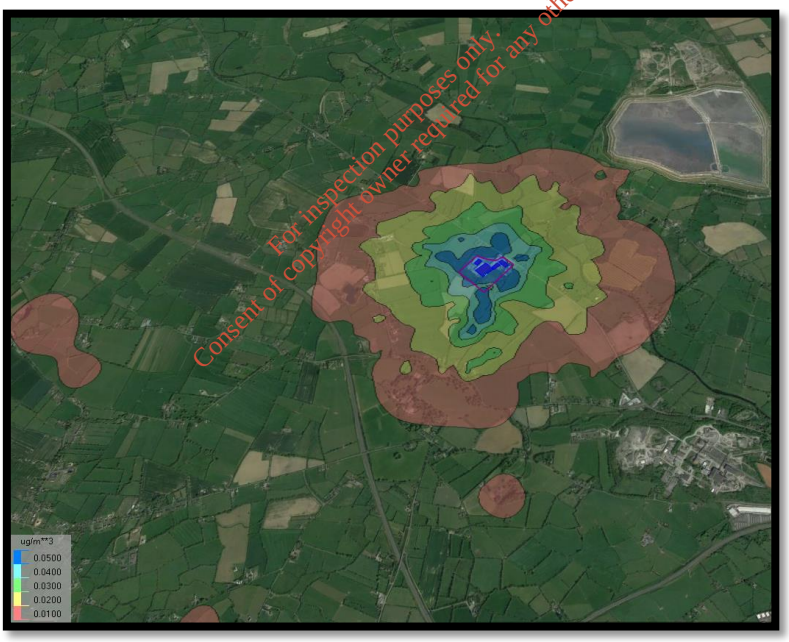
	0.001		0.002		0.003		0.004		0.005

Table 5-2.2: 1 Hour Results

Receptors	Year	Model Result	Background Note 1	Cumulative	Limit	Compliance Statement
		Process Contribution (PC)	Average of Annual Mean for Zone D EPA monitoring stations	Predicted Environmental Concentration (PEC)	Note 2	
		ug.m^{-3}	ug.m^{-3}	ug.m^{-3}	ug.m^{-3}	
1 Hour Result	2013	0.19	None	0.19	7	Compliant
	2014	0.18		0.18		Compliant
	2015	0.19		0.19		Compliant
	2016	0.19		0.19		Compliant
	2017	0.18		0.18		Compliant

Note 1: There is no background data for MDI;
Note 2: The limit has been obtained from the EPA Guidance Note AG4:2019 Appendix J for isocyanates.

Fig 5-4: 1 Hour Contour Plot Process Contribution



Contours (ug/m^3)

	0.01		0.02		0.03		0.04		0.05

6. Conclusions

The following conclusions may be made as a result of an air dispersion model completed for Xtratherm Limited;

- A model was completed in line with the Environmental Protection Agency Guidance Note for Air Dispersion Models, AG4:2019;
- The results quoted are worst case scenarios Predicted Environmental Concentrations (PEC) for the proposed source emissions outside the boundary of the installation;
- The model assumes that all emission points are operating at maximum flow rates and emission limits. It also assumes worst case meteorological conditions for dispersion of emissions to atmosphere. The model assumed that the facility operated 24 hours a day, 365 days a year;
- Background concentrations for organic compounds were used to obtain PEC's for Zone D (Rural Ireland) ambient air quality within the EPA network for 2019. There is very limited background monitoring completed by the EPA for organic compounds outside of Zone A areas;
- Environmental Assessment Levels were obtained by following the EPA guidance note AG4:2019 Appendix J. The organic compounds released from A2-1 and A2-2 are made up of isopentane and cyclopentane. As part of a conservative approach, it was assumed that the total ground level concentration predicted by the model consisted of cyclopentane, as this was deemed to have the lower EALs;
- Total Organic Carbon (TOC) was predicted to be in compliance with the EAL limits for protection of human health for the highest 1-hour result over the modelled period. The model predicted that the highest 1-hour result outside the boundary of the installation would be 413 µg/m^3 for a predicted environmental concentration (PEC) including background concentrations. This was 0.008% of the allowable EAL as advised under the EPA guidance note AG4 for the more conservative organic limit from the emissions, cyclopentane;
- Total Organic Carbon (TOC) was predicted to be in compliance with the EAL limits for protection of human health for the annual average over the modelled period. The predicted environmental concentration for an annual average was 13.63 µg/m^3. This is well within guidance applied by the EPA for EALs as advised under the EPA guidance note AG4;
- Isocyanates were in compliance with the EALs as set out in the EPA guidance note AG4 for both long and short term averages.