Knauf Insulation Ltd

Application for a variation of the permit at the Queensferry Installation

Air Quality Impact Assessment

December 2016

Amec Foster Wheeler Environment
& Infrastructure UK Limited

Report for

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Document revisions

No.	Details	Date
1	Draft Report 16421i1	November 2016
2	Final Report 16433i1	December 2016

Executive summary

Purpose of this report

Knauf Insulation Limited (Knauf) is making an application for a normal variation of Environmental Permit number EPR/BR9383ID, to operate a mineral fibre works installation under the Environmental Permitting (England and Wales) Regulations 2010 (EPR)[1], as amended, at its site in Queensferry, Flintshire.

The site is proposing to increase the nominal width of the main production line from 1.8 m to 2.0 m, which will allow the manufacture of a new range of products. This will increase the throughput of the site to the design figures given in the original permit application.

This document supports the application for a variation of the current environmental permit no. EPR/BR9383ID. This report provides the air quality impact assessment required to assist this application.

Dispersion modelling has been undertaken for the process emissions from Stack G and Stack Y as these are the two stacks where the proposed alterations within this variation will result in a change of emissions. Stack Y is the process discharge for the proposed grinder, the existing toothed saw and cross cut saw dust filtration unit. The normal operation for this dust filtration unit has been on full recirculation back in to the main factory. Due to the increased capacity and volumetric flow, it is propose to open the recirculation damper and allow the emissions to discharge to atmosphere via the new Emission Point Y which is adjacent to the filtration unit. Emission Point G is the mainline cooling zone stack, where a new fan will result in an increased volumetric discharge from the cooling zone.

Two scenarios were assessed to provide a 'before and after' picture of air quality effects resulting from emissions at the Knauf site. These were as follows:

- Scenario 1: assessed conditions as they are at present, with emission point G discharging to atmosphere and emission point Y discharging to the main process building; and
- Scenario 2: considered air quality effects with the variation in place and both emission points G and Y discharging to atmosphere.

This report will outline the assessment approach and present the results for the two Scenarios considered.

Conclusions

This assessment has used detailed dispersion modelling to undertake a comparative impact assessment of the emissions from Emission Point G and Emission Point Y at the Knauf Insulation site at Queensferry. It has evaluated two scenarios; Scenario 1 (current operation) and Scenario 2 (forecast operation), to assess how air quality effects will differ as a result of the permit variation. It has used emission rates derived from actual monitoring data recorded during 2015.

The assessment has incorporated a number of worst-case assumptions, which will likely result in an overestimation of the predicted ground level impact. The assessment demonstrates that, under both scenarios considered, exceedances of any Environmental Assessment Level (EAL) for human receptors or Critical Level (CLE) on ecological receptors are unlikely. Therefore, it is considered that the proposed changes as a result of the variation are not expected to have a significant impact on human health or the integrity of designated ecological sites.

[1] http://www.legislation.gov.uk/ukdsi/2010/9780111491423/contents

Contents

1. Introduction

1.1 Background

Knauf Insulation Limited (Knauf) is making an application for a normal technical variation of Environmental Permit number EPR/BR9383ID, to operate a mineral fibre works installation under the Environmental Permitting (England and Wales) Regulations 2010 (EPR)[2], as amended, at its site in Queensferry, Flintshire.

The site is proposing to increase the nominal width of the main production line from 1.8 m to 2.0 m, which will allow the manufacture of a new range of products which will be exported primarily to Germany, with occasional supply to other parts of Europe in smaller volumes. This will increase the throughput of the site to the design figures given in the original permit application.

The proposed activities will comply with the requirements of the EPR, including the obligation to demonstrate Best Available Techniques (BAT) that will be used to control the processes, to minimise emissions and the impact on the environment as a whole. This report has been produced to provide supplementary information regarding air quality effects from the process for permit number EPR/BR9383ID.

1.2 Site description

The Queensferry installation is located on Chemistry Lane close to Deeside, North Wales. The Knauf Insulation site, reference NGR: SJ 323679, is in the Flintshire County Council area. A location map is shown in Figure 1.1. The site is located in an industrial area with the North Wales Coast Railway Line running adjacent to the northern boundary.

The nearest residents are situated on Church View, approximately 100 metres south of the site boundary and 220 metres south of the main stack (R7 and R8 in section 2.7 of this report). The nearest European designated ecological site is the River Dee and Bala Lake Special Area of Conservation (SAC) located about 525 m to the north of site.

[2] http://www.legislation.gov.uk/ukdsi/2010/9780111491423/contents

Figure 1.1 Site location map (site and installation boundary in green)

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1.3 Air quality impacts of process emissions

This assessment considers the atmospheric dispersion of the following pollutants:

- Particulate Matter (PM_{10} and $PM_{2.5}$);
- Volatile Organic Compounds (VOCs);
- Ammonia (NH_3);
- Phenol (C_6H_6OH);
- Formaldehyde (HCHO); and
- Amines.

1.4 Sources of information

The information used in this assessment includes:

- Process and emission data provided by Knauf Insulation Ltd;
- Site layout including stack locations from Knauf Insulation Ltd;
- Baseline air quality data from surveys undertaken by Government bodies, Local Authorities and third parties;

- Ordnance Survey (OS) maps of the local area; and
- Meteorological data supplied by Atmospheric Dispersion Modelling Ltd.

1.5 Report structure

The remainder of the report is set out according to Table 1.1.

Table 1.1 Report structure

Section	Aims and Objectives
Section 2	Describes the dispersion model, assessment methodology, model inputs and assumptions used in the assessment
Section 3	Summarises existing air quality in the area
Section 4	Details the assessment criteria
Section 5	Presents an assessment of the potential air quality impacts arising from stack emissions
Section 6	Contains a summary and conclusions of the assessment

2. Assessment methodology

2.1 The dispersion model

There are two primary dispersion models which are used extensively throughout the UK for assessments of this nature and accepted as appropriate air quality modelling tools by the Regulators and local planning authorities alike:

- The ADMS model, developed in the UK by Cambridge Environmental Research Consultants (CERC) in collaboration with the Met Office, National Power and the University of Surrey; and
- The AERMOD model, developed in the United States by the American Meteorological Society (AMS)/United States Environmental Protection Agency (EPA) Regulatory Model Improvement Committee (AERMIC).

Both models are termed ‘new generation’ models, parameterising stability and turbulence in the planetary boundary layer (PBL) by the Monin-Obukhov length and the boundary layer depth. This approach allows the vertical structure of the PBL to be more accurately defined than by the stability classification methods of earlier dispersion models such as R91 or ISC. Like R91 and ISC, ADMS and AERMOD adopt a symmetrical Gaussian profile of the concentration distribution in the vertical and crosswind directions in neutral and stable conditions. However, unlike R91 or ISC, the ADMS and AERMOD vertical concentration profile in convective conditions adopts a skewed Gaussian distribution to take account of the heterogeneous nature of the vertical velocity distribution in the Convective Boundary Layer (CBL).

Numerous model inter-comparison studies have demonstrated little difference between the output of ADMS and AERMOD, except in certain scenarios. For the purposes of this particular study, the use of ADMS 5.1 model only is adopted. The justification for this selection is provided below. However, sensitivity analysis with respect to model selection is presented in Section 2.10.

ADMS is capable of calculating sub-hourly averaged concentrations based on site-specific meteorological and surface conditions, whereas AERMOD can only produce output down to hourly-averaged values. Therefore, to enable an assessment of impact against the 15-minute mean SO_2 AQO, a standard conversion factor (1.34) must be applied to the hourly output from AERMOD to estimate 15-minute mean concentrations. This factor is taken from Turner (1994)[3] who published estimated ratios of calculated peak and mean concentrations at 3 minutes, 15 minutes, 1 hour, 3 hours and 24 hours from published data on lateral and vertical diffusion co-efficients in steady winds as reported by Nonhebel (1960). What is important to note here is that these estimates were based upon calculated dispersion coefficients, rather than monitoring results. Furthermore, Turner (1994) cautions that:

“...ratios of peak to mean data depend also on the stability of the atmosphere and the type of terrain that the plume is passing over.”

Therefore, application of a standard, non-site specific conversion factor that does not have its basis in sampling data would significantly increase the uncertainty in modelled 15-minute mean values obtained from AERMOD. This limitation is not present in ADMS, which uses site specific meteorological and surface conditions to directly calculate sub-hourly averaged concentrations.

2.2 Process emissions

Dispersion modelling has been undertaken for the process emissions from Stack G (Main Line Cooling Zone Stack) and Stack Y (Saws and Grinder Filtration Unit) at the Queensferry installation. Two scenarios have been modelled in order to compare the difference in air quality effects as a result of the variation:

[3] Turner, D.B., 1994. ‘Workbook of Atmospheric Dispersion Estimates.’ Original values published in Turner (1970).

- Scenario 1: emissions from emission point G as currently operating, emission point Y on full recirculation; and
- Scenario 1: emissions from emission points G and Y as forecast (same emission concentrations but increased stack velocities and emission rates).

Emission rates for emission point G have been derived from monitoring data from the periodic monitoring undertaken in October 2015 (see Appendix B). The maximum monitoring result for each pollutant was taken forward for use in this assessment to ensure worst case conditions have been specified. Emission rates for emission point Y were derived from the Best Available Technique (BAT) condition relating to particulate matter (PM) for the PM emissions from the cooling, forming and curing as described within the BAT conclusions document. There is no correction for oxygen content or moisture.

Details of stack parameters modelled are given in Table 2.1 and Table 2.2 below and illustrated in Figure 2.6.

Table 2.1 Modelled stack parameters – Scenario 1

Input	Value		Units
	Emission Point G	Emission Point Y	
Exhaust conditions			
Temperature	27	27	°C
Stack diameter	1.00	1.1	m
Stack height	13	N/A	m (above ground level)
Velocity	5.24	N/A	m/s
Volume flowrate	4.12	13.89	m^3/h
Emission Concentrations			
Ammonia	22	-	mg/Nm^3
VOC	0.85	-	mg/Nm^3
Formaldehyde	4.6	-	mg/Nm^3
PM_{10}	17	50	mg/Nm^3
$PM_{2.5}$	17	50	mg/Nm^3
Amines	<0.17	-	mg/Nm^3
Phenol	<0.73	-	mg/Nm^3
Mass emission rate			
Ammonia	0.091	-	g/s
VOC	0.004	-	g/s
Formaldehyde	0.019	-	g/s
PM_{10}	0.070	N/A	g/s
$PM_{2.5}$	0.070	N/A	g/s
Amines	<0.001	-	g/s

Input	Value		Units
	Emission Point G	Emission Point Y	
Phenol	<0.003	-	g/s

N/A – not applicable, unit on full recirculation

Table 2.2 Modelled stack parameters – Scenario 2

Input	Value		Units
	Emission Point G	Emission Point Y	
Exhaust conditions			
Temperature	27	27	°C
Stack diameter	1.00	1.1	m
Stack height	13	13	m (above ground level)
Velocity	10.61	17.83	m/s
Volume flowrate	8.33	16.95	m^3/h
Emission Concentrations			
Ammonia	22	-	mg/Nm^3
VOC	0.85	-	mg/Nm^3
Formaldehyde	4.6	-	mg/Nm^3
PM_{10}	17	50	mg/Nm^3
$PM_{2.5}$	17	50	mg/Nm^3
Amines	<0.17	-	mg/Nm^3
Phenol	<0.73	-	mg/Nm^3
Mass emission rate			
Ammonia	0.18	-	g/s
VOC	0.007	-	g/s
Formaldehyde	0.038	-	g/s
PM_{10}	0.14	0.85	g/s
$PM_{2.5}$	0.14	0.85	g/s
Amines	<0.0014	-	g/s
Phenol	<0.006	-	g/s

2.3 Meteorology

For meteorological data to be suitable for dispersion modelling purposes, a number of meteorological parameters need to be measured on an hourly basis. These parameters include wind speed, wind direction, cloud cover and temperature. There are only a limited number of sites where the required meteorological measurements are made. The year of meteorological data that is used for a modelling assessment can also have a significant effect on ground level concentrations.

This assessment has used meteorological data recorded at Hawarden airport during the 2011-2015 period. Hawarden is likely to provide representative characteristics of the site for the assessment as it is located no more than 3.5 km away. Figures 2.1 through 2.5 depict the wind rose data from the Hawarden meteorological station for each of the years modelled, illustrating the frequency of monitored wind direction and wind speed. The wind roses show the predominance of winds from the south-east and north-west with a lesser component of south-westerly winds in most years. Cloud data was incomplete from Hawarden for the period 2011-2013 and was obtained from Liverpool John Lennon Airport, situated 18 km to the north-east of the site.

Figure 2.1 2011 wind rose

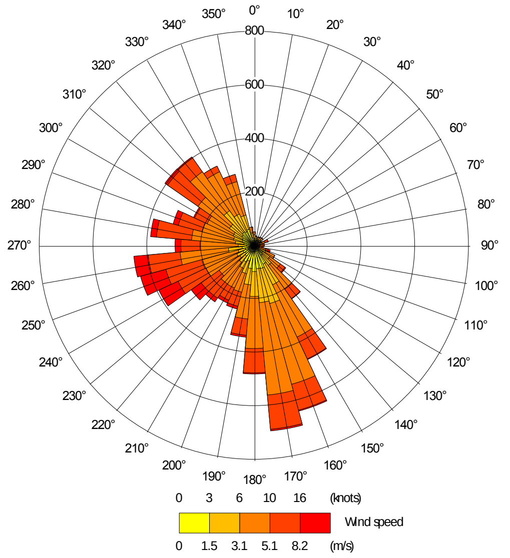


Figure 2.2 2012 wind rose

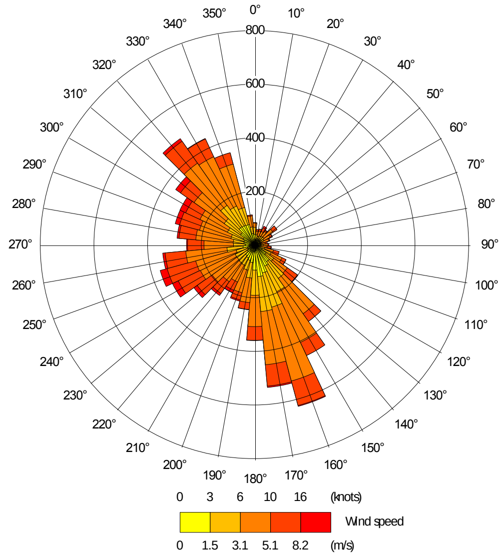


Figure 2.3 2013 wind rose

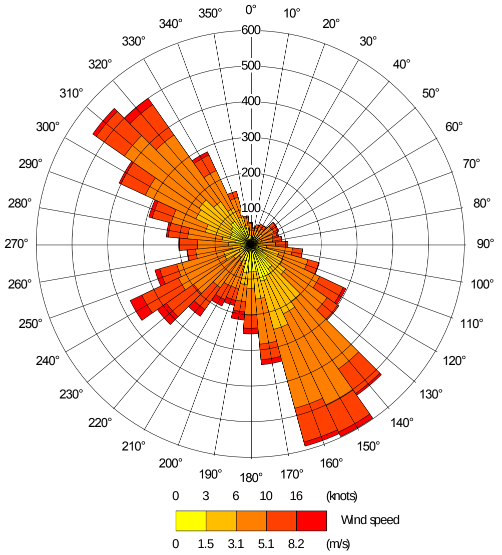


Figure 2.4 2014 wind rose

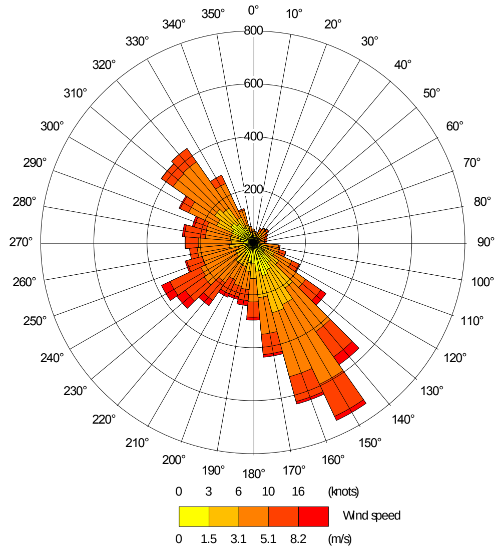
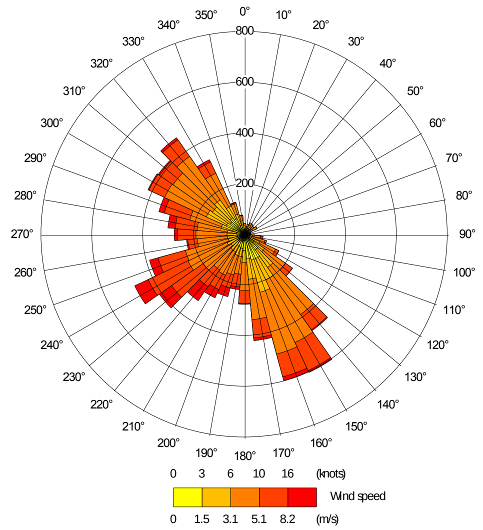


Figure 2.5 2015 wind rose



2.4 Surface characteristics

The predominant surface characteristics and land use in a model domain have an important influence in determining turbulent fluxes and, hence, the stability of the boundary layer and atmospheric dispersion. Factors pertinent to this determination are detailed below.

Surface Roughness

Roughness length, z_0, represents the aerodynamic effects of surface friction and is defined as the height at which the extrapolated surface layer wind profile tends to zero. This value is an important parameter used by meteorological pre-processors to interpret the vertical profile of wind speed and estimate friction velocities which are, in turn, used to define heat and momentum fluxes and, consequently, the degree of turbulent mixing in the boundary layer.

The surface roughness length is related to the height of surface elements; typically, the surface roughness length is approximately 10% of the height of the main surface features. Thus, it follows that surface roughness is higher in urban and congested areas than in rural and open areas. CERC (2014)[4] suggest typical roughness lengths for use in ADMS for various land use categories (Table 2.3).

Table 2.3 Typical Surface Roughness Lengths for Use in ADMS for Various Land Use Categories

Type of Surface	z_0 (m)
Sea	<0.0101
Short grass	<0.015
Open grassland	0.02
Root crops	0.1
Agricultural areas (min)	0.2
Agricultural areas (max)	0.3
Parkland, open suburbia	0.5
Cities, woodlands	1.0
Large urban areas	1.5

Increasing surface roughness increases turbulent mixing in the lower boundary layer. With respect to elevated sources under neutral and stable conditions, conflicting impacts in terms of ground level concentrations often occur due to:

- The increased mixing can bring portions of an elevated plume down towards ground level, resulting in increased ground level concentrations closer to the emission source; however
- The increased mixing increases entrainment of ambient air into the plume and dilutes plume concentrations, resulting in reduced ground level concentrations further downwind from an emission source.

The overall impact on ground level concentration therefore depends on the distance of a receptor from the emission source.

Surface energy budget

One of the key factors governing the generation of convective turbulence is the magnitude of the surface sensible heat flux. This, in turn, is a factor of the incoming solar radiation. However, not all solar radiation arriving at the Earth's surface is available to be emitted back to atmosphere in the form of sensible heat. By adopting a surface energy budget approach, it can be identified that, for fixed values of incoming short and long wave solar radiation, the surface sensible heat flux is inversely proportional to the surface albedo and latent heat flux.

The surface albedo is a measure of the fraction of incoming short-wave solar radiation reflected by the Earth's surface. This parameter is dependent upon surface characteristics and varies throughout the year. Oke (1987) recommends average surface albedo values of 0.6 for snow covered ground and 0.23 for non-snow covered ground, respectively.

[4] CERC, 2014. 'The Met Input Module'. ADMS Technical Specification.

The latent heat flux is dependent upon the amount of moisture present at the surface. The modified Priestly-Taylor parameter can be used to represent the amount of moisture available for evaporation. Areas where moisture availability is greater will experience a greater proportion of incoming solar radiation released back to atmosphere in the form of latent heat, leaving less available in the form of sensible heat and, thus, decreasing convective turbulence. Holstag and van Ulden (1983)[5] suggest modified Priestly-Taylor values of 0.45 and 1.0 for dry grassland and moist grassland respectively.

Selection of appropriate surface characteristic parameters for the installation

A detailed analysis of the effects of surface characteristics on ground level concentrations by Auld *et al.* (2002)[6] led them to conclude that, with respect to uncertainty in model predictions:

> *"…the energy budget calculations had relatively little impact on the overall uncertainty"*

In this regard, it is not considered necessary to vary the surface energy budget parameters spatially or, temporally, and annual averaged values have been adopted throughout the model domain for this assessment.

As snow covered ground is only likely to be present for a small fraction of the year, the surface albedo of 0.23 for non-snow covered ground advocated by Oke (1987) has been used, whilst the model default modified Priestly-Taylor parameter value of 1.0 has also been retained.

The assessment has adopted a surface roughness length of 0.5 m, based on previous air quality assessments undertaken for the site.

2.5 Buildings

Any large object has an impact on atmospheric flow and air turbulence within the locality of the object, which affects the dispersion of material emitted from nearby stacks. This can result in maximum ground level concentrations that are significantly different (generally higher) from those encountered in the absence of buildings. The building 'zone of influence' is generally regarded as extending a distance of 5L (where L is the lesser of the building height or width) from the foot of the building in the horizontal plane and three times the height of the building in the vertical plane.

Using these criteria, Table 2.4 and Figure 2.6 identify those buildings which may have an effect on dispersion and are included in the model set-up.

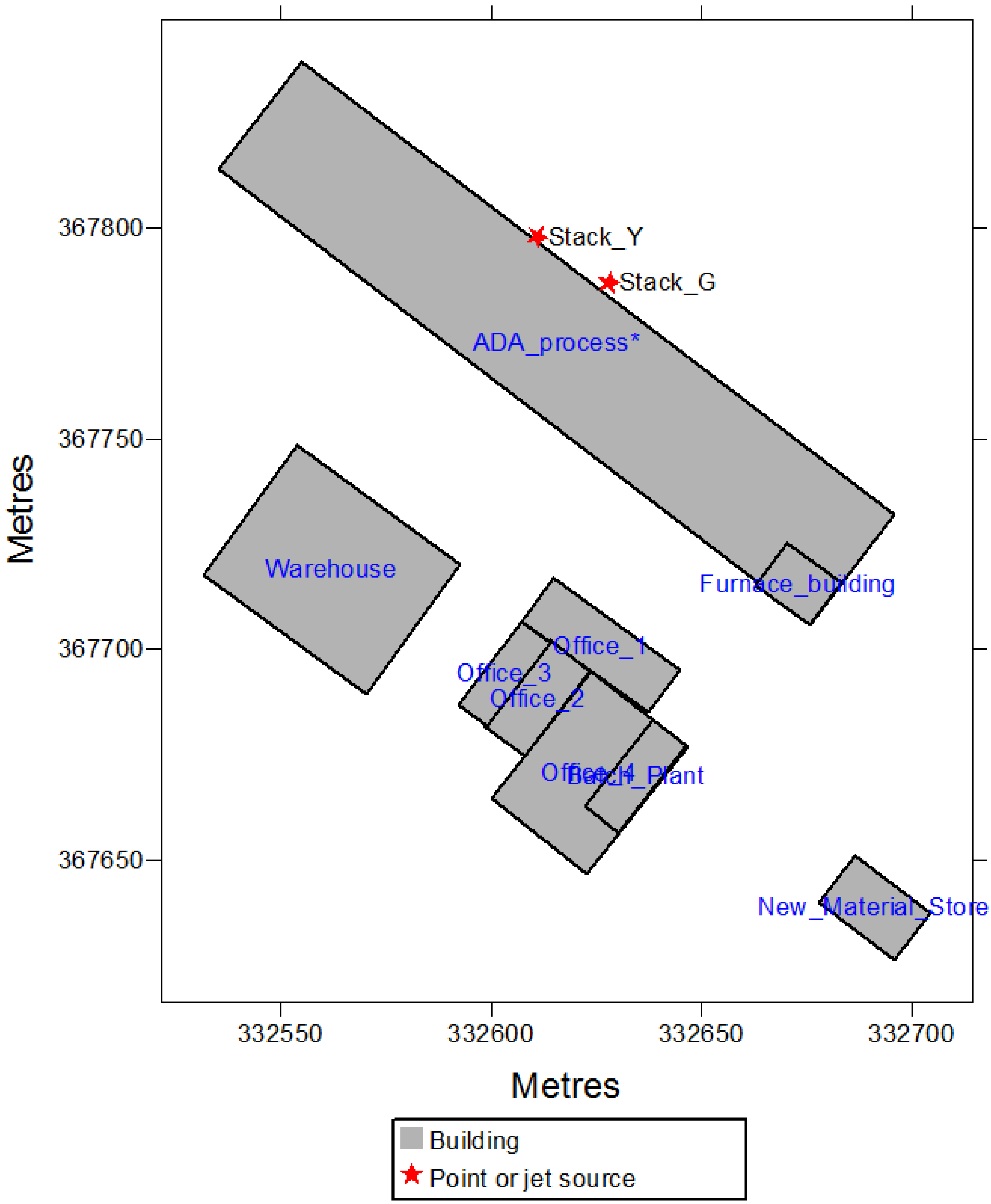
Table 2.4 Modelled buildings

Building Name	X	Y	Height (m)	Length (m)	Width (m)	Angle (°)
Furnace building	332673	367716	21.8	15.8	12.5	126
ADA process	332616	367773	12	177.2	32.3	127
Office 1	332626	367701	10.2	37	12.8	26
Office 2	332611	367688	15	12	25.6	128
Office 3	332603	367694	10.2	8.3	24.8	127
Office 4	332623	367671	15	29	38	128
Warehouse	332562	367719	9	48	38	126

[5] van Ulden, A.P. and Holstag, A.A.M., 1983. 'The Stability of the Atmospheric Surface Layer during Nighttime'. American Met. Soc., 6th Symposium on Turbulence and Diffusion.
[6] Auld, V., Hill, R. and Taylor, T.J., 2002. 'Uncertainty in Deriving Dispersion Parameters from Meteorological Data'. Atmospheric Dispersion Modelling Liaison Committee (ADMLC). Annual Report 2002-2003.

Building Name	X	Y	Height (m)	Length (m)	Width (m)	Angle (°)
Raw Material Store	332691	367639	25	22.7	14	128
Batch Plant	332623	367670	23	10	26	128

Figure 2.6 Building and emission source visualisation



2.6 Terrain

The concentrations of an emitted pollutant found in elevated, complex terrain differ from those found in simple level terrain. There have been numerous studies on the effects of topography on atmospheric flows. The UK ADMLC provides a summary of the main effects of terrain on atmospheric flow and dispersion of pollutants (Hill et al., 2005):

These effects are most pronounced when the terrain gradients exceed 1 in 10 i.e., a 100 m change in elevation per 1 km step in the horizontal plane.

As the Knauf Insulation site at Queensferry is located in close proximity to the Dee Estuary, and as the terrain gradient does not exceed the criterion stated above, it was determined that inclusion of a terrain file in the model was not necessary.

2.7 Modelled domain and receptors

Modelled domain

A 4 km x 4 km Cartesian grid was modelled, with a receptor resolution of 40 m, to assess the impact of emissions from the installation on local air quality. This resolution is considered suitable for capturing the maximum process contribution, and is within the generally accepted best practice guideline of adopting a model domain with a receptor resolution less than 1.5 times the stack height for the main emission point A on site. The process contribution isopleths are presented in Appendix A.

Human receptors

Guidance from the UK Government and Devolved Administrations makes it clear that exceedences of the human health based objectives should only be assessed at outdoor locations where members of the general public are regularly present over the averaging time of the objective. Table 2.5 provides an indication of those locations that may be relevant for different averaging periods.

Table 2.5 Typical examples of relevant exposure for different averaging periods

Averaging period	Objectives should apply	Objectives should not apply
Annual mean	All locations where members of the public might be regularly exposed. Building facades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
Daily mean and 8 hours	All locations where the annual mean objectives would apply, together with hotels Gardens of residential properties	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1 hour	All locations where the annual mean and 24 and 8-hour mean objectives would apply. Kerbside sites (e.g. pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not	Kerbside sites where the public would not be expected to have regular access

Averaging period	Objectives should apply	Objectives should not apply
	fully enclosed, where the public might reasonably be expected to spend one hour or more. Any outdoor locations at which the public may be expected to spend one hour or longer.	
15 minutes	All locations where members of the public might reasonably be expected to spend a period of 15 minutes or longer	

The human receptors considered in this assessment were chosen based on the above guidance by identifying places where people may be located, judged in terms of the likely duration of their exposure to pollutants, and proximity to the site.

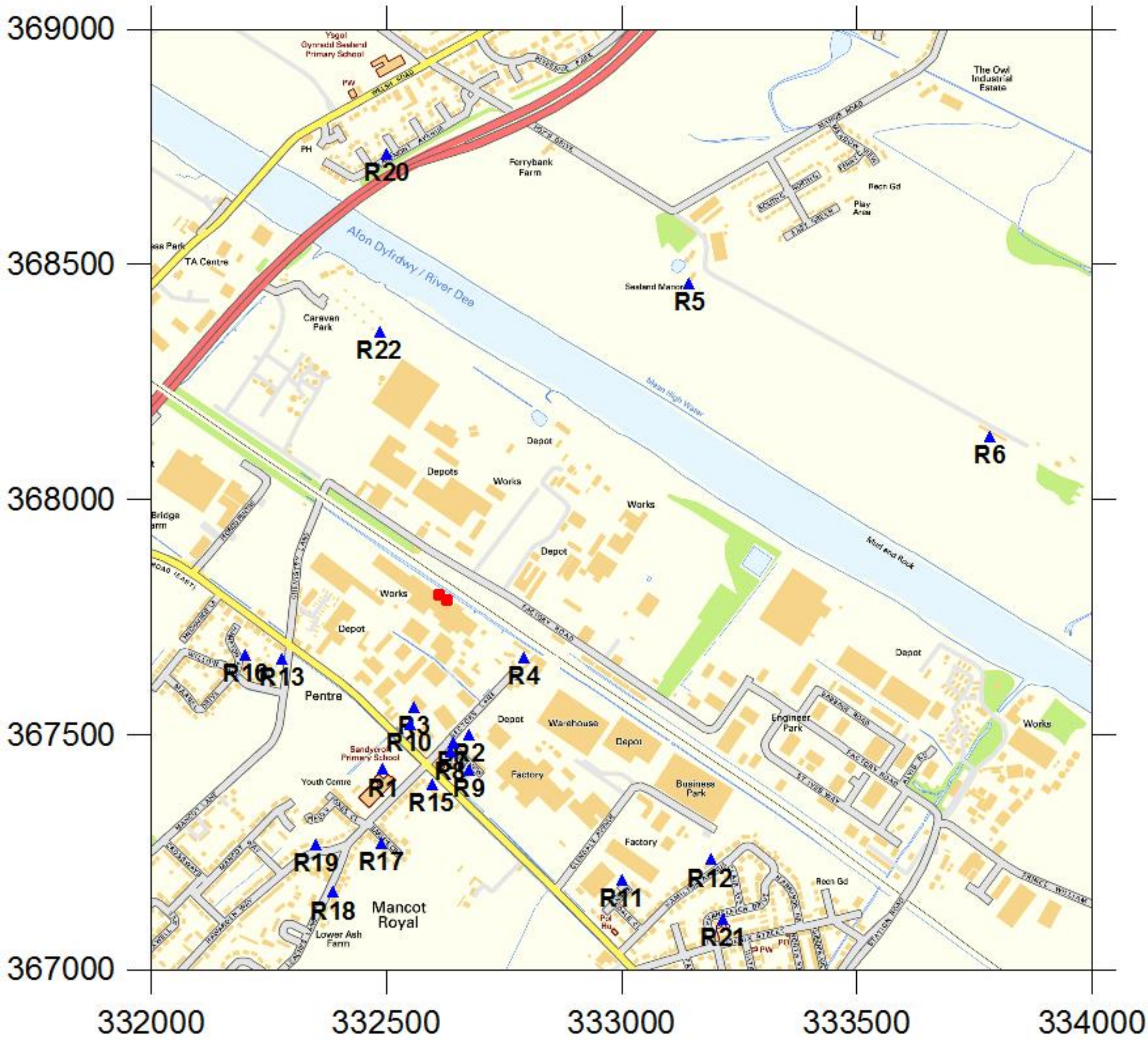
Details of all receptors considered are provided in Table 2.6 and Figure 2.7. It should be noted that this list of receptors is by no means exhaustive, with certain receptors grouped together to represent exposure over a wider area, rather than at specific residential properties, for example.

Table 2.6 Modelled human receptors

ID	Receptor name	Easting (m)	Northing (m)	Distance from stack (m)
R1	Sandycroft Primary School	332493	367426	349
R2	Rector Lane	332676	367501	207
R3	Chester Road1	332559	367558	205
R4	Chester Road2	332792	367665	100
R5	Sealand Manor	333144	368460	875
R6	Shooting School	333783	368135	1,164
R7	Church View1	332641	367483	231
R8	Church View2	332636	367463	252
R9	Gladstone Terrace	332676	367425	282
R10	Chester Road3	332549	367522	239
R11	Bernsdale Close	333000	367191	596
R12	Hamilton Avenue	333189	367235	678
R13	Mancot Lane	332278	367662	425
R14	Dundas Street	331974	368191	874
R15	Chester Road4	332596	367394	329
R16	Hampton Avenue	332200	367670	502
R17	Earles Crescent	332489	367269	486
R18	Leaches Lane	332387	367165	626
R19	Hawarden Way	332350	367266	563

ID	Receptor name	Easting (m)	Northing (m)	Distance from stack (m)
R20	Claremont Avenue	332501	368735	1,048
R21	Evansleigh Drive	333216	367108	789
R22	Caravan Park	332485	368357	686

Figure 2.7 Location of modelled human receptors (stack locations in red)



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Ecological receptors

NRW's guidance (2016) requires detailed dispersion modelling to be carried out based on local receptors. With regard to ecological receptors the guidance states:

> *"Check if there are any of the following within 10 km of your site (within 15 km if you operate a large electric power station or refinery):*

- Special Protection Areas (SPA);
- Special Areas of Conservation (SAC); and
- Ramsar sites (protected wetlands)".

"Check if there are any of the following within 2 km of your site:

- Sites of Special Scientific Interest (SSSI); and
- Local nature sites (Ancient Woodland, Local Wildlife Sites and National and Local Nature Reserves)".

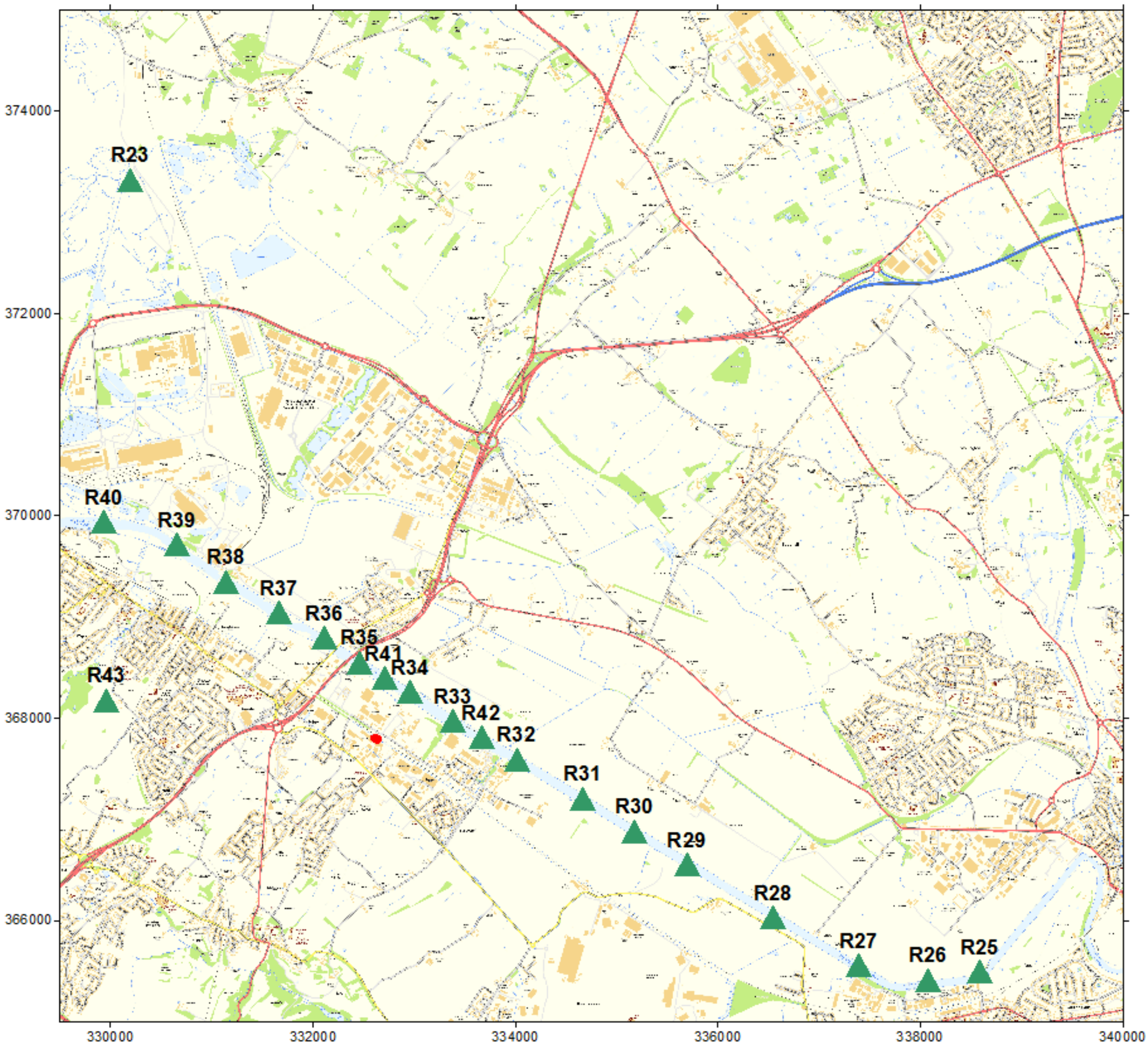
There are a small number of potentially sensitive ecological receptors in the region of the Knauf site, although none are within 2 km of the site boundary. Following the above guidance the following ecological receptors, as detailed in Table 2.7 and Figure 2.8, have been included in the assessment. This includes a number of receptor points along the linear feature of the River Dee, part of the River Dee and Bala Lake SAC. The maximum results from any of these receptor points representing the SAC have been presented in this report.

Table 2.7 Modelled ecological receptors

ID	Receptor Name	Easting (m)	Northing (m)	Distance from stack (km)	Receptor type
R23	The Dee Estuary Ramsar SPA	330193	373322	6.2	SPA/Ramsar
R24	Dee Estuary SAC	329317	371145	4.8	SAC/SSSI
R25	River Dee and Bala Lake SAC	338590	365494	6.3	SAC
R26	River Dee and Bala Lake SAC	338076	365414	5.8	SAC
R27	River Dee and Bala Lake SAC	337389	365556	5.2	SAC
R28	River Dee and Bala Lake SAC	336547	366030	4.2	SAC
R29	River Dee and Bala Lake SAC	335694	366552	3.2	SAC
R30	River Dee and Bala Lake SAC	335173	366884	2.6	SAC
R31	River Dee and Bala Lake SAC	334663	367204	2.0	SAC
R32	River Dee and Bala Lake SAC	334012	367595	1.3	SAC
R33	River Dee and Bala Lake SAC	333383	367974	0.7	SAC
R34	River Dee and Bala Lake SAC	332957	368258	0.6	SAC
R35	River Dee and Bala Lake SAC	332459	368554	0.9	SAC
R36	River Dee and Bala Lake SAC	332116	368791	1.2	SAC
R37	River Dee and Bala Lake SAC	331665	369040	1.7	SAC
R38	River Dee and Bala Lake SAC	331144	369348	2.3	SAC
R39	River Dee and Bala Lake SAC	330658	369716	2.9	SAC
R40	River Dee and Bala Lake SAC	329935	369941	3.6	SAC
R41	River Dee and Bala Lake SAC	332705	368397	0.7	SAC
R42	River Dee and Bala Lake SAC	333662	367811	1.0	SAC

ID	Receptor Name	Easting (m)	Northing (m)	Distance from stack (km)	Receptor type
R43	Deeside and Buckley Newt Sites SAC	329959	368178	2.8	SAC

Figure 2.8 Location of modelled ecological receptors (stack locations in red)



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2.8 Deposition

The predominant route by which emissions will affect land in the vicinity of a process is by deposition of atmospheric emissions. Potential ecological receptors can be sensitive to the deposition of pollutants, particularly nitrogen and sulphur compounds. Since these compounds are not emitted from Stacks G or Y, and hence are not the subject of this air quality assessment, deposition effects have not been considered in this study.

2.9 Sensitivity analysis and uncertainty

Sensitivity analysis

Wherever possible, this assessment has used worst case scenarios, which will exaggerate the impact of the emissions on the surrounding area, including emissions, operating profile, ambient concentrations, meteorology and surface roughness. As described in Section 2.3 results were calculated separately for the five different years of meteorological data ('met year'). For each of the specific receptors and for each pollutant measure, the met year giving the highest concentration was determined and the corresponding concentration is the one presented in this report. In other words, each of the individual receptor results are the worst case outcome for that measure. For plotting the concentration isopleths, a single met year was chosen, specifically the year producing the highest annual mean NH_3 concentration at any point in the model domain. This means that some results presented in Section 5 will not accord exactly with the contour bandings on the figure (they will be higher in the results tables). Contour plots are presented in Appendix A.

Model uncertainty

Process emissions have been modelled under the expected normal operational scenario using the standard steady state algorithms in ADMS to determine the impact on local human and ecological receptors. In order to model atmospheric dispersion using standard Gaussian methods, the following assumptions and limitations have to be made:

- Conservation of mass – the entire mass of emitted pollutant remains in the atmosphere and no allowance is made for loss due to chemical reactions or deposition processes (although the standard Gaussian model can be modified to include such processes). Portions of the plume reaching the ground are assumed to be dispersed back away from the ground by turbulent eddies (eddy reflection);
- Steady state emissions – emission rates are assumed to be constant and continuous over the time averaging period of interest; and
- Steady state meteorology – no variations in wind speed, direction or turbulent profiles occur during transport from the source to the receptor. This assumption is reasonable within a few kilometres of a source but may not be valid for receptor distances in the order of tens of kilometres. For example, for a receptor 50 km from a source and with a wind speed of 5 m s^{-1} it will take nearly three hours for the plume to travel this distance during which time many different processes may change (e.g., the sun may rise or set and clouds may form or dissipate affecting the turbulent profiles). For this reason, Gaussian models are practically limited to predicting concentrations within ~20 km of a source.

As a result of the above, and in combination with other factors, not least attempting to replicate stochastic processes (e.g., turbulence) by deterministic methods, dispersion modelling is inherently uncertain, but is nonetheless a useful tool in plume footprint visualisation and prediction of ground level concentrations. The use of dispersion models has been widely used in the UK for both regulatory and compliance purposes for a number of years and is an accepted approach for this type of assessment. The model used has also undergone extensive validation.

The assessment has incorporated a number of worst-case assumptions, which will likely result in an overestimation of the predicted ground level concentrations. As a result of these worst-case assumptions, the predicted results should be considered the upper limit of model uncertainty for a scenario where the actual site impact is determined.

The model is well validated with observed concentrations for a number of scenarios; however, as the complexity of the modelled domain increases, modelled concentrations are likely to deviate from observed concentrations.

2.10 Special model treatments

Specialised model treatments for short-term (puff) releases, coastal models, fluctuations or photochemistry have not been used in this assessment.

3. Ambient air quality

3.1 Local Air Quality Management

Under Part IV of the Environment Act 1995, Flintshire County Council is required to periodically review and assess air quality within its area of jurisdiction. This process of Local Air Quality Management (LAQM) is an integral process for achieving national air quality objectives (AQOs).

Review and assessments of local air quality aim to identify areas where national policies to reduce vehicle and industrial emissions are unlikely to result in air quality meeting the Government's air quality objectives by the required dates.

Where the assessment indicates that some or all of the objectives may be potentially exceeded, the Local Authority has a duty to declare an Air Quality Management Area (AQMA). The declaration of an AQMA requires the Local Authority to implement an Air Quality Action Plan (AQAP) to reduce air pollution concentrations so that the required AQOs are met.

Flintshire County Council have identified that, apart from a site at a road junction in Mold, ambient air quality in Flintshire is generally very good and there are no AQMAs declared.

3.2 Existing air quality concentrations

The most recent publicly available LAQM report from Flintshire County Council is for 2013[7]. Based on this report, it is understood the Council undertakes a combination of continuous and passive monitoring within its jurisdictional area; there are two continuous monitoring stations and 57 passive monitoring locations. However, this monitoring is undertaken for pollutants not under consideration for this variation.

Ammonia (NH_3) is measured at 85 sites across the UK under the National Ammonia Monitoring Network (NAMN). The nearest monitoring locations to the proposed development are situated at Bickerton Hill (~23km to the south east) and Ruabon (~21 km to the south west). However, these are described as rural background locations which may not be representative of receptors around the site in Queensferry. Further afield, there are suburban background monitoring sites in Sheffield and Edinburgh St Leonard's. The Air Pollution Information System (APIS) contains ammonia concentration data for specific locations throughout the UK on a 5 km x 5 km grid basis. For the purposes of this assessment, the ammonia concentration retrieved through APIS provided a more conservative estimation and therefore this information (summarised in Table 3.1) has been used as a worst-case assumption.

3.3 Mapped background concentrations

Defra, through its contractor, Ricardo, maintains a nationwide model (the Pollution Climate Mapping (PCM) model) of existing and future background concentrations at a 1 km grid square resolution. The PCM model is semi-empirical in nature; it uses data from the national atmospheric emissions inventory (NAEI) to model the concentrations of pollutants at the centroid of each 1 km grid square but then calibrates these concentrations in relation to actual monitoring data. For PM_{10} and $PM_{2.5}$, these estimates are produced using data for a base year of 2013, making projections for years from 2013 to 2030 inclusive. However, for benzene, data is based on a 2001 base year.

Similarly, the Air Pollution Information System (APIS) database provides estimated background concentrations of NH_3 but on a more coarse 5 km grid square resolution

7 https://www.whatdotheyknow.com/request/191206/response/474865/attach/3/Flintshire%20Annual%20Progress%20Report%202013%20final.pdf

The annual mean mapped background data for modelled human receptors and ecological receptors are detailed in Tables 3.2 and 3.3 respectively. All concentrations are for the most recent full calendar year available.

Table 3.1 Annual Mean Mapped Background Pollutant Concentrations at Modelled Human Receptors ($\mu g\ m^{-3}$)

ID	Receptor Name	PM_{10}	$PM_{2.5}$	Benzene	NH_3
Receptor 1	Sandycroft Primary School	14.87	10.98	0.35	2.35
Receptor 2	Rector Lane	14.87	10.98	0.35	2.35
Receptor 3	Chester Road1	14.87	10.98	0.35	2.35
Receptor 4	Chester Road2	14.87	10.98	0.35	2.35
Receptor 5	Sealand Manor	14.65	10.13	0.34	2.35
Receptor 6	Shooting School	14.65	10.13	0.34	2.35
Receptor 7	Church View1	14.87	10.98	0.35	2.35
Receptor 8	Church View2	14.87	10.98	0.35	2.35
Receptor 9	Gladstone Terrace	14.87	10.98	0.35	2.35
Receptor 10	Chester Road3	14.87	10.98	0.35	2.35
Receptor 11	Bernsdale Close	13.94	10.03	0.33	2.35
Receptor 12	Hamilton Avenue	13.94	10.03	0.33	2.35
Receptor 13	Mancot Lane	14.87	10.98	0.35	2.35
Receptor 14	Dundas Street	13.35	9.48	0.37	2.35
Receptor 15	Chester Road4	14.87	10.98	0.35	2.35
Receptor 16	Hampton Avenue	14.87	10.98	0.35	2.35
Receptor 17	Earles Crescent	14.87	10.98	0.35	2.35
Receptor 18	Leaches Lane	14.87	10.98	0.35	2.35
Receptor 19	Hawarden Way	14.87	10.98	0.35	2.35
Receptor 20	Claremont Avenue	15.84	10.66	0.36	2.35
Receptor 21	Evansleigh Drive	13.94	10.03	0.33	2.35
Receptor 22	Caravan Park	15.84	10.66	0.36	2.35

Table 3.2 Annual Mean Mapped Background Pollutant Concentrations at Modelled Ecological Receptors (µg m^{-3})

ID	Receptor Name	NH_3
Ecological Receptor 1	The Dee Estuary Ramsar SPA	2.31
Ecological Receptor 2	Dee Estuary SAC	1.12
Ecological Receptor 3	River Dee and Bala Lake SAC*	2.36
Ecological Receptor 4	Deeside and Buckley Newt Sites SAC	2.15

* Maximum of any of the receptor points considered

3.4 Background concentrations used in the assessment

Annual mean background concentrations and deposition rates for the receptors have been derived from the data in Section 3.2. The annual average process contribution is added to the annual average background concentration to give a total concentration at each receptor location. This total concentration can then be compared against the relevant Environmental Assessment Level (EAL) and the likelihood of an exceedance determined.

It is not technically rigorous to add predicted short-term or percentile concentrations to ambient annual average background concentrations, since peak contributions from different sources would not necessarily coincide at the same time or at the same location. Without hourly ambient background monitoring data available it is difficult to make an assessment against the achievement or otherwise of the short-term assessment criteria. For the current assessment, conservative short-term ambient levels have been derived by applying a factor of two to the annual mean background data as per the recommendation in *Risk assessment for environmental permit (previously H1).*

4. Assessment criteria

4.1 Relevant legislation and guidance

EU legislation

Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe

Directive 2008/50/EC (the 'Directive'), which came into force in June 2008, consolidates existing EU-wide air quality legislation (with the exception of Directive 2004/107/EC) and provides a new regulatory framework for $PM_{2.5}$.

The Directive sets limits, or target levels, for selected pollutants that are to be achieved by specific dates and details procedures EU Member States should take in assessing ambient air quality. The limit and target levels relate to concentrations in ambient air. At Article 2(1), the Directive defines ambient air as:

> *"…outdoor air in the troposphere, excluding workplaces as defined by Directive 89/654/EEC where provisions concerning health and safety at work apply and to which members of the public do not have regular access."*

In accordance with Article 2(1), Annex III, Part A, paragraph 2 details locations where compliance with the limit values does not need to be assessed:

> *"Compliance with the limit values directed at the protection of human health shall not be assessed at the following locations:*
>
> *a) any locations situated within areas where members of the public do not have access and there is no fixed habitation;*
>
> *b) in accordance with Article 2(1), on factory premises or at industrial installations to which all relevant provisions concerning health and safety at work apply; and*
>
> *c) on the carriageway of roads; and on the central reservation of roads except where there is normally pedestrian access to the central reservation.*

UK Legislation

The Air Quality Standards Regulations 2010

The Air Quality Standards Regulations 2010 (the 'Regulations') came into force on the 11th June 2010 and transpose Directive 2008/50/EC into UK legislation. The Directive's limit values are transposed into the Regulations as 'Air Quality Standards' (AQS) with attainment dates in line with the Directive.

These standards are legally binding concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on the assessment of the effects of each pollutant on human health including the effects of sensitive groups or on ecosystems.

Similar to Directive 2008/50/EC, the Regulations define ambient air as;

> *"…outdoor air in the troposphere, excluding workplaces where members of the public do not have regular access."*

with direction provided in Schedule 1, Part 1, Paragraph 2 as to where compliance with the AQS' does not need to be assessed:

> *"Compliance with the limit values directed at the protection of human health does not need to be assessed at the following locations:*

> a) *any location situated within areas where members of the public do not have access and there is no fixed habitation;*
>
> b) *on factory premises or at industrial locations to which all relevant provisions concerning health and safety at work apply;*
>
> c) *on the carriageway of roads and on the central reservation of roads except where there is normally pedestrian access to the central reservation."*

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland

The 2007 Air Quality Strategy for England, Scotland Wales and Northern Ireland provides a framework for improving air quality at a national and local level and supersedes the previous strategy published in 2000.

Central to the Air Quality Strategy are health-based criteria for certain air pollutants; these criteria are based on medical and scientific reports on how and at what concentration each pollutant affects human health. The objectives derived from these criteria are policy targets often expressed as a maximum ambient concentration not to be exceeded, without exception or with a permitted number of exceedences, within a specified timescale. At paragraph 22 of the 2007 Air Quality Strategy, the point is made that the objectives are:

> *"…a statement of policy intentions or policy targets. As such, there is no legal requirement to meet these objectives except where they mirror any equivalent legally binding limit values…"*

The air quality objectives (AQOs), based on a selection of the objectives in the Air Quality Strategy, were incorporated into UK legislation through the Air Quality Regulations 2000, as amended.

Paragraph 4(2) of The Air Quality Regulations 2000 states:

> *"The achievement or likely achievement of an air quality objective prescribed by paragraph (1) shall be determined by reference to the quality of air at locations – which are situated outside of buildings or other natural or man-made structures above or below ground; and where members of the public are regularly present"*

Consequently, compliance with the AQOs should focus on areas where members of the general public are present over the entire duration of the concentration averaging period specific to the relevant objective.

Guidance from the UK Government and Devolved Administrations makes clear that exceedences of the health based objectives should be assessed at outdoor locations where members of the general public are regularly present over the averaging time of the objective. Linked to the prevailing EU and UK legislative instruments, this also excludes workplaces.

The Environment Act

Part IV of the Environment Act 1995 requires that Local Authorities periodically review air quality within their individual areas. This process of Local Air Quality Management (LAQM) is an integral part of delivering the Government's AQOs.

To carry out an air quality Review and Assessment under the LAQM process, the Government recommends a three-stage approach. This phased review process uses initial simple screening methods and progresses through to more detailed assessment methods of modelling and monitoring in areas identified to be at potential risk of exceeding the objectives in the Regulations.

Review and assessments of local air quality aim to identify areas where national policies to reduce vehicle and industrial emissions are unlikely to result in air quality meeting the Government's air quality objectives by the required dates.

For the purposes of determining the focus of Review and Assessment, Local Authorities should have regard to those locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective.

Where the assessment indicates that some or all of the objectives may be potentially exceeded, the Local Authority has a duty to declare an Air Quality Management Area (AQMA). The declaration of an AQMA requires the Local Authority to implement an Air Quality Action Plan (AQAP), to reduce air pollution concentrations so that the required AQOs are met.

Other guideline values

In the absence of statutory standards for the other prescribed substances that may be found in the emissions, there are several sources of applicable air quality guidelines.

Air Quality Guidelines for Europe, the World Health Organisation (WHO)

The aim of the WHO Air Quality Guidelines for Europe (WHO, 2000) is to provide a basis for protecting public health from adverse effects of air pollutants and to eliminate or reduce exposure to those pollutants that are known or likely to be hazardous to human health or well-being. These guidelines are intended to provide guidance and information to international, national and local authorities making risk management decisions, particularly in setting air quality standards.

Environmental Assessment Levels (EALs)

NRW's air emissions risk assessment guidance[8] provides methods for quantifying the environmental impacts of emissions to all media. The guidance contains long and short-term Environmental Assessment Levels (EALs) for releases to air derived from a number of published UK and international sources. For the pollutants considered in this study, these EALs are equivalent to the AQS and AQOs.

4.2 Pollutant descriptions

Table 4.1 provides a brief description of the potential effects on human health and the environment for the pollutants considered in this assessment, together with their principal emission sources in the UK.

Table 4.1 Summary of the Pollutants Assessed

Pollutant	Description and effect on human health and the environment	Principal Sources
Particulate Matter (PM_{10} and $PM_{2.5}$)	Particulate matter is the term used to describe all suspended solid matter. Particulate matter with an aerodynamic diameter of less than 10 µm (PM_{10}) is the subject of health concerns because of its ability to penetrate and remain deep within the lungs. The health effects of particles are difficult to assess, and evidence is mainly based on epidemiological studies. Evidence suggests that there may be associations between increased PM_{10} concentrations and increased mortality and morbidity rates, changes in symptoms or lung function, episodes of hospitalisation or doctors consultations. Recent reviews by the World Health Organisation (WHO) and Committee on the Medical Effects of Air Pollutants (COMEAP) have suggested exposure to a finer fraction of particles ($PM_{2.5}$) give a stronger association with the observed health effects. $PM_{2.5}$ typically makes up around two-thirds of PM_{10} emissions and concentrations.	Road transport, industrial processes and electricity generation. Other pollutants, including NO_2 and SO_2, have the potential to form secondary particulates which are often smaller than PM_{10}.
Volatile Organic Compounds (VOCs)	Given that the speciation of VOC emissions is not known, specific details of the compounds emitted cannot be given. Certain VOCs are considered to be potential carcinogens, and to have an adverse effect on human health.	Wide variety of sources, both natural and anthropogenic.
Ammonia (NH_3)	Ammonia can lead to damage of terrestrial and aquatic ecosystems through deposition of eutrophying pollutants and through acidifying pollutants. Precursor to secondary PM and therefore contributes to the ill-health effects caused by PM_{10} and $PM_{2.5}$.	Mainly derived from agriculture, primarily livestock manure/slurry management and fertilisers. Small proportion derived from variety of sources including transport and waste disposal.

[8] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

Pollutant	Description and effect on human health and the environment	Principal Sources
Phenol (C_6H_5OH)	Exposure can cause extensive local corrosion with pain, nausea, vomiting, sweating, and diarrhoea. There is depression of the central nervous system, with circulatory and respiratory failure which may lead to death.	Phenol is a common industrial chemical that is used in the manufacture of resins, plastics, fibres, adhesives, iron, steel, aluminium, leather, and rubber. It is also found in disinfectants, cleaners, cigarette smoke and motor vehicle emissions.
Formaldehyde (HCHO)	Severely irritating to eyes, skin and mucous membranes. It can cause hypersensitivity with a variety of manifestations.	Wide variety of sources.

4.3 Criteria appropriate to the assessment

Air Quality Standards and Critical Levels

Table 4.2 sets out those Air Quality Standards (AQS), Air Quality Objectives (AQOs) and Environmental Assessment Levels (EALs) that are relevant to this assessment.

As the speciation of the VOC emissions is not known, these have been compared against the benzene AQO and EAL as a conservative measure as per the procedure in NRW guidance.

Table 4.2 Air Quality Standards, Objectives and Environmental Assessment Levels

Pollutant	AQO/EAL	Averaging Period	Value ($\mu g\ m^{-3}$)
PM_{10}	AQO	Annual mean	40
	AQO	24-hour mean, not more than 35 exceedences per year (90.41 percentile)	50
$PM_{2.5}$	AQS	Annual mean	25
Volatile Organic Compounds (as Benzene)	AQO	Annual mean	5
	EAL	1-hour mean	195
Ammonia (NH_3)	EAL	Annual mean	180
	EAL	1-hour mean	2500
Ammonia (NH_3) – ecological receptors	EAL	Annual mean	3
Formaldehyde (CH_2O)	EAL	Annual mean	5
	EAL	1-hour mean	100
Phenol (C_6H_5OH)	EAL	Annual mean	200
	EAL	1-hour mean	3900

5. Assessment of impacts

This section sets out the results of the dispersion modelling and compares the predicted ground level concentrations against the assessment criteria detailed in Section 4. The predicted concentrations resulting from the process (i.e. the process contribution (PC)) are presented along with background concentrations and the percentage contribution that the predicted environmental concentrations (PEC) would make towards the relevant standard, objective or guideline value.

The impact of the emissions has been modelled for the emission conditions described in Section 2.2 on a 4 x 4 km Cartesian grid.

5.1 Impacts at human receptors

The following tables show the maximum ground level concentration predicted at any receptor for each of the pollutants considered for Scenario 1 and Scenario 2. A summary which compares results for both scenarios is provided in Section 5.3.

Scenario 1 – human receptors

The results tables for Scenario 1 are provided below.

Table 5.1 Maximum PCs and PECs for annual mean PM_{10} and 24-hour mean PM_{10} – Scenario 1

Receptor	Annual mean PM_{10}				90.41 percentile 24-hour mean PM_{10}			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PEC of EAL	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PEC of EAL
Sandycroft School	40	0.03	14.90	37.2%	50	0.11	29.84	59.7%
Rector Lane	40	0.13	15.00	37.5%	50	0.45	30.18	60.4%
Chester Road1	40	0.07	14.93	37.3%	50	0.26	29.99	60.0%
Chester Road2	40	0.50	15.37	38.4%	50	1.54	31.27	62.5%
Sealand Manor	40	0.03	14.69	36.7%	50	0.10	29.40	58.8%
Shooting School	40	0.02	14.68	36.7%	50	0.07	29.37	58.7%
Church View1	40	0.09	14.96	37.4%	50	0.32	30.05	60.1%
Church View2	40	0.08	14.94	37.4%	50	0.29	30.02	60.0%
Gladstone Terrace	40	0.08	14.94	37.4%	50	0.26	29.99	60.0%
Chester Road3	40	0.05	14.92	37.3%	50	0.18	29.91	59.8%
Bernsdale Close	40	0.06	14.00	35.0%	50	0.20	28.08	56.2%
Hamilton Avenue	40	0.06	14.00	35.0%	50	0.21	28.09	56.2%
Mancot Lane	40	0.04	14.91	37.3%	50	0.13	29.86	59.7%
Dundas Street	40	0.05	13.40	33.5%	50	0.13	26.84	53.7%
Chester Road4	40	0.04	14.91	37.3%	50	0.16	29.89	59.8%

Receptor	Annual mean PM_{10}				90.41 percentile 24-hour mean PM_{10}			
	EAL ($\mu g\ m^{-3}$)	PC ($\mu g\ m^{-3}$)	PEC ($\mu g\ m^{-3}$)	% PEC of EAL	EAL ($\mu g\ m^{-3}$)	PC ($\mu g\ m^{-3}$)	PEC ($\mu g\ m^{-3}$)	% PEC of EAL
Hampton Avenue	40	0.03	14.90	37.2%	50	0.11	29.84	59.7%
Earles Crescent	40	0.02	14.88	37.2%	50	0.06	29.79	59.6%
Leaches Lane	40	0.01	14.88	37.2%	50	0.04	29.77	59.5%
Hawarden Way	40	0.01	14.88	37.2%	50	0.05	29.78	59.6%
Claremont Avenue	40	0.06	15.91	39.8%	50	0.15	31.84	63.7%
Evansleigh Drive	40	0.05	13.99	35.0%	50	0.16	28.04	56.1%
Caravan Park	40	0.13	15.97	39.9%	50	0.31	32.00	64.0%

The maximum annual mean PM_{10} PEC at any human receptor location is predicted as 15.97 $\mu g\ m^{-3}$ or 39.9% of the EAL at the Caravan Park receptor, comfortably below the standard.

The maximum 90.41 percentile 24-hour mean PM_{10} PEC at any human receptor location is predicted as 32.00 $\mu g\ m^{-3}$ or 64.0% of the EAL at the Caravan Park receptor.

Table 5.2 Maximum PCs and PECs for annual mean $PM_{2.5}$ – Scenario 1

Receptor	Annual mean $PM_{2.5}$			
	EAL ($\mu g\ m^{-3}$)	PC ($\mu g\ m^{-3}$)	PEC ($\mu g\ m^{-3}$)	% PEC of EAL
Sandycroft School	25	0.03	11.01	44.1%
Rector Lane	25	0.13	11.11	44.5%
Chester Road1	25	0.07	11.05	44.2%
Chester Road2	25	0.50	11.49	45.9%
Sealand Manor	25	0.03	10.16	40.7%
Shooting School	25	0.02	10.15	40.6%
Church View1	25	0.09	11.07	44.3%
Church View2	25	0.08	11.06	44.2%
Gladstone Terrace	25	0.08	11.06	44.2%
Chester Road3	25	0.05	11.04	44.1%
Bernsdale Close	25	0.06	10.09	40.4%
Hamilton Avenue	25	0.06	10.09	40.4%
Mancot Lane	25	0.04	11.02	44.1%
Dundas Street	25	0.05	9.52	38.1%

Receptor	Annual mean $PM_{2.5}$			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PEC of EAL
Chester Road4	25	0.04	11.03	44.1%
Hampton Avenue	25	0.03	11.01	44.1%
Earles Crescent	25	0.02	11.00	44.0%
Leaches Lane	25	0.01	10.99	44.0%
Hawarden Way	25	0.01	11.00	44.0%
Claremont Avenue	25	0.06	10.72	42.9%
Evansleigh Drive	25	0.05	10.08	40.3%
Caravan Park	25	0.13	10.79	43.1%

The maximum annual mean $PM_{2.5}$ PEC at any human receptor location is predicted as 11.49 µg m^{-3} or 45.9% of the EAL at the Chester Road 2 receptor, comfortably below the standard.

Table 5.3 Maximum PCs and PECs for annual mean NH_3 and maximum 1-hour mean NH_3 – Scenario 1

Receptor	Annual mean NH_3				Maximum 1-hour mean NH_3			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PEC of EAL	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PEC of EAL
Sandycroft School	180	0.04	2.39	1.3%	2500	3.69	8.39	0.3%
Rector Lane	180	0.17	2.52	1.4%	2500	6.27	10.97	0.4%
Chester Road1	180	0.09	2.44	1.4%	2500	6.17	10.87	0.4%
Chester Road2	180	0.65	3.00	1.7%	2500	9.56	14.26	0.6%
Sealand Manor	180	0.04	2.39	1.3%	2500	1.68	6.38	0.3%
Shooting School	180	0.03	2.38	1.3%	2500	1.58	6.28	0.3%
Church View1	180	0.12	2.47	1.4%	2500	5.24	9.94	0.4%
Church View2	180	0.10	2.45	1.4%	2500	4.84	9.54	0.4%
Gladstone Terrace	180	0.10	2.45	1.4%	2500	4.67	9.37	0.4%
Chester Road3	180	0.07	2.42	1.3%	2500	4.89	9.59	0.4%
Bernsdale Close	180	0.07	2.42	1.3%	2500	2.40	7.10	0.3%
Hamilton Avenue	180	0.08	2.43	1.4%	2500	2.90	7.60	0.3%
Mancot Lane	180	0.05	2.40	1.3%	2500	3.51	8.21	0.3%
Dundas Street	180	0.06	2.41	1.3%	2500	2.87	7.57	0.3%

Receptor	Annual mean NH_3				Maximum 1-hour mean NH_3			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PEC of EAL	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PEC of EAL
Chester Road4	180	0.06	2.41	1.3%	2500	3.58	8.28	0.3%
Hampton Avenue	180	0.04	2.39	1.3%	2500	3.04	7.74	0.3%
Earles Crescent	180	0.02	2.37	1.3%	2500	2.55	7.25	0.3%
Leaches Lane	180	0.02	2.37	1.3%	2500	2.06	6.76	0.3%
Hawarden Way	180	0.02	2.37	1.3%	2500	2.21	6.91	0.3%
Claremont Avenue	180	0.08	2.43	1.3%	2500	1.86	6.56	0.3%
Evansleigh Drive	180	0.06	2.41	1.3%	2500	2.38	7.08	0.3%
Caravan Park	180	0.16	2.51	1.4%	2500	2.54	7.24	0.3%

The maximum annual mean NH_3 PEC at any human receptor location is predicted as 3.00 µg m^{-3} or 1.7% of the EAL at the Chester Road 2 receptor. The maximum 1-hour mean NH_3 PEC at any human receptor location is predicted as 14.26 µg m^{-3} or 0.6% of the EAL at the same receptor.

Table 5.4 Maximum PCs and PECs for annual mean VOC and maximum 1-hour mean VOC – Scenario 1

Receptor	Annual mean VOC				Maximum 1-hour mean VOC			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PEC of EAL	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PEC of EAL
Sandycroft School	5	<0.01	0.35	7.0%	195	0.14	0.84	0.4%
Rector Lane	5	0.01	0.36	7.1%	195	0.24	0.94	0.5%
Chester Road1	5	<0.01	0.35	7.1%	195	0.24	0.94	0.5%
Chester Road2	5	0.03	0.38	7.5%	195	0.37	1.07	0.5%
Sealand Manor	5	<0.01	0.34	6.9%	195	0.07	0.75	0.4%
Shooting School	5	<0.01	0.34	6.9%	195	0.06	0.75	0.4%
Church View1	5	<0.01	0.35	7.1%	195	0.20	0.90	0.5%
Church View2	5	<0.01	0.35	7.1%	195	0.19	0.89	0.5%
Gladstone Terrace	5	<0.01	0.35	7.1%	195	0.18	0.88	0.5%
Chester Road3	5	<0.01	0.35	7.1%	195	0.19	0.89	0.5%
Bernsdale Close	5	<0.01	0.34	6.7%	195	0.09	0.76	0.4%
Hamilton Avenue	5	<0.01	0.34	6.7%	195	0.11	0.78	0.4%
Mancot Lane	5	<0.01	0.35	7.0%	195	0.14	0.84	0.4%
Dundas Street	5	<0.01	0.37	7.4%	195	0.11	0.85	0.4%

Receptor	Annual mean VOC				Maximum 1-hour mean VOC			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PEC of EAL	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PEC of EAL
Chester Road4	5	<0.01	0.35	7.0%	195	0.14	0.84	0.4%
Hampton Avenue	5	<0.01	0.35	7.0%	195	0.12	0.82	0.4%
Earles Crescent	5	<0.01	0.35	7.0%	195	0.10	0.80	0.4%
Leaches Lane	5	<0.01	0.35	7.0%	195	0.08	0.78	0.4%
Hawarden Way	5	<0.01	0.35	7.0%	195	0.09	0.79	0.4%
Claremont Avenue	5	<0.01	0.36	7.2%	195	0.07	0.79	0.4%
Evansleigh Drive	5	<0.01	0.34	6.7%	195	0.09	0.76	0.4%
Caravan Park	5	0.01	0.36	7.3%	195	0.10	0.81	0.4%

The maximum annual mean VOC PEC at any human receptor location is predicted as 0.38 µg m^{-3} or 7.5% of the EAL at the Chester Road 2 receptor. The maximum 1-hour mean VOC PEC at any human receptor location is predicted as 1.07 µg m^{-3} or 0.5% of the EAL at the same receptor.

Table 5.5 Maximum PCs for annual mean Formaldehyde and maximum 1-hour mean Formaldehyde – Scenario 1

Receptor	Annual mean formaldehyde				Maximum 1-hour mean formaldehyde			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL
Sandycroft School	5	0.01	-	0.2%	100	0.77	-	0.8%
Rector Lane	5	0.04	-	0.7%	100	1.31	-	1.3%
Chester Road1	5	0.02	-	0.4%	100	1.29	-	1.3%
Chester Road2	5	0.14	-	2.7%	100	2.00	-	2.0%
Sealand Manor	5	0.01	-	0.2%	100	0.35	-	0.4%
Shooting School	5	0.01	-	0.1%	100	0.33	-	0.3%
Church View1	5	0.02	-	0.5%	100	1.09	-	1.1%
Church View2	5	0.02	-	0.4%	100	1.01	-	1.0%
Gladstone Terrace	5	0.02	-	0.4%	100	0.98	-	1.0%
Chester Road3	5	0.01	-	0.3%	100	1.02	-	1.0%
Bernsdale Close	5	0.02	-	0.3%	100	0.50	-	0.5%
Hamilton Avenue	5	0.02	-	0.3%	100	0.61	-	0.6%
Mancot Lane	5	0.01	-	0.2%	100	0.73	-	0.7%

Receptor	Annual mean formaldehyde				Maximum 1-hour mean formaldehyde			
	EAL (μg m^{-3})	PC (μg m^{-3})	PEC (μg m^{-3})	% PC of EAL	EAL (μg m^{-3})	PC (μg m^{-3})	PEC (μg m^{-3})	% PC of EAL
Dundas Street	5	0.01	-	0.2%	100	0.60	-	0.6%
Chester Road4	5	0.01	-	0.2%	100	0.75	-	0.7%
Hampton Avenue	5	0.01	-	0.2%	100	0.64	-	0.6%
Earles Crescent	5	<0.01	-	0.1%	100	0.53	-	0.5%
Leaches Lane	5	<0.01	-	0.1%	100	0.43	-	0.4%
Hawarden Way	5	<0.01	-	0.1%	100	0.46	-	0.5%
Claremont Avenue	5	0.02	-	0.3%	100	0.39	-	0.4%
Evansleigh Drive	5	0.01	-	0.3%	100	0.50	-	0.5%
Caravan Park	5	0.03	-	0.7%	100	0.53	-	0.5%

The maximum annual mean formaldehyde PC at any human receptor location is predicted as 0.14 μg m^{-3} at the Chester Road 2 receptor. The maximum 1-hour mean formaldehyde PC at any human receptor location is predicted as 2.00 μg m^{-3} at the same receptor.

Table 5.6 Maximum PCs for annual mean Phenol and maximum 1-hour mean Phenol – Scenario 1

Receptor	Annual mean phenol				Maximum 1-hour mean phenol			
	EAL (μg m^{-3})	PC (μg m^{-3})	PEC (μg m^{-3})	% PC of EAL	EAL (μg m^{-3})	PC (μg m^{-3})	PEC (μg m^{-3})	% PC of EAL
Sandycroft School	200	<0.01	-	<0.1%	3900	0.12	-	<0.1%
Rector Lane	200	0.01	-	<0.1%	3900	0.21	-	<0.1%
Chester Road1	200	<0.01	-	<0.1%	3900	0.20	-	<0.1%
Chester Road2	200	0.02	-	<0.1%	3900	0.32	-	<0.1%
Sealand Manor	200	<0.01	-	<0.1%	3900	0.06	-	<0.1%
Shooting School	200	<0.01	-	<0.1%	3900	0.05	-	<0.1%
Church View1	200	<0.01	-	<0.1%	3900	0.17	-	<0.1%
Church View2	200	<0.01	-	<0.1%	3900	0.16	-	<0.1%
Gladstone Terrace	200	<0.01	-	<0.1%	3900	0.16	-	<0.1%
Chester Road3	200	<0.01	-	<0.1%	3900	0.16	-	<0.1%
Bernsdale Close	200	<0.01	-	<0.1%	3900	0.08	-	<0.1%
Hamilton Avenue	200	<0.01	-	<0.1%	3900	0.10	-	<0.1%
Mancot Lane	200	<0.01	-	<0.1%	3900	0.12	-	<0.1%

Receptor	Annual mean phenol				Maximum 1-hour mean phenol			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL
Dundas Street	200	<0.01	-	<0.1%	3900	0.10	-	<0.1%
Chester Road4	200	<0.01	-	<0.1%	3900	0.12	-	<0.1%
Hampton Avenue	200	<0.01	-	<0.1%	3900	0.10	-	<0.1%
Earles Crescent	200	<0.01	-	<0.1%	3900	0.08	-	<0.1%
Leaches Lane	200	<0.01	-	<0.1%	3900	0.07	-	<0.1%
Hawarden Way	200	<0.01	-	<0.1%	3900	0.07	-	<0.1%
Claremont Avenue	200	<0.01	-	<0.1%	3900	0.06	-	<0.1%
Evansleigh Drive	200	<0.01	-	<0.1%	3900	0.08	-	<0.1%
Caravan Park	200	0.01	-	<0.1%	3900	0.08	-	<0.1%

The maximum annual mean phenol PC at any human receptor location is predicted as 0.02 µg m^{-3} at the Chester Road 2 receptor. The maximum 1-hour mean phenol PC at any human receptor location is predicted as 0.32 µg m^{-3} at the same receptor.

Table 5.7 Maximum PCs for maximum 1-hour mean Amines – Scenario 1

Receptor	1-hour mean Amines			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL
Sandycroft School	-	0.03	-	-
Rector Lane	-	0.05	-	-
Chester Road1	-	0.05	-	-
Chester Road2	-	0.07	-	-
Sealand Manor	-	0.01	-	-
Shooting School	-	0.01	-	-
Church View1	-	0.04	-	-
Church View2	-	0.04	-	-
Gladstone Terrace	-	0.04	-	-
Chester Road3	-	0.04	-	-
Bernsdale Close	-	0.02	-	-
Hamilton Avenue	-	0.02	-	-
Mancot Lane	-	0.03	-	-

Receptor	1-hour mean Amines			
	EAL ($\mu g\ m^{-3}$)	PC ($\mu g\ m^{-3}$)	PEC ($\mu g\ m^{-3}$)	% PC of EAL
Dundas Street	-	0.02	-	-
Chester Road4	-	0.03	-	-
Hampton Avenue	-	0.02	-	-
Earles Crescent	-	0.02	-	-
Leaches Lane	-	0.02	-	-
Hawarden Way	-	0.02	-	-
Claremont Avenue	-	0.01	-	-
Evansleigh Drive	-	0.02	-	-
Caravan Park	-	0.02	-	-

The maximum 1-hour mean PC for Amines at any human receptor location is predicted as 0.07 $\mu g\ m^{-3}$ at the Chester Road 2 receptor.

Scenario 2 – human receptors

The results tables for Scenario 2 are provided below.

Table 5.8 Maximum PCs and PECs for annual mean PM_{10} and 24-hour mean PM_{10} – Scenario 2

Receptor	Annual mean PM_{10}				90.41 percentile 24-hour mean PM_{10}			
	EAL ($\mu g\ m^{-3}$)	PC ($\mu g\ m^{-3}$)	PEC ($\mu g\ m^{-3}$)	% PEC of EAL	EAL ($\mu g\ m^{-3}$)	PC ($\mu g\ m^{-3}$)	PEC ($\mu g\ m^{-3}$)	% PEC of EAL
Sandycroft School	40	0.31	15.17	37.9%	50	1.11	30.84	61.7%
Rector Lane	40	1.32	16.18	40.5%	50	4.59	34.32	68.6%
Chester Road1	40	0.66	15.53	38.8%	50	2.54	32.28	64.6%
Chester Road2	40	4.34	19.20	48.0%	50	13.68	43.41	86.8%
Sealand Manor	40	0.34	15.00	37.5%	50	1.01	30.32	60.6%
Shooting School	40	0.24	14.89	37.2%	50	0.69	29.99	60.0%
Church View1	40	0.91	15.77	39.4%	50	3.27	33.00	66.0%
Church View2	40	0.79	15.66	39.1%	50	2.90	32.63	65.3%
Gladstone Terrace	40	0.80	15.66	39.2%	50	2.72	32.45	64.9%
Chester Road3	40	0.54	15.40	38.5%	50	2.02	31.76	63.5%
Bernsdale Close	40	0.59	14.52	36.3%	50	1.96	29.84	59.7%
Hamilton Avenue	40	0.64	14.58	36.5%	50	2.13	30.00	60.0%

Receptor	Annual mean PM_{10}				90.41 percentile 24-hour mean PM_{10}			
	EAL (µg m⁻³)	PC (µg m⁻³)	PEC (µg m⁻³)	% PEC of EAL	EAL (µg m⁻³)	PC (µg m⁻³)	PEC (µg m⁻³)	% PEC of EAL
Mancot Lane	40	0.41	15.28	38.2%	50	1.42	31.16	62.3%
Dundas Street	40	0.48	13.83	34.6%	50	1.42	28.13	56.3%
Chester Road4	40	0.43	15.30	38.2%	50	1.70	31.43	62.9%
Hampton Avenue	40	0.32	15.19	38.0%	50	1.19	30.92	61.8%
Earles Crescent	40	0.18	15.05	37.6%	50	0.65	30.38	60.8%
Leaches Lane	40	0.12	14.99	37.5%	50	0.45	30.18	60.4%
Hawarden Way	40	0.15	15.02	37.5%	50	0.56	30.29	60.6%
Claremont Avenue	40	0.60	16.45	41.1%	50	1.53	33.22	66.4%
Evansleigh Drive	40	0.47	14.41	36.0%	50	1.56	29.44	58.9%
Caravan Park	40	1.32	17.16	42.9%	50	3.40	35.09	70.2%

The maximum annual mean PM_{10} PEC at any human receptor location is predicted as 19.2 µg m^{-3} or 48.0% of the EAL at the Chester Road 2 receptor, comfortably below the standard.

The maximum 90.41 percentile 24-hour mean PM_{10} PEC at any human receptor location is predicted as 43.41 µg m^{-3} or 86.8% of the EAL at the Chester Road 2 receptor.

Table 5.9 Maximum PCs and PECs for annual mean $PM_{2.5}$ – Scenario 2

Receptor	Annual mean $PM_{2.5}$			
	EAL (µg m⁻³)	PC (µg m⁻³)	PEC (µg m⁻³)	% PEC of EAL
Sandycroft School	25	0.31	11.29	45.2%
Rector Lane	25	1.32	12.30	49.2%
Chester Road1	25	0.66	11.64	46.6%
Chester Road2	25	4.34	15.32	61.3%
Sealand Manor	25	0.34	10.47	41.9%
Shooting School	25	0.24	10.37	41.5%
Church View1	25	0.91	11.89	47.6%
Church View2	25	0.79	11.78	47.1%
Gladstone Terrace	25	0.80	11.78	47.1%
Chester Road3	25	0.54	11.52	46.1%
Bernsdale Close	25	0.59	10.62	42.5%

Receptor	Annual mean $PM_{2.5}$			
	EAL ($\mu g\ m^{-3}$)	PC ($\mu g\ m^{-3}$)	PEC ($\mu g\ m^{-3}$)	% PEC of EAL
Hamilton Avenue	25	0.64	10.67	42.7%
Mancot Lane	25	0.41	11.40	45.6%
Dundas Street	25	0.48	9.95	39.8%
Chester Road4	25	0.43	11.42	45.7%
Hampton Avenue	25	0.32	11.30	45.2%
Earles Crescent	25	0.18	11.17	44.7%
Leaches Lane	25	0.12	11.10	44.4%
Hawarden Way	25	0.15	11.14	44.5%
Claremont Avenue	25	0.60	11.27	45.1%
Evansleigh Drive	25	0.47	10.50	42.0%
Caravan Park	25	1.32	11.98	47.9%

The maximum annual mean $PM_{2.5}$ PEC at any human receptor location is predicted as 15.32µg m^{-3} or 61.3% of the EAL at the Chester Road 2 receptor.

Table 5.10 Maximum PCs and PECs for annual mean NH_3 and maximum 1-hour mean NH_3 – Scenario 2

Receptor	Annual mean NH_3				Maximum 1-hour mean NH_3			
	EAL ($\mu g\ m^{-3}$)	PC ($\mu g\ m^{-3}$)	PEC ($\mu g\ m^{-3}$)	% PEC of EAL	EAL ($\mu g\ m^{-3}$)	PC ($\mu g\ m^{-3}$)	PEC ($\mu g\ m^{-3}$)	% PEC of EAL
Sandycroft School	180	0.07	2.42	1.3%	2500	5.29	9.99	0.4%
Rector Lane	180	0.29	2.64	1.5%	2500	8.23	12.93	0.5%
Chester Road1	180	0.15	2.50	1.4%	2500	8.81	13.51	0.5%
Chester Road2	180	1.10	3.45	1.9%	2500	12.62	17.32	0.7%
Sealand Manor	180	0.07	2.42	1.3%	2500	2.62	7.32	0.3%
Shooting School	180	0.05	2.40	1.3%	2500	2.25	6.95	0.3%
Church View1	180	0.20	2.55	1.4%	2500	7.36	12.06	0.5%
Church View2	180	0.17	2.52	1.4%	2500	6.69	11.39	0.5%
Gladstone Terrace	180	0.17	2.52	1.4%	2500	7.28	11.98	0.5%
Chester Road3	180	0.12	2.47	1.4%	2500	7.29	11.99	0.5%
Bernsdale Close	180	0.13	2.48	1.4%	2500	3.34	8.04	0.3%

Receptor	Annual mean NH_3				Maximum 1-hour mean NH_3			
	EAL ($\mu g\ m^{-3}$)	PC ($\mu g\ m^{-3}$)	PEC ($\mu g\ m^{-3}$)	% PEC of EAL	EAL ($\mu g\ m^{-3}$)	PC ($\mu g\ m^{-3}$)	PEC ($\mu g\ m^{-3}$)	% PEC of EAL
Hamilton Avenue	180	0.14	2.49	1.4%	2500	4.73	9.43	0.4%
Mancot Lane	180	0.09	2.44	1.4%	2500	6.02	10.72	0.4%
Dundas Street	180	0.10	2.45	1.4%	2500	4.99	9.69	0.4%
Chester Road4	180	0.09	2.44	1.4%	2500	5.32	10.02	0.4%
Hampton Avenue	180	0.07	2.42	1.3%	2500	5.24	9.94	0.4%
Earles Crescent	180	0.04	2.39	1.3%	2500	4.08	8.78	0.4%
Leaches Lane	180	0.03	2.38	1.3%	2500	3.54	8.24	0.3%
Hawarden Way	180	0.03	2.38	1.3%	2500	3.85	8.55	0.3%
Claremont Avenue	180	0.13	2.48	1.4%	2500	2.54	7.24	0.3%
Evansleigh Drive	180	0.10	2.45	1.4%	2500	3.19	7.89	0.3%
Caravan Park	180	0.28	2.63	1.5%	2500	4.49	9.19	0.4%

The maximum annual mean NH_3 PEC at any human receptor location is predicted as 3.45 $\mu g\ m^{-3}$ or 1.9% of the EAL at the Chester Road 2 receptor. The maximum 1-hour mean NH_3 PEC at any human receptor location is predicted as 17.32 $\mu g\ m^{-3}$ or 0.7% of the EAL at the same receptor.

Table 5.11 Maximum PCs and PECs for annual mean VOC and maximum 1-hour mean VOC – Scenario 2

Receptor	Annual mean VOC				Maximum 1-hour mean VOC			
	EAL ($\mu g\ m^{-3}$)	PC ($\mu g\ m^{-3}$)	PEC ($\mu g\ m^{-3}$)	% PEC of EAL	EAL ($\mu g\ m^{-3}$)	PC ($\mu g\ m^{-3}$)	PEC ($\mu g\ m^{-3}$)	% PEC of EAL
Sandycroft School	5	<0.01	0.35	7.1%	195	0.20	0.90	0.5%
Rector Lane	5	0.01	0.36	7.2%	195	0.32	1.02	0.5%
Chester Road1	5	0.01	0.36	7.1%	195	0.34	1.04	0.5%
Chester Road2	5	0.04	0.39	7.8%	195	0.49	1.19	0.6%
Sealand Manor	5	<0.01	0.35	6.9%	195	0.10	0.79	0.4%
Shooting School	5	<0.01	0.34	6.9%	195	0.09	0.77	0.4%
Church View1	5	0.01	0.36	7.2%	195	0.28	0.98	0.5%
Church View2	5	0.01	0.36	7.1%	195	0.26	0.96	0.5%
Gladstone Terrace	5	0.01	0.36	7.1%	195	0.28	0.98	0.5%
Chester Road3	5	<0.01	0.35	7.1%	195	0.28	0.98	0.5%
Bernsdale Close	5	<0.01	0.34	6.8%	195	0.13	0.80	0.4%

Receptor	Annual mean VOC				Maximum 1-hour mean VOC			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PEC of EAL	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PEC of EAL
Hamilton Avenue	5	0.01	0.34	6.8%	195	0.18	0.85	0.4%
Mancot Lane	5	<0.01	0.35	7.1%	195	0.23	0.93	0.5%
Dundas Street	5	<0.01	0.37	7.4%	195	0.19	0.93	0.5%
Chester Road4	5	<0.01	0.35	7.1%	195	0.21	0.91	0.5%
Hampton Avenue	5	<0.01	0.35	7.1%	195	0.20	0.90	0.5%
Earles Crescent	5	<0.01	0.35	7.0%	195	0.16	0.86	0.4%
Leaches Lane	5	<0.01	0.35	7.0%	195	0.14	0.84	0.4%
Hawarden Way	5	<0.01	0.35	7.0%	195	0.15	0.85	0.4%
Claremont Avenue	5	<0.01	0.36	7.3%	195	0.10	0.81	0.4%
Evansleigh Drive	5	<0.01	0.34	6.8%	195	0.12	0.79	0.4%
Caravan Park	5	0.01	0.37	7.4%	195	0.17	0.89	0.5%

The maximum annual mean VOC PEC at any human receptor location is predicted as 0.39 µg m^{-3} or 7.8% of the EAL at the Chester Road 2 receptor. The maximum 1-hour mean VOC PEC at any human receptor location is predicted as 1.19 µg m^{-3} or 0.6% of the EAL at the same receptor.

Table 5.12 Maximum PCs for annual mean Formaldehyde and maximum 1-hour mean Formaldehyde – Scenario 2

Receptor	Annual mean formaldehyde				Maximum 1-hour mean formaldehyde			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL
Sandycroft School	5	0.01	-	0.3%	100	1.11	-	1.1%
Rector Lane	5	0.06	-	1.2%	100	1.72	-	1.7%
Chester Road1	5	0.03	-	0.6%	100	1.84	-	1.8%
Chester Road2	5	0.23	-	4.6%	100	2.64	-	2.6%
Sealand Manor	5	0.02	-	0.3%	100	0.55	-	0.5%
Shooting School	5	0.01	-	0.2%	100	0.47	-	0.5%
Church View1	5	0.04	-	0.8%	100	1.54	-	1.5%
Church View2	5	0.04	-	0.7%	100	1.40	-	1.4%
Gladstone Terrace	5	0.04	-	0.7%	100	1.52	-	1.5%
Chester Road3	5	0.02	-	0.5%	100	1.52	-	1.5%

Receptor	Annual mean formaldehyde				Maximum 1-hour mean formaldehyde			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL
Bernsdale Close	5	0.03	-	0.5%	100	0.70	-	0.7%
Hamilton Avenue	5	0.03	-	0.6%	100	0.99	-	1.0%
Mancot Lane	5	0.02	-	0.4%	100	1.26	-	1.3%
Dundas Street	5	0.02	-	0.4%	100	1.04	-	1.0%
Chester Road4	5	0.02	-	0.4%	100	1.11	-	1.1%
Hampton Avenue	5	0.01	-	0.3%	100	1.09	-	1.1%
Earles Crescent	5	0.01	-	0.2%	100	0.85	-	0.9%
Leaches Lane	5	0.01	-	0.1%	100	0.74	-	0.7%
Hawarden Way	5	0.01	-	0.1%	100	0.80	-	0.8%
Claremont Avenue	5	0.03	-	0.5%	100	0.53	-	0.5%
Evansleigh Drive	5	0.02	-	0.4%	100	0.67	-	0.7%
Caravan Park	5	0.06	-	1.2%	100	0.94	-	0.9%

The maximum annual mean formaldehyde PC at any human receptor location is predicted as 0.23 µg m^{-3} at the Chester Road 2 receptor. The maximum 1-hour mean formaldehyde PC at any human receptor location is predicted as 2.64 µg m^{-3} at the same receptor.

Table 5.13 Maximum PCs for annual mean Phenol and maximum 1-hour mean Phenol – Scenario 2

Receptor	Annual mean phenol				Maximum 1-hour mean phenol			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL
Sandycroft School	200	<0.01	-	<0.1%	3900	0.18	-	<0.1%
Rector Lane	200	0.01	-	<0.1%	3900	0.27	-	<0.1%
Chester Road1	200	0.00	-	<0.1%	3900	0.29	-	<0.1%
Chester Road2	200	0.04	-	<0.1%	3900	0.42	-	<0.1%
Sealand Manor	200	<0.01	-	<0.1%	3900	0.09	-	<0.1%
Shooting School	200	<0.01	-	<0.1%	3900	0.07	-	<0.1%
Church View1	200	0.01	-	<0.1%	3900	0.24	-	<0.1%
Church View2	200	0.01	-	<0.1%	3900	0.22	-	<0.1%
Gladstone Terrace	200	0.01	-	<0.1%	3900	0.24	-	<0.1%
Chester Road3	200	<0.01	-	<0.1%	3900	0.24	-	<0.1%

Receptor	Annual mean phenol				Maximum 1-hour mean phenol			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL
Bernsdale Close	200	<0.01	-	<0.1%	3900	0.11	-	<0.1%
Hamilton Avenue	200	<0.01	-	<0.1%	3900	0.16	-	<0.1%
Mancot Lane	200	<0.01	-	<0.1%	3900	0.20	-	<0.1%
Dundas Street	200	<0.01	-	<0.1%	3900	0.17	-	<0.1%
Chester Road4	200	<0.01	-	<0.1%	3900	0.18	-	<0.1%
Hampton Avenue	200	<0.01	-	<0.1%	3900	0.17	-	<0.1%
Earles Crescent	200	<0.01	-	<0.1%	3900	0.14	-	<0.1%
Leaches Lane	200	<0.01	-	<0.1%	3900	0.12	-	<0.1%
Hawarden Way	200	<0.01	-	<0.1%	3900	0.13	-	<0.1%
Claremont Avenue	200	<0.01	-	<0.1%	3900	0.08	-	<0.1%
Evansleigh Drive	200	<0.01	-	<0.1%	3900	0.11	-	<0.1%
Caravan Park	200	0.01	-	<0.1%	3900	0.15	-	<0.1%

The maximum annual mean phenol PC at any human receptor location is predicted as 0.04 µg m^{-3} at the Chester Road 2 receptor. The maximum 1-hour mean phenol PC at any human receptor location is predicted as 0.42 µg m^{-3} at the same receptor.

Table 5.14 Maximum PCs for maximum 1-hour mean Amines – Scenario 2

Receptor	1-hour mean Amines			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL
Sandycroft School	-	0.04	-	-
Rector Lane	-	0.06	-	-
Chester Road1	-	0.07	-	-
Chester Road2	-	0.10	-	-
Sealand Manor	-	0.02	-	-
Shooting School	-	0.02	-	-
Church View1	-	0.06	-	-
Church View2	-	0.05	-	-
Gladstone Terrace	-	0.06	-	-
Chester Road3	-	0.06	-	-

Receptor	1-hour mean Amines			
	EAL (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	% PC of EAL
Bernsdale Close	-	0.03	-	-
Hamilton Avenue	-	0.04	-	-
Mancot Lane	-	0.05	-	-
Dundas Street	-	0.04	-	-
Chester Road4	-	0.04	-	-
Hampton Avenue	-	0.04	-	-
Earles Crescent	-	0.03	-	-
Leaches Lane	-	0.03	-	-
Hawarden Way	-	0.03	-	-
Claremont Avenue	-	0.02	-	-
Evansleigh Drive	-	0.02	-	-
Caravan Park	-	0.03	-	-

The maximum 1-hour mean Amine PC at any human receptor location is predicted as 0.10 µg m^{-3}.

5.2 Impacts at ecological receptors

The following tables show the maximum ground level concentration predicted at any receptor for each of the pollutants considered for Scenario 1 and Scenario 2. A summary which compares results for both scenarios is provided in Section 5.3.

Scenario 1 – ecological receptors

Table 5.15 indicates that the maximum result occurs at one of the River Dee and Bala Lake SAC receptors, with a maximum PC of 0.11 µg m^{-3} which equates to a PEC of 82% of the Critical Level (CLE), applicable to ecological receptors.

Table 5.15 Maximum PCs and PECs for annual mean NH_3 – Scenario 1

Receptor	Annual mean NH_3 (µg m^{-3})			
	CLE	PC	PEC	%PEC of CLE
The Dee Estuary Ramsar SPA	3	0.05	2.36	78.8%
Dee Estuary SAC	3	0.04	1.16	38.7
River Dee and Bala Lake SAC	3	0.11	2.46	81.9%
Deeside and Buckley Newt Sites SAC	3	<0.01	2.15	71.8

Scenario 2 – ecological receptors

Table 5.16 shows the maximum result occurs at one of the River Dee and Bala Lake SAC receptors, with a maximum PC of 0.18 µg m^{-3} which equates to a PEC of 84% of the Critical Level (CLE).

Table 5.16 Maximum PCs and PECs for annual mean NH_3 – Scenario 2

Receptor	Annual mean NH_3 (µg m^{-3})			
	CLE	PC	PEC	%PEC of CLE
The Dee Estuary Ramsar SPA	3	0.06	2.37	78.9
Dee Estuary SAC	3	0.05	1.17	38.9
River Dee and Bala Lake SAC	3	0.18	2.53	84.3%
Deeside and Buckley Newt Sites SAC	3	0.01	2.16	71.9%

5.3 Results comparison

Results from Scenario 1 (as currently operating) and Scenario 2 (as forecast) have been compared against each other in order to ascertain the air quality effects at nearby receptors as a result of the variation. Table 5.17 presents the maximum result for each pollutant at any receptor from Scenarios 1 and 2.

The results summary indicates that results from Scenario 2 are consistently higher when compared with Scenario 1, as expected. However, as discussed in Section 5.1 and 5.2, none of the EAL's are exceeded at any receptor for any pollutant for either scenario.

Table 5.17 Results comparison with Scenario 1 modelling results and Scenario 2 modelling results

Pollutant	Averaging Period	Scenario 1	Scenario 2	Increase (%)
PM_{10}	Annual mean	0.5	4.34	768%
	90.41 %-ile 24-hour mean	1.54	13.68	788%
$PM_{2.5}$	Annual mean	0.5	4.34	768%
VOC	Annual mean	0.03	0.04	33%
	Maximum 1-hour mean	0.37	0.49	32%
Ammonia	Annual mean	0.65	1.1	69%
	Maximum 1-hour mean	9.56	12.62	32%
Formaldehyde	Annual mean	0.14	0.23	64%
	Maximum 1-hour mean	2	2.64	32%
Phenol	Annual mean	0.02	0.04	100%
	Maximum 1-hour mean	0.32	0.42	31%
Amine	Maximum 1-hour mean	0.07	0.1	43%

6. Conclusions

This assessment has used detailed dispersion modelling to undertake a comparative impact assessment of the emissions from emission point G and emission point Y at the Knauf Insulation site at Queensferry. It has evaluated two scenarios; Scenario 1 (current operation) and Scenario 2 (forecast operation), to assess how air quality effects will differ as a result of the permit variation. It has used emission rates derived from actual monitoring data recorded during 2015.

The assessment has incorporated a number of worst-case assumptions, which will likely result in an overestimation of the predicted ground level impact. The assessment demonstrates that, under both scenarios considered, exceedances of any EAL or CLE are unlikely. Therefore, it is considered that the proposed changes as a result of the variation are not expected to have a significant impact on human health or the integrity of designated ecological sites.

Appendix A
Contour plots

Figure A.1 Contour plot of annual mean NH_3 concentrations – Scenario 1 for the 2013 meteorological year

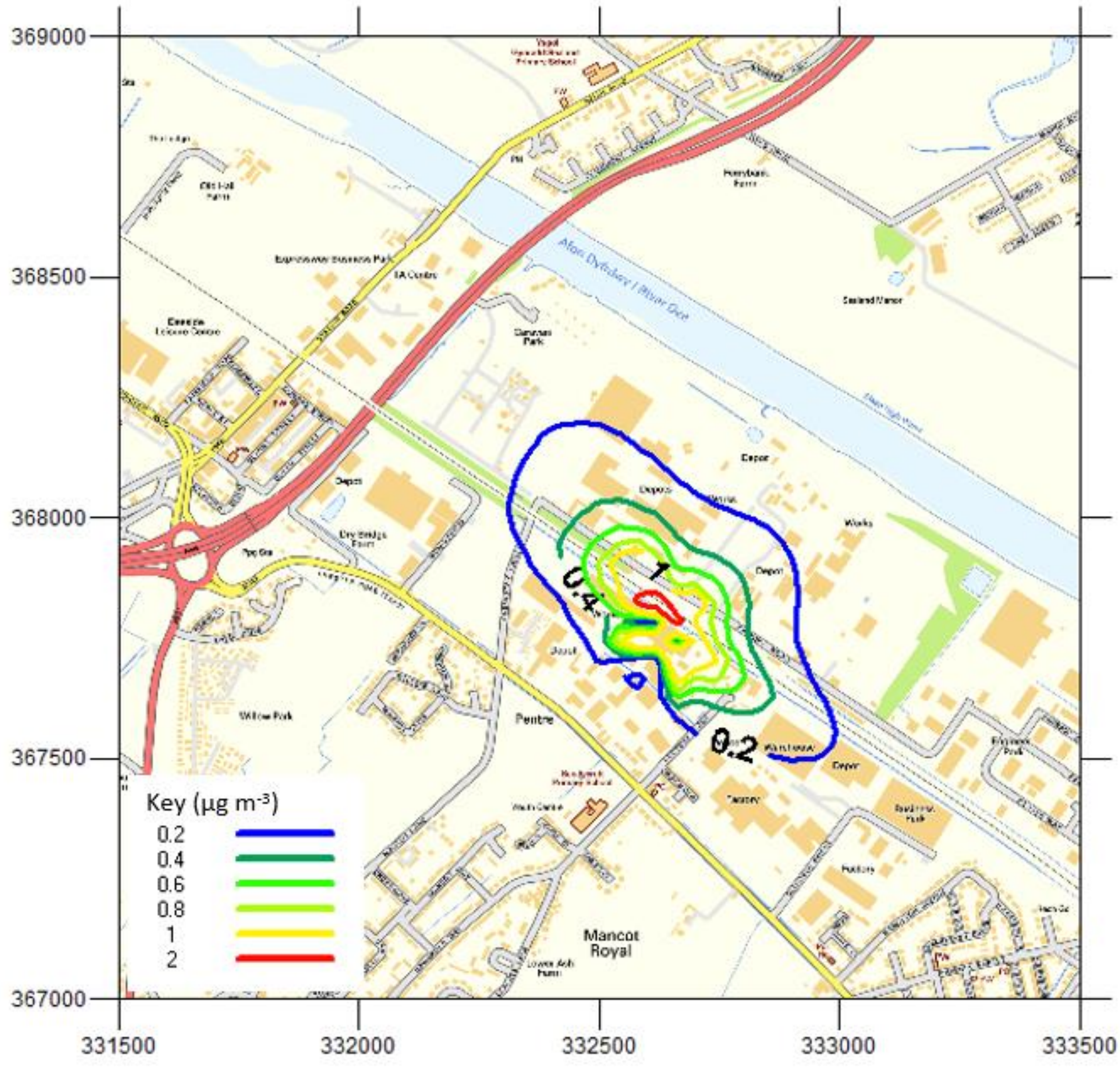


Figure A.2 Contour plot of annual mean NH_3 concentrations – Scenario 2 for the 2013 meteorological year

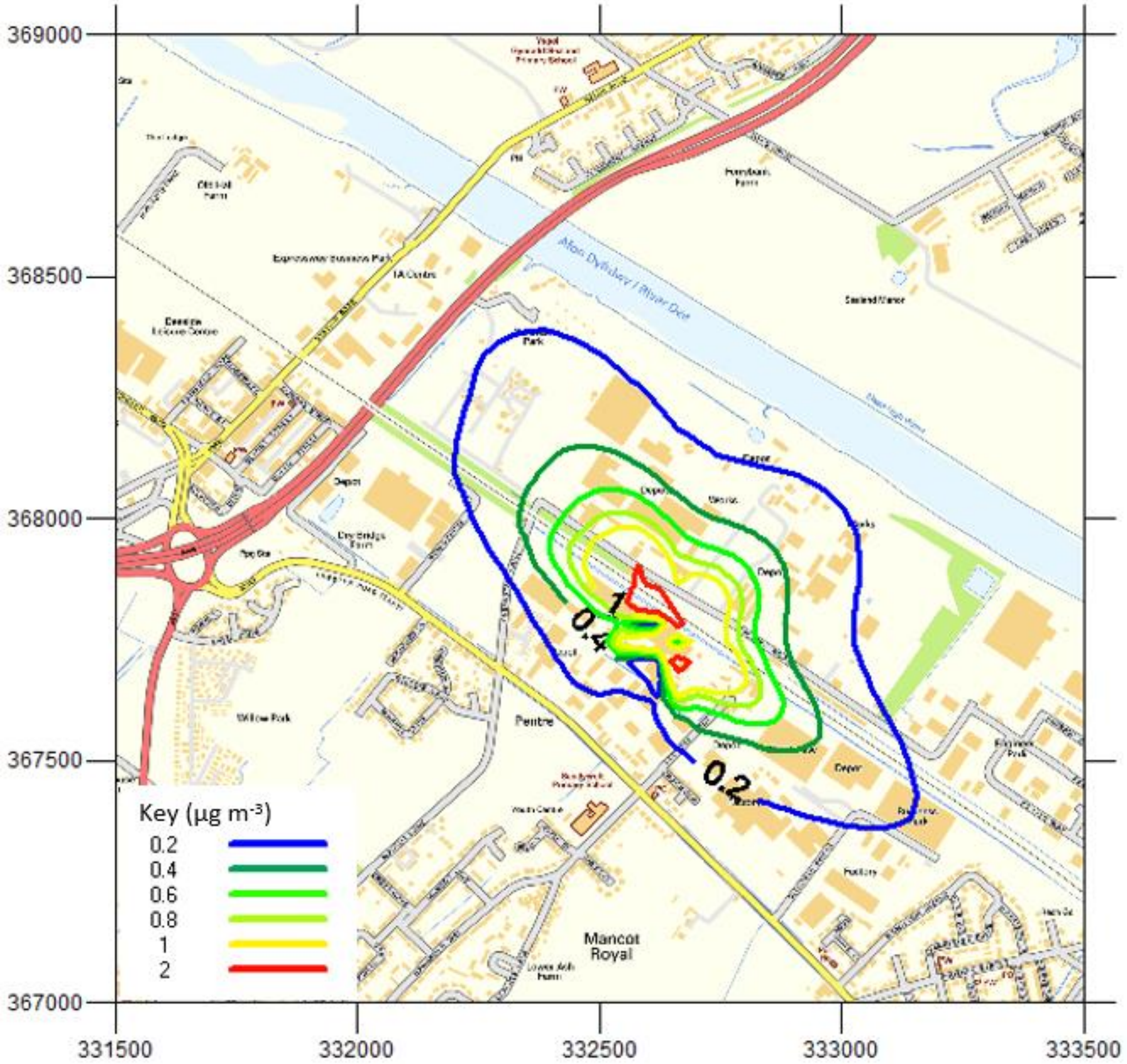


Figure A.3 Contour plot of 1-hour mean NH_3 concentrations – Scenario 1 for the 2011 meteorological year

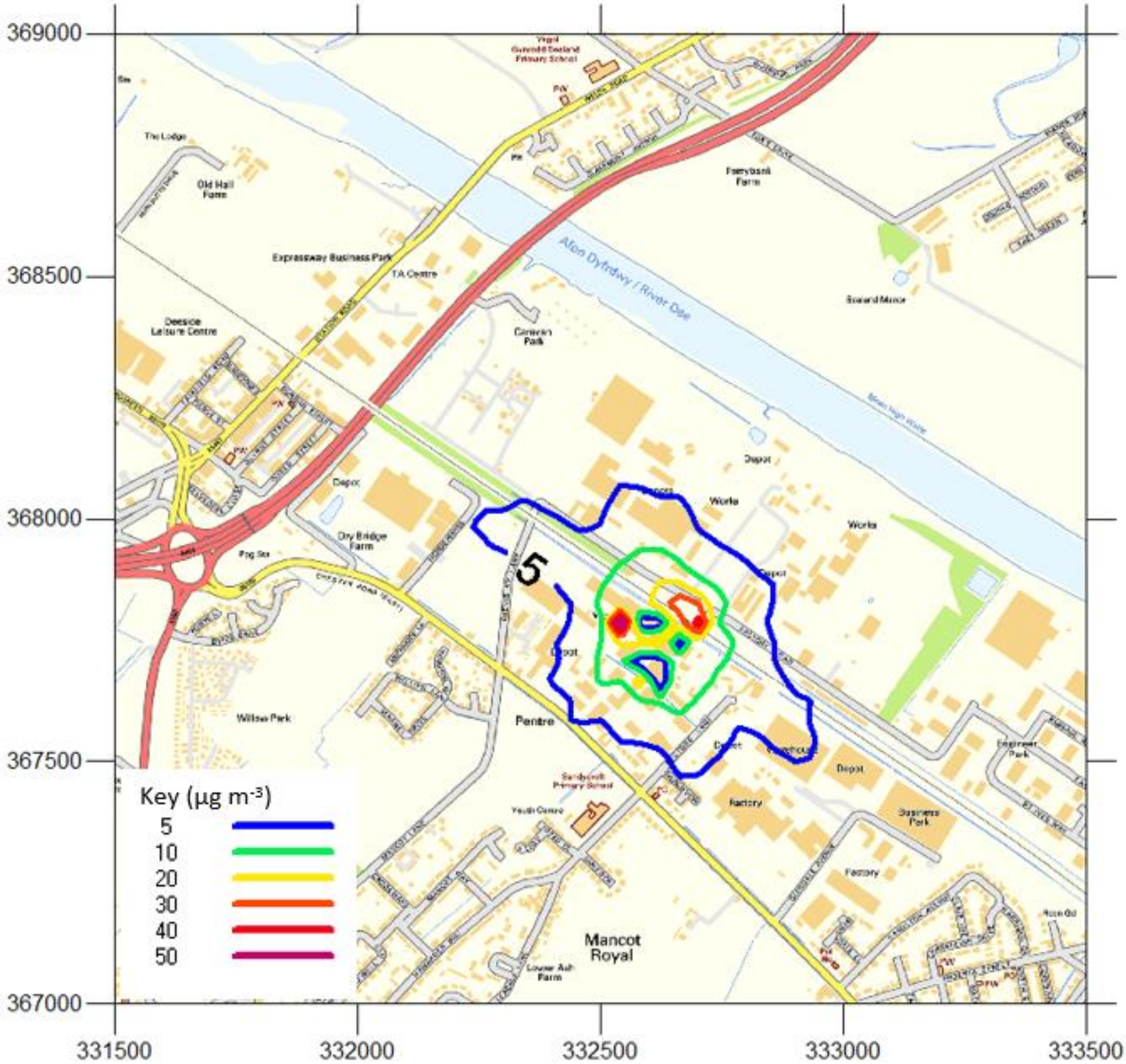
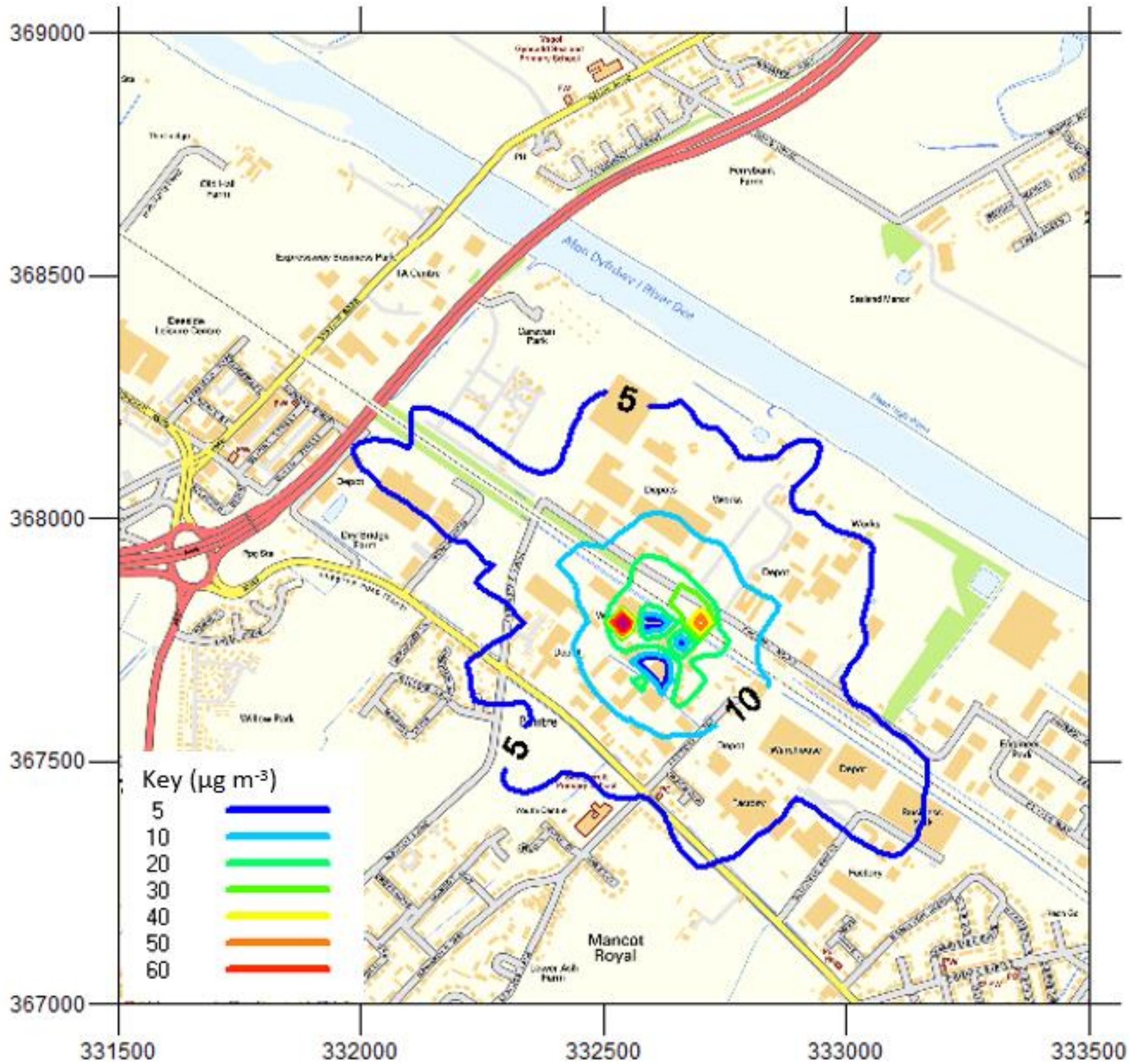


Figure A.4 Contour plot of 1-hour mean NH_3 concentrations – Scenario 2 for the 2011 meteorological year



Appendix B
2015 monitoring report