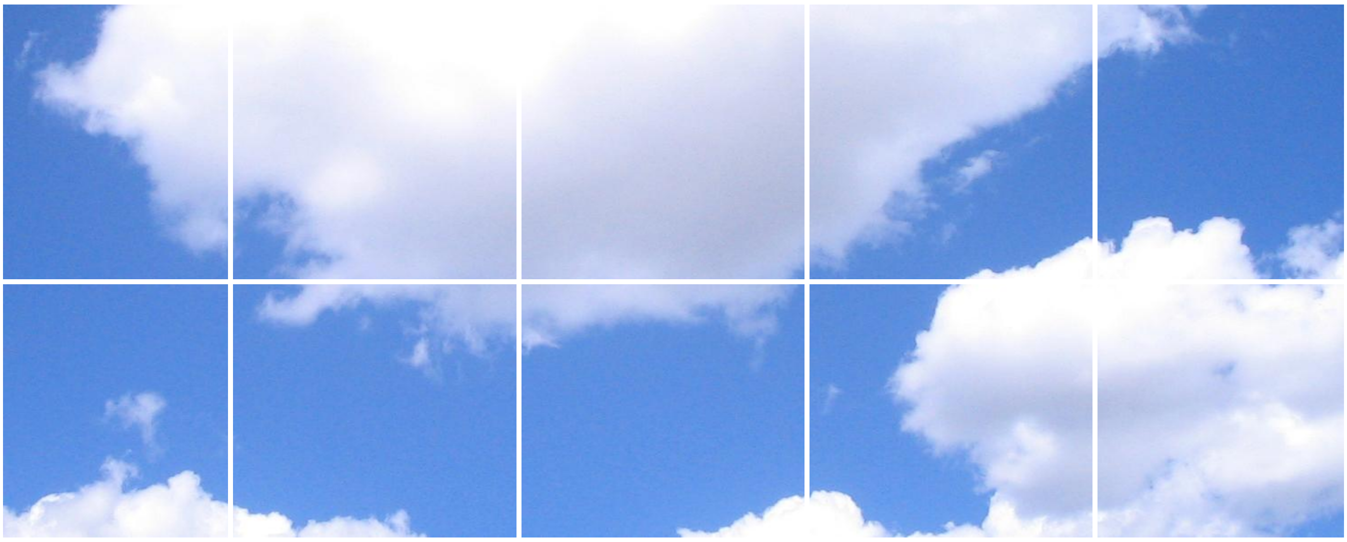


Air Quality Assessment: Queen Margaret University Biomass Boiler

Report to East Lothian Council

Unrestricted

AEAT/ENV/R/3079

October 2010

Title	East Lothian Council: Queen Margaret University Biomass Boiler Air Quality Assessment
Customer	East Lothian Council
Customer reference	AEA/BIOMASS/QMU
Confidentiality, copyright and reproduction	This report is the Copyright of AEA Technology plc and has been prepared by AEA Technology plc under contract to East Lothian Council. The contents of this report may not be reproduced in whole or in part, nor passed to any organisation or person without the specific prior written permission of the Commercial Manager, AEA Technology plc. AEA Technology plc accepts no liability whatsoever to any third party for any loss or damage arising from any interpretation or use of the information contained in this report, or reliance on any views expressed therein.
File reference	ED56066
Reference number	AEAT/ENV/R/3079

AEA
Glengarnock Technology Centre
Caledonian Road
Glengarnock
Ayrshire
KA14 3DD

t: 0870 190 6574
f: 0870 190 5151

AEA is a business name of AEA Technology plc

AEA is certificated to ISO9001
and ISO14001

Author	Name	David Monaghan
Approved by	Name	Dr Scott Hamilton
	Signature	
	Date	October 2010

Executive Summary

AEA were commissioned by East Lothian Council to investigate the air quality impact of an existing biomass boiler installation, adjacent to Queen Margaret University, Musselburgh, East Lothian.

The main pollutants of concern for this assessment are particulate material with aerodynamic diameter of 10 microns or less (PM_{10}) and nitrogen dioxide (NO_2).

The assessment has been carried out for the scenario based on a stack height of 6.8 m above ground level. Air quality impacts were calculated using Atmospheric Dispersion Modelling System (ADMS 4.2). ADMS is a dispersion model developed by the UK consultancy CERC. The most recent version of the model was used in conjunction with three years of hourly sequential meteorological data.

Results are presented in terms of the contribution to the annual, 1-hour and 24-hour mean air quality standards for NO_2 and PM_{10}, respectively. Currently, the annual and 1-hour mean objectives for NO_2 are set at 40 $\mu g/m^3$ and 200 $\mu g/m^3$, respectively. For PM_{10} the annual and 24-hour mean objectives are 18 $\mu g/m^3$ and 50 $\mu g/m^3$.

The annual mean standard (the average of all hourly concentrations in the year) is an absolute value which should not be exceeded at locations with relevant exposure, whereas the NO_2 1-hour standard represents a value which can be exceeded no more than 18 times in a calendar year and the PM_{10} 24-hour standard can be exceeded no more than 7 times per calendar year.

For the purposes of this study we have considered a number of receptors located in the vicinity of the existing biomass boiler stack.

In order to quantify the emission rate we have utilised the information available from biomass boiler test reports and certified information provided by Queen Margaret University and East Lothian Council.

Emissions from the biomass boiler have been modelled as a point source with a release height of 6.8 m at 151°C. Contour plots of PM_{10} and NO_2 dispersion have been prepared.

There is very little process contribution to both the NO_2 and PM_{10} annual mean concentrations and 1-hour for NO_2 or 24-hour for PM_{10} objectives observed at each of the specified receptors. For all monitored objectives, the contribution from background dominates predicted total concentrations (background contribution plus process contribution).

The results indicate that the boiler emissions will not result in any exceedences of the AQS objectives for NO_2 and PM_{10}, indeed the process contributions are typically a small percentage of the overall AQS objectives.

For example, the worst case process contribution modelled during this exercise was modelled at Receptor 1 for annual mean objectives for NO_2 (2.0 $\mu g/m^3$) and PM_{10}.(1.0 $\mu g/m^3$). Modelled results for all discrete receptors are shown below.

It should also be noted that the results shown in the table are extremely conservative as it assumed that NOx converts entirely to NO_2 and that the biomass boiler is running 24 hours per day, 365 days per year.

Receptor ID	Background NO_2 (µg/m^3)	Background PM_{10} (µg/m^3)	Process contribution NO_2 Annual Mean (µg/m^3)	Process contribution NO_2 99.8 %ile (µg/m^3)	Process contribution PM_{10} Annual Mean (µg/m^3)	Process contribution PM_{10} 90.4 %ile (µg/m^3)
1	13.7	12.8	1.99	15.71	1.04	13.84
11	13.7	12.8	1.97	4.83	1.03	4.49
12	13.7	12.8	1.97	4.67	1.03	4.54
13	13.7	12.8	1.80	5.05	0.94	4.44
14	13.7	12.8	1.77	5.00	0.93	4.42
10	13.7	12.8	1.66	5.26	0.87	4.18
9	13.7	12.8	1.55	5.36	0.81	4.54
15	13.7	12.8	1.48	5.28	0.78	3.81
8	13.7	12.8	1.24	5.51	0.65	3.94
16	13.7	12.8	1.18	5.35	0.62	3.42
7	13.7	12.8	1.04	5.11	0.54	4.08
6	13.7	12.8	0.90	5.03	0.47	3.91
5	13.7	12.8	0.59	4.78	0.31	3.31
4	13.7	12.8	0.56	4.83	0.29	3.21
3	13.7	12.8	0.45	4.69	0.24	3.04
2	13.7	12.8	0.33	4.26	0.18	2.46

Table of contents

1 Introduction

1.1 Purpose of the study

The objective of this study is to describe and assess the impacts on air quality of emissions from the proposed 1500kW biomass-fuelled boiler that is proposed for Queen Margaret University, Musselburgh. The study seeks to provide East Lothian Council with a quantitative estimate of the air quality impact of the existing biomass boiler in the context of current UK air quality standards.

1.2 General approach taken

The approach taken in this study was to:

- Collect and interpret boiler specification data for input to the dispersion model;
- Obtain one year of meteorological data, and terrain data for the study area;
- Obtain local background concentrations from national mapping;
- Model the concentrations of oxides of nitrogen (NO_x) and fine particulates (PM_{10}) around the study area, concentrating on the locations (receptors) where people might be exposed over the relevant averaging times of the air quality objectives; and
- Present the concentrations as contour plots of concentrations and assess the uncertainty in the predicted concentrations.

1.3 Numbering of figures and tables

The numbering scheme is not sequential, and the figures and tables are numbered according to the chapter and section that they relate to.

1.4 Units of concentration

The units throughout this report are presented in $\mu g/m^3$ (which is consistent with the presentation of Air Quality Strategy (AQS) objectives), unless otherwise noted.

1.5 Structure of the report

This document is an air quality impact assessment for the area surrounding Queen Margaret University in Musselburgh. Chapter 1 summarises the need for the work and the approach to completing the study.

Chapter 2 introduces the latest Scottish legislative standards and objectives for NO_2 and PM_{10} and discusses background air quality in the study area.

Chapter 3 contains details of the information and methodology used to conduct the air quality assessment and outlines the study area.

Chapter 4 describes the results of the modelling assessment and discusses whether the Scottish objectives for NO_2 or PM_{10} are considered likely to be exceeded in the study area as a result of emissions from the boiler installation. The contribution of boiler emissions to concentrations of these pollutants at key receptors will be presented and discussed. The results of the analysis are discussed and shown in tabular form and as contour plots.

Chapter 5 outlines the conclusions and recommendations for both NO_2 and PM_{10} from the assessment.

1.6 Explanation of the modelling output

The contour maps generated in the modelling for this report are an indication of the predicted pollutant concentrations around the area modelled. They are not lines of absolute values and should not be considered as such. Care should also be taken, in cases where contours join up as enclosed loops. No assumptions of pollutant concentrations can be made on locations outside of the area being modelled.

2 Air quality standards and guidelines

2.1 Air Quality Strategy and objectives

Biomass burners emit PM_{10} and oxides of nitrogen NO_x Local Authorities are required under the Environment Act 1995 to assess air quality in their areas from time to time against air quality objectives set out in regulation; both of these pollutants are normally included in such assessments.

Local Authorities are required to declare an Air Quality Management Area (AQMA) where it is likely that these objectives will not be achieved and to prepare an Action Plan to set out proposed measures to be taken to achieve the air quality objectives. There are no AQMAs throughout East Lothian.

The latest Air Quality Strategy for England, Wales and Northern Ireland was published on 17th July 2007. The Scottish objectives are set out in the Air Quality (Scotland) Amendment Regulations 2002. A new EU Directive has recently been published which consolidates the Framework and first three Daughter Directives, but this has yet to be transposed into UK Regulations. Table 2.1 shows an outline of the current UK Air Quality Objectives. NO_2 andPM_{10} are considered in this report in relation to the annual average and short-term objectives for each pollutant for Scotland.

Experience from monitoring shows that if the 40 $\mu g/m^3$ annual mean value is achieved, for NO_2, there is normally no risk of the hourly mean objective being breached. The relationship between annual and daily mean for PM_{10} is less predictable, and exceedences of the short term objective can still be observed even where the annual mean complies with the objective.

The other Air Quality Strategy pollutants do not need to be considered in this assessment.

The Air Quality Strategy's standards and objectives are shown in Table 2.1. The table shows the standards in $\mu g/m^3$ (mg/m^3 for CO) with the number of exceedences that are permitted (where applicable).

Table 2.1 Objectives included in the Air Quality Regulations and subsequent Amendments, for the purpose of Local Air Quality Management

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene All authorities	16.25 µg/m^3	running annual mean	31.12.2003
Authorities in England and Wales only	5.00 µg/m^3	annual mean	31.12.2010
Authorities in Scotland and Northern Ireland only	3.25 µg/m^3	running annual mean	31.12.2010
1,3-Butadiene	2.25 µg/m^3	running annual mean	31.12.2003
Carbon monoxide Authorities in England, Wales and Northern Ireland only	10.0 mg/m^3	maximum daily running 8-hour mean	31.12.2003
Authorities in Scotland only	10.0 mg/m^3	running 8-hour mean	31.12.2003
Lead	0.5 µg/m^3 0.25 µg/m^3	annual mean annual mean	31.12.2004 31.12.2008
Nitrogen dioxide	200 µg/m^3 not to be exceeded more than 18 times a year 40 µg/m^3	1 hour mean annual mean	31.12.2005 31.12.2005
Particles (PM_{10}) (gravimetric)[a] All authorities	50 µg/m^3 not to be exceeded more than 35 times a year 40 µg/m^3	24 hour mean annual mean	31.12.2004 31.12.2004
Authorities in Scotland only[b]	50 µg/m^3 not to be exceeded more than 7 times a year 18 µg/m^3	24 hour mean annual mean	31.12.2010 31.12.2010
Sulphur dioxide	350 µg/m^3 not to be exceeded more than 24 times a year 125 µg/m^3 not to be exceeded more than 3 times a year 266 µg/m^3 not to be exceeded more than 35 times a year	1 hour mean 24 hour mean 15 minute mean	31.12.2004 31.12.2004 31.12.2005

a. Measured using the European gravimetric transfer sampler or equivalent.
b. These 2010 Air Quality Objectives for PM_{10} apply in Scotland, as set out in the Air Quality (Scotland) Amendment Regulations 2002.

2.2 Sensitive locations

The locations where objectives apply are defined in the AQS as locations outside buildings or other natural or man-made structures above or below ground where members of the public are regularly present and might reasonably be expected to be exposed over the relevant averaging period of the objectives. Typically, these include residential properties, hospitals and schools for the longer averaging periods (i.e. annual mean) pollutant objectives and residential dwellings for short-term (i.e. 1-hour and 24 hour) pollutant objectives.

2.3 Combustion plant emissions

The utilisation of biomass for energy can affect air quality in a variety of ways. A large proportion of the total air pollutants of a bioenergy production chain are released during combustion of biomass or biomass-derived fuels. Emission levels of some of these pollutants, such as NO_x and oxides of sulphur (SO_x) depend heavily on the chemical composition of individual fuels while emission levels of other pollutants such as particulates (PM), PAHs and carbon monoxide depend on the completeness of the combustion process. The sulphur and nitrogen content of wood biomass is low but higher than for gas and hence displacement of gas may lead to a modest increase in SO_2 and NO_x emission.

The emissions to atmosphere from combustion can cause impact on the environment at a local, national and transboundary scale. However, the pollutants associated with biomass combustion are also associated with other combustion processes (including transport) and the use of biomass can lead to an increase or decrease in emission. The relative contribution will depend on the type of fuel and combustion technology displaced. Some of these pollutants (e.g. PM, SO_2 and NO_x) are regulated by British and European legislation on air quality.

The subject of this assessment is the dispersion of PM_{10} and NO_x resulting from operation of the Queen Margaret University biomass boiler. The relevant pollutants are described below.

Particulates (PM_{10})

Particle pollution is one of the most difficult measurements but most widely understood by the public as it is visible through its effects on soiling and nasal passages. The quantification of particulate material (PM) is defined by its effective aerodynamic diameter i.e. PM_{10} is all material up to aerodynamic diameter of 10 μm. This size fraction represents the depth particles travel into the respiratory system. Particles arise from both combustion processes such as coal, biomass or traffic and from abrasive processes such as construction, vehicle movement, grinding and cutting operations. These are both regarded a primary particles. Secondary PM results from atmospheric reactions between other pollutants emitted such as sulphur, nitrogen oxides and ammonia, and consists of a mix of compounds but to a large degree is composed of ammonium nitrate, chloride and sulphate. Exposure to fine particles is associated with respiratory and cardiovascular illnesses, as these particle sizes are likely to be inhaled into the thoracic region of the respiratory tract.

Oxides of nitrogen (NO_x)

As part of combustion using air as the source of oxygen, oxides of nitrogen are produced as a result of the reaction between the nitrogen present in the air. Oxides of nitrogen include nitric oxide (NO) and NO_2. In addition to these species, nitrous oxide (N_2O) can be produced under certain conditions and within certain processes e.g. fluidised bed combustion. Road transport is the main source of NO_X associated with the air quality issues but power and industrial sectors using combustion make appreciable contributions. High levels of NO_x are associated with damage to lung function and enhancement of the response to allergens in sensitive individuals. In addition, NO_X contributes to acidification and/or eutrophication of habitats. This affect does not necessarily impact on the local environment but can impact great distances from the source. N_2O has a contribution to global warming and hence climate change as it acts as a greenhouse gas and is 290 times more effective as a greenhouse gas than methane. NO_X also contributes to ground level ozone via reactions with volatile organic compounds and sunlight.

2.4 Background air quality in Musselburgh

The background data available at the air quality archive were used to assess current levels of NO_x, NO_2 and PM_{10} in the study area. This data estimated concentrations of key pollutants at a resolution of 1x1km for the whole of Scotland in 2009. (http://laqm1.defra.gov.uk/review/tools/background.php)

Background concentrations of NOx, NO_2 and PM_{10} for 2009 are provided in Table 2.2.

Table 2.2 2008 Background Concentrations of PM_{10} and NO_2

Pollutant	2009 Mapped Concentration
PM_{10}	12.8
NO_2	13.7
NOx	20.1

3 Modelling methodology

The air quality impact in the area surrounding the biomass boiler emissions was calculated using Atmospheric Dispersion Modelling System (ADMS). ADMS is a dispersion model developed by the UK consultancy CERC. The most up-to-date version of the model, ADMS 4.2, was used for this assessment.

Dispersion models, which are used to predict ground level pollutant concentrations, are commonly based on Gaussian Dispersion Theory. The simplest realisation of this is to imagine a puff of pollution being released by a point source. As the puff moves downwind away from the source it expands in volume, incorporating dilution air from around it, thereby reducing its concentration. A Gaussian distribution has the appearance of a bell-shaped curve with maximum concentration occurring along the plume centreline. The latest dispersion models replace the concept of discrete atmospheric stability classes with an infinitely variable measure of the surface heat flux. This influences the turbulent structure of the atmosphere and hence the dispersion of the plume.

A study by AEA[1] has provided a toolkit for local authorities in Greater London to assess the potential air quality impact of new biomass boiler installations. A set of nomographs is provided to estimate the required stack height to limit ground level pollution to an acceptable level, and where necessary, a correction calculation based on the 3rd Memorandum on Chimney Heights is provided. A similar set of nomographs was developed for inclusion in the latest air quality guidance documents for Local Authorities- LAQM.TG(09).

3.1 Mapping

East Lothian Council provided an OS Mastermap of the study area. This enabled accurate OS x,y grid references to be obtained for the study area as a whole, and specific features such as stack location, buildings, and local receptors to be accurately identified.

3.2 Meteorology

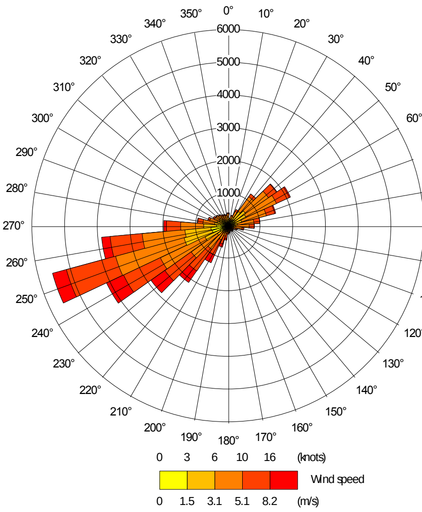
Hourly sequential meteorological data for the nearest suitable meteorological station with adequate data capture, Edinburgh Airport, was obtained for the three year period 2002 to 2006. The meteorological data provided information on wind speed, direction and the extent of cloud cover for each hour of the period.

Prevailing winds are mostly south-westerly with strongest winds being observed between 240° and 260°. The wind rose for 2002 - 2006 is shown in Figure 3.1.

A minimum Monin – Obukhov length of 30m was used as CERC recommend this value for use with mixed urban areas.

[1] Review of Potential Impact on Air Quality from Increased Wood Fuelled Biomass Use in London, AEA Energy and Environment, 2007

Figure 3.1 Edinburgh Airport Wind Roses for 2002-2006



3.3 Building parameters

Nearby buildings and complex topography can have a significant effect on the dispersion characteristics of a stack plume. The main effect can be to increase concentrations in the immediate vicinity of the building, while reducing concentrations further away. The estimated dimensions of the idealised buildings (Queen Margaret University main building) were input to the model to assess the effect of on-site buildings on dispersion. ADMS contains algorithms that account for these effects and these have been included in this exercise. Building locations and dimensions were added using the ADMS Mapper utility using a DXF base map to ensure correct location and orientation. The utility calculates the width, length and rotation of the buildings from the graphical input of the user. ADMS Mapper cannot model complex building shapes so the idealised buildings are rectangular. The building input data used in the assessment is provided in Table 3.1 below.

Table 3.1 Building Parameters as defined in ADMS

Building	Grid Reference at Centre X	Grid Reference at Centre Y	Height (m)	Length (m)	Width (m)
Biomass Unit Housing	333197.3	671346.7	3.5	17.8	21.1
QMU 1	333090	671367.8	15	44.8	21.0
QMU 2	333100.5	671412.8	15	12.6	48.5
QMU 3	333076.7	671424	15	21.9	28.3
QMU 4	333061.6	671407.7	15	51.6	24.5

3.4 Terrain and land use

The site is located in a flat area of East Lothian and has a typical elevation of around 30 m above sea level. The boiler house building is bounded by university and residential buildings situated to the north and east, with mainly open land to the south.

A surface roughness value of 0.5m was used as CERC suggest this is appropriate for open suburbia and parkland. Model default values were used for surface albedo (0.23) and the Priestley Taylor parameter (1).

3.5 Addition of background concentrations to modelled contribution

In order to assess the impact of emissions on local air quality using dispersion models it is necessary to add the modelled concentrations to background concentrations. If the impact on air quality is assessed in terms of pollutant concentrations averaged over a year, then the total concentration is the sum of the source and background averaged concentrations. However, serious effects of many air pollutants on human health arise from short-term peak concentrations rather than longer term averages. This is reflected in the AQS objectives, which, in terms of NO_2, are set in terms of the highest percentiles of hourly concentrations experienced in a year. For impacts assessed in this way, it is not appropriate to add the maximum-modelled source concentrations to the maximum background concentrations because they are unlikely to occur simultaneously.

Research carried out by the Environment Agency provided a method for addition of these components[2]. It was found that simple addition can overestimate the source contribution by a factor of up to two and that in general the overestimate is more severe for higher percentiles. Two additional methods were proposed- with the one used in this assessment being the twice-annual mean method. This takes the form:

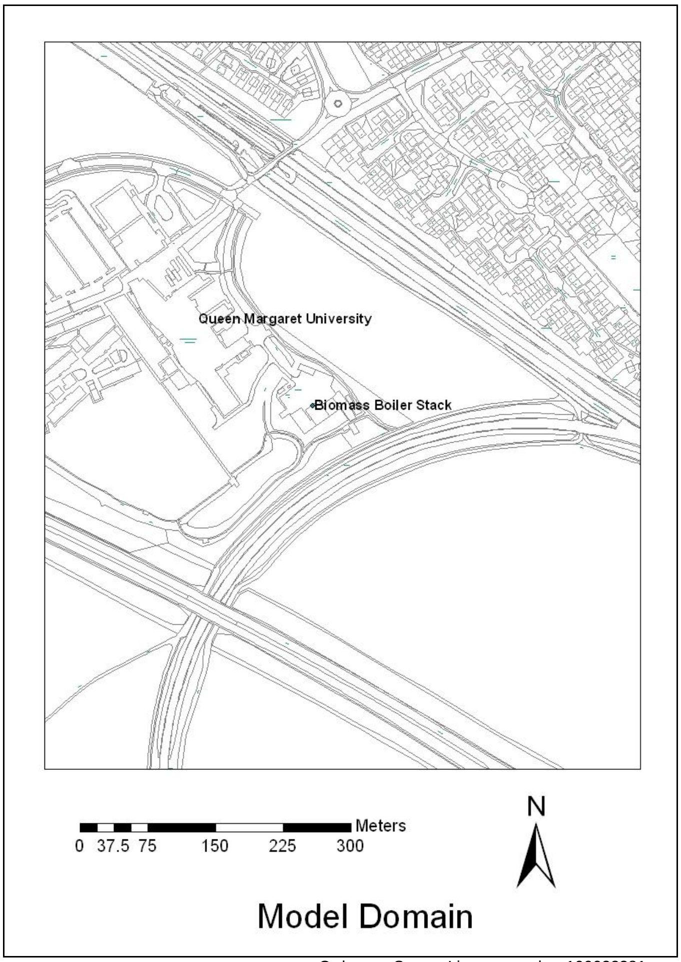
$$T_q = S_q + 2A_m$$

S is the source concentration, *A* is the background concentration, *T* is the sum of the two, *q* is the required percentile, and *m* is the annual mean.

3.6 Model domain

The domain comprises a 1km square, centred on the existing biomass boiler stack (grid ref. 333192,671354). The extent of the study area is shown in Figure 3.2 below.

Figure 3.2: Extent of Model Domain



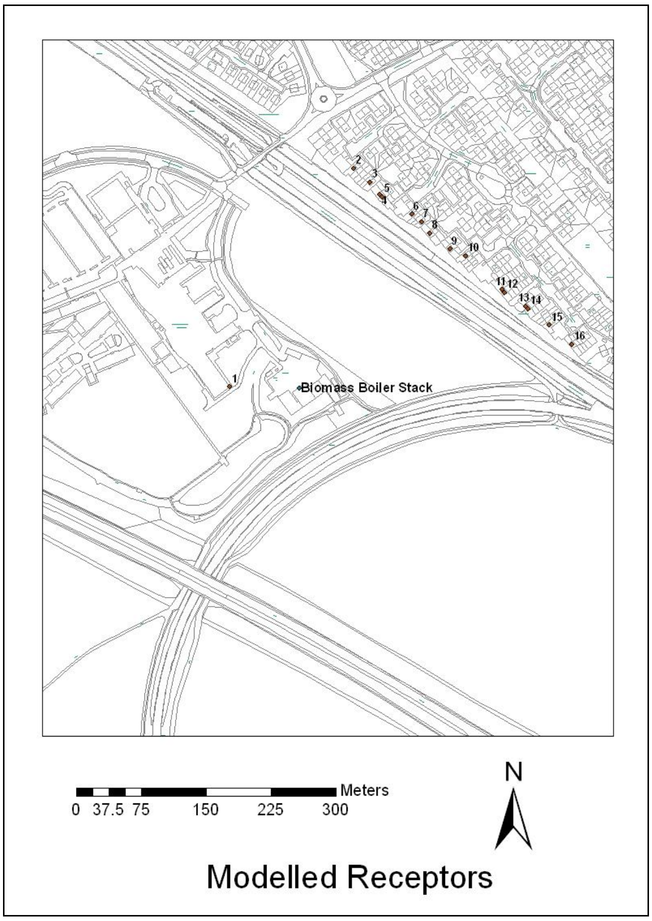
[2] Environment Agency Research and Development Technical Report: P361 Addition of Background Concentrations to Modelled Concentrations from Discharge Stacks

A grid resolution of 20m was used resulting in 50 points in both x and y directions. This resulted in a model output with 2500 separate concentration estimates for each iteration. In addition to the 20m grid, and within the area immediately surrounding the school, relevant receptors were selected by AEA. These are listed in Table 3.2 below, and shown in Figure 3.3.

Table 3.2 Modelled Receptor Coordinates

Receptor ID	OS x,y
1 (QMU worst case location)	333112,671356
2 (Residential)	333255,671608
3 (Residential)	333274,671592
4 (Residential)	333285,671578
5 (Residential)	333288,671575
6 (Residential)	333322,671555
7 (Residential)	333333,671546
8 (Residential)	333343,671533
9 (Residential)	333366,671515
10 (Residential)	333384,671507
11 (Residential)	333426,671468
12 (Residential)	333429,671465
13 (Residential)	333453,671449
14 (Residential)	333456,671446
15 (Residential)	333480,671427
16 (Residential)	333506,671405

Figure 3.3 Modelled Receptor Locations



Ordnance Survey Licence number 100023381.

The grid reference of each receptor was input to the model to obtain predicted concentrations of the pollutants of interest at these properties. This approach ensures information can be provided for the properties most likely to see concentration increases. The high resolution of the automatically generated 20m grid is sufficiently detailed to estimate concentrations at the majority of surrounding properties which lie further away from the biomass boiler stack and that were not explicitly input to the model.

3.7 Boiler specifications

The in-situ boiler is a Kohlbach K8 1500kW wood chip boiler, for which specifications were provided by East Lothian Council and Queen Margaret University. All pollutant emission rates used in the model have been provided from a boiler test report provided to East Lothian Council from Buccleuch Bioenergy. Key boiler specifications used in the modelling exercise are presented in Table 3.4. It should also be noted that the model represents a conservative estimate of boiler emissions as the boiler will not run at full capacity 24 hours a day, 365 days per year. Additionally, velocity has been calculated based on available information such as heat output and flue exhaust diameter.

Table 3.4 Biomass boiler specifications

Boiler specification	
Heat output	1500kW
Flue gas velocity	10.9 m/s
Flue diameter	500 mm
Flue gas temperature	151^{o}C

3.8 Stack parameters

Emissions of NO_x and PM_{10} from the existing biomass boiler will originate from one stack. The stack has been modelled based on the current stack height of 6.8 m. Pollutant emission rates are provided in Table 3.5, and are expressed in g/s. Stack height was modelled using the same emissions data.

Table 3.5 Stack emission rates

Pollutant	Emission rate (g/s)
NO_x	0.21
PM_{10}	0.11

The stack location is a fixed parameter and does not change in the modelled scenario, and is at OS Grid X (m) 333192, Y (m) 671354. The dispersion modelling assessment is based on parameters of the existing biomass boiler and stack.

All PM_{10} emissions and modelled concentrations were compared with the relevant PM_{10} objectives. Additionally, a conservative approach to assessing NO_2 has also been used; 100% of NO_x emissions are assumed to completely convert to NO_2 on leaving the stack so modelled results will be compared with the relevant NO_2 objectives. This represents a conservative approach to predicting NO_2 as it is likely a portion of the emitted NO_x will not convert fully within the model domain. In addition, it is very unlikely the boiler will operate 24 hours a day which lends additional conservatism to the assessment.

4 Dispersion Modelling Results

The dispersion model has been used to predict ground level concentrations across the domain providing concentration estimates for 2500 points. In addition to their ground level concentrations being modelled explicitly, nearby residential receptors were also assigned a height relative to the number of storeys for each building to assess the concentrations that could be encountered on the (where relevant) first floor of these properties.

Results are presented for the highest predicted concentrations across the domain and at designated receptors for the modelled stack height of 6.8 m. See table 4.1 for details.

Additionally, contour maps showing the contribution of the boiler to local concentrations of PM_{10} and NO_2 are provided in Figures 4.1-4.4. Figure 4.5 shows the locations of maximum modelled concentrations.

4.1 Results

PM_{10} Annual Mean

For the PM_{10} annual mean, the maximum stack contribution predicted at any ground level location within the grid of receptor points (1kmx1km) is **6.1 $\mu g/m^3$** located at an area immediately to the east of the Biomass Boiler House. This equates to 34% of the PM_{10} objective. When background for PM_{10} (12.8 $\mu g/m^3$) is added to the stack contribution, a value of **18.9 $\mu g/m^3$** is derived. This equates to 105% of the annual mean objective for PM_{10}, however this is not an area where continuous exposure is expected and information is included for completeness.

The maximum stack contribution predicted at any of the receptors was observed at Receptor 1 (South East corner of main QMU building), and is around **1.0 $\mu g/m^3$**. This equates to 6% of the PM_{10} objective. When combined with the 2009 annual background, a value of **13.8 $\mu g/m^3$** is derived, which equates to 77% of the PM_{10} objective.

Details of concentrations at other receptors are shown in Table 4.1. Annual mean PM_{10} predictions for this stack height are presented spatially in the contour plot in Figure 4.1.

PM_{10} Short Term 24hr Mean

For the particulate 24 hr mean, the maximum 98.08 percentile stack contribution predicted at any ground level location within the grid of receptor points is **32.4 $\mu g/m^3$** located at an area immediately to the east of the Biomass Boiler House. This is equivalent to 65% of the 24 hour mean objective. When this is added to twice the annual background for 2009 (25.6 $\mu g/m^3$) a value of **58.0 $\mu g/m^3$** is derived which is equivalent to 116% of the objective, however this is not an area where continuous exposure is expected and information is included for completeness.

The maximum stack contribution predicted at any of the additional receptors was observed at Receptor 1, and is around **13.8 $\mu g/m^3$**. This is equivalent to 28% of the 24 hour mean objective. When this is added to twice the annual background for 2009 (25.6 $\mu g/m^3$) a value of **39.4 $\mu g/m^3$** is derived which is equivalent to 79% of the objective.

Details of concentrations at other receptors are shown in Table 4.1. 24 hour mean PM_{10} predictions for this stack height are presented spatially in the contour plot in Figure 4.2.

NO_2 Annual Mean

For the NO_2 annual mean, the maximum stack contribution predicted at any ground level location within the grid of receptor points is **11.7 $\mu g/m^3$** located at an area immediately to the east of the Biomass Boiler House. This equates to 29% of the NO_2 objective. When the 2009 background concentration (13.7 $\mu g/m^3$) is added to the stack contribution, a value of **25.4 $\mu g/m^3$** is derived. This equates to 64% of the annual mean objective for NO_2, however this is not an area where continuous exposure is expected and information is included for completeness.

The maximum stack contribution predicted at any of the receptors was observed at Receptor 1, and is around **2.0 μg/m³**. This equates to 5% of the NO_2 objective. When combined with the 2009 annual background, a value of **15.7 μg/m³** is derived, this equates to 39% of the NO_2 objective.

Details of concentrations at other receptor are shown in Table 4.1. Annual mean NO_2 predictions for this stack height are presented spatially in the contour plot in Figure 4.3.

NO_2 Short Term 1hr Mean

For the NO_2 1 hour mean, the maximum 99.8 percentile stack contribution predicted at any ground level location within the grid of receptor points is **66.2 μg/m³** located east of the Biomass Boiler House. This is equivalent to 33% of the 1 hour mean objective. When this is added to twice the annual background for 2009 (27.4 μg/m³) a value of **93.6 μg/m³** is derived which is equivalent to 47% of the objective, however this is not an area where continuous exposure is expected and information is included for completeness.

The maximum stack contribution predicted at any of the additional receptors was observed at Receptor 1, and is around **15.7 μg/m³**. This is equivalent to 8% of the 1 hour mean objective. When this is added to twice the annual background for 2009 a value of **43.1 μg/m³** is derived which is equivalent to 22% of the objective. It should be noted that a very conservative assessment technique has been used so it is likely that the NO_2 concentrations described will be overestimates as some proportion of the released NO_x will not convert to NO_2 in the domain.

Details of concentrations at other receptor are shown in Table 4.1. 1 hour mean NO_2 predictions for this stack height are presented spatially in the contour plot in Figure 4.4.

Table 4.1: Details and Concentrations at various specified receptors based on 6.8 m-stack height

Receptor ID	Background NO_2 (μg/m³)	Background PM_{10} (μg/m³)	Process contribution NO_2 Annual Mean (μg/m³)	Process contribution NO_2 99.8 %ile (μg/m³)	Process contribution PM_{10} Annual Mean (μg/m³)	Process contribution PM_{10} 98.08 %ile (μg/m³)
1	13.7	12.8	1.99	15.71	1.04	13.84
11	13.7	12.8	1.97	4.83	1.03	4.49
12	13.7	12.8	1.97	4.67	1.03	4.54
13	13.7	12.8	1.80	5.05	0.94	4.44
14	13.7	12.8	1.77	5.00	0.93	4.42
10	13.7	12.8	1.66	5.26	0.87	4.18
9	13.7	12.8	1.55	5.36	0.81	4.54
15	13.7	12.8	1.48	5.28	0.78	3.81
8	13.7	12.8	1.24	5.51	0.65	3.94
16	13.7	12.8	1.18	5.35	0.62	3.42
7	13.7	12.8	1.04	5.11	0.54	4.08
6	13.7	12.8	0.90	5.03	0.47	3.91
5	13.7	12.8	0.59	4.78	0.31	3.31
4	13.7	12.8	0.56	4.83	0.29	3.21
3	13.7	12.8	0.45	4.69	0.24	3.04
2	13.7	12.8	0.33	4.26	0.18	2.46

4.2 Dispersion Contour Plots

The results of the modelling exercise for PM_{10} and NO_x (NO_x has been conservatively assumed to completely convert to NO_2) are presented spatially for the existing stack height of 6.8 m (from ground level) in Figures 4.1-4.4. Results are presented as process contribution in $\mu g/m^3$.

Figure 4.1: PM_{10} Annual Mean Spacial Distribution

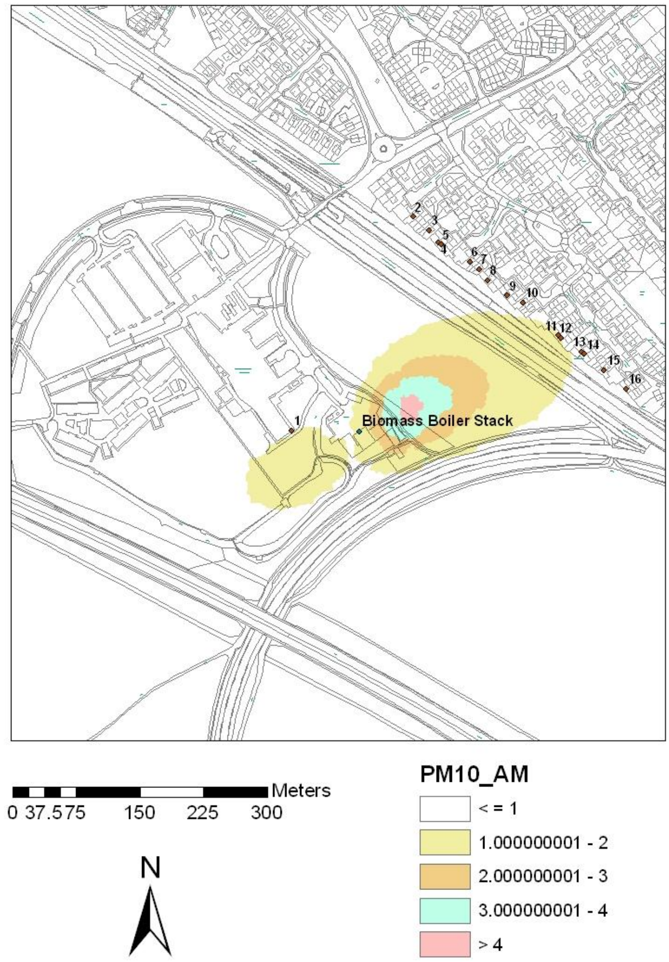
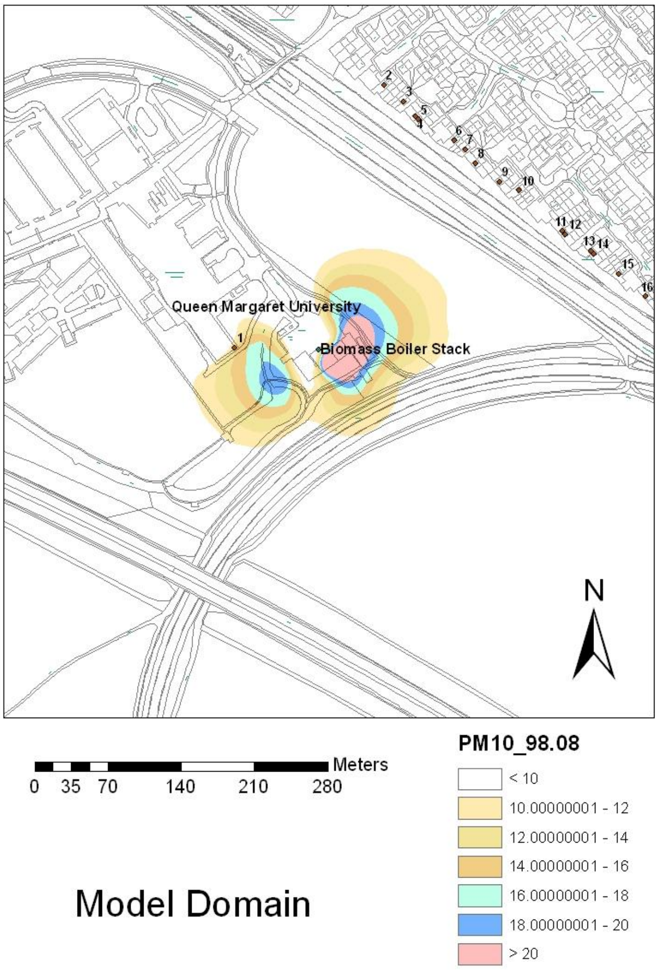
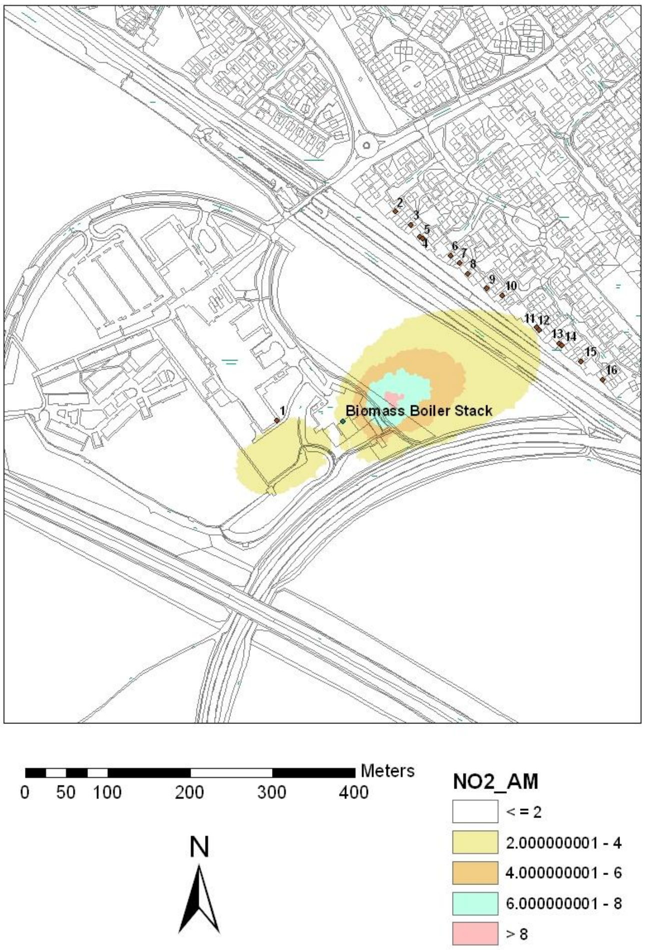


Figure 4.2: PM_{10} 98.08th percentile distribution



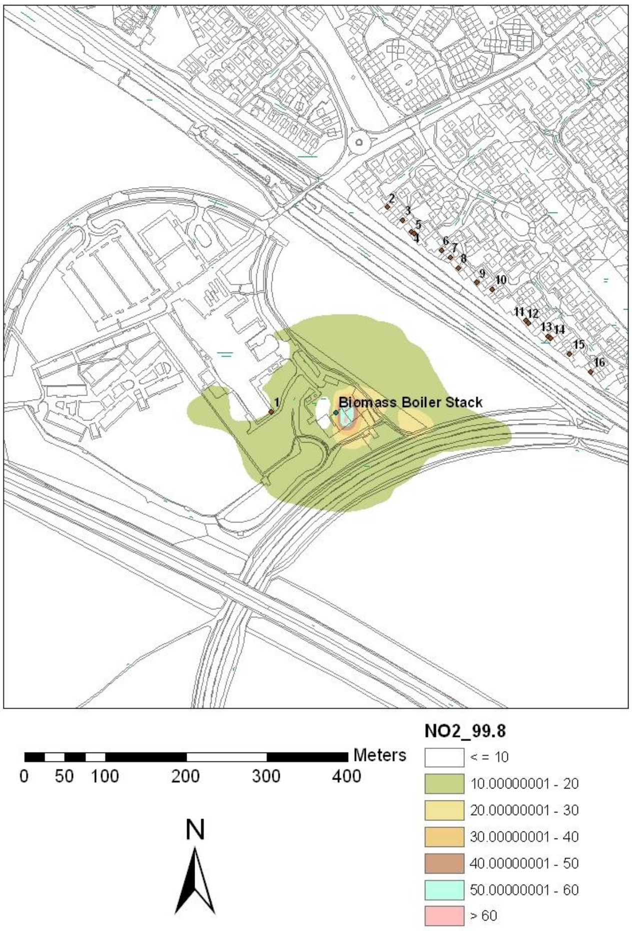
Ordnance Survey Licence number 100023381.

Figure 4.3: NO_2 Annual Mean Spacial Distribution



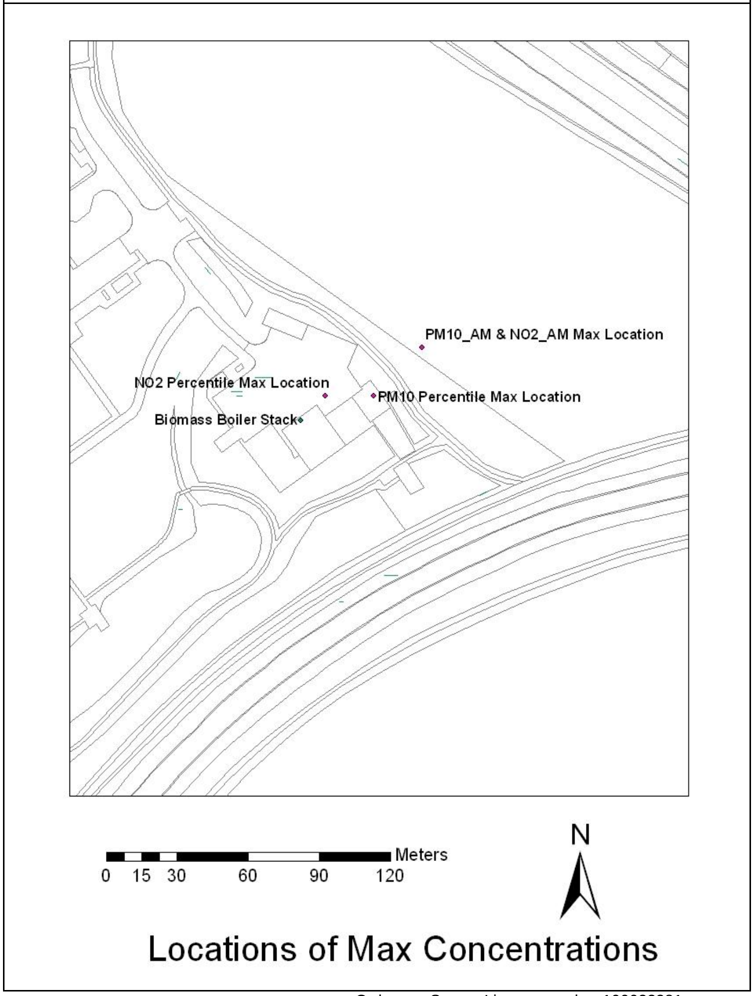
Ordnance Survey Licence number 100023381.

Figure 4.4: NO_2 99.8th percentile distribution



Ordnance Survey Licence number 100023381.

Figure 4.5: Locations of Modelled Maximum Concetrations



Ordnance Survey Licence number 100023381.

5 Conclusions

Atmospheric Dispersion Modelling System (ADMS) Version 4.2 was used to predict the air quality impact of the proposed Woodpecker 1500kW biomass burning boiler on the locality surrounding Queen Margaret University, in Musselburgh. A constant emission scenario has been assumed to produce a conservative assessment of air quality impact. Concentrations of NO_2 and PM_{10} have been predicted for an existing stack height of 6.8 m above ground level.

The results indicate that the boiler emissions will not result in any exceedences of the AQS objectives for NO_2 and PM_{10} at identified discrete receptors, indeed the process contributions are typically a small percentage of the overall AQS objectives.

Glengarnock Technology Centre
Caledonian Rd
Lochshore Business Park
Glengarnock
Ayrshire
KA14 3DD

Tel: 0845 345 3302
Fax: 0870 190 5051

E-mail: info@aeat.co,uk

www.aeat.co.uk