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THE CITY OF EDINBURGH COUNCIL

Detailed Assessment of Particles for City of Edinburgh Council 2016

In fulfilment of Part IV of the Environment Act 1995

(Local Air Quality Management)

June 2016

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Executive Summary

This report fulfils the requirements of the Local Air Quality Management (LAQM) process as set out in Part IV of the Environment Act 1995 and has been completed in accordance with LAQM Technical Guidance (TG16) produced by DEFRA and the Devolved Administrations.

The report has considered the following key sources of particulate matter which are likely to contribute to exceedances of the air quality objectives in the administrative area of Edinburgh:

- Road traffic exhaust emissions.
- Fugitive emissions from stockpiling and handling of aggregate material at Leith Docks.
- Poultry Farms.

PM_{10} and $PM_{2.5}$ monitoring data from a number air quality monitoring stations located at background and busy roadside sites in Edinburgh have been reviewed, including roadside modelled data derived from the Pollution Climate Mapping (PCM) model.

PM_{10} and $PM_{2.5}$ monitoring data meets with the Scottish Air Quality Objectives apart from the roadside location at Salamander Street. This location fails to comply with the PM_{10} annual mean concentration of 18µg/m^3 and the permitted number (7) of daily mean exceedances of 50µg/m^3.

There is evidence from the assessment of measured data, polar plots and visual observations within and adjacent to Leith Docks to suggest that activities regarding handling and storage of open material are a contributory factor to the elevated PM_{10} concentrations at Salamander Street.

PM_{10} (2014) data from the PCM model shows that a number of road sections on the A8 corridor and A702 (Tollcross) are at the current air quality objective of 18µg/m^3. Also, the majority of roadside locations are either at or exceed the revised $PM_{2.5}$ air quality annual mean standard of 10µg/m^3.

Although the PCM model has identified a number of road sections in Edinburgh which may exceed the $PM_{2.5}$ air quality standard; Scottish Local Authorities are not required to declare Air Quality Management Areas (AQMAs) until robust measured data becomes available from future $PM_{2.5}$ monitoring networks.

Annual mean PM_{10} and $PM_{2.5}$ concentrations from all monitoring stations are decreasing over time, which illustrates a downward trend. However, data from the monitoring stations at Queensferry Road and St Leonards requires to be viewed with caution due to poor data capture over successive years. Also data capture was poor at the Currie location in 2015.

The revised screening tool for assessment of poultry farms identified that breaches of the Scottish PM_{10} daily mean standard were likely at all relevant receptors within the site boundary of the farms and that a number of residential properties outside the boundaries would also be affected. Two poultry farms, Gogarburn and Easter Norton were also likely to exceed the UK daily mean objective.

PM_{10} monitoring equipment has been deployed adjacent to cottage 2 at Gogarburn Poultry Farm which represents a worst case scenario. Interim data which has been gathered from the Partisol unit implies that PM_{10} Scottish Air Quality Objectives are likely to be achieved at this location and therefore an AQMA will not be necessary. It is likely that the screening tool is conservative. A full report will be submitted to the Scottish Government on completion of this study.

The report concludes that it will be necessary to declare an AQMA at Salamander Street to incorporate the predicted area of PM_{10} exceedances based on the modelling study undertaken by Environmental Consultants, Ricardo on behalf of the Council.

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1.0 Introduction

1.1 Particulate Matter (PM_{10} and $PM_{2.5}$)

Fine particles are described by their size, those which are 10 micro metres in diameter or less are known as PM_{10} and particles which are 2.5 micro metres in diameter or less are referred to as $PM_{2.5}$. $PM_{2.5}$ forms part of the overall PM_{10} fraction.

Fine particulate matter can penetrate deep into the lungs and pass into the blood stream. It is a ‘non-threshold pollutant’ meaning, there is no safe concentration in ambient air which does not adversely affect health. Medical studies have shown that exposure can cause cancer, have an adverse impact on the respiratory system and precipitate heart attacks and strokes.

In Scotland, 3.9% of all deaths are attributed to long-term $PM_{2.5}$ exposure.[1]

Particles are derived from a wide range of sources for example, emissions from combustion processes, including transport and re suspended dust from movement of road vehicles. Particles also arise from abrasive processes such as aggregate handling, construction activities and poultry farm activities. These types of source are referred to as primary particles. Secondary particles are formed by chemical reactions in the atmosphere and are mainly composed of sulphates and nitrates.

Fine particles are transboundary and therefore concentrations which are measured in Edinburgh are not all locally derived but can originate from secondary sources and combustion processes in Europe as well as dusts blown from the Sahara and ash from volcanic eruptions.

Scotland has adopted more onerous standards for PM_{10} and $PM_{2.5}$ in comparison to the rest of the UK and European Union (EU), thus providing greater protection for its citizens and visitors. It is the Scottish Government’s intention to align the current annual mean standards for particles with the World Health Organisation (W.H.O) recommendations.

Under a refocused LAQM regime Scottish Local Authorities are now responsible for monitoring, reporting and taking necessary action on the $PM_{2.5}$ fraction of particulate matter. This will require a network of $PM_{2.5}$ monitors to be established under the direction of the Scottish Government.[2]

Local sources and activities identified in Edinburgh which may lead to non compliance of the PM_{10} air quality objectives include emissions from road traffic, fugitive emissions from stockpiling activities at Leith Docks and poultry farms.

1.2 Background Summary

A city-wide Detailed Assessment (DA) for fine particles (PM_{10}) was undertaken in 2004 by City of Edinburgh Council. This was prompted by:

- Tightening of Scottish Air Quality Objectives for PM_{10} from an annual mean concentration of 40µg/m^3 to 18µg/m^3.
- The uncertainty associated with the application of a national gravimetric factor to PM_{10} monitoring data to account for the loss of volatile components.
- The lack of local background data.

The European Union (EU) reference method for monitoring PM_{10} is a gravimetric sampler, whereby particulate matter is collected on a filter and weighed. This takes account of volatile material. In the UK, the Tapered Element Oscillating Membrane (TEOM) instrument is widely used. The operational temperature of the unit can result in the loss of volatile material namely sulphates and nitrates, leading to an underestimated concentration of PM_{10}. To take account of this, local authorities were at the time advised to apply a national correction factor (1.3) to the TEOM data.

The gravimetric equivalence factor of 1.3 was considered conservative. Therefore, the key component of the DA involved the co-location of a partisol gravimetric sampler with a TEOM instrument at a roadside location to determine a local gravimetric factor. Additional background monitoring was also undertaken at a suburban location to adjust the UK background maps.

The DA illustrated that the national gravimetric factor applied to TEOM data over estimated the annual mean concentrations and subsequently a new local factor of 1.14 was derived.

Application of the 'new' locally derived gravimetric equivalence factor to TEOM measured data and use of adjusted background maps to reflect suburban monitoring data showed that PM_{10} concentrations would be achieved city-wide based on 2003 monitoring and therefore the compliance date of 2010 would be met.

The report also concluded that there was no correlation between NO_x and PM_{10} roadside concentrations, indicating that local traffic was not a dominant source and that air borne long range transport of PM_{10} i.e. from Europe was likely to influence the overall concentrations in Edinburgh. In addition, PM_{10} concentrations were elevated when the wind was blowing from, an easterly, south easterly and southerly direction and analysis of ions obtained from exposed filters indicated that concentrations of sulphate and nitrate were highest when overall PM_{10} concentrations were elevated and vice versa. This suggested that periods of higher PM_{10} concentrations in Edinburgh are being driven by secondary particulate episodes.[3]

Annual mean PM_{10} monitoring concentrations measured at St Leonards AURN urban background location increased in 2006 and 2007 to 18µg/m^3 with the application of the local derived gravimetric factor (1.14). Roadside monitoring at Haymarket and

Queen Street also exceeded the annual mean objective, identifying a need to undertake a further DA.

In 2008, DEFRA started a programme of replacing TEOM instruments with Filter Dynamic Measurement System units (FDMS) throughout the AURN monitoring network. New technical guidance was also issued to local authorities in 2009 on use of the Volatile Correction Model (VCM) for correcting TEOM data.

Monitoring PM_{10} using FDMS units and VCM corrected TEOM data has generally led to lower concentrations across the UK monitoring networks, including Edinburgh.

Background pollution maps specific for Scotland were also produced in 2008 which local authorities are advised to use in their studies.

Based on PM_{10} 2007 measured data, it was considered that the majority of the urban area in Edinburgh would fail the Scottish Objectives and it would be prudent to monitor on busy roads on the outskirts of Edinburgh. However, relocation of the Air Quality Station from Roseburn to Glasgow Road was fraught with many problems including connection to a mains power supply and in 2010 the unit was damaged when it was blown over in high winds. Technical problems also ensued with the newly installed FDMS units at the AURN background site at St Leonards and Queensferry Road resulting in poor data capture. This made it difficult to provide a robust assessment from the data gathered which has contributed to the delay of the DA report.

1.3 Detailed Assessment Approach

With respect to a change in the monitoring methodology and latest PM_{10} measured data it is unlikely that an AQMA will be required for the entire administrative area of the city as previously thought.

Therefore this DA study will assess and evaluate the following:

- Roadside measured data and the modelled Pollution Climate Mapping (PCM) data which is used by DEFRA to inform the EU Commission on UK wide pollution concentrations.
- Data trends.
- Fugitive sources handling and storage of materials Leith Docks and adjacent areas.
- Poultry farms.

Particulate Monitoring and Modelling (PM_{10} and $PM_{2.5}$)

2.1 PM_{10} and $PM_{2.5}$ Air Quality Objectives and EU Limit Values

Scottish Local Authorities are now required to review and assess $PM_{2.5}$ under the LAQM regime. In April 2016 the Scottish Government also tightened the annual mean $PM_{2.5}$ standard concentration from 12µg/m^3 to 10µg/m^3.

Therefore, it was deemed appropriate to include $PM_{2.5}$ data and relevant standards in this report.

EU Limit Values and UK and current Scottish Air Quality Objectives for particles are shown in Table 2.1. The EU limit values for particles are in keeping with the UK domestic objectives.

Table 2.1 Air Quality Objectives and W.H.O recommended standards for Particles

Pollutant	Status	Concentration in Ambient air	Measured as	To be achieved by
PM_{10}	*Scottish Statutory Air Quality Objective	18 µg/m^3 50 µg/m^3 not to be exceeded more than 7 times a year	Annual mean Daily mean	2010 2010
	Statutory UK Objective and EU limit values	40 µg/m^3 50 µg/m^3 not to be exceeded more than 35 times a year	Annual mean Daily mean	2004 2004
	W.H.O Recommended Standards	20 µg/m^3	Annual mean	2020
$PM_{2.5}$	Scottish Local Authorities	10 µg/m^3	Annual mean	2020
	Statutory UK Objective and EU limit values	25 µg/m^3 15% reduction in urban background	Annual mean	2020 2010-2020
	W.H.O Recommended Standards	10 µg/m^3	Annual mean	2010

* Scottish Government propose to align with W.H.O recommendations

W.H.O recommended guidelines for the protection of human health are also detailed in the table.

2.2 Monitoring sites

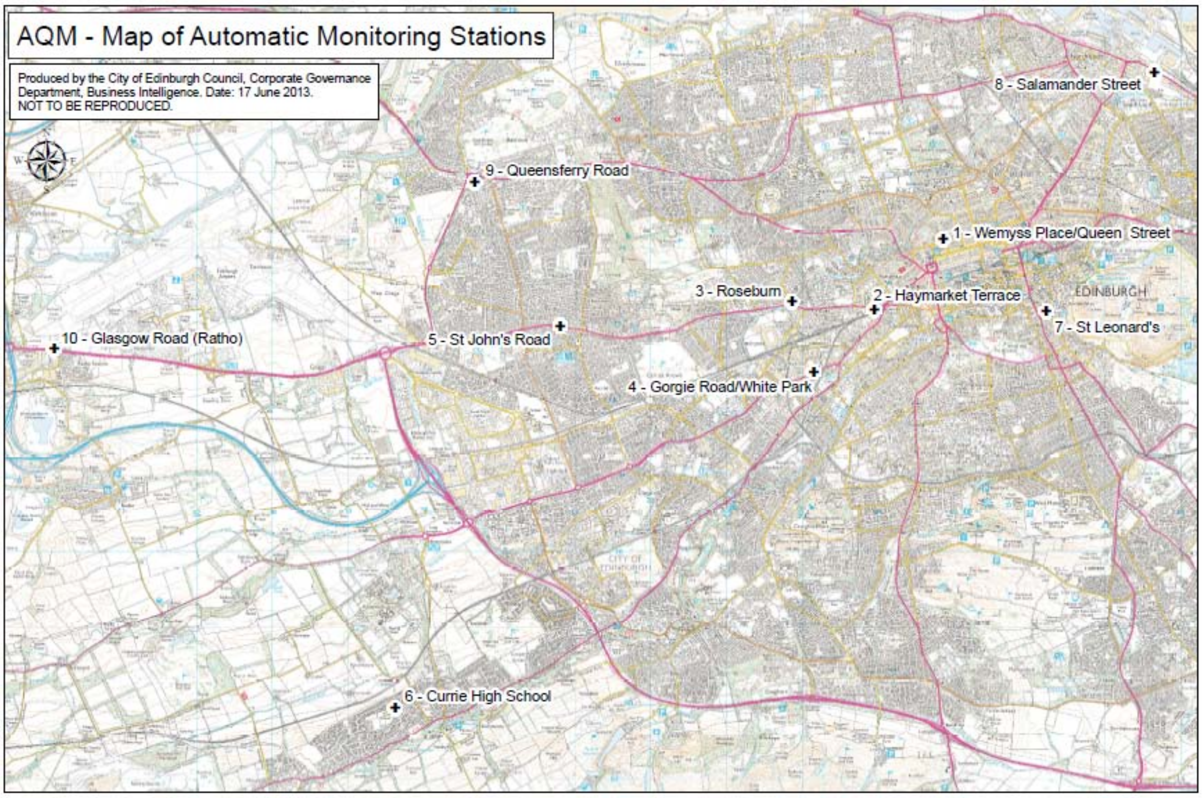
City of Edinburgh Council currently has eight Air Quality Monitoring Stations (AQMSs) six of which measure PM_{10}. One of the sites St Leonards, also measures $PM_{2.5}$. Monitoring site descriptions are summarised in Table 2.2 and site locations are illustrated in Figure 2.1. A detailed description of distances to relevant exposure and monitoring techniques deployed at each of the site locations are shown in Appendix 2

Table 2.2 Description of $PM_{10/2.5}$ monitoring (current and historic) locations

Site ID	Site Name	Description of Monitoring Location
ID1	Queen Street	Roadside on pavement in line with residential property located 5.2m from road edge. No buildings at rear of unit.
ID2	Haymarket*	Roadside located in a car parking bay at Haymarket Station. 9.2m from road edge, set back from the facade of adjacent residential property. Not in street canyon
ID3	Roseburn*	Roadside located on footbridge over Water of Leith 7.6m from road edge. Set back from line of residential property. Not in street canyon.
ID6	Currie High School	Suburban/ semi rural located adjacent to school building at rear of school
ID7	St Leonards	Urban background. Located in small park area adjacent to Medical Centre 45m from nearest main road
ID8	Salamander Street	Roadside. Located on pavement 2.13m from road edge, in line with adjacent residential property.
ID9	Queensferry Road	Roadside. Located on pavement 1.7m from busy road edge and adjacent bus stop. 6.5m in front of residential property.
1D10	Glasgow Road	Roadside on recreational land 6m from A8 eastbound carriageway, in line with nearby residential properties.

* Historical monitoring sites

Figure 2.1 Map of current and historical automatic monitoring sites



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2.3 Measured and Modelled (PCM) results

2.3.1 Comparison of measured results with Air Quality Standards.

Current and historical monitoring data gathered from background and roadside AQMSs is shown in Table 2.3 and 2.4. Where appropriate all TEOM data has been corrected using the VCM model in accordance with Technical Guidance LAQM TG16. Early data has been corrected using both Edinburgh's local gravimetric factor (1.14) and the national factor (1.3).

Current PM_{10} annual mean measured data from the AQMSs meet with the EU Limit Values and Scottish PM_{10} Air Quality Standard (18µg/m^3) except Salamander Street. This location has failed to comply with Scottish Objectives since monitoring commenced. Further assessment of this site is detailed in Section 3.0.

There is uncertainty in the data sets obtained from the FDMS unit at Queensferry Road due to poor data capture over successive years. However, based on available monitoring data this location failed to meet the annual mean standard in 2011, 2013 and 2014, but met in years 2012 and 2015 when data capture was 86% and 87%

respectively. PM_{10} concentrations obtained from the PCM model also comply at this location.

Table 2.3 PM_{10} and $PM_{2.5}$ annual mean measured concentrations in µg/m^3

Site	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
St Leonards Urban background AURN (ID 7)										
PM_{10}	18* (20)	18* (20)	15	*17*	14	15	*16*	14	*13*	-
Data capture	98%	97%	97%	*53%*	95%	99%	*68%*	94%	*71%*	*45%*
$PM_{2.5}$	N/A	N/A	N/A	8	9	12	*11*	8	*9*	*6*
Data capture				95%	94%	98%	72%	98%	*66%*	*86%*
Currie Suburban background (ID 6)										
PM_{10}	12* (14)	N/A	N/A	N/A	11	13	11	*12*	11	*9*
Data capture	90%				98%	99%	98%	*64%*	98%	*77%*
Queen Street Roadside (ID1)										
PM_{10}	21* (24)	20* (23)	19	18	18	16	16	17	17	15
Data capture	<90%	*87%*	*84%*	96%	96%	94%	94%	96%	96%	98%
Haymarket Roadside (ID2)										
PM_{10}	20* (23)	19* (22)	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Data capture	90%	*88%*	*86%*							
Roseburn Roadside (ID3)										
PM_{10}	18* (20)	16 (19)	16	15	15	15	N/A	N/A	N/A	N/A
Data capture	91%	98%	90%	99%	99%	61%				
Salamander Street Roadside (ID8)										
PM_{10}	N/A	N/A	N/A	*22*	26	26	23	22	21	20
Data capture				27%	97%	97%	96%	94%	98%	90%
Queensferry Road Roadside (ID9)										
PM_{10}	N/A	N/A	N/A	N/A	N/A	*21*	*18*	*19*	*19*	*16*
Data capture						*63%*	*86%*	*77%*	*68%*	*87%*
Glasgow Road Roadside (ID10)										
PM_{10}	N/A	N/A	N/A	N/A	N/A	N/A	*15*	16	16	15
Data capture							*32%*	97%	97%	97%

Notes for table overleaf

Table 2.4 Number of daily exceedances of PM_{10} (50µg/m^3)

Site	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
St Leonards Urban Background (ID 7)										
	2	6	0	2	1	0	2(40)[A]	3	0	-
Currie Suburban Background (ID 6)										
	N/A	N/A	N/A	N/A	0	0	0	0	0	0
Queen Street Roadside (ID 1)										
	2	4	0	1	1	0	2	2	1	2
Haymarket Roadside (ID 2)										
	6	7	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Roseburn Roadside (ID 3)										
	2	6	0	0	0	0	N/A	N/A	NA	N/A
Salamander Street Roadside (ID 8)										
	N/A	N/A	N/A	*2**	19	22	13	5	5	8
Queensferry Road Roadside (ID 9)										
	N/A	N/A	N/A	N/A	N/A	2	3	2	1	1
Glasgow Road Roadside (ID 10)										
	N/A	N/A	N/A	N/A	N/A	N/A	0	1	0	1

Notes

*TEOM data adjusted with local gravimetric factor 1.14.

Data in brackets represents concentration of TEOM data with national gravimetric equivalence factor of 1.3 applied.

TEOM was replaced by a FDMS unit in July 2007 at St Leonards. However, due to instability of FDMS data, for purposes of reporting data for 2007 is based on 6 months of TEOM data corrected using both national and local gravimetric factors.

Data in italics represents less than 90% data capture.

The AURN monitoring unit at St Leonards was decommissioned for 4 months (September to December 2014) due to fitment of a new enclosure.

In 2015 the FDMS dryer developed an undetected fault at the AURN which led to a substantial amount of data being removed.

Data highlighted in red indicates that concentration is at or exceeded an air quality objective.

[A] If data capture for full calendar year is less than 90% include 98.1th percentile of 24- hour means in brackets (expressed in µg/m^3).
QC/QA of data is undertaken by Ricardo on behalf of Scottish Government.

All monitoring locations currently meet the annual permitted number of exceedances of the daily mean standard (50µg/m^3) apart from Salamander Street. This location failed to comply in 2010, 2011, 2012 and 2015.

To assess EU compliance with $PM_{2.5}$ a FDMS unit was installed within the AURN unit at the urban background location, St Leonards. The range of annual mean concentrations has ranged between 6 µg/m^3 and 12µg/m^3 since 2009. This location met with the revised annual mean standard of 10µg/m^3 for all monitoring years, apart from 2011 and 2012.

Data capture for particles at St Leonards was low in 2014 due to decommissioning of the monitoring station to provide a new housing enclosure. During 2015 data capture for PM_{10} was very low 45% due to a faulty dryer.

Data has not been annualised at sites where data capture was poor, due to lack of suitable background data and sporadic nature of data collection.

All monitoring data contained in this report has been subject to quality assurance and quality control procedures undertaken by Environmental Consultants, Ricardo on behalf of the Scottish Government.

2.3.2 Comparison of modelled results (PCM) with air quality standards

Each year the UK Government and Devolved Administrations report on a range of pollutants to the European Commission. PM_{10} concentrations are based on a modelling method known as the Pollution Climate Mapping Model. This data has recently become available to local authorities and is reported on the DEFRA air quality web site. The link to the PCM is shown below;

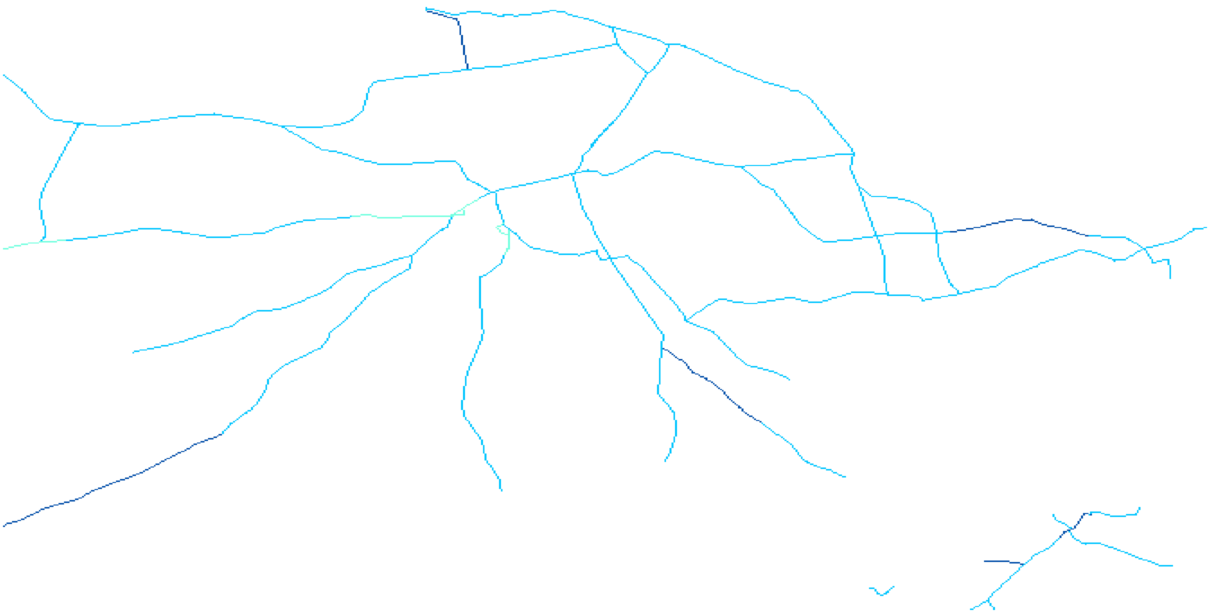
http://uk-air.defra.gov.uk/data/gis-mapping

Not all roads are assessed under EU requirements, for example B roads and roads which are less than 100m in length. The Scottish Government considers this data for the Edinburgh Urban agglomeration appropriate for use in this assessment.

Modelled roadside annual mean concentrations obtained from the PCM assessment shows that there are a number of roads which are at the current PM_{10} Scottish annual mean Air Quality Objective of 18µg/m^3 in 2014. At the time of reporting the latest modelled data available was for year 2014.

An outline of roads modelled is shown in Fig 2.2 and the associated PCM data is detailed in Table 2.5.

Figure 2.2 Road network modelled for Edinburgh Urban Agglomeration PCM Assessment



PM_{10} µg/m^3 concentration 2014

< 13	
13 - 17	
17 - 20	

Table 2.5 Annual mean roadside PM_{10} and $PM_{2.5}$ concentrations derived from PCM model for 2013 and 2014.

Location	Roadside PM_{10}		Roadside $PM_{2.5}$	
	2013	2014	2013	2014
A 900				
Leith Walk	17	16	12	11
A901				
Gt Junction Street	16	15	11	11
Lindsay Road	14	14	10	10
A8:				
Gogar/Gyle	19	18	12	12
Haymarket Terrace	18	18	12	12
West Coates	18	18	12	12
West Maitland Street	18	18	12	12
Morrison Street	18	18	12	12
Shandwick Place	18	18	12	12
St Johns Road	16	16	10	10
Princes Street	17	16	11	11
A70				
Dalry	17	16	11	11
Slateford Road	15	15	10	10
Lanark Road West/Currie	13	13	9	9
A71				
Calder Road	17	16	11	11
Gorgie Road	15	15	10	10
A702				
Tollcross Home St	18	18	12	12
Morningside Rd	15	14	10	10
A 90				
Queensferry Rd/Barnton	17	16	11	11
Hillhouse /Blackhall	15	15	11	10
A 902				
Telford Road	15	15	10	10
Ferry Road	15	15	10	10
A 700				
Lothian Rd	15	15	10	10
Melville Drive	15	15	10	10
A 701				
Liberton Brae	14	13	9	9
A1				
Willowbrae	15	15	10	10
London Road	15	15	10	10
A 7				
Dalkeith Rd	15	14	10	10
North Bridge	16	15	11	11
South Bridge	16	15	11	11
Nicholson St	16	15	11	11
A 6095				
Peffermill Rd	14	14	10	9
Niddrie Mains Rd	14	14	10	9

Location	Roadside PM_{10}		Roadside $PM_{2.5}$	
	2013	2014	2013	2014
A199				
Sir Harry Lauder Rd	15	14	10	10
Seafield Rd	14	14	9	9
Seafield Rd East	15	14	10	9
Salamander Street	14	14	9	9
Bernard St	16	15	11	10
Commercial St	16	15	11	10

Data highlighted in red is either at or exceeds current standards.
Data sets are only available to 2014.

PM_{10} concentrations from the PCM model for Salamander Street are much lower than the measured data from the air quality monitoring station, 14µg/m^3 compared with 21µg/m^3. Air borne materials and re suspended road dust emanating from operations at and adjacent to Leith Docks have been identified as the likely cause of high concentrations. It is possible that this source is not accounted for in the PCM model.

However, the PM_{10} concentrations from the PCM model are in keeping with the measured data at Queensferry Road AQMS.

The majority of $PM_{2.5}$ roadside concentrations are at or exceed the new 10µg/m^3 standard. Sections of the road network which are lower than the standard are:

A6095 Niddrie Mains Road/ Peffermill
A701 Liberton Brae
A199 Seafield Road, Seafield Road East
A71 Lanark Road

2.4 Particle PM_{10} and $PM_{2.5}$ Trends

The methodology for correcting the volatile fraction of PM_{10} changed in 2008. In addition, FDMS units were deployed at a number of monitoring sites. This instrumentation measures both volatile and non volatile components and therefore negates the requirement to correct the data. To account for the change local authorities were advised to undertake trend analysis on the non volatile fraction of PM_{10} at well established monitoring sites to determine long term trend pattern. The non volatile fraction has been used at St Leonards to establish the trend.

PM_{10} and $PM_{2.5}$ data shows a downward trend level (decreasing concentrations) at all monitoring locations. However, trend data for St Leonards and Queensferry Road requires to be tempered with caution due to overall poor data capture. Also, consideration should be given with respect to replacement of a TEOM with an FDMS unit in 2009 at St Leonards. Trend data is shown in Figures 2.3 to 2.8 and summarised in Table 2.6.

Table 2.6 Summary of particle trends in Edinburgh

Monitoring site/Type	$PM_{10/2.5}$	Trend in annual mean (years)	Concentrations
Currie (Suburban)	PM_{10}	2010 to 2015 ↓	Decreasing
St Leonards (Urban background)	$PM_{2.5}$	2009 to 2015 ↓	Decreasing
St Leonards (Urban background)	PM_{10}	2004 to 2014 ↓	Decreasing
Queen Street (Roadside)	PM_{10}	2008 to 2015 ↓	Decreasing
Salamander Street (Roadside)	PM_{10}	2010 to 2015 ↓	Decreasing
Queensferry Road (Roadside)	PM_{10}	2011 to 2015 ↓	Decreasing

Figure 2.3 Trend in annual mean PM_{10} concentrations (μg/m³) measured at Currie

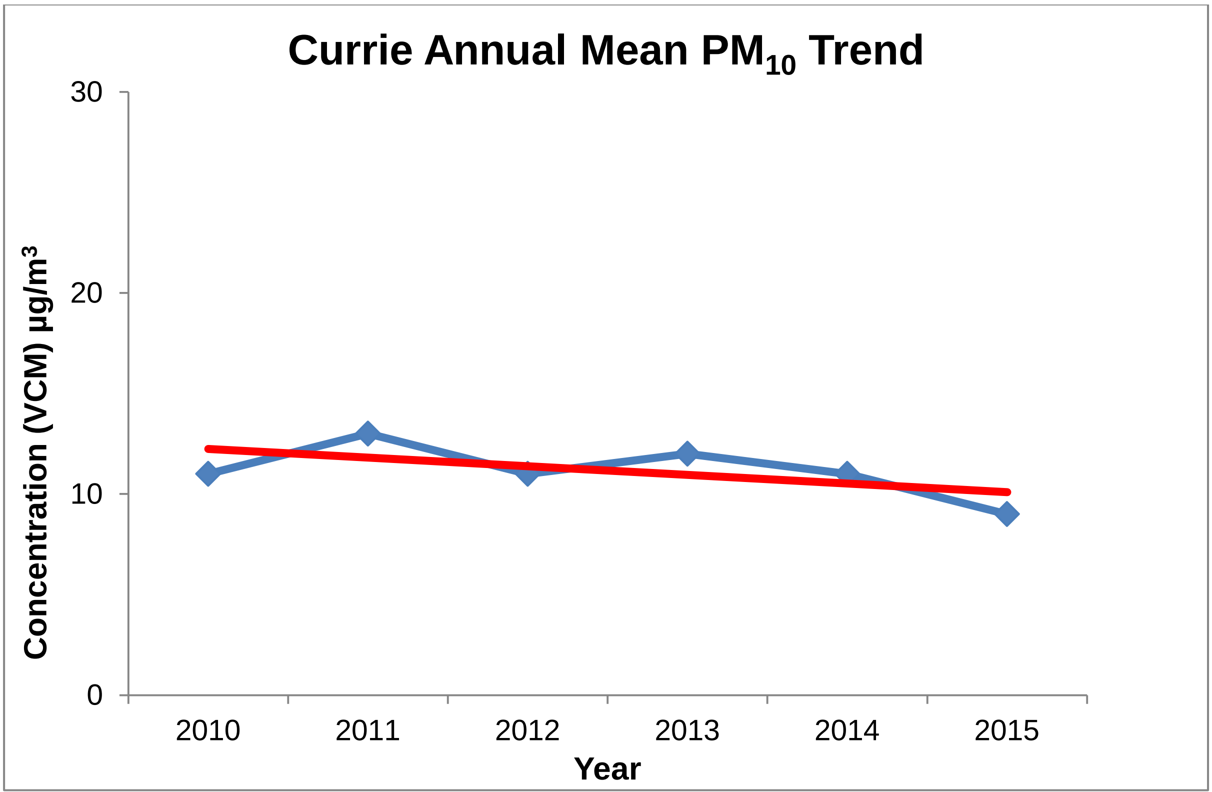


Figure 2.4 Trend in annual mean $PM_{2.5}$ concentrations (µg/m^3) (FDMS) measured at St Leonards

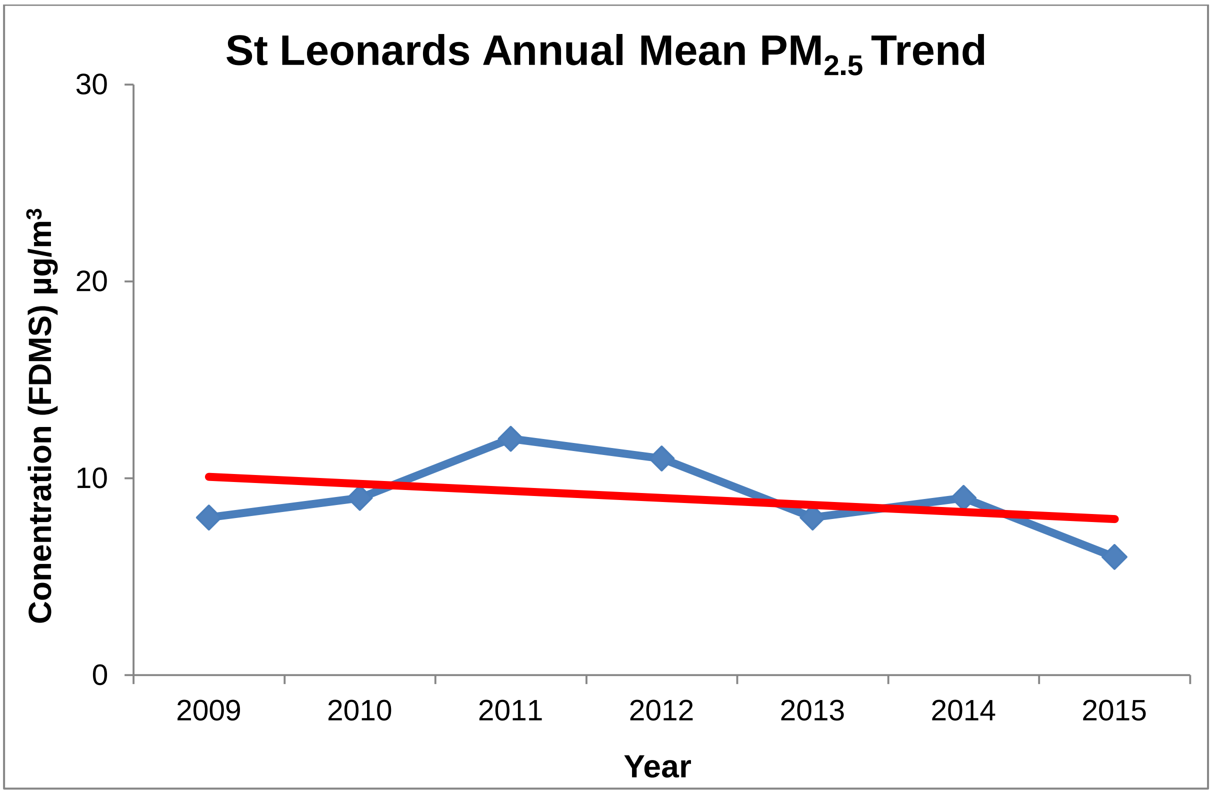


Figure 2.5 Trend in annual mean non volatile fraction PM_{10} concentrations (µg/m^3) measured at St Leonards

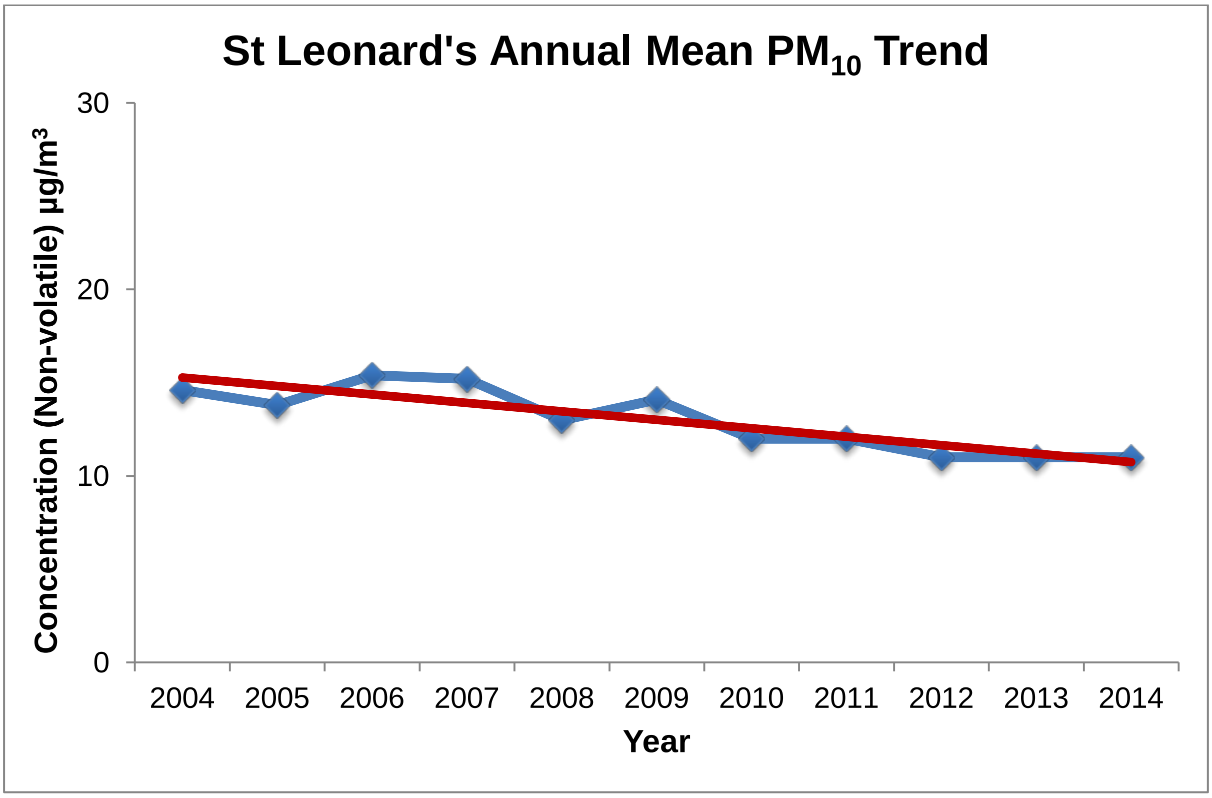


Figure 2.6 Trend in annual mean PM_{10} concentrations ($\mu g/m^3$) measured at Queen Street

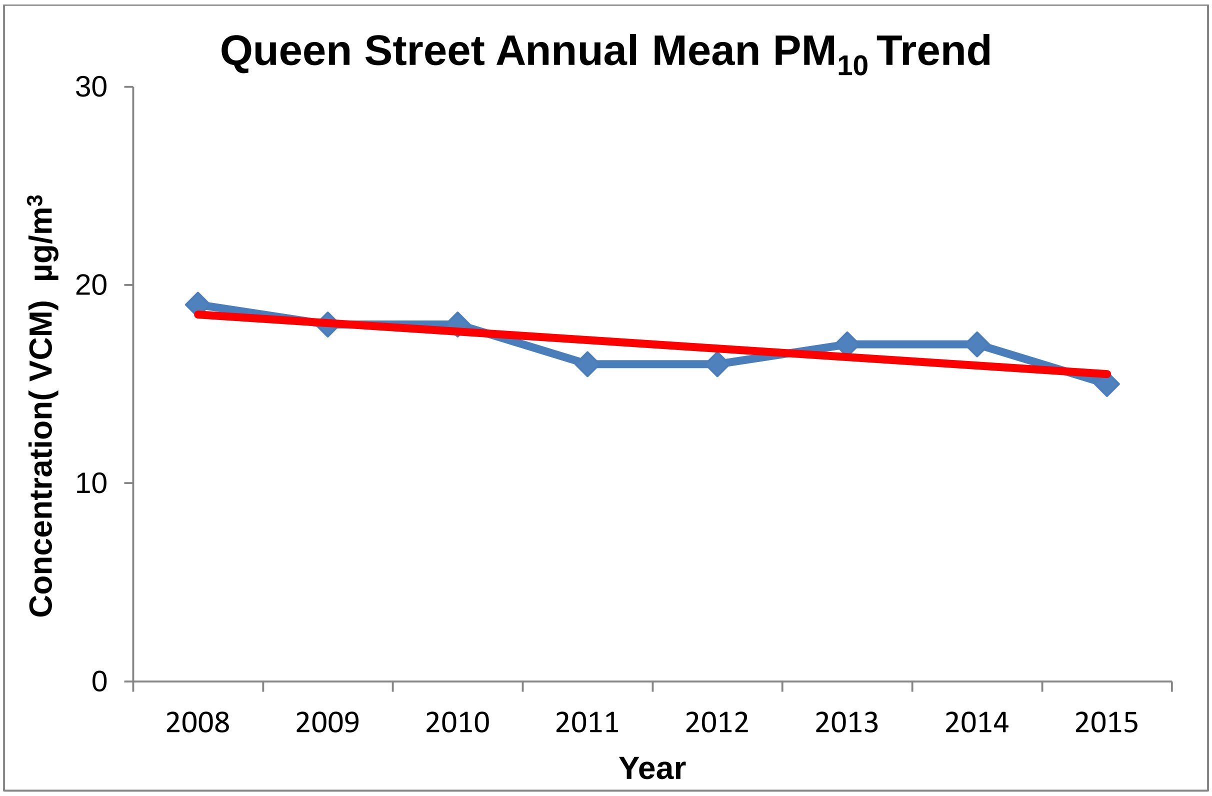


Figure 2.7 Trend in annual mean PM_{10} concentrations ($\mu g/m^3$) measured at Salamander Street

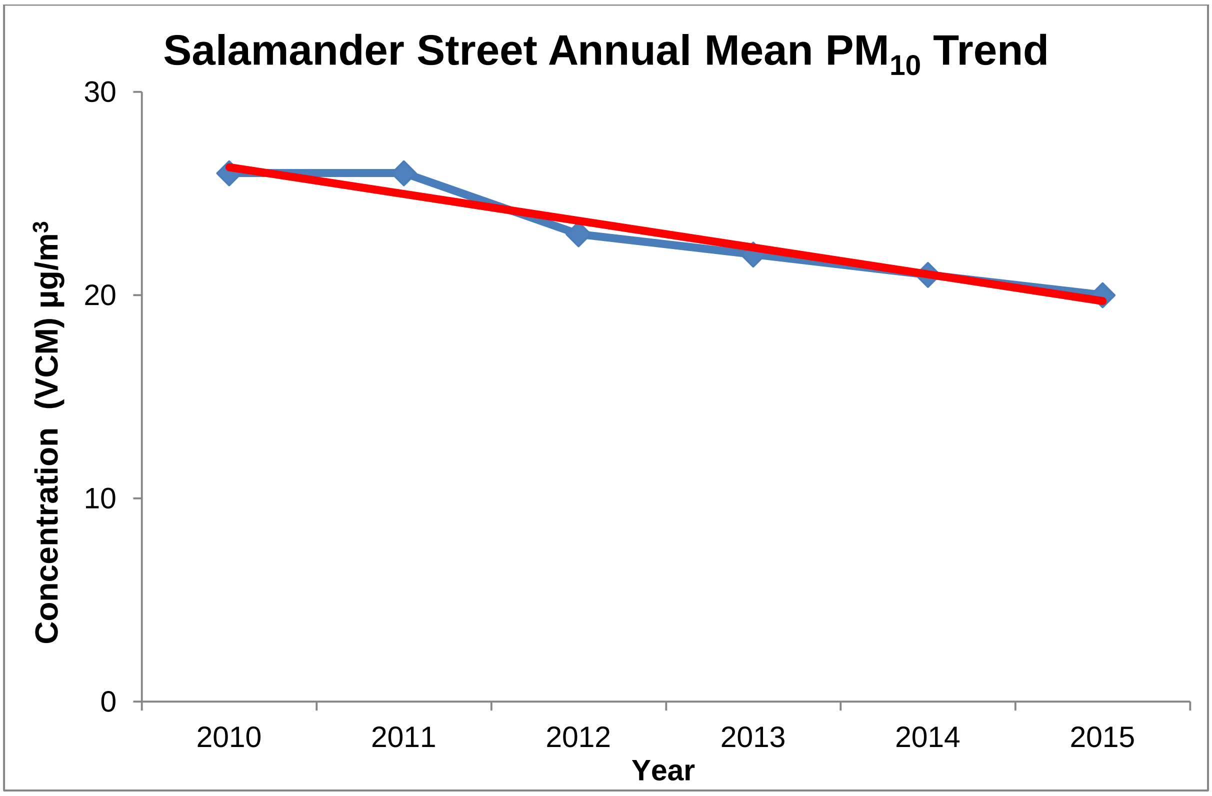
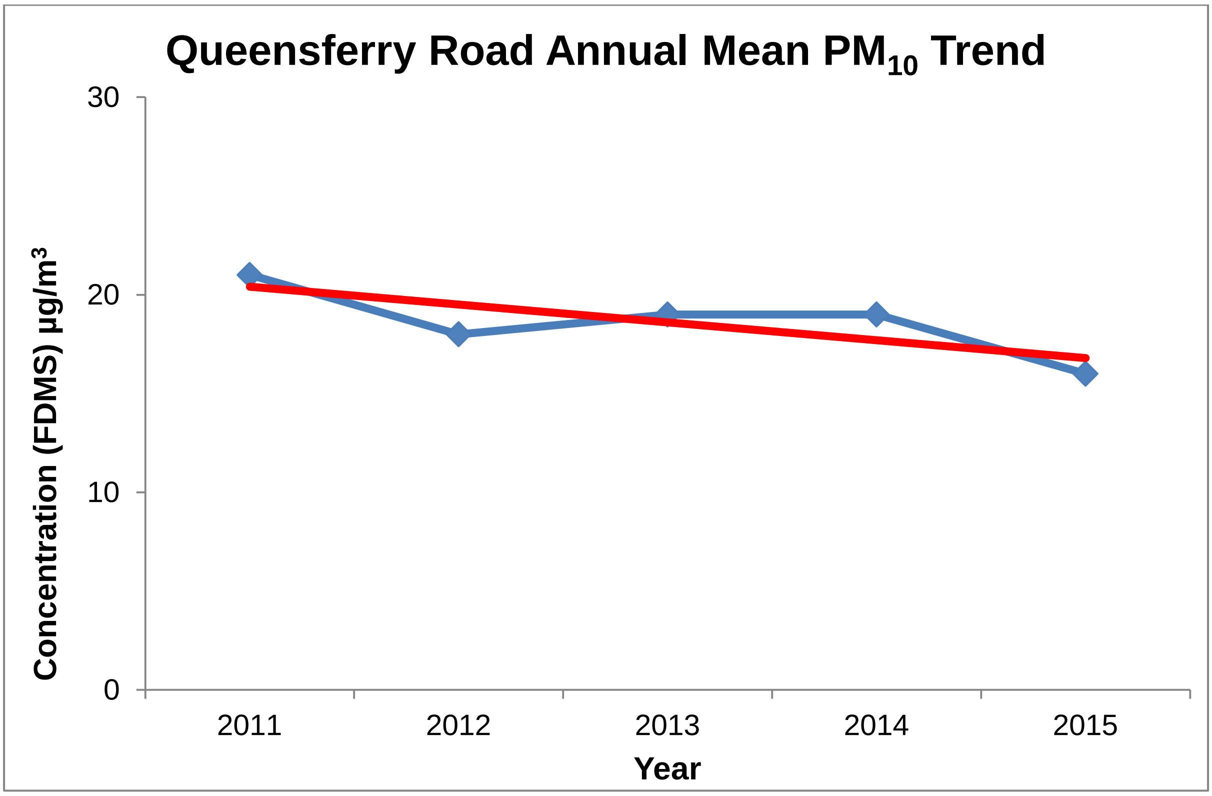


Figure 2.8 Trend in annual mean PM_{10} concentrations (µg/m^3) measured at Queensferry Road



3.0 Fugitive Sources

3.1 Handling and storage of material at Leith Docks

Fugitive emissions of particles are derived from various sources for example, quarrying activities, stock piles of uncovered fine material, poultry farm operations, construction and building work.

The Port of Leith and associated docks are located to the North and North East of the city. The docks are managed by Forth Ports and provide handling and storage provision for a range of cargo.

Materials which pass through the Port include grain, animal feed, iron ore, cement, coal and aggregates. The Port has the capacity to handle 500 tonnes of cement per hour and open storage for up to 50,000 tonnes of material.

A number of industries and activities requiring Pollution Prevention Control (PPC) permits operate within and adjacent to the boundary of the Port of Leith, including a number of cement batching plants and pipe coating works. Potential fugitive emissions are likely to arise when materials are off-loaded, handled and then stored and moved within the docks. Uncovered aggregate material within the docks is moved and stored to where ever there is available space.

There are also two scrap metal storage areas adjacent to the dock boundary, which no longer crush materials. Details of the industries are shown in Table 3.1 and Figure 3.1.

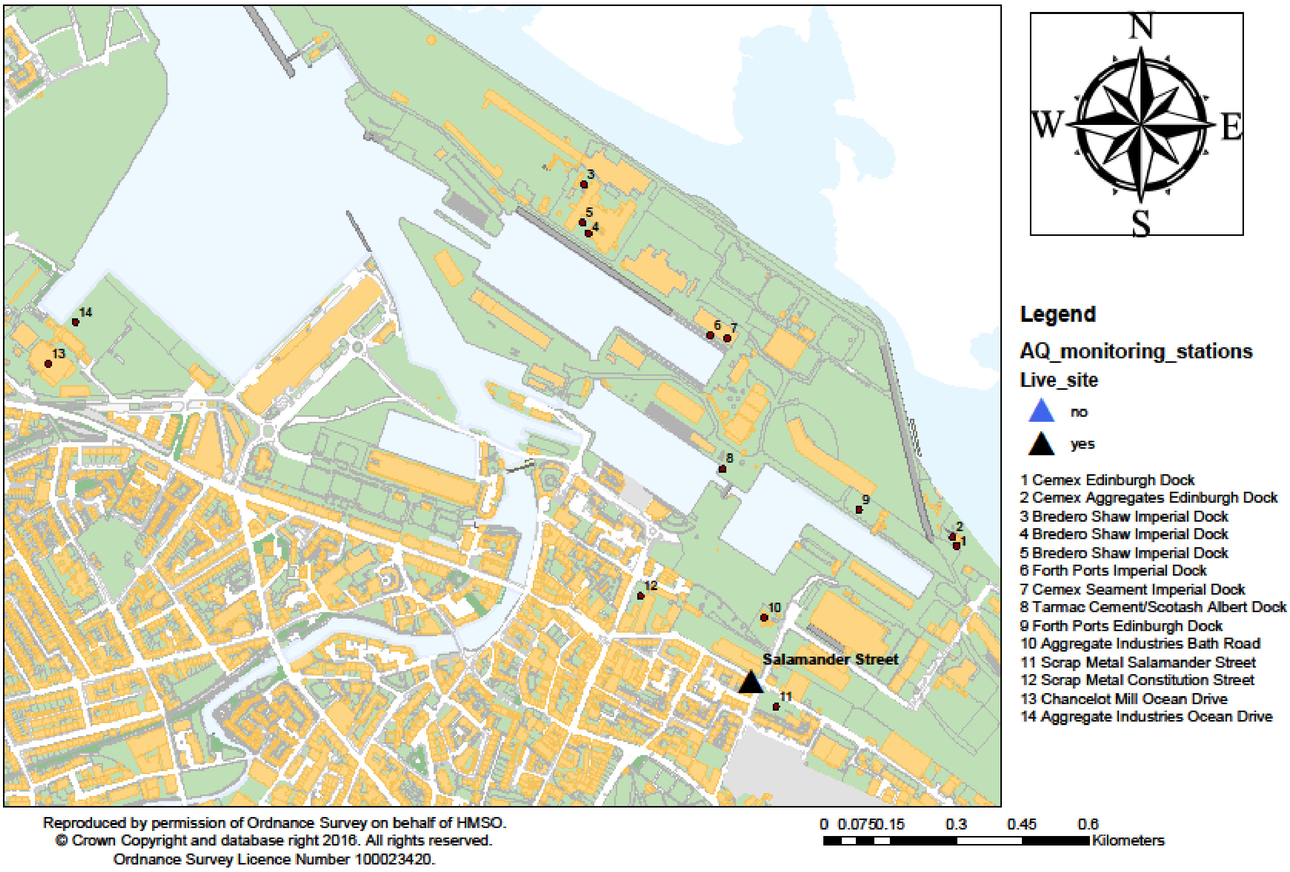
Table 3.1 Details of industries within and adjacent to Leith Docks

ID	Site Name	Process
1	Cemex Edinburgh Dock	Coating Plant
2	Cemex Aggregates Edinburgh Dock	Ready mix concrete batching
3	Bredero Shaw Imperial Dock	Cement batching
4	Bredero Shaw Imperial Dock	Internal pipe coating
5	Bredero Shaw Imperial Dock	Tar and bitumen coating
6	Forth Ports Imperial Dock	Cement unloading
7	Cemex Seament Imperial Dock	Cement Storage
8	Tarmac Cement /Scotash Albert Dock	Cement Storage and handling
9	Forth Ports Edinburgh Dock	Coal handling
10	Aggregate Industries Bath Road	Cement batching
11	Scrap metal Salamander Street	Storage
12	Scrap metal Constitution Street	Storage
13	Chancelot Mill Ocean Drive	Milling/ Grain Unloading
14*	Aggregate Industries Ocean Drive	Ready mix concrete batching

Scottish Environment Protection Agency 2015

*Planning issue with site

Figure 3.1 Locations of PPC industries and activities within and adjacent to Leith Docks.



3.2 Visual observations at Bath Road and Salamander Street

Officers have visited Salamander Street and the surrounding area on numerous occasions and a large stock pile of material has always been visible adjacent to the cement batching plant on Bath Road. This area is available for open storage of any type of material and is currently used by Aggregate Industries (Bardons). Material is moved to and from this location as and when it is required. During one site visit a fine dust cloud was evident at Bath Road and Salamander Street. This was due to the effects of wind on the stock pile. A typical stock pile at this location is shown in Figure 3.2.

Dust clouds have also been witnessed as material is unloaded at the dock side by mechanical grabbers. A dust incident occurred in July 2015 during unloading operations, which led to a number of complaints being made to the Council and SEPA from local residents and staff at the Scottish Government. Unfortunately, the air quality monitoring station at Salamander Street was not operational at the time and therefore PM_{10} data was not available.

A number of HGVs enter Leith Docks via Bath Road from Salamander Street and re-suspended road dust has also been witnessed from the movement of heavy vehicles.

The roads within the docks and at Bath Road are dusty and dirty. Although, wet methods are deployed at Aggregate Industries to reduce the impact of air borne material there is no wheel washing facility at the site or at the Bath Road entrance to the dock.

Figure 3.2 Stock pile of material observed from Bath Road

3.3 Dust analysis

Visual and microscopic analysis was undertaken by Scottish Environment Protection Agency (SEPA) on three dust samples which were collected for 4 months from within the Air Quality Monitoring Station at Salamander Street.

The report concluded that there was no evidence of dust from industrial, manufacturing, demolition or anthropogenic sources. All three samples contained sand, fine silt and dirt. On the basis that metal fragments were not identified it was assumed that the adjacent Scrap Yard was not likely to be the main source of the high concentrations observed. [4]

3.4 Data Analysis

The AQMS at Salamander Street is located approximately 590 metres from the Firth of Forth shoreline and 130 metres south from an area used for open storage of fine aggregate material at Leith Docks. The dock locations where material is unloaded lie to the North, North West and North East of the monitoring station.

Exceedances of the daily mean and annual mean PM_{10} Scottish Air Quality Objectives have been recorded at Salamander Street since monitoring commenced as shown in Tables 2.3 and 2.4.

Hourly and 15- minute concentrations which have been recorded from the monitoring station are exceptionally high on occasions, within the range of 200 $\mu g/m^3$ and 300 $\mu g/m^3$. Comparable levels have not been recorded at other nearby roadside monitoring sites, for example, Queen Street (Edinburgh), Musselburgh High Street (East Lothian) or the urban background site at St Leonards and suburban background site at Currie. This indicates that the elevated concentrations are localised and not solely due to pollution episodes.

Musselburgh High Street AQMS was selected as a comparison roadside site due to its proximity to the Firth of Forth (360 metres from the shore line). Therefore, the location is likely to have similar climatic conditions and potential sea salt effects as Salamander Street AQMS.

Examples, of very high concentrations of PM_{10} at Salamander Street compared with Musselburgh and background locations in Edinburgh are shown in Figures 3.3 and 3.4.

PM_{10} concentrations tend to be higher during the daytime at Salamander Street and fall at night time which would relate to a decline in activity at the docks and a decrease in re-suspended material due to the reduction of vehicle movements.

Figure 3.5 shows how a typical PM_{10} pollution episode would appear with concentrations elevated at a number of locations including the Currie suburban background location on 23rd April 2015. The concentrations also remain high at Salamander Street the following day.

Figure 3.3 High PM_{10} concentrations at Salamander Street during March 2011

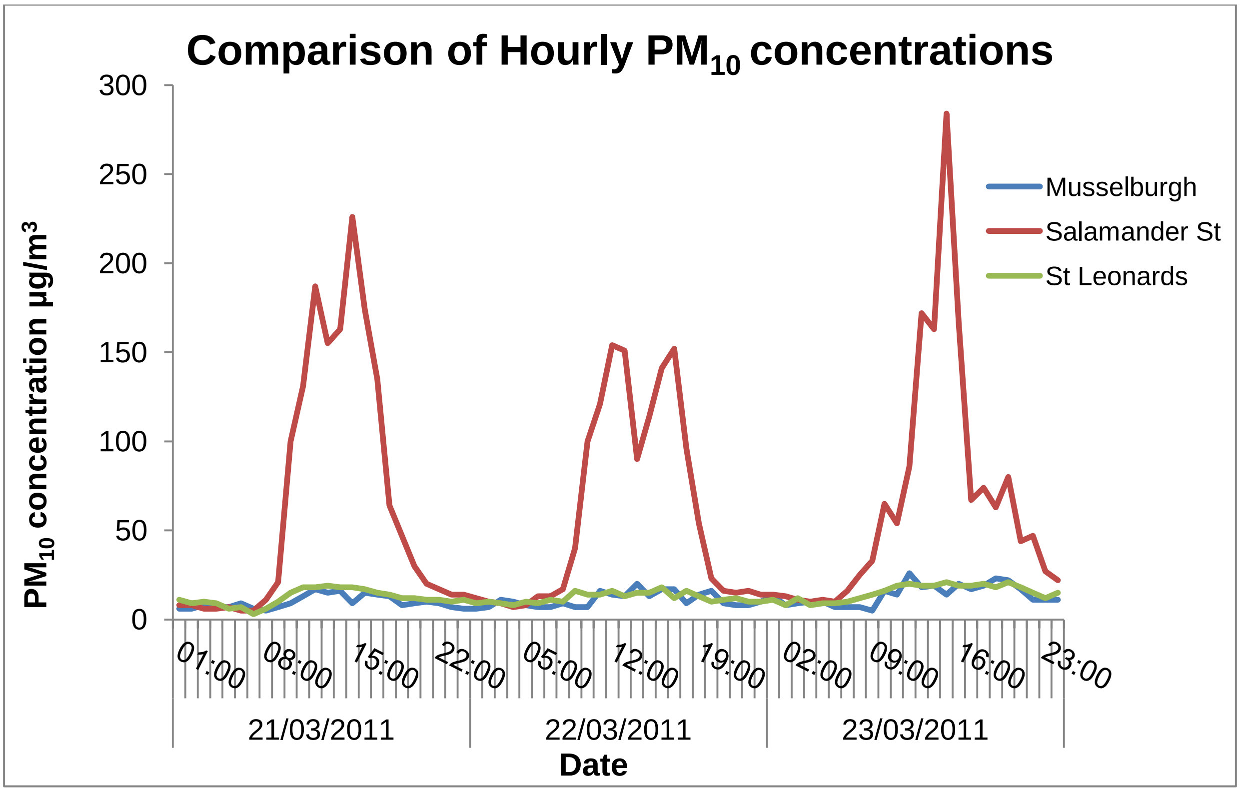


Figure 3.4 High PM_{10} concentrations at Salamander Street on 7th April 2015

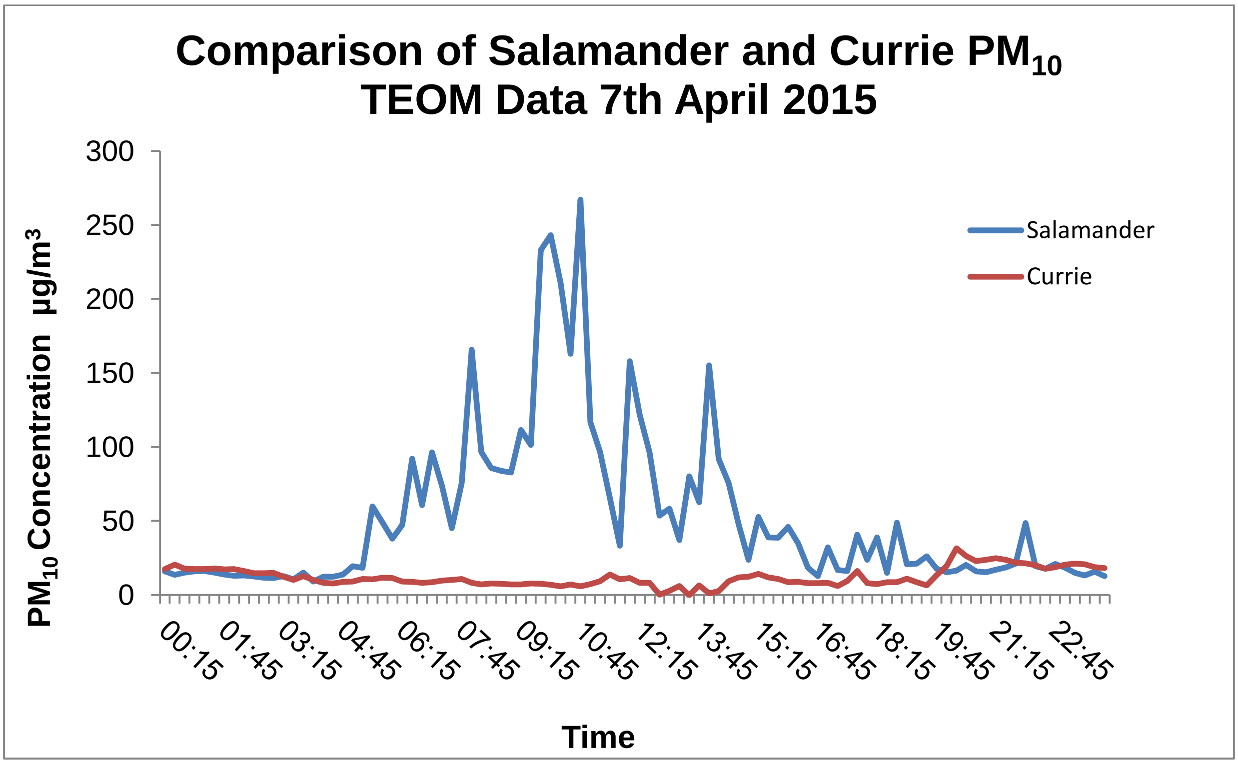
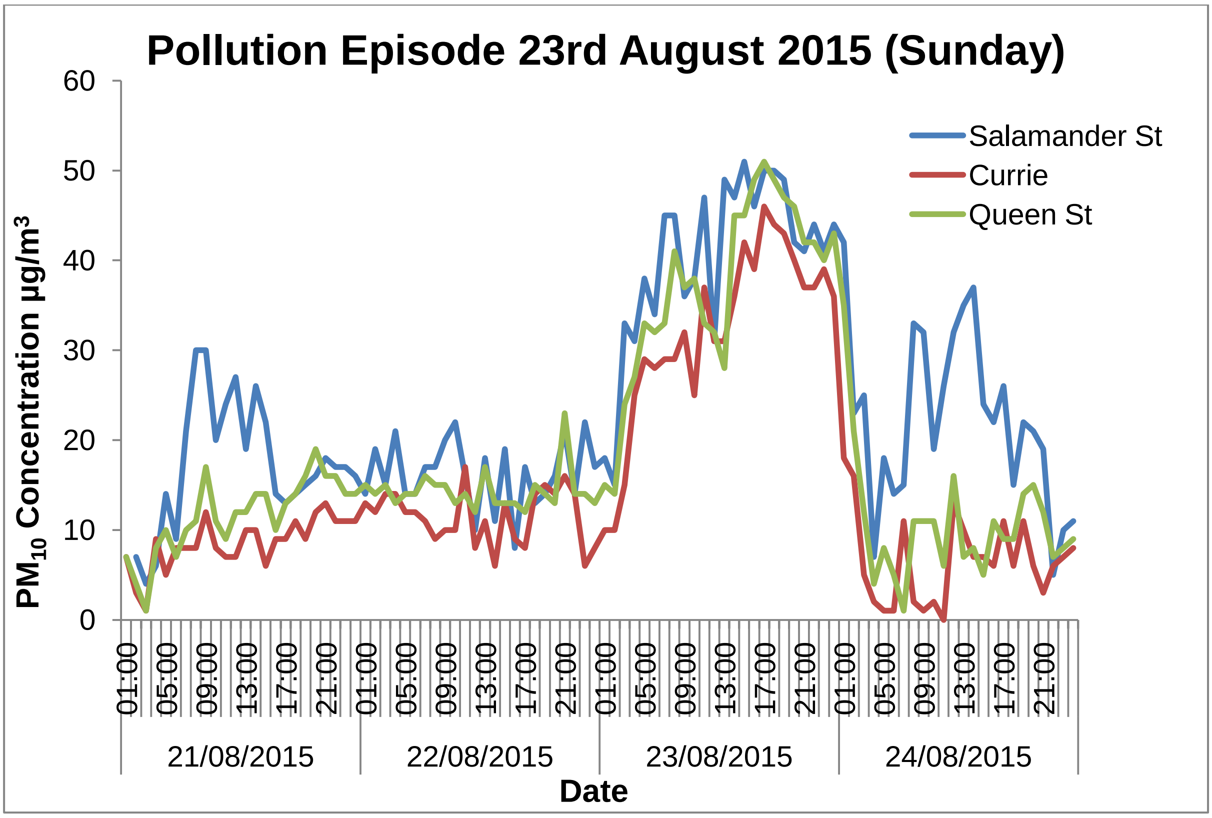


Figure 3.5 High PM_{10} concentrations due to a pollution episode.

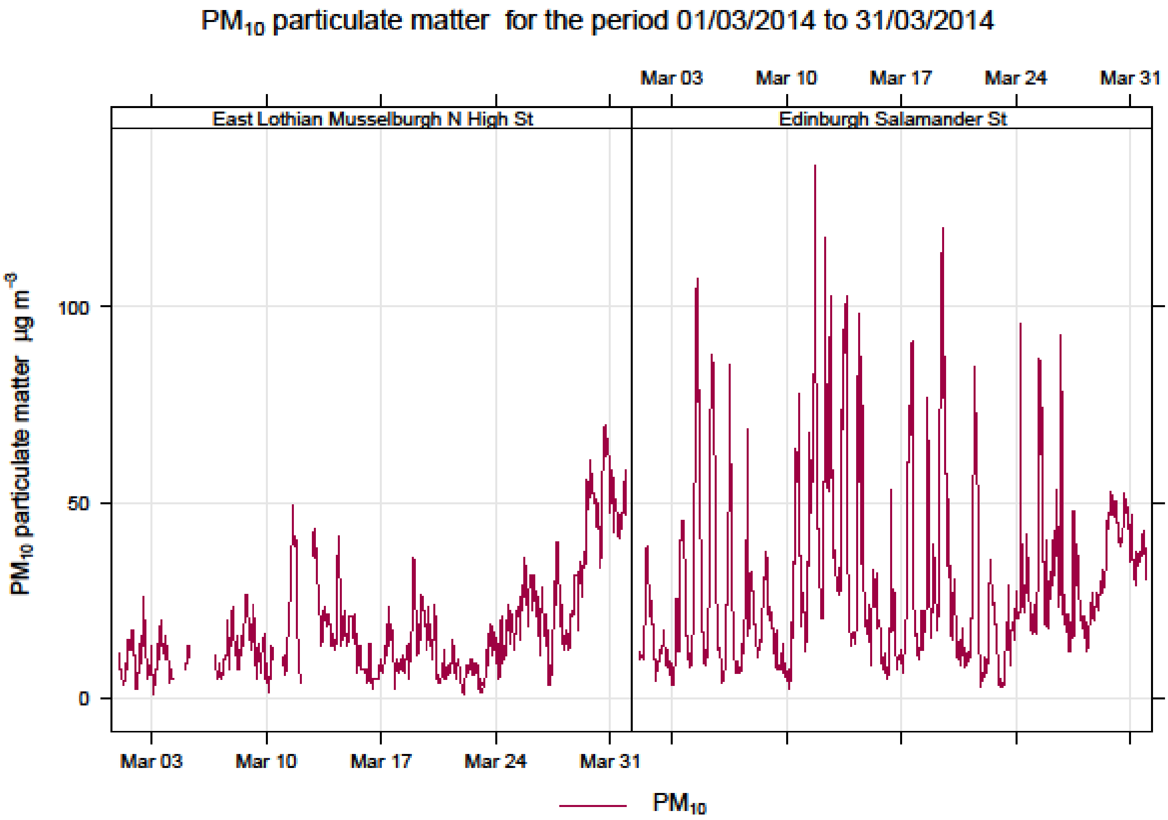


The Open Air Analysis Tool on the Scottish Government air quality web site has also been used to produce time plots and polar plots of PM_{10} data to provide further evidence that higher concentrations observed at Salamander Street are due to a localised source.

Time plots enable data from different sites to be compared over an identical time period. Musselburgh High Street AQMS was selected for this comparison study. The graphs are shown in Figures 3.6 and 3.7 which illustrate higher hourly and daily PM_{10} concentrations at Salamander Street compared with those obtained from Musselburgh High Street.

Polar Plots are useful in identifying potential sources of pollution affecting a location. They provide a graphical representation of the relationship between pollutant concentration and meteorological conditions.

Figure 3.6 Comparison of hourly PM_{10} concentrations at Musselburgh and Salamander Street for March 2014 and April 2014



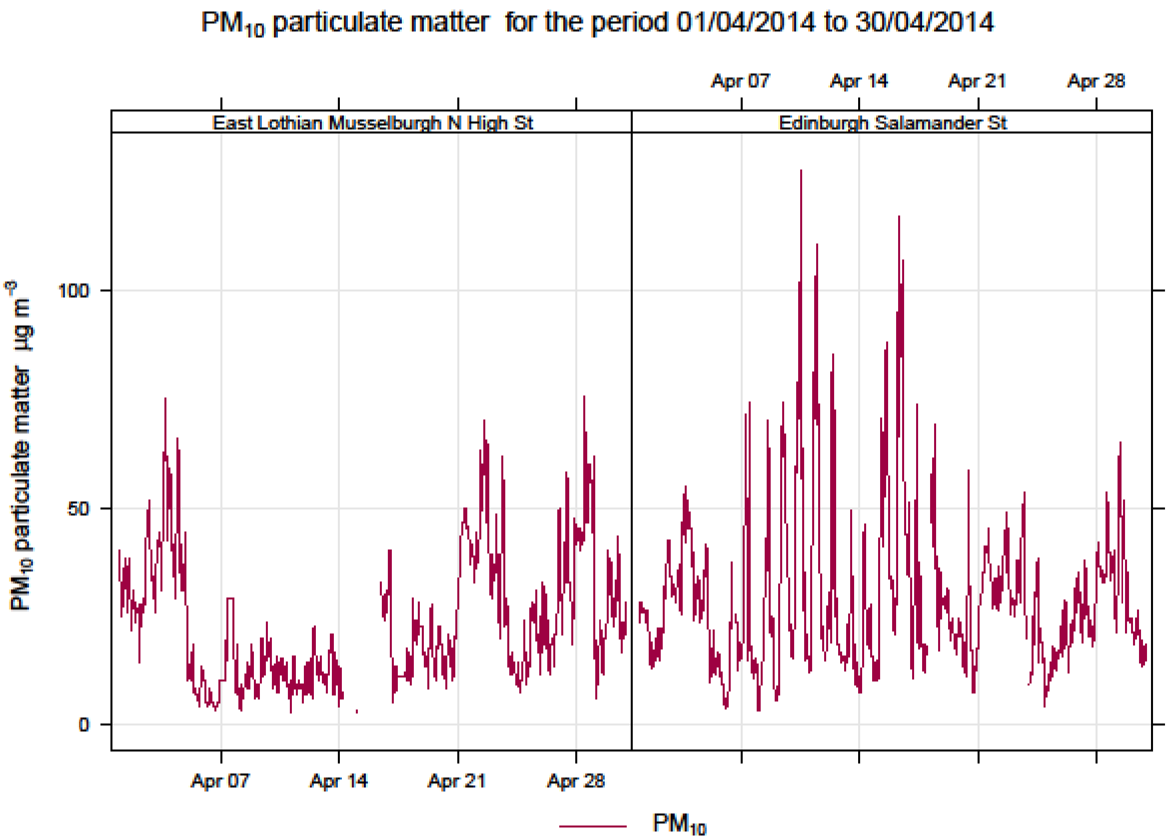
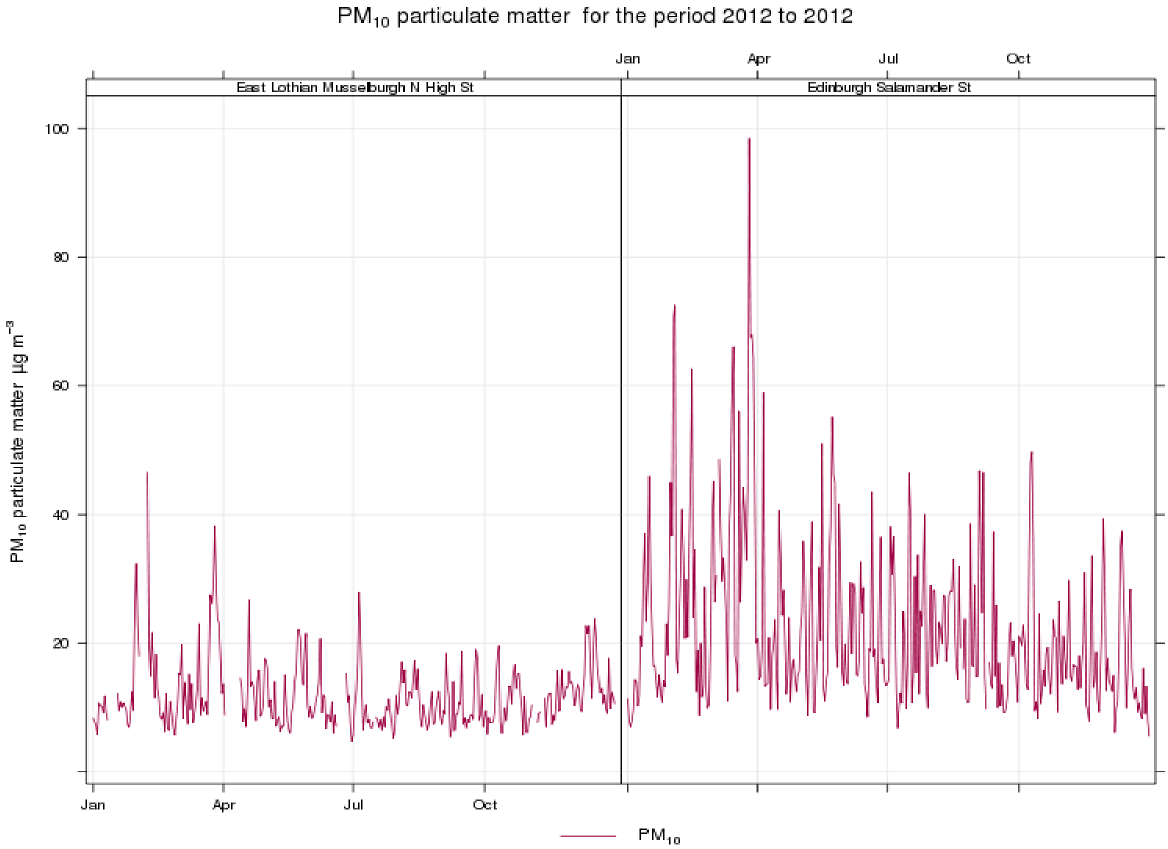
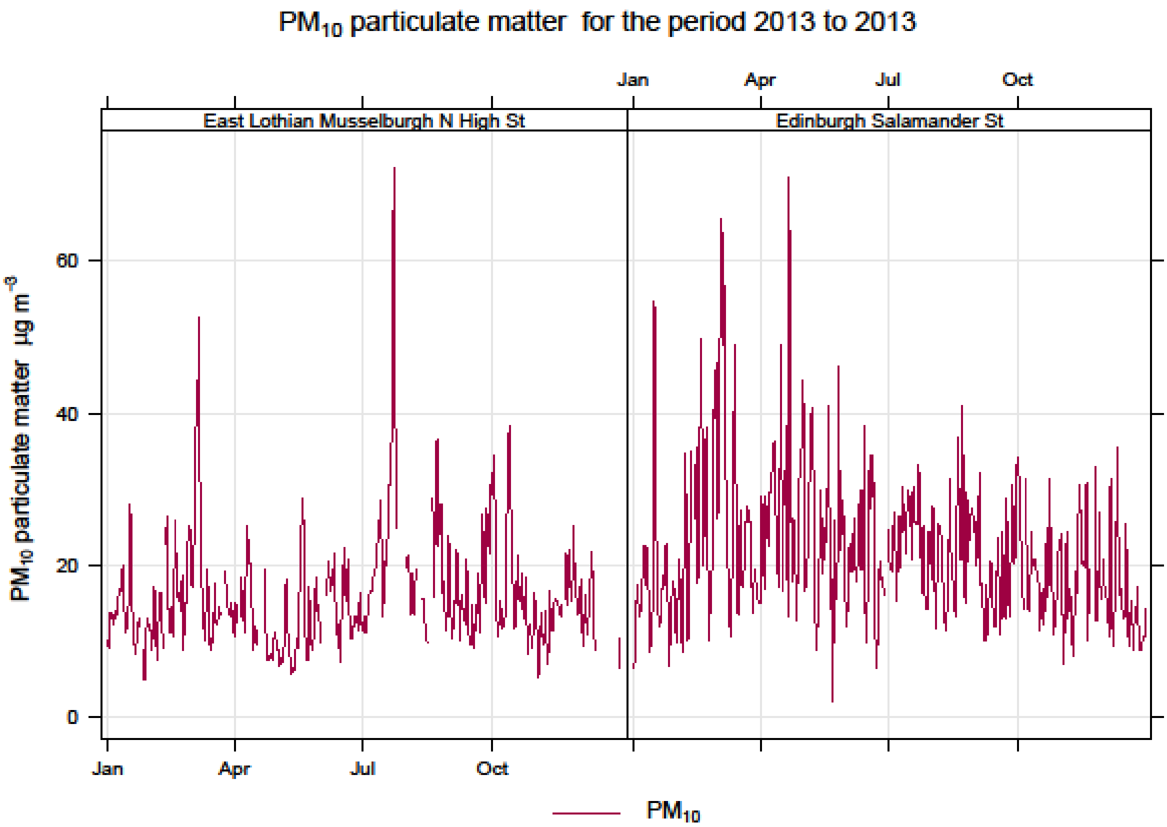
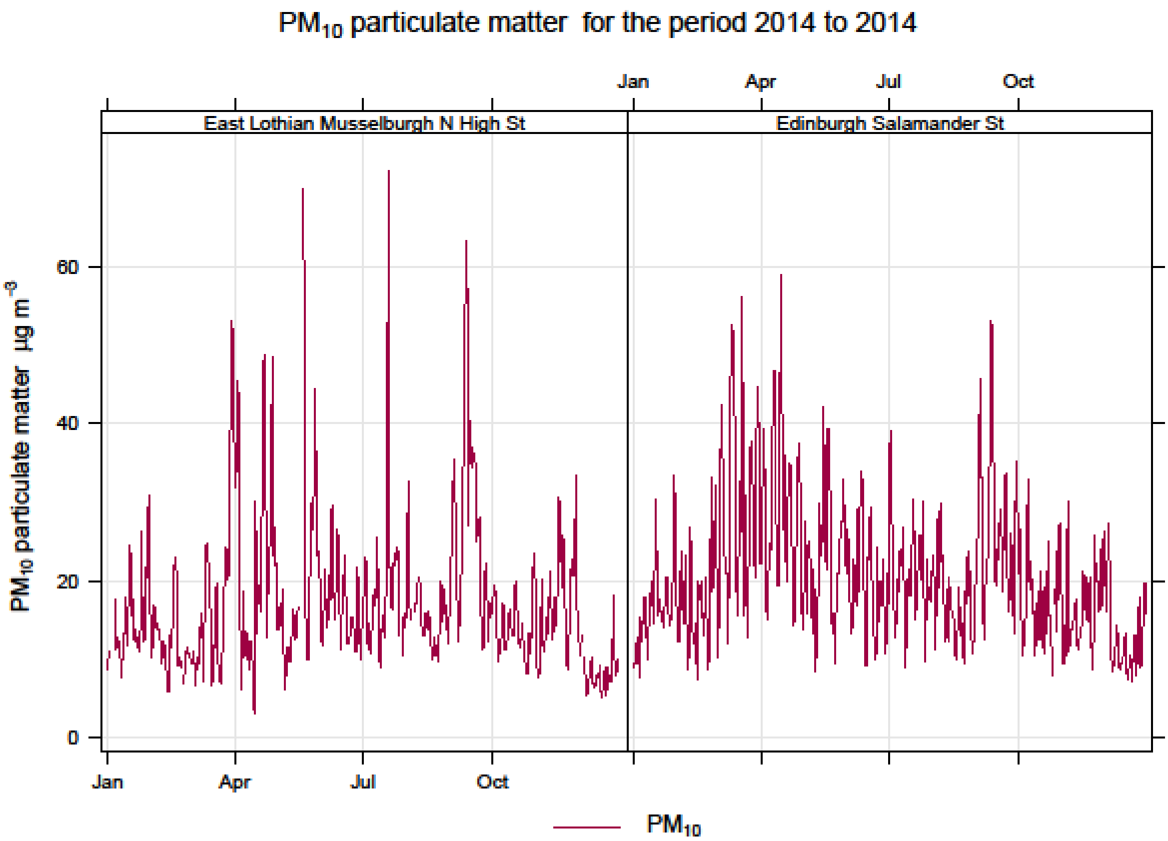
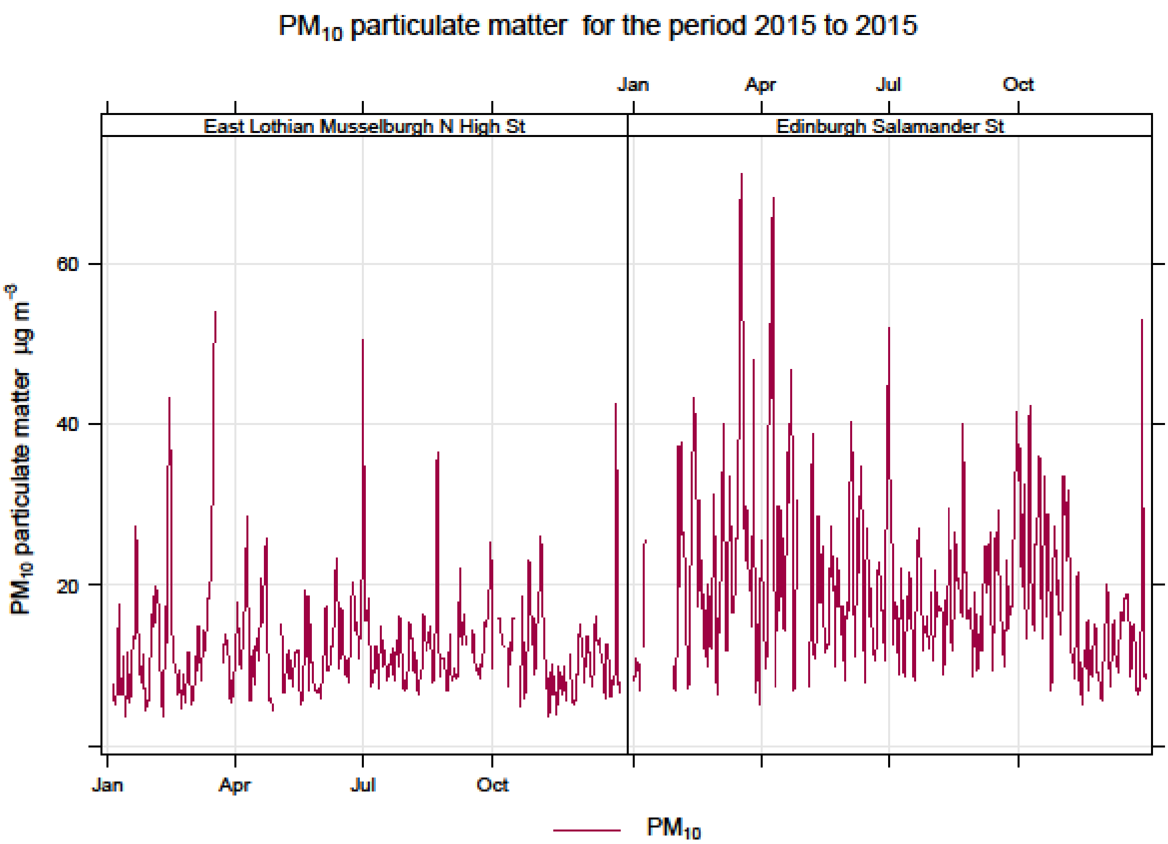


Figure 3.7 Comparison of daily PM_{10} concentrations at Musselburgh and Salamander Street for years 2012, 2013, 2014 and 2015






PM10 particulate matter for the period 2014 to 2014
East Lothian Musselburgh N High St
Edinburgh Salamander St
Jan
Apr
Jul
Oct
0
20
40
60
PM10 particulate matter µg m-3
PM10


PM10 particulate matter for the period 2015 to 2015
East Lothian Musselburgh N High St
Edinburgh Salamander St
Jan
Apr
Jul
Oct
20
40
60
PM10 particulate matter µg m-3
PM10

Polar Plots using mean PM_{10} data measured at Salamander Street (when values were high) for months March 2011 and April 2014 were compared with plots over the same time period using data from Musselburgh High Street and St Leonards background site and the rural site at Auchencoth Moss.

This enabled a visual assessment of transboundary effects as high concentrations of particles in Edinburgh tend to be driven by secondary particulate episodes when the wind direction is easterly, south easterly and southerly.

Polar Plots 3.8 (A) show that in March 2011, the highest PM_{10} concentrations (greater than 50µg/m^3) at Salamander Street occur when the wind direction is north westerly. Whereas at St Leonards urban background site for the same time period the highest values are associated with southerly and easterly winds.

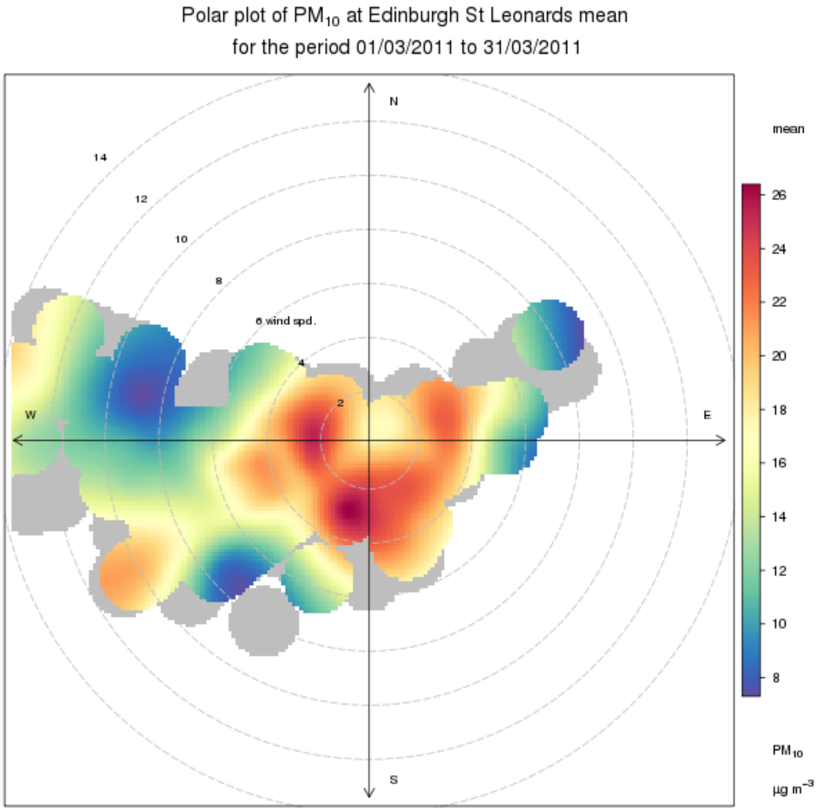
Polar Plots 3.8 (B) show that in March 2014, the highest values (70µg/m^3) at Salamander Street are associated with a north easterly wind direction and higher wind speeds. There is also influence from non localised effects shown by higher values measured at background and rural locations. The highest concentrations at the background locations and Musselburgh tend to be linked to easterly and south easterly wind directions.

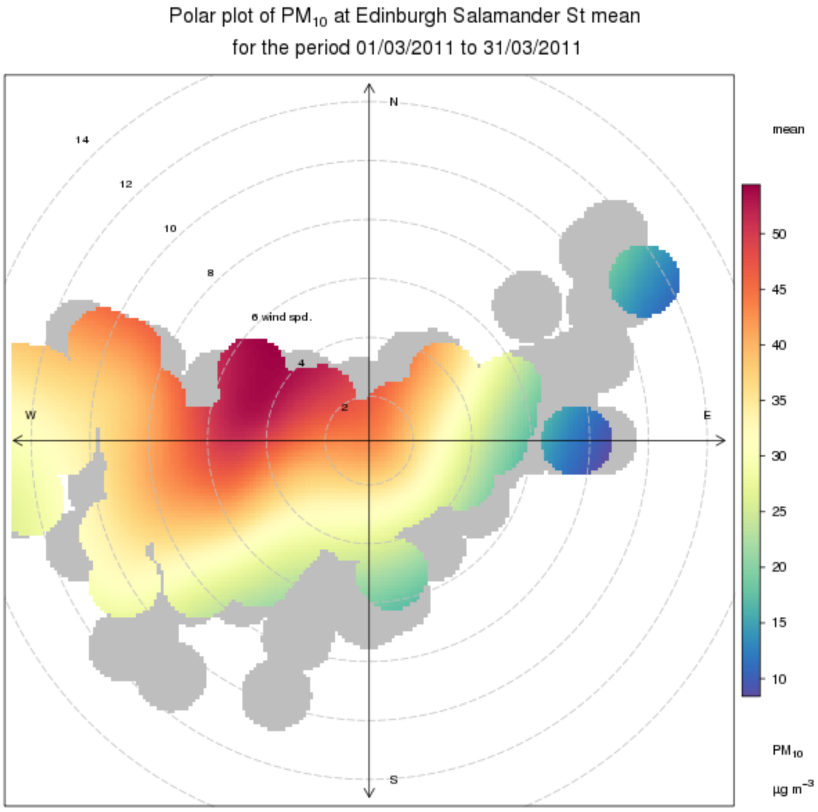
Polar Plots 3.8 (C) have been derived from annual PM_{10} data. The higher concentrations at Salamander Street are generally associated with a north easterly wind and at Musselburgh and Auchencoth Moss higher values tend to be related to south easterly and easterly wind directions.

The polar plots indicate that there are localised sources and activities within Leith Docks which are contributing to the higher concentrations observed at the Salamander Street AQMS.

Figure 3.8 Polar Plots

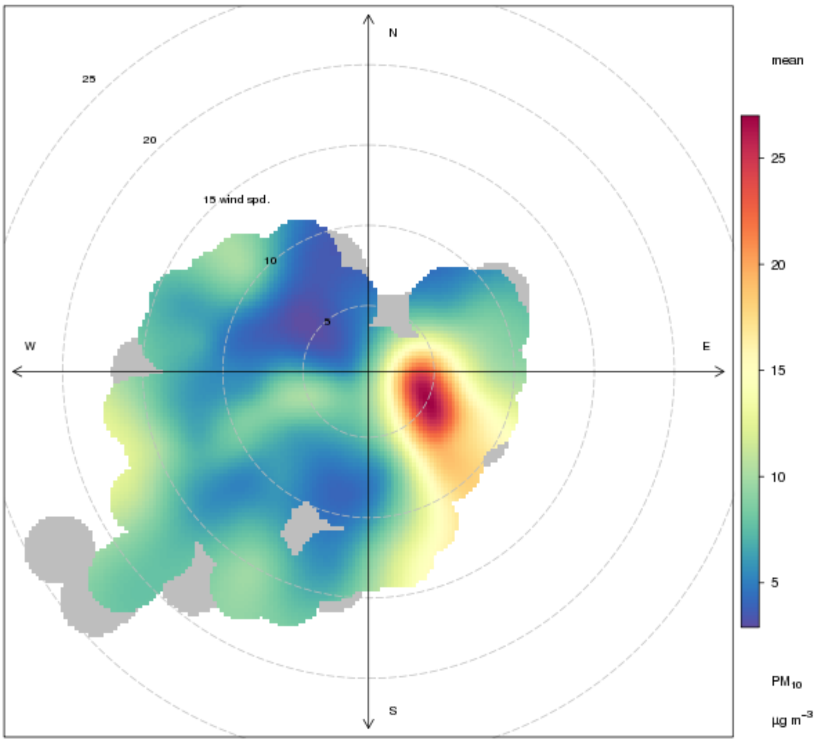
A



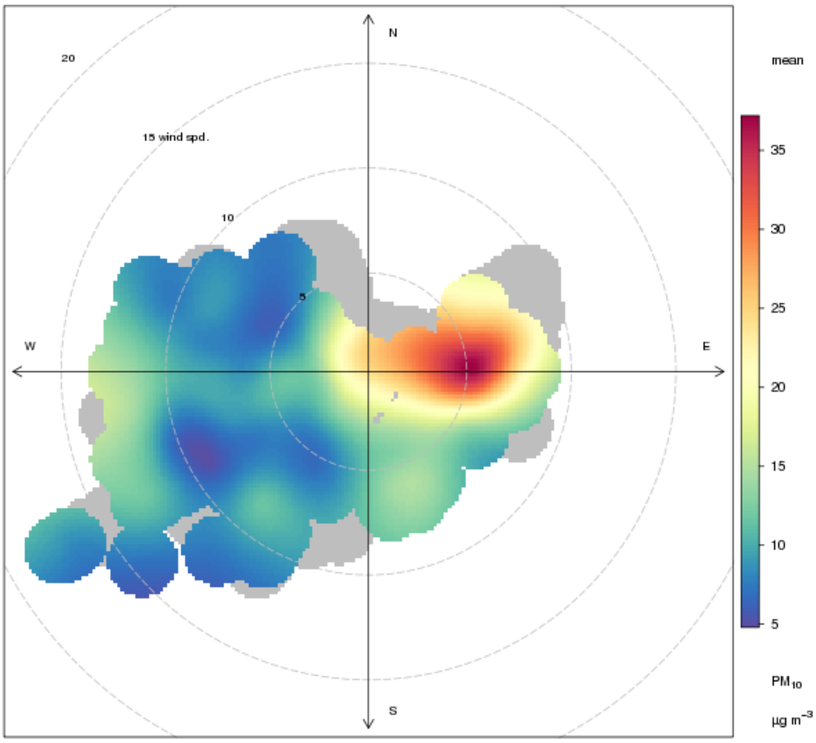


B

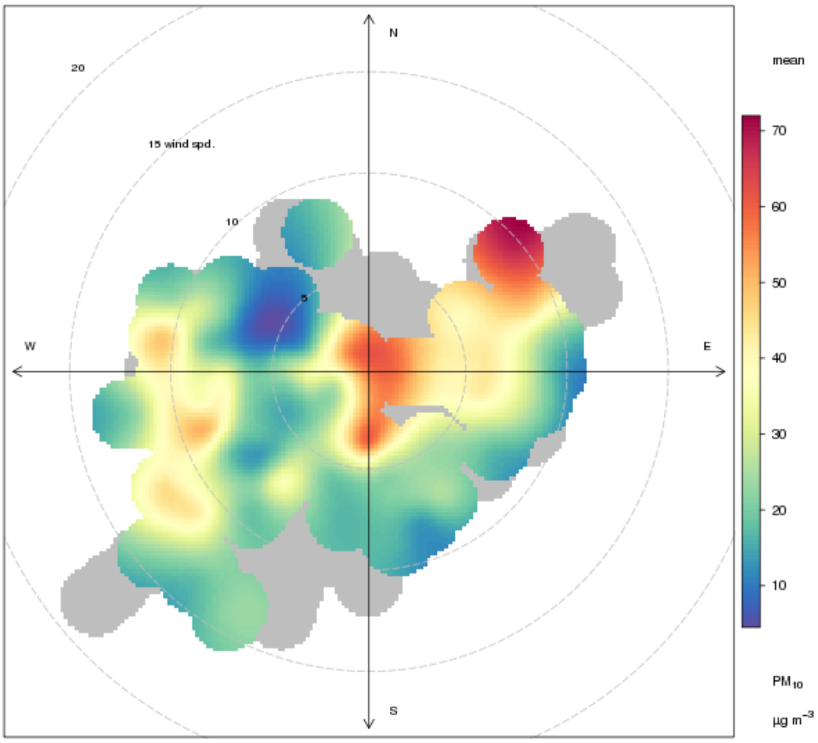
Polar plot of PM_{10} at Auchencorth Moss mean
for the period 01/03/2014 to 31/03/2014



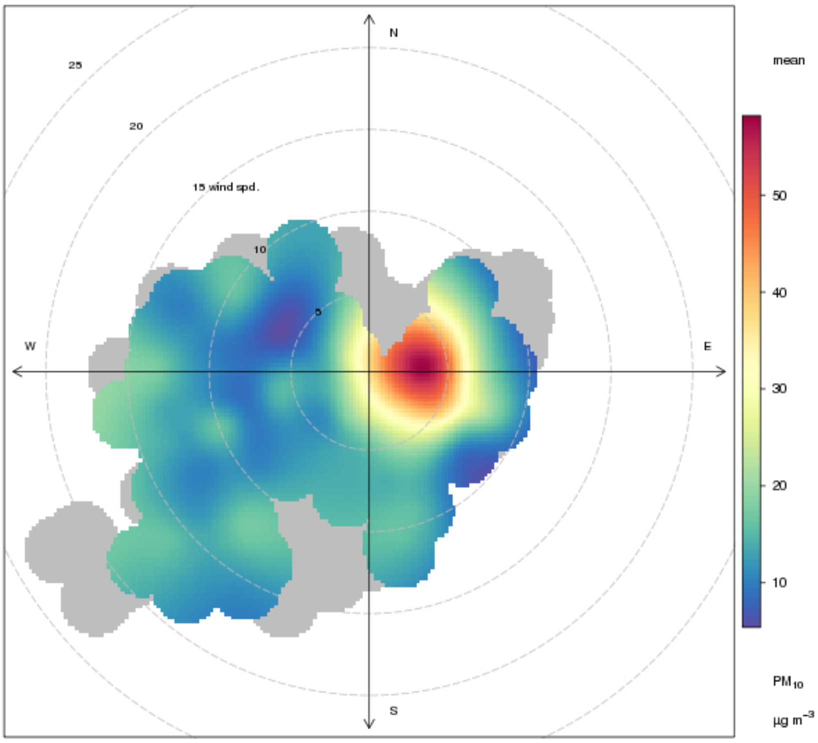
Polar plot of PM_{10} at Edinburgh St Leonards mean
for the period 01/03/2014 to 31/03/2014



Polar plot of PM_{10} at Edinburgh Salamander St mean
for the period 01/03/2014 to 31/03/2014

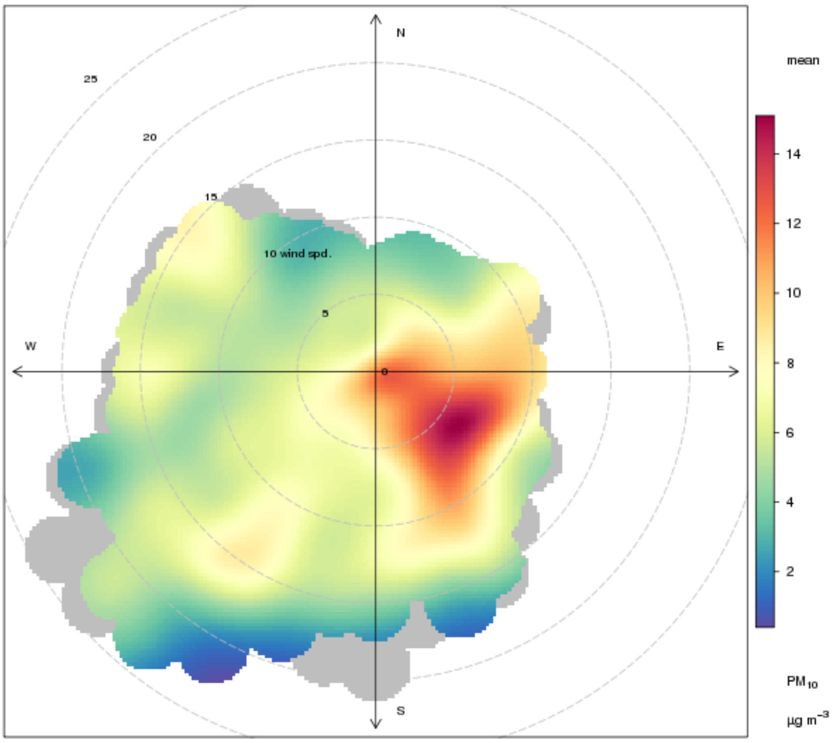


Polar plot of PM_{10} at East Lothian Musselburgh N High St mean
for the period 01/03/2014 to 31/03/2014

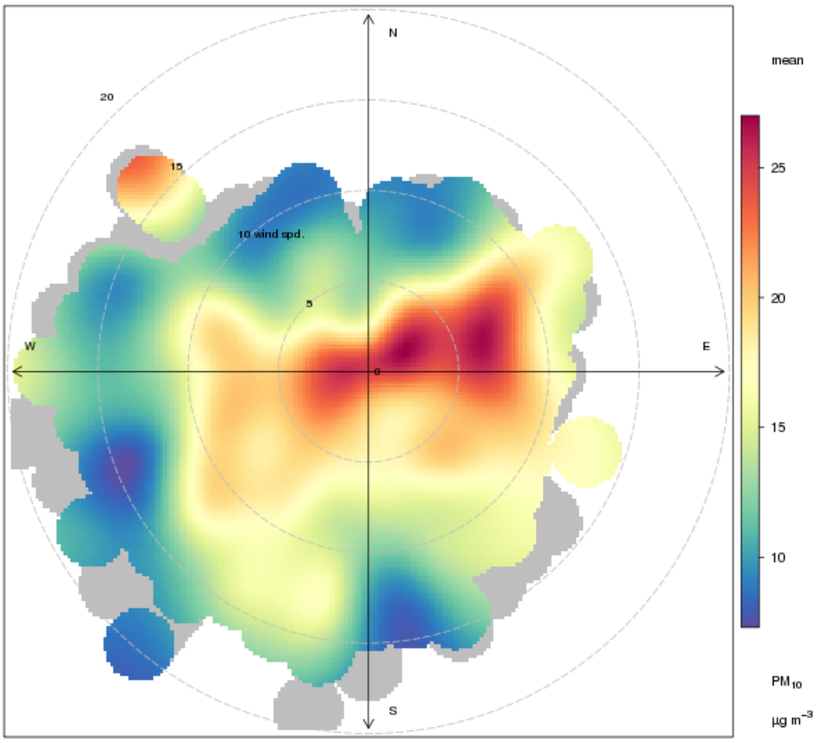


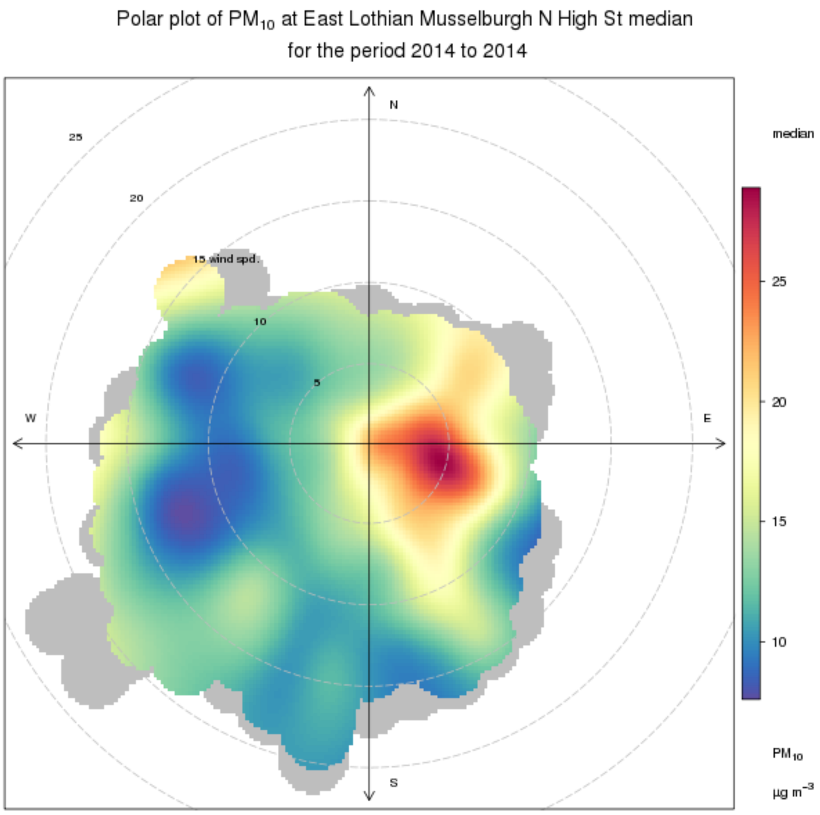
C

Polar plot of PM_{10} at Auchencorth Moss mean
for the period 2014 to 2014



Polar plot of PM_{10} at Edinburgh Salamander St mean
for the period 2014 to 2014





The roadside air quality monitoring station at Salamander Street also measures NO_2. This pollutant is compliant, with the air quality objectives at this location. Annual mean concentrations are between 27µg/m^3 and 30µg/m^3 as shown in Table 3.2.

Table 3.2 Annual mean concentrations of nitrogen dioxide measured at Salamander Street Air Quality Monitoring Station from 2010 to 2015.

Year	2010	2011	2012	2013	2014	2015
Annual mean NO_2 µg/m^3	30	29	30	28	27	28
Data Capture %	97%	98%	98%	96%	98%	100%

Hourly data of PM_{10} and oxides of nitrogen (NOx) obtained from the air quality monitoring station at Salamander Street were used to undertake correlation studies during periods when concentrations of PM_{10} were high. NO_x was used rather than NO_2 as this provides a more robust traffic indicator. The scatter plots in Figures 3.9 and 3.10 show no correlation between NO_x and $PM_{10,}$ with r^2 values of 0.2 and 0.4. This is indicative that traffic emissions are not a major source of particles at this location.

Figure 3.9 Relationship of hourly NO_x and PM_{10} values for March 2011

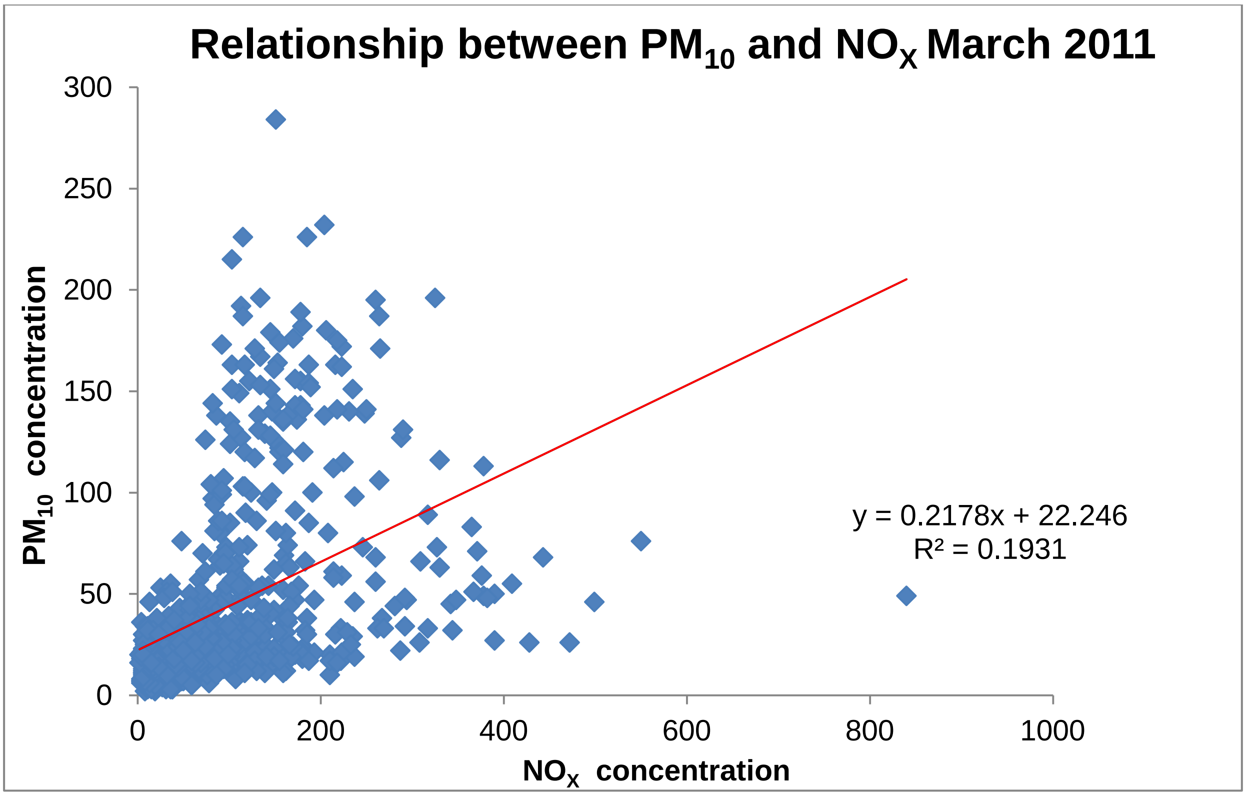
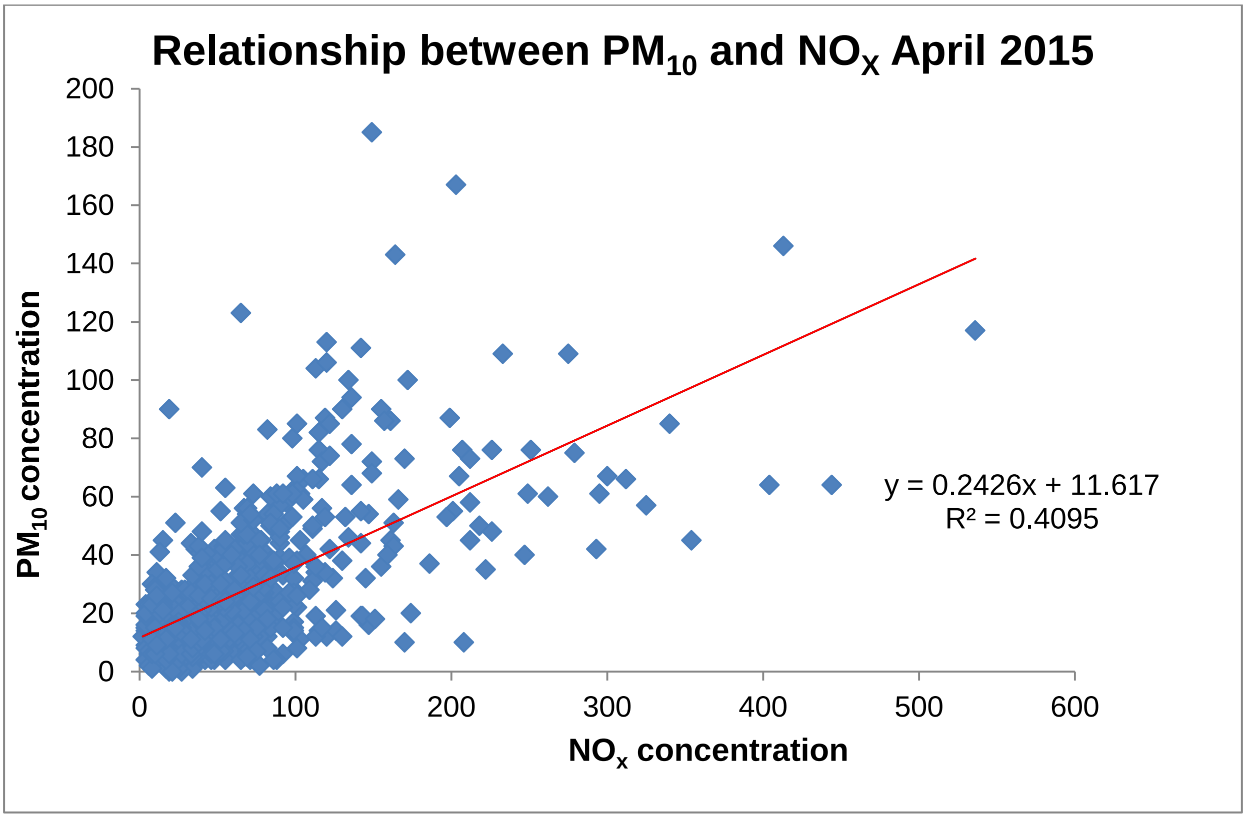


Figure 3.10 Relationship of hourly NO_x and PM_{10} values for April 2015



3.4 Potential area of PM_{10} exceedance associated with local traffic and activities at Leith Docks

City of Edinburgh Council commissioned Environmental Consultants Ricardo (formally Ricardo-AEA) to carry out a modelling study to identify a zone within which levels of PM_{10} concentrations could potentially be above the Scottish air quality objectives.[5]

Using approved methodology, the study assessed the likely emissions from fugitive sources and vehicle exhaust emissions from local traffic movements. Traffic data was provided by City of Edinburgh Council and information regarding the type of materials handled, stock pile quantities and their open storage locations were provided by the industries operating within and adjacent to Leith Docks.

Emissions from materials being stored were calculated using methods contained in the United States Environmental Protection Agency (US EPA) AP- 42 publication. These methods provide the best available means for calculating fugitive dust emissions. Emissions of PM_{10} due to dust generated from three types of source were calculated:

- Handling and movement of minerals
- Wind generation of dust from storage piles
- Vehicle- generated movement of dust from site roads

Emissions Factors Toolkit (EFT V5.2c Jan 2013) was used to calculate pollutant emission factors for each road link modelled. The calculated emission factors were imported into the ADMS-Roads model.

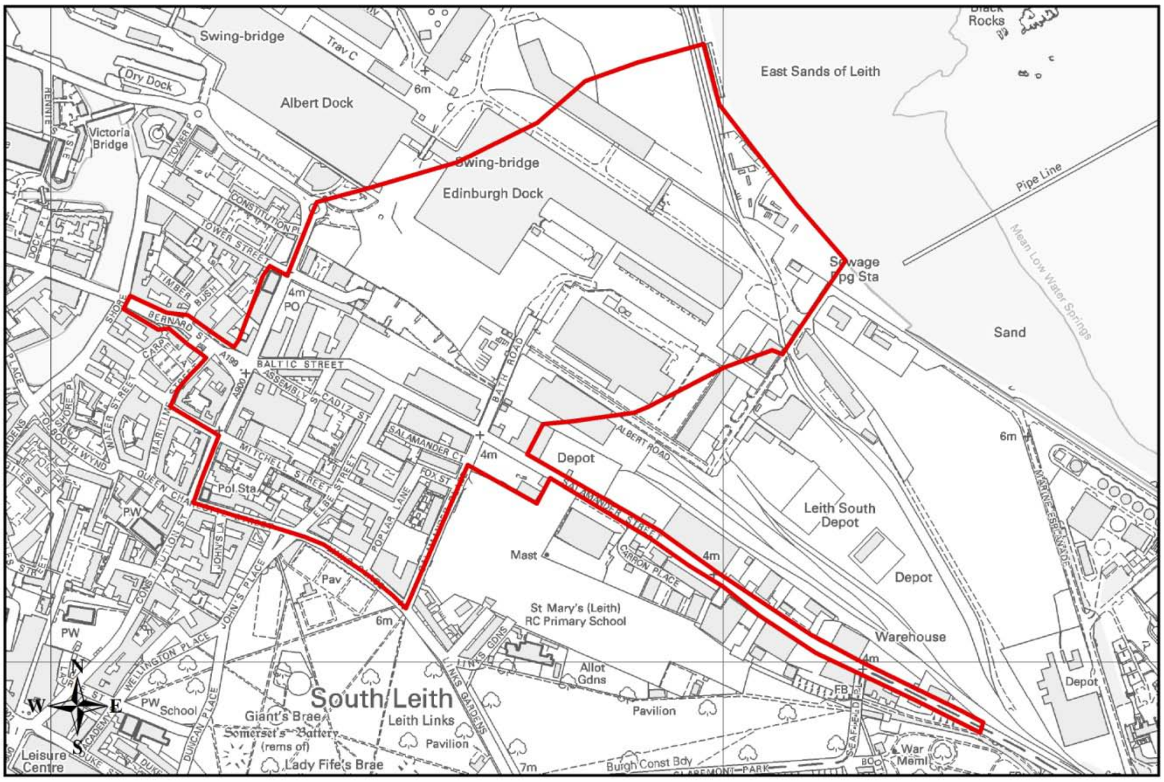
PM_{10} emissions from both road vehicles and fugitive dust sources were modelled within the study area using the atmospheric dispersion model ADMS Roads (version 3.2).

The model inputs used in the study, summary of the methodology and modelled contour outputs from the dispersion results are shown in Appendix 3.

Based on the modelling study, the proposed AQMA will encompass the zone marked red as shown in Figure 3.11. The estimated number of households currently living within the boundary of the AQMA is 1,500.

Ricardo's report recommended using cost-effective directional dust monitoring techniques to assist in the evaluation of the sources in the vicinity of Leith Docks. However, to date City of Edinburgh Council has not being granted access by Forth Ports to undertake this work. This will be pursued following the AQMA declaration.

Figure 3.11 AQMA designation for exceedances of PM_{10} Air Quality Objectives at Salamander Street



4.0 Industrial Sources (Poultry Farms)

4.1 Poultry Farm Screening Assessment

Edinburgh has 5 poultry farms located in the rural west of its administrative boundary, 4 of which are operational (Gogarbank has temporarily ceased operations). All farms are owned by Hook2 Sister Company barring one which is a private concern.

The screening criteria used to determine the need to progress to a Detailed Assessment as described in LAQM (TG 09) has been revised by DEFRA and was approved for use by the Scottish Government in 2014. The revised updated Poultry Screening method is now included in Local Air Quality Management Technical Guidance (TG16).

The methodology is based on an empirical equation derived from monitoring data obtained from several poultry farms in England.

Two factors have been calculated from the studies which represent the 98th percentile and 90.4th percentile of daily means. The PM_{10} short-term (daily mean) Air Quality Standard (AQS) Objective are equivalent to a 98th percentile of daily mean values in Scotland, and a 90.4th percentile for the rest of the UK. The formula calculates the total percentile of daily mean PM_{10} concentrations, based on the number of birds, distance of relevant exposure to the poultry sheds and local background concentration. The screening assessment outcomes determine if the PM_{10} short-term (daily mean) Air Quality Objectives for both Scotland and the rest of the UK are likely to be exceeded.[6]

The screening assessment concluded that relevant receptors within the site boundaries of all poultry farms were likely to breach the Scottish PM_{10} daily mean objective based on the 98th percentile of daily mean concentrations which ranged from 53.1µg/m^3 to 103µg/m^3. There were also breaches of the UK PM_{10} daily mean objective with respect to the 90.4th percentile of daily mean values at the following poultry farms, Gogarburn, Clifton Road and Easter Norton. Although the majority of potential exceedances occur at cottages within the poultry farm boundaries, three residential properties outside the boundaries were also likely to fail the Scottish daily mean objective, Milburn House, Fernwood House and Cliftonwood House.

Gogarbank and Gogarburn poultry farms are next to each other. Cottages 3 and 4 are located within the site boundary of Gogarbank Farm; however, the potential breaches are due to operations associated with Gogarburn Farm. A summary of the assessment data is shown in Table 4.1 and all calculations are detailed in Appendix 1.

4.2 PM_{10} monitoring at Gogarburn Poultry Farm

City of Edinburgh Council met with Scottish Government and SEPA to establish a way forward regarding the potential PM_{10} issue at poultry farms in Scotland. It was agreed that a programme of monitoring would be undertaken and that funding would be provided by the Scottish Government.

Gogarburn Poultry Farm was selected for the study due to it being a worst case scenario and suitable for the deployment of monitoring equipment. A Partisol (EU reference method) and a Beta Attenuation Monitor (BAM) were located adjacent to Cottage 2 in July 2015 as shown in Figure 4.1.

Real time data obtained from the BAM instrument will be used to link site activity with elevated concentrations. PM_{10} data from the suburban background AQMS at Currie will also be assessed to determine possible transboundary affects and pollution episodes. This background site is located approximately 3.3 Km due south of the poultry farm. It is anticipated that the study will conclude at the end of July 2016.

Table 4.1 Summary of poultry farm assessment

Farm Site and receptors	Distance of receptor to nearest shed (m)	98^{th} Total Percentile Contribution	90.4^{th} Total Percentile Contribution
Gogarburn Farm (number of birds = 295,200)			
Cottage 2	24 m	100.5	67.3
Cottage 1	36 m	84.5	55.3
Cottage 3*	40 m	80.5	52.2
Cottage 4*	43 m	77.5	50.1
Milburn House	73 m	56.6	34.5
Gogarbank Farm (number of birds = 80,000)			
Cottage 3*	52m	42.0	23.6
Cottage 4*	36m	45.8	26.5
Easter Norton Farm (number of birds = 250,000)			
Farm House	17m to NW shed	103.3	68.9
	32m to W sheds	82.2	53.2
	37m to E shed	77.3	49.5
Clifton Road Farm (number of birds = 250,000)			
Cottage 1	22m	94.7	63.0
Cottage 2	44m	71.5	45.7
Fernwood House	57m	60.9	37.7
Cliftonwood House	72m	53.1	31.8
Beechgrove Farm (number of birds = (144,000)			
Farm Cottage	26m	55.7	41.8
Farm House	44m	45.6	28.2

Data highlighted in red is indicative of a potential exceedance of the Scottish and UK short-term daily mean air quality objectives.

*Cottages are at Gogarbank Farm.

Concentrations of PM_{10} values from the Partisol show an average daily mean of 11µg/m^3 over a period of 240 days. The highest daily concentration was 49µg/m^3 and therefore over the monitoring period there have been no exceedances of the daily mean objective of 50µg/m^3. The high PM_{10} concentration occurred on the 28 December 2015 and a similar daily value of 44µg/m^3 was also recorded from the AQMS at Currie on that date. This is indicative of a transboundary issue rather than an activity from the poultry farm. Interim data from the Partisol is shown in Table 4.2.

Findings from this study will help verify the new screening model for Scotland and assist other Scottish Local Authorities determine whether poultry farms are likely to be an issue. A full report will be submitted to the Scottish Government following completion of the study.

Figure 4.1 Monitoring at Gogarburn Poultry Farm

Table 4.2 Daily mean PM_{10} concentration (µg/m^3) averaged over a 240 day period at Gogarburn Poultry Farm.

Study period	Average daily mean (Partisol)	Highest daily mean value	Data capture %
17.07.2015 to 14/3/2016 (240 days)	11 µg/m^3	49 µg/m^3 (28.12.2015)	83%

5.0 Conclusions

Measured PM_{10} data from roadside, urban background and suburban background locations in Edinburgh show that annual mean PM_{10} concentrations currently comply with the annual mean Scottish Air Quality Objective of 18µg/m^3, apart from data gathered at Salamander Street.

PM_{10} concentrations from the monitoring location at Salamander Street also failed the permitted number (7) of daily exceedances of 50µg/m^3 for years, 2010, 2011, 2012 and 2015.

2014 annual mean PM_{10} concentrations for the modelled road network using the PCM model meet with the Scottish Air Quality Objective. However, the PCM model for the same road network has identified that the majority of locations are at or exceed the revised $PM_{2.5}$ annual standard of 10µg/m^3.

The measured background $PM_{2.5}$ data at St Leonards currently meets the new standard, but failed to comply in 2011 and 2012. However, data capture for 2012, 2014 and 2015 was less than 90%, which is required for comparison against the objective.

Although it is mandatory for local authorities in Scotland to review and assess $PM_{2.5}$ against the new standard, they are not required to declare AQMAs until robust data has been gathered from monitoring stations and findings from the PM_{10} and $PM_{2.5}$ ratio evaluation study for Scotland are available.

Particle (PM_{10} and $PM_{2.5}$) trends from measured data in Edinburgh show a downward trend (decrease in concentrations with time) at all monitoring stations.

There is evidence from the assessment of measured data, polar plots and visual observations within and adjacent to Leith Docks to suggest that activities regarding handling and storage of open material are a contributory factor to the higher concentrations observed at Salamander Street. Re-suspended road dust also plays a role with respect to elevated concentrations however, this is difficult to quantify.

It will therefore be necessary to declare an AQMA to include the area of PM_{10} exceedance at Salamander Street and beyond. The designated area will be based on the modelling study undertaken by Ricardo on behalf of Edinburgh Council and will take account of existing and proposed relevant receptors.

Further dialogue with SEPA and Forth Ports will be necessary with respect to overall site management of Leith Docks.

The revised screening tool for assessment of poultry farms identified that breaches of the Scottish PM_{10} daily mean standard were likely at all relevant receptors within the site boundary of the farms and that a number of residential properties outside the boundaries would also be affected. However, PM_{10} measured data gathered over

240 days from the Partisol unit deployed at Gogarburn Poultry Farm shows that PM_{10} Scottish Air Quality Objectives are likely to be achieved at this location, and therefore an AQMA will not be necessary. It is likely that the screening tool is conservative. A full report will be submitted to the Scottish Government on completion of this study.

6.0 References

1.https://www.gov.uk/government/publications/estimating-local-mortality-burdens-associated-with-particulate-air-pollution

2. Cleaner Air for Scotland November 2015

3. Detailed Assessment Report (Local Air Quality Management Round 2) City of Edinburgh Council December 2004.

4.Visual and Microscopic Assessment of Particulate SW/2013/03 SEPA

5.Assessment of airborne particulate matter at Salamander Street Leith Ricardo-AEA. 2015.

6 Review of Air Quality Impacts Resulting from Particle Emissions from Poultry Farms. AECOM Environment

Appendices

Appendix 1 Poultry Farm Calculations

Notes

City of Edinburgh Council has used the equations which were circulated to the Scottish Government by DEFRA in November 2012 to estimate the impact of operations from Poultry Farms on the PM_{10} short-term AQS objectives.

The assessment methodology and equations are contained in a report by AECOM Environment; Review of Air Quality Impacts Resulting from Particle Emissions from Poultry Farms, which was recently released by DEFRA.

The Poultry Farm screening assessment has been updated in Draft Local Air Quality Management – Revised Technical Guidance 2016 and is in keeping with the initial equations which were circulated in 2012.

Scotland

The PM_{10} short-term (daily mean) Air Quality Standard (AQS) Objective are equivalent to a **98^{th} percentile** of daily mean values in Scotland.

England, Wales and Northern Ireland

The PM_{10} short-term (daily mean) Air Quality Standard (AQS) Objective are equivalent to a **90.4^{th} percentile** of daily mean values in the UK

Empirical equations used for the screening study

Scotland 98^{th} percentile contribution (PC) to the daily mean PM_{10} calculation

PC_{98th} = 0.83x (-000161 In(d) + 0.000793) x (b)

England 90.4^{th} percentile contribution (PC) to the daily mean PM_{10} calculation

$PC_{90.4th}$ = 0.62x (-000161 In(d) + 0.000793) x (b)

In both equations

d = distance to relevant receptor

b = number of birds

Poultry Farm Calculations

Equation relevant to Scottish Air Quality Short Term Objectives (98th Percentile Contribution to daily mean PM_{10} concentration)
0.83 x (-0.000161 In (d) +0.000793) x (b)

Equation relevant to UK Air Quality Short Term Objectives (90.4th Percentile Contribution to daily mean PM_{10} concentration)
0.62 x (-0.000161 In (d) +0.000793) x (b)
d = Distance of receptor to nearest shed (This was calculated using measurement tool on the GIS system)
b = Number of birds (Data was provided by Poultry Managers during farm visit 2014).

Gogarburn Farm Gogar Station Road	Grid References	Number of birds	Distance (m)	Calculation 98th Percentile Contribution	Calculation 90.4th Percentile Contribution
Farm cottage no 2 (on site)	317352 671356	295,200	24 m	(-0.000161x24 (In) + 0.000793) x 295,200 = 83.04 0.83 x 3.04 = 68.9	(-0.000161x24 (In) + 0.000793) x 295,200 = 83.04 0.62 x 83.04 = 51.5
Farm cottage no 1 (on site)	317317 671406	295,200	36 m	(-0.000161x36 (In) + 0.000793) x 295,200 = 63.77 0.83 x 63.77 = 52.9	(-0.000161x36 (In) + 0.000793) x 295,200 = 63.77 0.62 x 63.77 = 39.5
Farm cottage no 3 (Gogarbank)	317379 671238	295,200	40 m	(-0.000161x40 (In) + 0.000793) x 295,200 = 58.77 0.83 x 58.77 = 48.8	(-0.000161x40 (In) + 0.000793) x 295,200 = 58.77 0.62 x 58.77 = 36.4
Farm cottage no 4 (Gogarbank)	317387 671219	295,200	43 m	(-0.000161x43 (In) + 0.000793) x 295,200 = 55.33 0.83 x 55.33 = 45.9	(-0.000161x43 (In) + 0.000793) x 295,200 = 55.33 0.62 x 55.33 = 34.3
Millburn Lodge	317260 671463	295,200	73 m	(-0.000161x73 (In) + 0.000793) x 295,200 = 30.18 0.83 x 30.18 = 25.0	(-0.000161x73 (In) + 0.000793) x 295,200 = 30.18 0.62 x 30.18 = 18.7

Gogarbank Farm Gogar Station Road	Grid References	Number of birds	Distance (m)	98th Percentile Contribution	90.4th Percentile Contribution
Farm cottage no 3 (on site)	317379 671238	80,000	52 m	(-0.000161x52 (In) + 0.000793) x 80,000 = 12.55 0.83 x12.55 = 10.4	(-0.000161x52 (In) + 0.000793) x 80,000 = 12.55 0.62 x12.55 = 7.8
Farm cottage no 4 (on site)	317387 671219	80,000	36 m	(-0.000161x36 (In) + 0.000793) x 80,000 = 17.2 0.83 x 17.2 = 14.2	(-0.000161x36 (In) + 0.000793) x 80,000 = 17.2 0.62 x 17.2 = 10.7

Easter Norton East Field	Grid References	Number of birds	Distance (m)	98th Percentile Contribution	90.4th Percentile Contribution
Farm House (on site)	315234 672129	250,000	17m to NW shed	(-0.000161x17 (In) + 0.000793) x 250,000 = 84.21 0.83 x 84.21 = 69.9	(-0.000161x17 (In) + 0.000793) x 250,000 = 84.21 0.62 x 84.21 = 52.2
		250,000	32m to W sheds	(-0.000161x 32 (In) + 0.000793) x 250,000 = 58.75 0.83 x 58.75 = 48.8	(-0.000161x 32 (In) + 0.000793) x 250,000 = 58.75 0.62 x 58.75 = 36.4
		250,000	37m to E shed	(-0.000161x 37 (In) + 0.000793) x 250,000 = 52.91 0.83 x 52.91 = 43.9	(-0.000161x 37 (In) + 0.000793) x 250,000 = 52.91 0.62 x 52.91 = 32.8

Clifton Road Clifton Road	Grid References	Number of birds	Distance	98th Percentile Contribution	90.4th Percentile Contribution
Farm Cottage 1 (on site)	311069 670545	250,000	22m	(-0.000161x 22 (In) + 0.000793) x 250,000 = 73.83 0.83 x 73.83 = 61.3	(-0.000161x 22 (In) + 0.000793) x 250,000 =73.83 0.62 x 73.83 = 45.8
Farm cottage 2 (on site)	311102 670537	250,000	44m	(-0.000161x 44 (In) + 0.000793) x 250,000 = 45.93 0.83 x 45.93 = 38.1	(-0.000161x 44 (In) + 0.000793) x 250,000 = 45.93 0.62 x 45.93 = 28.5
Fernwood (Private house)	310785 670423	250,000	57m	(-0.000161x 57 (In) + 0.000793) x 250,000 = 35.51 0.83 x 35.51 = 29.5	(-0.000161x 57 (In) + 0.000793) x 250,000 = 35.51 0.62 x 35.51 = 22.0

Cliftonwood (Private house)	310785 670423	250,000	72m	(-0.000161x 72 (In) + 0.000793) x 250,000 =26.11 0.83 x 26.11 = 21.7	(-0.000161x 72 (In) + 0.000793) x 250,000 =26.11 0.62 x 26.11 = 16.1

Beech Grove Farm A70	**Grid References**	**Number of birds**	**Distance**	**98th Percentile Contribution**	**90.4th Percentile Contribution**
Farm cottage (on site)	313136 665522	144,000	26m	(-0.000161x 26 (In) + 0.000793) x 144,000 =38.65 0.83 x 38.65 = 32.1	(-0.000161x 26 (In) + 0.000793) x 144,000 =38.65 0.62 x 38.65 = 30.0
Farm House (on site)	313131 665530	144,000	44m	(-0.000161x 44 (In) + 0.000793) x 144,000 =26.45 0.83 x 26.45 = 22.0	(-0.000161x 44 (In) + 0.000793) x 144,000 =26.45 0.62 x 26.45 = 16.4

The total percentile PM_{10} concentrations are calculated by adding the percentile contributions to the annual mean background concentrations.

In Scotland the advice is to add the percentile contributions to twice the annual mean background concentration.

Receptors	PM_{10} µg/m^3 2014 Background	PM_{10} µg/m^3 2014 Background x2	Total 98th percentile 24-hour mean concentration	Total 90.4th percentile 24-hour mean concentration
Gogarburn Farm				
Farm cottage 2	15.8	31.6	31.6 + 68.9 = 100.5	15.8 + 51.5 = 67.3
Farm cottage 1	15.8	31.6	31.6 + 52.9 = 84.5	15.8 + 39.5 = 55.3
Farm cottage 3	15.8	31.6	31.6 + 48.8 = 80.4	15.8 + 36.4 = 52.2
Farm cottage 4	15.8	31.6	31.6 + 45.9 = 77.5	15.8 + 34.3 = 50.1
Milburn Lodge	15.8	31.6	31.6 + 25.0 = 56.6	15.8 + 18.7 = 34.5
Gogarbank Farm				
Farm cottage 3	15.8	31.6	31.6 + 10.4 = 42.0	15.8 + 7.8 = 23.6
Farm cottage 4	15.8	31.6	31.6 + 14.2 = 45.8	15.8 + 10.7 = 26.5
Easter Norton Farm				
Farm House	16.7	33.4	33.4 + 69.9 = 103.3	16.7 + 52.2 = 68.9
	16.7	33.4	33.4 + 48.8 = 82.2	16.7 + 36.4 = 53.2
	16.7	33.4	33.4 + 43.9 = 77.3	16.7 + 32.8 = 49.5
Clifton Road Farm				
Farm cottage 1	17.2	34.4	33.4 + 61.3 = 94.7	17.2 + 45.8 = 63.0
Farm cottage 2	17.2	34.4	33.4 + 38.1 = 71.5	17.2 + 28.5 = 45.7
Fernwood	15.7	31.4	31.4 + 29.5 = 60.9	15.7 + 22.0 = 37.7.
Cliftonwood	15.7	31.4	31.4 + 21.7 = 53.1	15.7 + 16.1 = 31.8
Beechgrove Farm				
Farm cottage	11.8	23.6	23.6 + 32.1 = 55.7	11.8 + 30.0 = 41.8
Farm House	11.8	23.6	23.6 + 22.0 = 45.6	11.8 + 16.4 = 28.2

Data which is highlighted in red is greater than 50µg/m^3 and therefore there is a potential to breach the short-term objectives.

Appendix 2 Details of Automatic Monitoring Sites

Site ID	Site Name	Site Type	X OS Grid Ref.	Y OS Grid Ref.	Pollutants Monitored	In AQMA?	Monitoring Technique	Distance to Relevant Exposure(1) (m)	Distance to kerb of nearest road (m)	Inlet Height (m)
ID1	**Queen Street**	Roadside	324826	674078	NO_2 PM_{10}	Yes	Chemiluminescent TEOM	0	5.2	2.87
ID2	**Haymarket[1]**	Roadside	323896	673197	NO_2 PM_{10}	Yes	Chemiluminescent TEOM	7	9.2	N/A
ID3	**Roseburn[1]**	Roadside	322939	673233	NO_2 PM_{10}	Yes	Chemiluminescent TEOM	4.9	7.6	n/a
ID4	**Gorgie Road**	Roadside	323121	672314	NO_2	Yes	Chemiluminescent	0	2.5	2.63
ID5	**St. John's Road**	Kerbside	320101	672907	NO_2	Yes	Chemiluminescent	1.35	0.5	1.98
ID6	**Currie High School**	Suburban	317595	667909	NO_2 PM_{10}	No	Chemilum TEOM	N/A	N/A	3.59 3.24

Continued overleaf.../

Site ID	Site Name	Site Type	X OS Grid Ref.	Y OS Grid Ref.	Pollutants Monitored	In AQMA?	Monitoring Technique	Distance to Relevant Exposure[1] (m)	Distance to kerb of nearest road (m)	Inlet Height (m)
ID7	**St. Leonards**	Urban Back-ground (AURN)	326265	673129	NO_2 PM_{10} $PM_{2.5}$ O_3 CO SO_2 PAH	No	Chemiluminescent FDMS FDMS UV absorp IR absorp UV absorp Digitalsamp	29.0 (NB. background site)	35m	3.4m 3.2m 3.1m 3.4m 3.4m 3.4m 3.4m
ID8	**Salamander Street**	Roadside	327615	676333	NO_2 PM_{10}	No	Chemiluminescent TEOM	0	2.13m	2.86
ID9	**Queensferry Road**	Roadside	318736	674930	NO_2 PM_{10}	No	Chemiluminescent TEOM/FDMS	6.5	1.7m	2.96
ID10	**Glasgow Road**	Roadside	313103	672663	NO_2 PM_{10}	Yes	Chemiluminescent TEOM	0	6m	2.84

Notes for Table;

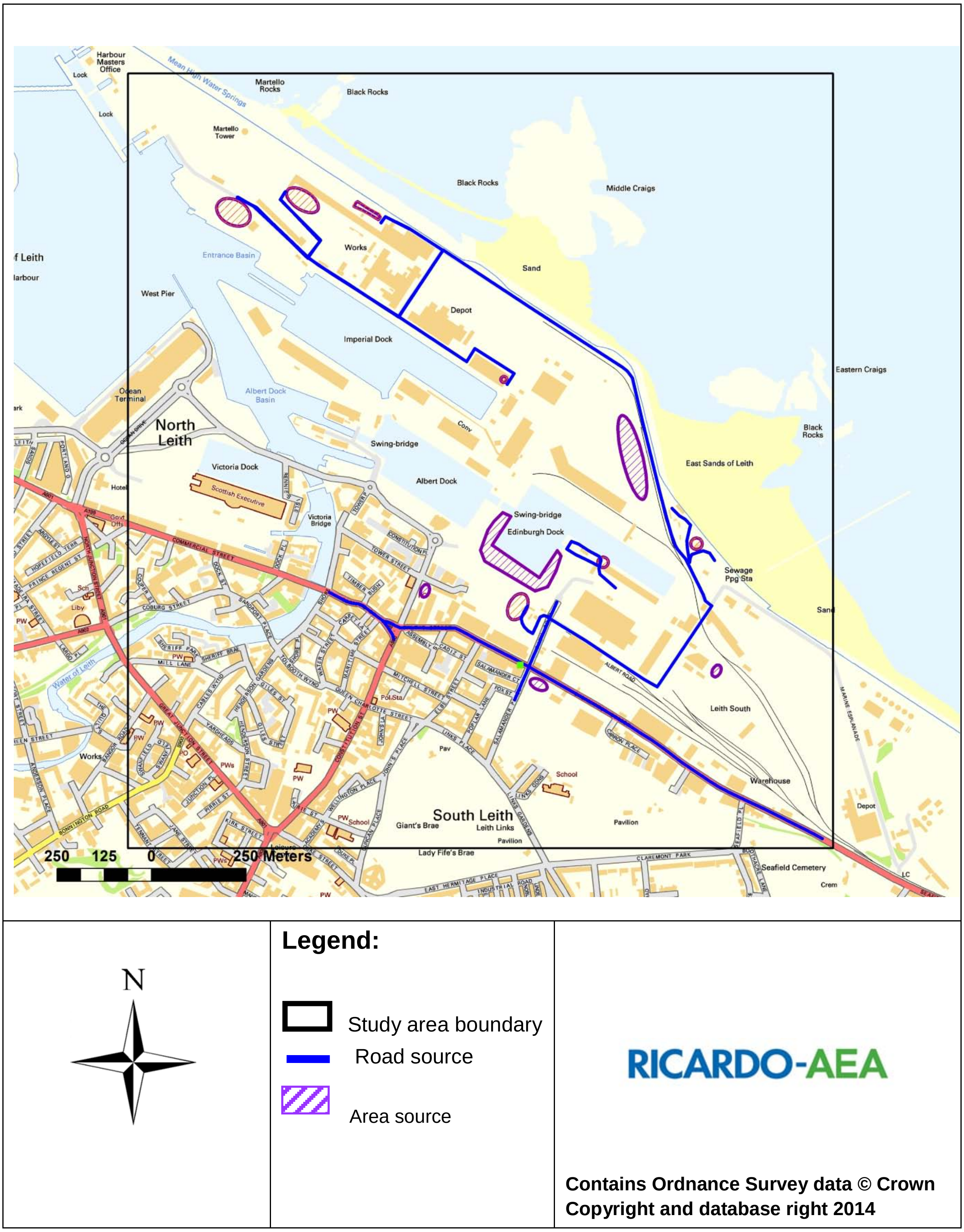
- 0 meters if the monitoring site is at a location of exposure (e.g. representative of the façade of a residential property).

Appendix 3

Summary of Modelling Study

The area which was modelled in the vicinity of Leith Docks is shown in Figure 3A

Figure 3A Model domain /study area extent and modelled source locations



Model inputs

Fugitive dust emissions

Emissions from the following sources were calculated using methods provided by the United States Environmental Protection Agency (US EPA) in the AP-42 publication and are considered the best available means for calculating fugitive dust emissions.

Handling and movement of materials:

AP- 42 chapter 13.2.4 2
"Aggregate Handling and Storage Piles 2" Emission factors were rated as "B; above average"

Wind generation of dust from storage piles:

AP-42 Chapter 13.2.5
"Industrial Wind Erosion" Meteorological data for these calculations were obtained from Edinburgh Airport for 2010.

Vehicle- generated movement of dust from site roads:

AP-42 Chapter 13.2.2
"Unpaved roads" Dust emissions were calculated on the basis of 14 tonnes (metric) material per vehicle movement, with an average laden weight of 30 tons (imperial). Emission factors were rated as "D; below average"

Dust from concrete batching process:
AP- 42 chapter 11.12
"Concrete Batching" Emission factors were rated as "D; below average"

Table 4A Emission calculations: handling and movement of minerals

ID	Source name	Material	Calculated PM_{10} release rate (g/s)	Basis
1	Virtual Quarry	Sand	0.000066	Assume movement of 20% of capacity per month
2	Coal Storage			Contract ended 2011, hence no material movement
3	Aggregate Industries	Sand	0.00033	Based on 60,000 t material handled per year
4	Scrap Metal			Recent observation indicated low dust source :metals not observed in dust samples
5	Sandstone products			Dust generated from cutting process assumed to be effectively abated

ID	Source name	Material	Calculated PM_{10} release rate (g/s)	Basis
6&7	Scrap Metal/ Salamander Street / Constitution Street			Recent observation indicated low dust source :metals not observed in dust samples
8	Cemax cement covered storage	Cement	0.0014	Assume movement of 20% of capacity per month
9	Bredero Shaw Concrete batching	Cement	0.091	Calculated from typical throughput of concrete batching process estimated to be 500 tonnes per day
10	Bredero Shaw Storage	Aggregate	0.015	Assume movement of 20% per month
11	Cemex readymix batching plant storage	Sand Aggregate	0.00019 0.0035	Based on 35,000T per year Based on 35,000T per year
12	Asphalt plant	Sand Pebbles	0.000085 0.0016	Based on 300 T per year Based on 300 T per year

Table A5 Emission calculations: wind erosion

ID	Source name	Material	Calculated PM_{10} release rate $g/m^2/s)$	Basis
1	Virtual Quarry	Sand	0.000026	Assume 1 disturbance of stockpile per month
2	Coal Storage			Contract ended 2011, hence no material disturbance
3	Aggregate Industries	Sand	0.000051	Assume 1 disturbance of stockpile surface per day
4	Scrap Metal			Recent observation indicated low dust source: metals not observed in dust samples
5	Sandstone products			No significant stockpiling
6&7	Scrap Metal/ Salamander Street / Constitution Street			Recent observation indicated low dust source: metals not observed in dust samples
8	Cemax cement covered storage	Cement		Covered storage no significant wind generated dust
9	Bredero Shaw Concrete batching	Cement		Working area no significant stockpiling
10	Bredero Shaw Storage	Aggregate	0.000018	Assume 1 disturbance of stockpile per day

ID	Source name	Material	Calculated PM_{10} release rate $g/m^2/s)$	Basis
11	Cemex readymix batching plant storage	Sand Aggregate	0.000051 0.000018	Assume 1 disturbance of stockpile per day
12	Asphalt plant	Sand Pebbles		Covered storage no significant wind-generated dust

Table 5A Emissions calculations: unpaved roads.

ID	From	To	Vehicle movements per day	Calculated PM_{10} release rate (g/vehicle km)	Basis
A	Virtual Quarry	Site entrance Bath Rd	2.38	2.7	Outbound only assume inbound from shipping
B	Coal Storage	Site entrance Bath Rd			Contract ended 2011, hence no movement
C	Aggregate Rear	Site entrance Bath Rd	17.61	1.9	50% of raw materials assumed to be transported from offsite; 100% of product assumed to be transported offsite
D	Scrap Metal	Site entrance Bath Rd			No data
E	Sandstone products	Site entrance Bath Rd			No data
F	Scrap Metal	Site entrance Bath Rd	0	0	Access directly to road network, so no unpaved road movements
G	Scrap Metal	Site entrance Bath Rd	0	0	Access directly to road network, so no unpaved road movements
H	Covered storage -shed	Site entrance Bath Rd	8.57	3.6	Movements of product outbound only
I	Bredero Shaw Concrete batching	Site entrance Bath Rd	28.57	1.88	All product assumed to be moved offsite
J	Bredero Shaw Storage	Site entrance Bath Rd	14.29	2.67	50% of raw materials assumed to go from Virtual Quarry to storage area
K	Cemax readymix	Site entrance Bath Rd	83.33		Access directly to road network, so no unpaved road movements

ID	From	To	Vehicle movements per day	Calculated PM_{10} release rate (g/vehicle km)	Basis
L	Asphalt	Site entrance Bath Rd	83.33		Access directly to road network, so no unpaved road movements
M	Virtual Quarry	Aggregates Bath Road	5.87	1.88	50% of raw meterials assumed to be transported from Virtual Quarry to storage area
N	Virtual Quarry	Bredero Shaw batching			No movements because materials assumed to go from Virtual Quarry to storage area
O	Virtual Quarry	Bredero Shaw batching	14.29	2.67	50% of raw materials assumed to be transported from Virtual Quarry

Traffic data

A summary of the calculated Annual Average Daily Traffic (AADT) and fleet compositions used within the model are shown in the Table 3A

Table 3A Annual Average Daily Traffic (AADT)

Street	% Cars	%LGV	% HGVs	%Bus	% 2WM	AADT 2013
Bath Road	46%	21.8%	31.6%	0.1%	0.4%	1599
Salamander Street W	81.6%	12.2%	5.4%	0.3%	0.5%	16528
Salamander Street E	80.5%	13.2%	5.3%	0.5%	0.4%	16451
Salamander Place	71.5%	19.2%	9.1%	0.1%	0.0%	1861

LGV = Light Goods Vehicles; HGV = Heavy Goods Vehicles (Artic and Rigid); 2WM = Motorcycles

Dispersion model methodology

Dispersion Model - ADMS Roads (version 3.2).

Vehicle emissions and fugitive dust emissions from unpaved roads were modelled as line source emissions. Wind-blown fugitive dust from storage and loading operations in the Leith Docks were modelled as area sources.

Grid height = 1.5m
Surface roughness= 1.5m
Minimum value for the Monin- Obukhov length = 30m

Meteorology – hourly sequential data of wind speed, direction etc for 2013 from Edinburgh Airport meteorological measurement site is located approximately 12.5 km west of the study area was used.

The measured annual mean PM_{10} background concentration of 14µg/m^3 (2013) obtained from St Leonards Air Quality Monitoring Station was used for this study. This figure was subtracted from the measured concentration at Salamander Street and the modelled contribution was then compared to the local component measured in 2013.

The modelled results under- predicted the measured data, and three different approaches were used to calculate an adjustment factor so that the predicted annual mean concentration matched the measured data. Each approach was noted to have a significant degree of uncertainty. However, the approaches provide a reasonable indication of the worst case scenario for potential impact from each type of PM_{10} source.

Approach 1- adjustment factor calculated for both road traffic and fugitive dust emissions
Approach 2- adjustment factor road emissions only and added to unadjusted fugitive dust contribution plus background
Approach 3- adjustment factor applied to fugitive emissions only and added to unadjusted road traffic contribution plus background contribution.

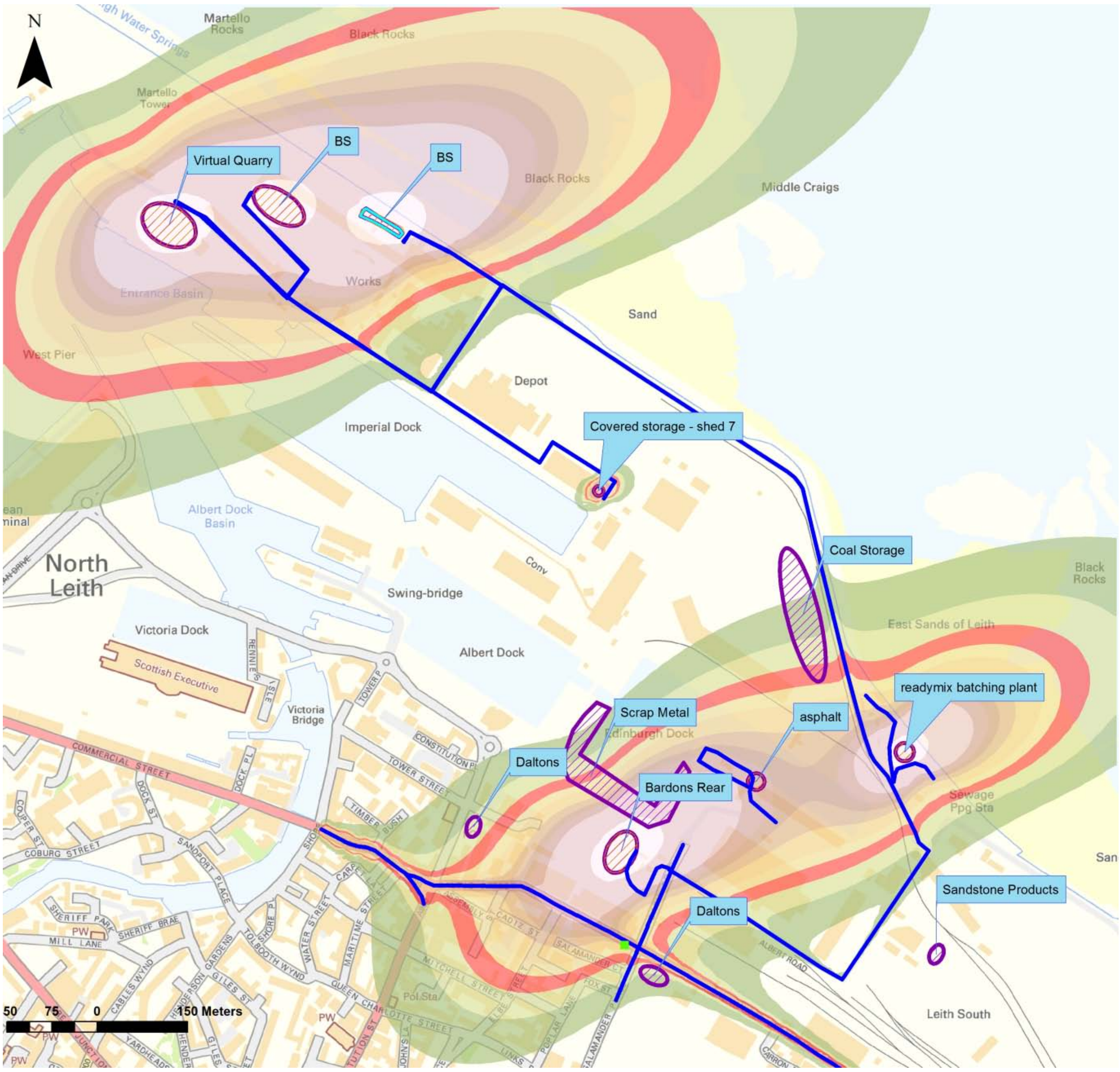
The contours of these approaches are shown in Figures 3B, 3C and 3D.

The recommendation for an initial approach to setting an AQMA is as follows

- Include all areas adjacent to Salamander Street and Baltic Street enclosed by the orange contour in Figure 3C.
- Include all areas enclosed by the orange contour covering the south-eastern area of Leith Docks and nearby streets in Figure 3D.

The area is shown in Figure 3E.

Figure 3B Predicted PM_{10} annual mean concentrations (combined adjustment factor – Approach 1)



Legend:

PM_{10} annual mean concentration ($\mu g.m^{-3}$)

- < 16
- 16 - 17
- 17 - 18
- 18 - 19
- 19 - 20
- 20 - 22
- 22 - 24
- 24 - 26
- 26 - 30
- 30 - 100
- 100 - 810.6

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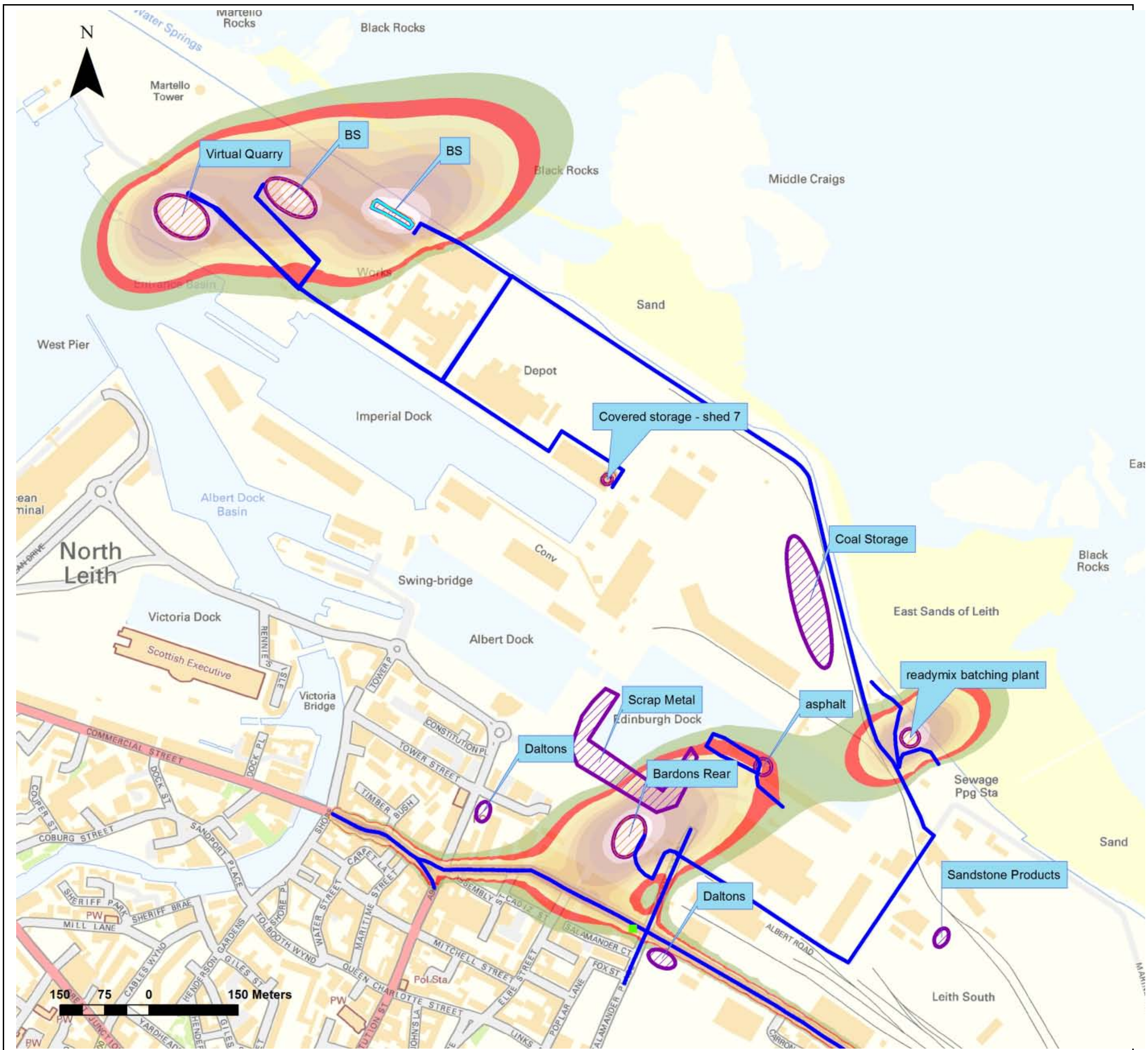
Figure 3C: Predicted PM_{10} annual mean concentrations (adjustment factor applied to road traffic emissions only – Approach 2)



Legend:

PM_{10} annual mean concentration ($\mu g.m^{-3}$)

- < 17
- 17 - 18
- 18 - 19
- 19 - 20
- 20 - 22
- 22 - 24
- 24 - 30
- 30 - 50
- 50 - 100
- 100 - 264

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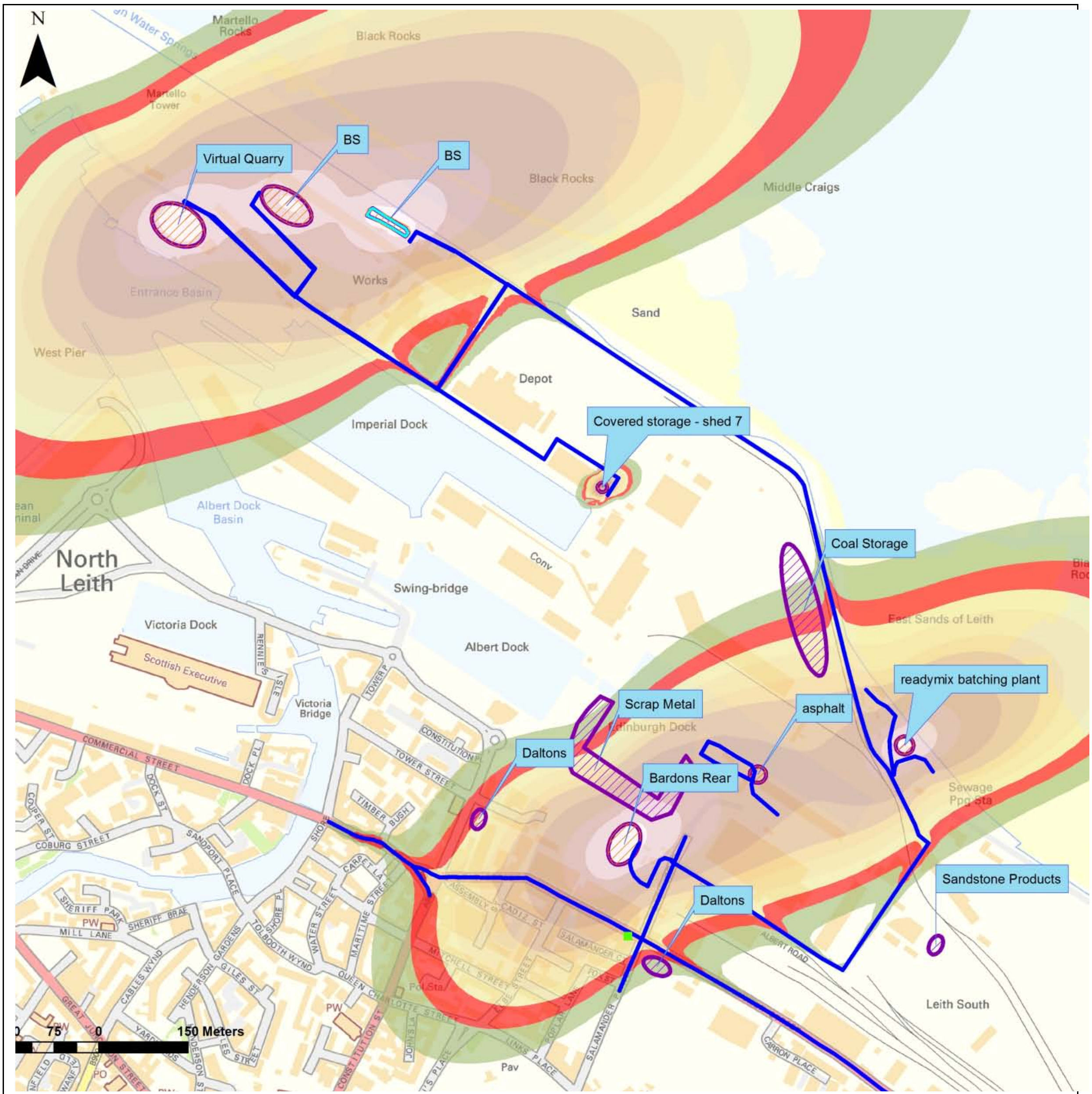
Figure 3D: Predicted PM_{10} annual mean concentrations (adjustment factor applied to fugitive dust emissions only – Approach 3)



Legend:

PM_{10} annual mean concentration ($\mu g.m^{-3}$)

- < 17
- 17 - 18
- 18 - 19
- 19 - 20
- 20 - 22
- 22 - 24
- 24 - 30
- 30 - 50
- 50 - 100
- 100 - 500
- 500 - 1,355

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Figure 3E Potential AQMA for PM_{10} exceedances at Salamander Street