Further Assessment of PM_{10}
Low Santon
North Lincolnshire Council

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Date	

Executive Summary

North Lincolnshire Council undertook this Further Assessment because of continued exceedances of the Annual Mean Objective of 40µg/m^3 at Low Santon, Scunthorpe. Because of this an Air Quality Management Area was declared on the 10th December 2008.

This AQMA became the second within North Lincolnshire joining the previously declared 2005 Scunthorpe wide AQMA created for continued breaches of the Daily Mean Objective of less than 35 days >50µg/m^3 in a calender year. The 2008 Low Santon AQMA sits within the 2005 Scunthorpe AQMA and are the result of industrial activities on Local Integrated Steelworks.

This study has looked at a number of factors likely to influence the elevated concentrations being recorded at Low Santon including:

- Location of the monitoring stations
- Method of measurement
- Historical MET data
- Particle size fractions
- Relationships with other pollutants
- Triangulation with other monitoring stations
- Directional analysis

This study has also reviewed and highlighted ongoing work designed to inform interested parties of exceedance risk and ongoing area contributions including:

- North Lincolnshire Council Tea Break Report
- North Lincolnshire Council Daily Review Analysis
- North Lincolnshire Council PM_{10} Alert System
- North Lincolnshire Council Low Santon PM10 Risk Assessment
- AEA Low Santon Modelling Report
- Environment Agency PM_{10} Action Plan

Due to the scale of the issues at Low Santon it has proved difficult to identify a single source. A number of sources around the Integrated Works contribute to the problem. This study has identified a number of key elements which will prove to inform Operators local to Low Santon including:

- Concentrations increase from compliant concentrations overnight to non compliant concentrations during the daytime focused between 06:00 & 16:00.
- Concentrations consist of predominantly coarse material and not finer material associated with combustion processes.
- Elevated levels are sufficiently localised as not to create an exceedance at a further monitoring station 300m to the East of Low Santon
- Many of the exceedances are near misses and a small reduction in concentrations may well demonstrate a large step change.

- Correlation between PM_{10} exceedance days and Manganese concentrations courtesy of the Heavy Metals Network
- Higher wind speeds lead to increase concentrations from wind sectors housing large storage areas
- AEA modelling report suggesting Tarmac is the highest contributor to the issues although removing Tarmac does not show compliance. Issues have also been raised over the inputs of this model
- PM_{10} hotspots do not correlate with other gaseous sources suggesting releases are primarily PM_{10}

A number of further steps have been suggested in the conclusion of this report that will refine and further what is already understood about the source locations on and around the Integrated Steelworks.

No one company is responsible for the problems at Low Santon. It is the responsibility of all localised Operators to review their processes and identify areas of weakness.

Table of contents

Appendices

List of Tables

List of Figures

1 Introduction

1.1 Description of Local Authority Area

North Lincolnshire is an area of around 85,000 hectares located on the southern side of the Humber estuary and occupying tracts of land on either side of the River Trent. Parliamentary Order created the administrative area of North Lincolnshire in March 1995 and on 1st April 1996 the new Unitary Authority area of North Lincolnshire came into being. North Lincolnshire covers a large, mainly agricultural area. The pattern of settlements in the area reflects this with market towns surrounded by many small villages. An important exception to this is the substantial urban area of Scunthorpe and the adjoining town of Bottesford. Almost half of North Lincolnshire's population, approximately 73,250 people, live in Scunthorpe and the adjacent town of Bottesford. Overall, 71 percent of the population live in this main urban area and other towns. The local economy of North Lincolnshire was built on traditional industries such as steel manufacturing and related industries and agriculture. More recently there has been the establishment of two oil refineries and the introduction of several gas fired power stations. The M180 motorway and several primary and strategic routes, including the A18 and A15, are located within North Lincolnshire. By rail there are regular freight movements to and from Scunthorpe Steelworks and Humber port related industries. With several wharf facilities along the banks of the Humber and the Trent, North Lincolnshire is well positioned to take advantage of water transport.

1.2 Purpose of the Further Assessment

Further Assessments are required following the declaration of an AQMA. An AQMA at Low Santon was declared because of continual breaches of the Annual Mean Objective as highlighted in review and assessment reports since the installation of the monitoring station at Low Santon in October 2005. The 2008 Progress Report highlighted a need for a Detailed Assessment which concluded the necessity for the AQMA.

This Further Assessment is designed to identify the likely origin of the source and its likely effect on local receptors. This report will inform and aid the forthcoming Low Santon Action Plan designed to tackle and reduce the emission of particulate currently responsible for the Air Quality Objective breaches at Low Santon.

1.3 Air Quality Objectives

The air quality objectives applicable to Local Air Quality Management (LAQM) **in England** are set out in the Air Quality (England) Regulations 2000 (SI 928), and the Air Quality (England) (Amendment) Regulations 2002 (SI 3043). They are shown in Table 1.1. This table shows the objectives in units of microgrammes per cubic metre $\mu g/m^3$ (for carbon monoxide the units used are milligrammes per cubic metre, mg/m^3). Table 1.1. includes the number of permitted exceedances in any given year (where applicable).

Pollutant	Concentration	Measured as	Date to be achieved by
Benzene	16.25 µg/m^3	Running annual mean	31.12.2003
	5.00 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	10.0 mg/m^3	Running 8-hour mean	31.12.2003
Lead	0.5 µg/m^3	Annual mean	31.12.2004
	0.25 µg/m^3	Annual mean	31.12.2008
Nitrogen dioxide	200 µg/m^3 not to be exceeded more than 18 times a year	1-hour mean	31.12.2005
	40 µg/m^3	Annual mean	31.12.2005
Particles (PM_{10}) (gravimetric)	50 µg/m^3, not to be exceeded more than 35 times a year	24-hour mean	31.12.2004
	40 µg/m^3	Annual mean	31.12.2004
Sulphur dioxide	350 µg/m^3, not to be exceeded more than 24 times a year	1-hour mean	31.12.2004
	125 µg/m^3, not to be exceeded more than 3 times a year	24-hour mean	31.12.2004
	266 µg/m^3, not to be exceeded more than 35 times a year	15-minute mean	31.12.2005

Table 1: AQ Objectives

1.4 Summary of Previous Review and Assessments

Previous rounds of review and assessment have led to a number of focused assessments of different pollutants and sources. Summaries of the assessment findings are as follows;

Updating and Screening Assessment (USA) 2003

Results of monitoring and the screening exercises in this Review & Assessment, proposed that a further detailed assessment of PM_{10} would be conducted in relation to the following: -

- Industrial emissions of PM_{10} in Scunthorpe.
- Emissions of PM_{10} from quarries and landfills in Barnetby.
- Emissions of PM_{10} and SO_2 from domestic solid fuel burning in Keadby.
- Industrial emissions of SO_2 in Killingholme
- Industrial emissions of Benzene in Killingholme and Scunthorpe

Detailed Assessment 2004

Continuing on from the 2003 USA, recommendations for each pollutant were as follows;

Benzene

To gather further data in both Scunthorpe and Killingholme and review and report findings in the next annual Progress Report.

Sulphur Dioxide

To gather further data at Keadby and review and report findings in the next annual Progress Report. No further action was required in respect of sulphur dioxide at Killingholme. No further action was required in connection with stationary railway locomotives at Scunthorpe Station.

PM_{10}

An Air Quality Management Area or Areas shall be defined and then designated for the Scunthorpe area where there is likely exceedance of the Air Quality Objectives. Gather additional PM_{10} data at Keadby and subsequently review and report conclusions in the next annual Progress Report. No further action is required in respect of PM_{10} in Croxton/Barnetby.

Benzene Detailed Assessment 2005

The annual mean of benzene concentrations at relevant locations did not exceed the 2010 objective, although at one location at Santon, Scunthorpe some monthly concentrations did exceed $5µg/m^3$ and consequently further investigations were required. The monthly concentrations at certain boundary locations were greater than $5µg/m^3$ at installations in Scunthorpe and Killingholme, however where there were no relevant receptors and exposure is unlikely to effect human health, no further investigation was required in relation to air quality assessment.

Progress Report 2005

From the results of the monitoring data in this Progress Report, it was proposed that the following actions be implemented; A benzene diffusion tube survey would continue for a further 12-month period commencing March 2005 at two sites in Scunthorpe identified as having the potential to breach the 2010 annual mean objective of 5µg/m^3.

The two locations identified in Scunthorpe as likely to breach the annual mean air quality objective for nitrogen dioxide of 40µg/m^3, a chemiluminescence NO_x analyser was installed.

The council will declare an Air Quality Management Area for PM_{10} in Scunthorpe, in relation to the 24 hour mean objective of 50µg/m^3 not to be exceeded more than 35 times a year, and continue with the further assessment work to determine the relative contributions of different sources of PM_{10}.

Updating & Screening Assessment 2006

From the results of the monitoring and the screening exercises in this Review & Assessment, it was proposed that detailed assessments would be conducted in relation to the following: -

- Industrial emissions of 1,3-Butadiene in the vicinity of the Conoco Phillips Ltd and Total UK Ltd Oil Ltd Refineries, North Killingholme.
- Industrial emissions of Lead in the vicinity of the Tata (UK) Ltd Integrated Steelworks, Scunthorpe.
- Emissions of Nitrogen Dioxide in the vicinity of Doncaster Rd / Hilton Avenue, Scunthorpe, Junction of Brigg Road and A18, Mortal Ash, Scunthorpe

Detailed Assessment PM_{10} 2008

The results presented indicate that the annual PM_{10} objective has been breached in the vicinity of the Low Santon TEOM monitoring station in 2006 and 2007. The mean concentration recorded between October and December 2005 was also greater than 40 µg/m^3.

Further Assessment of PM_{10} 2008

Further assessment of past monitoring data recorded at continuous sites within the AQMA Scunthorpe shows levels remain non-compliant with the short-term objective. The Council has no current plans to move the monitors within the AQMA.

Air Quality Progress Report 2008

The progress report concluded that NO_2 concentrations within Killingholme had decreased and there had been no significant changes to road traffic flows or other transportation.

Updating & Screening Assessment 2009

The Updating & Screening Assessment 2009 highlighted no new areas of non-compliance. Existing problems such as the ongoing issues with the Integrated Steel Works were again noted and are due to be addressed within forthcoming Further Assessments and Action Plans

Progress Report 2010

The 2010 Progress Report identified no new exceedances of the relevant Air Quality Objectives. It did however continue to highlight issues surrounding the local integrated steelworks.

1.5 Significant Industrial Operations in Scunthorpe

Under the Environmental Permitting Regulations 2010 Tata UK Ltd (Tata) and Harsco Ltd (Harsco) are regulated by the Environment Agency as Part A1 processes. Tata manufacture steel, this is a process that involves several stages. Various parts of the Integrated Steelworks are shown below including the locations of other companies generating PM_{10}. Harsco de-metal and process steel slag on the Integrated Steelworks.

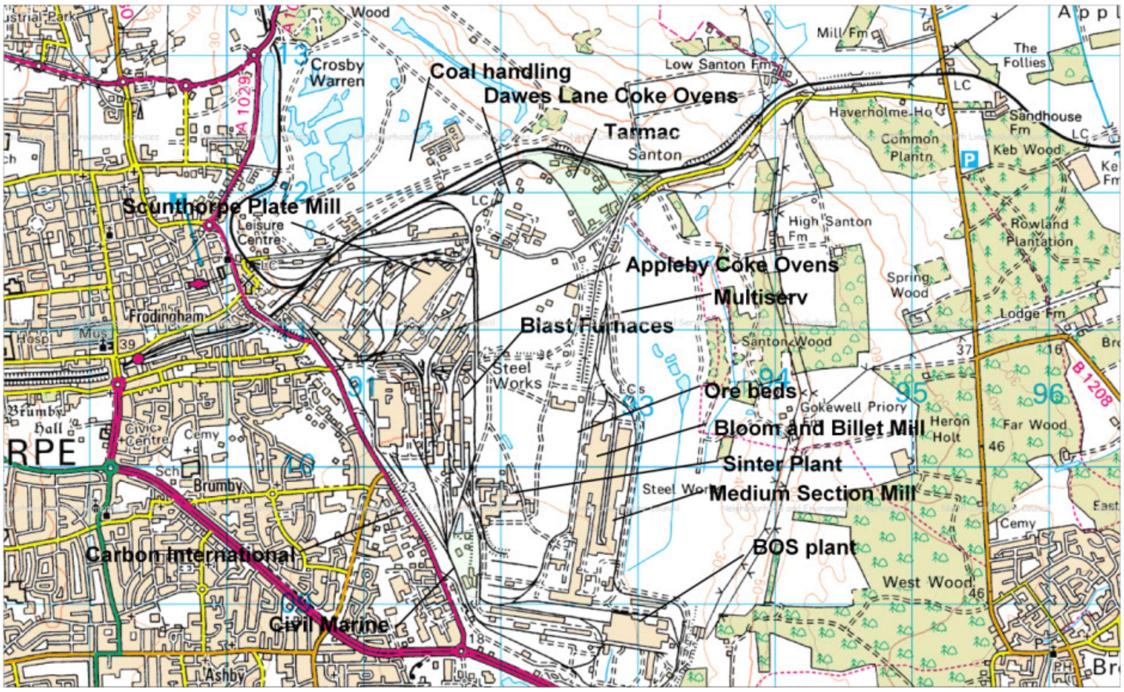

Figure 1: Significant Industrial Operations in Scunthorpe

In addition, North Lincolnshire Council regulates three smaller sites that are potential emitters of PM_{10} in the Scunthorpe area.

Hanson Cement, previously known as Civil & Marine (Part A2) grind granulated blast furnace slag (a by-product from the steelworks) to produce a cementitous material for use in concrete manufacture and a more granular material for use within the glass industry as a raw material. There are two main processes: one takes solidified slag (similar in size to coarse sand), which is dried and ground down to a fine powder known as granulated blast furnace slag (GGBS). The other process produces a coarser product known as Calumite.

Carbon International Ltd (Part B) perform heating, drying, screening and packaging of metallurgical coke, calcined petroleum coke and graphite.

Tarmac Northern Ltd (Part B) process both blast furnace and steel slag from the iron and steel making operations from the adjacent Tata steelworks. The slag is imported to the works at Santon via a fleet of dumptrucks, the material is then screened and crushed to relatively large size fractions in an enclosed building. Further screening and crushing is then carried out to smaller size fractions within double-decked screens. There is one operational roadstone coating plant with stacks, both of which were regularly tested for total particulate matter emissions. The Barber Greene Plant is currently mothballed and has no plans to restart operations. The plant currently operates the Parker Roadstone Coating Plant and will remain a single plant operation for the foreseeable future.

Tarmac also weather slag in windrows on the former Yarborough Landfill Site located to the South of the Low Santon Monitoring Station.

The site has made many environmental improvements including the surfacing of unmade roads, enclosing crushing operations, the use of dust suppression foam, the bunding of raw materials, site greening, wheel washing and much more.

Tarmac operates to ISO14001 standards. All incidents are recorded and reported and staff are trained on site to be aware of the potential risk that Tarmac poses to Low Santon.

1.6 Definition and Health Effects of PM_{10}

The definition of PM_{10} is the fraction of particulate matter capable of passing through an inlet of defined characteristics at 50% sampling efficiency with 10 μm aerodynamic diameter. PM_{10} has been assigned an Air Quality Standard as evidence suggests it has a range of effects on human health, concentrated specifically on the cardiovascular and respiratory systems;

- Increased use of asthma medication.
- Attacks of asthma in pre-existing cases.
- Attacks of chronic obstructive pulmonary disease.
- Admission to hospital for cardiovascular causes.
- Deaths from heart attacks, strokes and respiratory causes.

The effects of particulate matter described are most likely to be suffered by susceptible groups in the population who already have say, a pre-existing heart or lung condition. The PM_{10} fraction is currently monitored as it is thought that particles of this size can penetrate the larynx and enter the thoracic region of the respiratory system. The smaller the particle the further it penetrates into the lung.

Epidemiological studies have consistently shown a link between health effects and PM_{10}. In a COMEAP (Committee on the Medical Effects of Pollutants) report on Cardiovascular Disease and Air Pollution a summary of the health effects of PM_{10} in a variety of studies was given. The percentage change in the outcome measure varied from 0.4 to 1.4% per 10 μg m^{-3} increase in PM_{10} concentrations. Although this is a small affect the large potential exposure (i.e. a whole population within a given area) could mean the public health impact is large. It is thought there is no concentration that can give complete protection to particulate matter, as threshold levels have not been identified.

PM_{10} are also linked to other problems, it can cause a reduction in local and regional visibility, it has been implicated in climate change through a possible cooling effect and may also provide a surface for chemical reactions to occur. It is likely that further focus will concentrate on the smaller size fraction, $PM_{2.5}$ (particles less than 2.5 μm in diameter) due to the increasing likelihood of its greater contribution to poor health.

1.7 Concentrations, Sources and Types of PM_{10}

Figure 2 shows the estimated spatial distribution of PM_{10} concentrations across the UK in 2006;

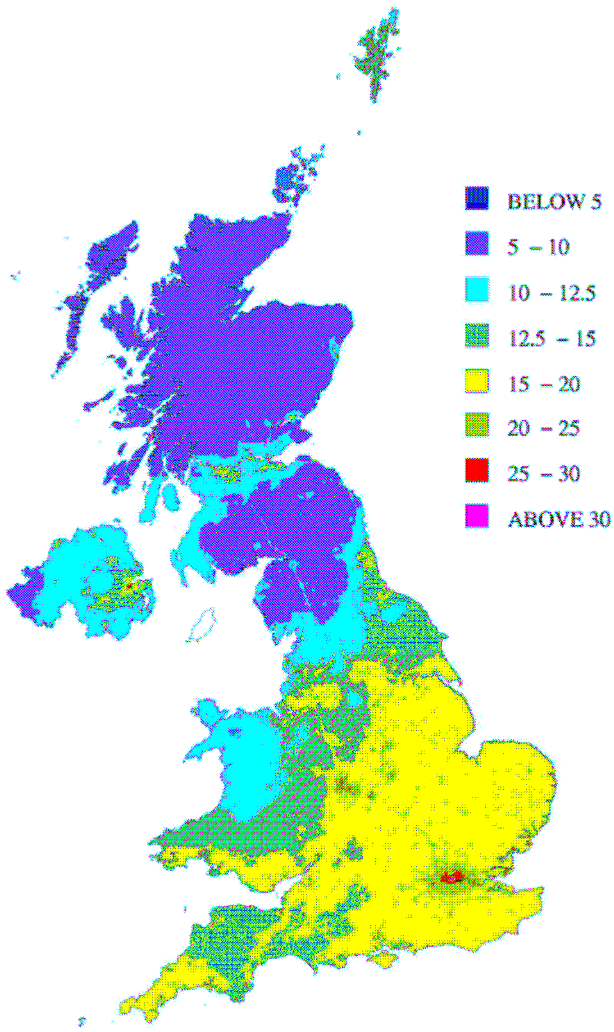

Figure 2: UK Concentration Map

Although there may have been reductions since 2006 the overall trend will remain the same. North Lincolnshire sits within the yellow area surrounding a Central London hotspot. The expected background concentrations of 15µg/m^3 – 20µg/m^3 will leave lower than average headroom before air quality exceedances are recorded.

PM_{10} can be classified into several different categories; primary PM_{10} are those particles that have been directly emitted into the atmosphere. Secondary particles are formed by the condensation of low volatile gases and small particles condensing onto existing aerosol particles in the atmosphere. Species that encourage the formation of secondary particles are inorganic sulphates and nitrates. E.g. ammonium sulphate and nitrate.

The smallest group of particles, with diameters of less than 0.05 µm, are usually referred to as nucleation mode particles. These particles are formed either by nucleation in the atmosphere or by nucleation processes that occur within the emissions from high temperature sources. Accumulation mode particles (0.05 µm and 1 µm) can then be formed by the growth of nucleation mode particles, primarily by vapour condensation and coagulation processes. Coarse particles are defined as those with a diameter between 2.5 and 10 µm, atmospheric lifetimes for these particles tend to be shorter than for smaller particles due to gravitational settling velocities.

Typical anthropogenic sources are fossil fuel combustion emissions, wear and tear from road traffic, metal works and construction activities. Natural primary sources include wind blown dust or soil and sea salt, typically these are coarse particles due to their size.

The graph below shows the PM_{10} emissions in the UK between 1970 and 2007 from various anthropogenic sources. It is clear that emissions (by mass) have decreased during that period, particularly from industry and power stations. Although modern combustion processes tend to emit less particulate mass, the number of nucleation and accumulation mode particles produced is greater than for the processes they replaced.

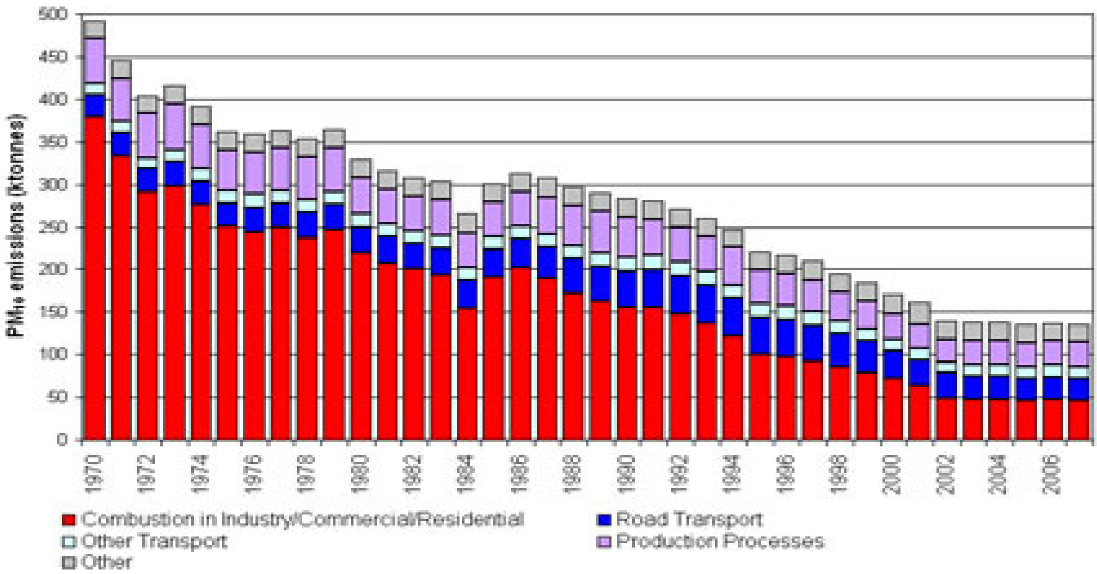

Figure 3: Sector Contribution Map

1.8 PM_{10} Measurement Techniques

The PM_{10} Air Quality objectives are based on a gravimetric system of measurement. In a TEOM (Tapered Element Oscillating Microbalance) machine particles are collected on a filter that is mounted on a glass element; this oscillates with a natural frequency that then decreases as the mass of PM_{10} on the filter increases. Thus it is an in-direct measurement of particulate mass.

The majority of the data recorded for this report was measured using TEOM machines. The main advantage of the TEOM is that it gives real-time measurements of PM_{10}; a reading is taken by the machine every other second with a 15-minute mean then recorded.

Problems arise when comparing TEOM results to the Air Quality objectives; this is because the element is maintained at $50^{o}C$ thus resulting in the potential 'driving off' of volatile PM_{10}. Previous advice from Defra was to multiply raw TEOM results by a factor of 1.3 to make a conversion to gravimetric equivalent results. All information available from the North Lincolnshire Council website is multiplied by 1.3. All data between 2008 & 2010 was corrected and reported using the Volatile Correction Model.

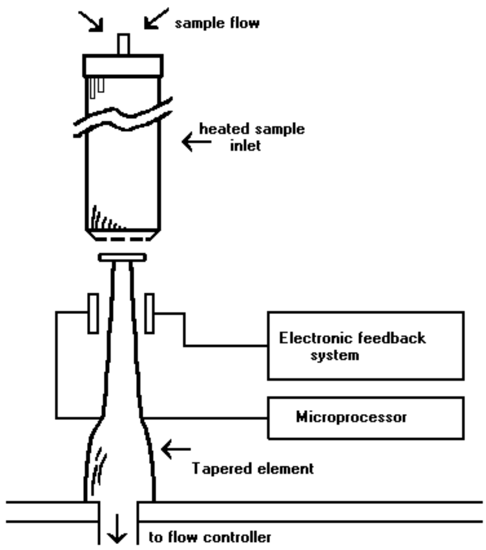

Figure 4 : A schematic diagram of a TEOM machine.

To avoid concerns regarding the correction factor an alternative machine, the Partisol 2025, can be used. This machine performs a direct measurement of PM_{10} collected on to a filter and is an 'equivalent' method with the additional advantage that further analysis of the filters is possible e.g Heavy Metal analysis. This method is currently being utilized at High Santon some 300m East of the main area of concern at Low Santon.

To minimise visits to a Partisol, 14 daily filters are housed within a cartridge. Each filter is exposed between midnight and midnight with a changeover occurring automatically, every fortnight the cartridge is exchanged by the local site operator.

However, filters need to be exposed for at least 24 hours followed by analysis at an external laboratory. The cartridge is then sent off to an analyst for the gravimetric analysis to be undertaken and results returned around two weeks later. This means real-time data is not possible as the results are only returned several weeks after exposure. The temporal resolution is also poor with only a 24-hour mean concentration being recorded compared to a 15 minute mean concentration being possible with a TEOM. Partisols are also a relatively expensive method of measurement compared to a TEOM which was the basis for the decision to locate a TEOM at Low Santon and a Partisol at High Santon

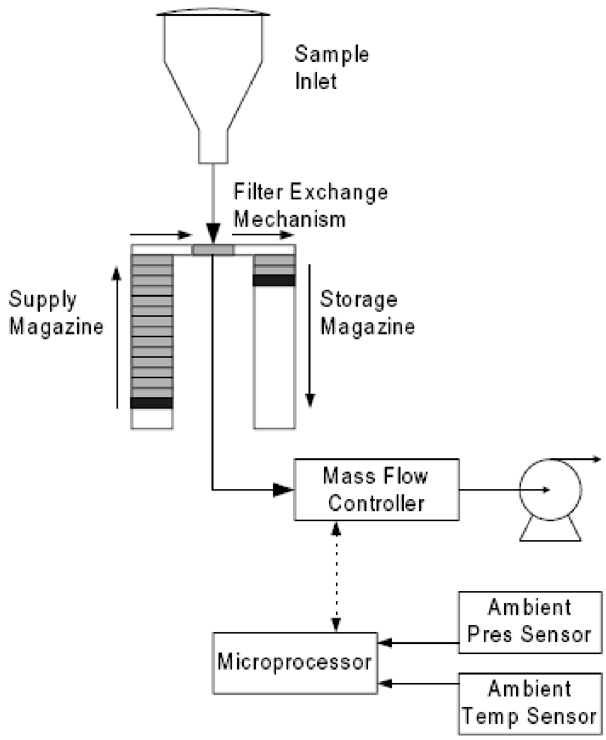

Figure 5: Partisol Schematic

The FDMS is a self referencing airborne particulate monitor based on TEOM technology. The TEOM uses first principle physics to measure the mass of particles collected on a filter. The FDMS measures the core and volatile fractions of the collected mass by using a self referencing technique to measure the effects of these materials as they collect on the filter. Core particulate matter has an additive effect whereas semi volatile materials can both add mass as they arrive on the filter and can later lose mass as they volatilize.

Gases and vapours (including water vapour) can also have both positive and negative effects on the mass of the filter and collected PM over time. The FDMS is able to monitor and report these changes (or filter dynamics) as they occur and provide a more accurate and 'true' measurement of airborne particulate mass concentration.

North Lincolnshire Council installed two FDMS sites in 2010; Low Santon and Scunthorpe Town. The purpose of these installations was to house an equivalent method as a reporting tool. Concerns were also raised over the validity and suitability of the VCM for the issues being observed in North Lincolnshire given the large distances between this Authority and the nearest FDMS sites used in the corrections.

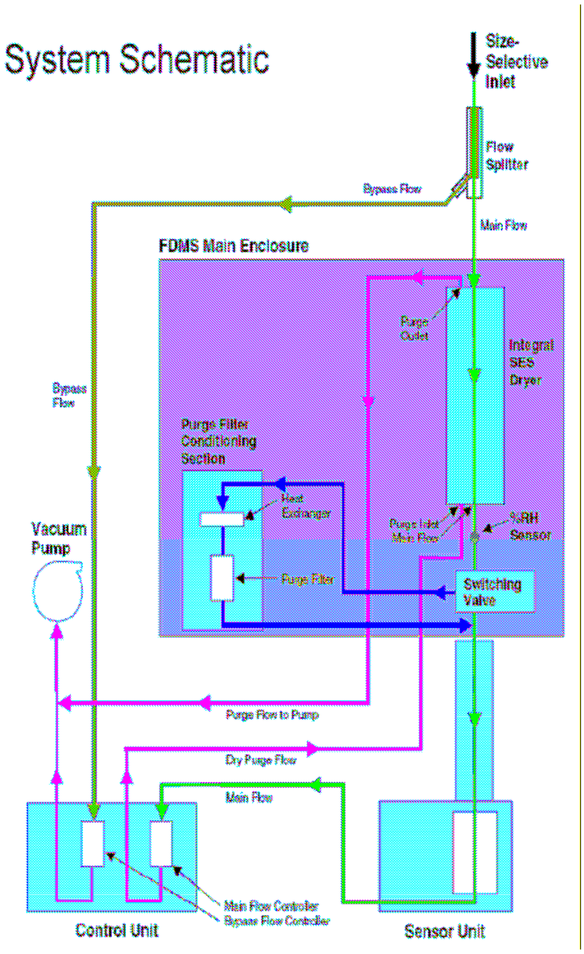

Figure 6: FDMS Schematic

1.9 PM_{10} in North Lincolnshire

As a result of the Updating and Screening Assessment (2003) North Lincolnshire Council proceeded to a Detailed Assessment for PM_{10}. The subsequent detailed assessment found that there was potential for the Daily Air Quality Objective to be breached for PM_{10} and thus the declaration of an AQMA was necessary.

On the 26th October 2005 North Lincolnshire Council declared an AQMA for a potential breach of the Air Quality objective in relation to the number of daily exceedances allowed (maximum of 35) for $PM_{10.}$ The designated area encompasses the steelworks and other industry as well as residential parts of the Town.

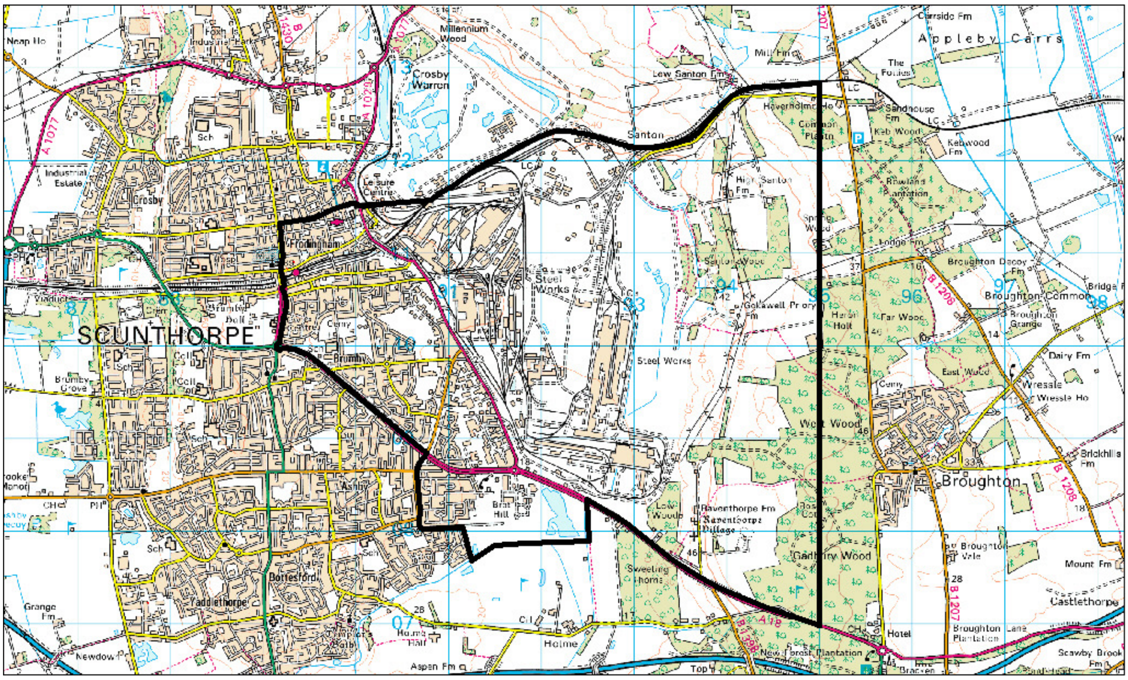

Figure 7: 2005 Scunthorpe Daily Mean AQMA

The resulting focus at Low Santon proved that the area was subject to a further breach of the PM_{10} annual mean objective. The annual mean should not exceed 40µg/m^3 of which previous years monitoring data had on a number of occasions.

On the 1st of December 2008 the Low Santon Annual Mean AQMA was declared, the driver of this Further Assessment.

Low Santon continues to report issues with both its Annual and Daily Mean Objectives. As a result, this study is primarily concerned with identifying processes on site giving rise to PM_{10} events contributing to the elevated annual and daily means.

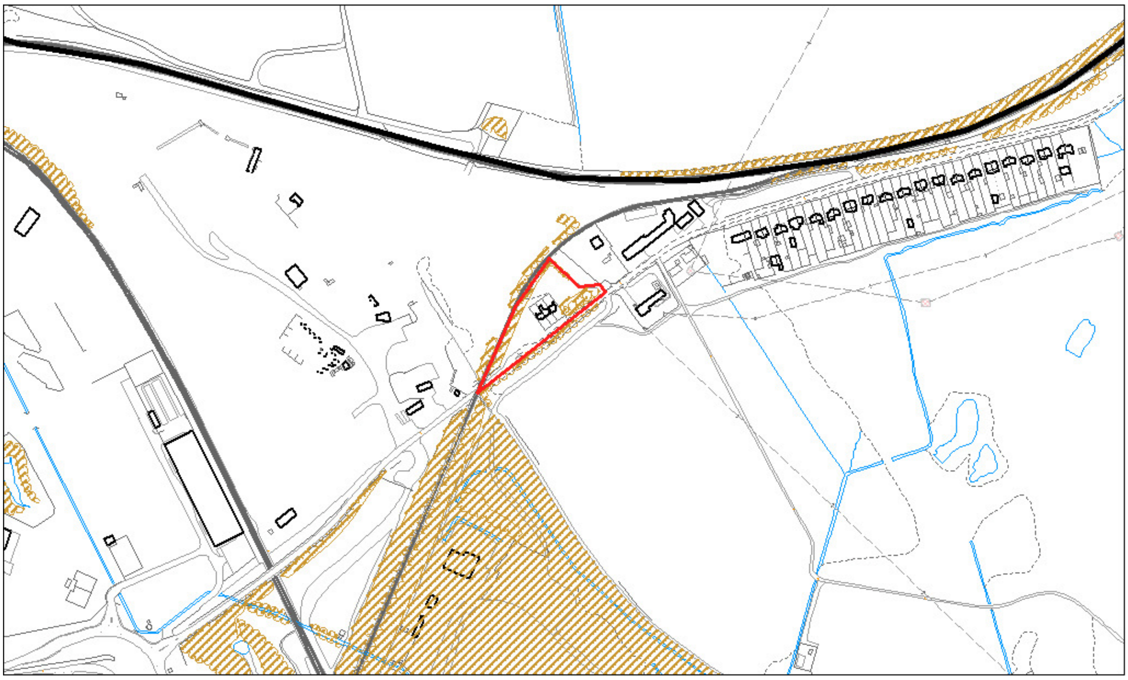

Figure 8: 2008 Low Santon Annual Mean AQMA

2 Monitoring Sites & Data

2.1 North Lincolnshire Monitoring Sites

North Lincolnshire Council currently operates an extensive network of air quality monitors for a variety of pollutants including NO_x, SO_2, PAHs and PM_{10}.

A short description of each of the PM_{10} monitoring sites relevant to this Further Assessment is documented below including the locations of each site, OS grid reference, monitoring start and finish date, pollutants measured and the classification of each site.

All TEOM sites have an air-conditioning unit within the enclosure. All sites with a TEOM machine are calibrated fortnightly with a filter change occurring once the mass on the filter reaches 80% or after 4 weeks, whichever is sooner. Since February 2007 the TEOM heads have also been cleaned on a monthly basis. In addition, each site is serviced and calibrated at six monthly intervals by Casella measurement.

Description of sites:

Scunthorpe Town AURN (Rowland Road)
This monitoring station is housed within an enclosed air-conditioned unit in the northeast of Scunthorpe approximately 10 metres to the north of Rowland Road. The nearest busy road is Brigg Road (A1029), at its closest point it is 124 metres to the northeast of the monitoring site.
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The monitoring equipment at the station consists of an Enviro-Technology Services model 100A Fluorescent sulphur dioxide (SO_2) analyser, a Monitor Labs Inc ML9841B oxides of nitrogen chemi-luminescence analyser and a Rupprecht & Patterschnick TEOM 1400a PM_{10} monitor. The logging system used is an Odessa DSM3260. In addition wind direction and wind speed are measured at this site. The PM_{10}, NOx and SO_2 analysers are affiliate members of the AURN (Automatic and Urban Rural Network). The site also comprises of an equivalent Partisol Particulate Monitor (Now Suspended 31/03/2010), a National Physics Laboratory funded Heavy Metals sampler and a Digitel DHA-80 High volume PAH sampler

An FDMS C was installed in the Monitoring Station in January 2010 designed to increase confidence in the Volatile Correction Model currently used to correct the TEOM network.

East Common Lane

PM_{10} is monitored at this site using a TEOM 1400a. This site is located behind a block of flats, 34m south of East Common Lane, to the west of the site is a residential area; whilst to the northeast and southeast are several industrial estates. The site is approximately 500 m west of the steelworks site boundary.

Low Santon

This monitoring station is housed within an enclosed air-conditioned unit to the north east of Scunthorpe on the eastern boundary of the steelworks. Dawes Lane is 5m to the south of the station, running from a rural location in the east through the steelworks and into Scunthorpe. A raised embankment 5m north of the site carries freight traffic along one of the major rail lines into the steelworks. The surrounding area consists of arable fields with a number of trees and to the east, a small residential area. The monitoring equipment at this station consists of a Signal Ambitech Ambirak analyser, monitoring sulphur dioxide and oxides of nitrogen, and a Rupprecht & Patterschnick TEOM 1400a monitoring PM_{10}. In addition, a Digitel DHA-80 High volume PAH sampler began operation at the site in September 2007.

A Partisol 2000 was installed in April 2008 to measure concentrations of heavy metals. Further to this an additional Rupprecht & Patterschnick TEOM 1400a was installed in June 2008 to monitor $PM_{2.5}$ and finished in March 2010.

An PM_{10} FDMS C was installed in the Monitoring Station in March 2010 replacing the original $PM_{2.5}$ TEOM designed to increase confidence in the Volatile Correction Model currently used to correct the TEOM network and to aid this Further Assessment.

High Santon

This monitoring station is located in a domestic garden 400m from the Low Santon monitoring station. The site comprises of a Partisol 2000 equivalent particulate monitor and was installed in January 2008.

Appleby Village

This site is located on a playing field in the village of Appleby, see figure 1.4; the village is surrounded by arable fields and open fields and is 6 km north-east of Scunthorpe. PM_{10} is monitored at this site using a TEOM 1400a.

Dawes Lane Coke Oven Osiris

This monitoring station can be found within the Integrated Steelworks boundary close to the Coke Ovens Stores Compound. 200m to the West of the site lies the Dawes Lane Coke Ovens, a large combustion process. 50m to the East lies an internal Tata Train Line, 100m to the East lies the boundary of Tarmac and a further 350m beyond that lies the Santon Groundhog monitoring station.

Further Osiris units are intended to be placed around the Scunthorpe area over the next few months to assist with planning decisions resulting from a zoning exercise in respect of the 2005 Daily Objective AQMA. These include;

- Amvale, Queensway, Scunthorpe
- Station Road Depot, Scunthorpe
- Scunthorpe Leisure Centre

Relocations of existing TEOMs will move to;

- Redbourne Social Club, Cemetery Road, Scunthorpe
- Lakeside Housing Development, Scunthorpe

Site Name	Site Type	OS Grid Ref	Pollutants Monitored	In AQMA?	Relevant Exposure? *(Y/N with distance (m) to relevant exposure)*	Distance to kerb of nearest road *(N/A if not applicable)*	Worst-case Location?
Scunthorpe Town	Urban Industrial	X490320 Y410831	PM_{10}, SO_2, NO_x	Y	Y (21m)	7m	N
East Common Lane	Urban Industrial	X490663 Y409789	PM_{10}	Y	Y (3m)	28m	N
Low Santon	Industrial	X492945 Y411931	PM_{10}, SO_2, NO_x, $PM_{2.5}$	Y	Y (41m)	5m	N
High Santon	Industrial	X492945 Y411931	PM_{10}	Y	Y(8m)	5m	N
Appleby	Rural	X495075 Y414767	PM_{10}	N	Y (17m)	N/a	N
Dawes Lane Osiris	Industrial	X492494 Y411853	PM_{10}	Y	N	N/a	Y

Table 2: NLC Monitoring Sites

It should be noted that the accuracy of the wind direction sensor at Scunthorpe Town and Killingholme is +/-5º and that any pollution rose takes results from 10º sectors. All the Scunthorpe sites are within 7km of the Scunthorpe Town site; it has been assumed that the meteorological data collected is applicable to all Scunthorpe sites.

Part 2.2: Calibration Club

In order to minimise measurement uncertainty it is important to apply stringent quality assurance/quality control procedures to monitoring programmes. North Lincolnshire Council therefore subscribe to a service known as the ‘Calibration Club’ operated by AEA Energy and Environment.

The Calibration Club provides independent equipment audits at six-monthly intervals, an audit report detailing any required data management actions, a UKAS certificate of calibration and audits providing traceability to national meteorology standards.

AEA Technology also carry out data management services on behalf of the council using the same procedures applied to the UK Government National Network monitoring stations. This service incorporates:

- Data collection, screening and provisional scaling.
- Full ratification of data sets and comparison to air quality objectives.

3 Policy Developments

3.1 Planning Policy

North Lincolnshire Council has been working with Development Control to produce a useful air quality tool to assist with the determination of planning applications within the AQMA. The Scunthorpe AQMA has been zoned according to measured and modelled concentrations of PM_{10}.

A major source of PM_{10} within Scunthorpe is the Integrated Steelworks. The 2005 AQMA covers all of the Integrated Steelworks Site and a significant area of Scunthorpe to the West of its process boundary.. A number of areas close to the boundary of the Integrated Steelworks have been highlighted by developers as potential residential sites. The Council wished to adopt a precautionary approach to such developments to prevent relevant receptors moving closer to the potential source of PM_{10} and possible non-compliant levels of PM_{10}.

A working document zones the AQMA in to 3 areas drawn using historic, current and modelled data. At present the zones have been drawn to a worst case scenario and will be reviewed periodically as new data becomes available. A monitoring regime designed to capture robust data using a network of Osiris Monitoring Units has been installed. It is anticipated that the data captured within this exercise will lead to a rescaling of the current AQMA.

Zones within this AQMA are as follows;

Zone 1 – No Residential Development

Zone 1 covers the area 550m to the west of the site boundary. Monitoring has identified a significant potential for Air Quality Objective breaches within this zone. The monitoring sites at East Common Lane and Scunthorpe Town have recorded exceedances consistently over the last few years and if subject to periods of strong Easterly winds have the potential to exceed again.

Site ID	Location	Within AQMA?	Data Capture 2008 %	Number of Exceedances of daily mean (50 µg/m^3) *If data capture < 90%, include the 90th %ile of hourly means in brackets.*		
				2006 *	2007 *	2008
5	Scunthorpe Town (AURN) TEOM	Y	94	37	18	22
6	East Common Lane	Y	98	43	34	40

Table 3: Scunthorpe Zone Exceedances 1

Due to PM_{10} being a non threshold pollutant it is important that a precautionary approach to exposure is taken. On this basis it is recommended that **no residential development should take place within this zone.**

Zone 2 – Residential Development possible Subject to Further Investigation

Zone 2 covers the area between 550m and 1100m to the west of the Integrated Steelworks Site. No historical monitoring data exists for zone 2 although a monitoring station is now operational at Redbourne Club (Grid Ref SE8990910026). The external boundary of zone 2 runs through this monitoring location.

Due to the lack of measured data in zone 2 any applications for residential development should be the **subject of further investigation.**

Further investigation of a site for residential development is likely to require on site monitoring of PM_{10}.

Zone 3 – Residential Development unlikely to be affected by PM_{10}

Zone 3 covers the area beyond 1100m from the Integrated Works site boundary to the present AQMA boundary line. Although no monitoring has been carried out within this zone data is available from the Lincoln Gardens (Grid Ref SE8946308939) and Allanby Street site (Grid Ref SE892231145). These sites are equidistant from the Steelworks boundary and suggest this area would be compliant.

Site ID	Location	Within AQMA?	Data Capture 2008 %	Number of Exceedances of daily mean (50 µg/m^3) *If data capture < 90%, include the 90th %ile of hourly means in brackets.*		
				2006 *	2007 *	2008
2	Allanby Street	Y	98	23	11	20
4	Lincoln Gardens	Y	95	17	14	21

Table 4: Scunthorpe Zone Exceedances 2

Data from monitoring at Redbourn Club will hopefully demonstrate that air quality in this zone is satisfactory and may lead to a possible review of the AQMA boundary.

3.2 Transport Policy

North Lincolnshire Council's second Local Transport Plan (LTP) shows how NLC will deliver effective, value for money transport measures over the next five years using a LTP capital award, additional Council revenue and other capital investments to improve the highway network, reduce casualties, improve the environment, reduce congestion and deliver increased accessibility. NLC wants to build on the successes achieved in the first LTP developing it a stage further by placing greater emphasis on effective demand management that makes the best use of the existing highway network whilst promoting greater travel choice.

The LTP is set within a wider context than transport and considers the social and economic factors that affect the lives of people living in North Lincolnshire. It identifies what contribution will be made to deliver transport objectives and broader aspirations at a national and regional level. The government has identified four transport priorities that it wants all local authorities to contribute toward improving and these are:

- Safer roads
- **Better air quality**
- Reducing congestion
- Delivering accessibility

The main chapters of the LTP, which set out what NLC will be doing over the next five years, are based on these shared priorities. Nationally and regionally North Lincolnshire ports have been identified as being of significant economic importance, supporting initiatives that increase capacity of road and rail networks to improve access to this priority area. Social and transport issues that have been identified as being of particular relevance to North Lincolnshire include:

- Regeneration and improved economic activity
- Improving access to the ports
- The impact of additional housing
- Reducing the number of killed and seriously injured (KSI)casualties
- Providing a cleaner and greener environment
- Increasing car use and reduced junction capacity at particular locations on the highway network in Scunthorpe
- Concerns relating to the inability of public transport to reduce the demand for travel and meet the needs of communities.
- Social exclusion and accessibility, particularly in the rural areas and in relation to employment

These issues combined with the extensive consultation identified safety as the top priority of residents, stakeholders and partners which has enabled NLC to develop a long-term strategy for transport that will make North Lincolnshire a place where people can:

- Work and enjoy economic prosperity
- Access the services they need
- Feel safe
- Lead healthy lives
- Live in sustainable communities
- Enjoy a high quality environment

Being a predominantly rural area North Lincolnshire has relatively good air quality and large areas of countryside. Air quality monitoring undertaken over the lifetime of the current LTP has shown that our air quality is more affected by industry than transport, however we will:

- Continue to monitor roads and areas that are close to exceeding pollutant thresholds
- Wherever possible include environmental improvements in all our schemes
- Traffic management measures to reduce community severance

Transport Mode	Measures	Cost	Integration with other measures	Environmental impact	Other priorities which measures impact				Justification and Notes
					Cong-estion	Safer Roads	Accessi-bility	Air Quality	
Walking	Improve Pedestrian facilities for easy access	Low	Positive	Low	•	•	•	•	Encourage more people to walk by improving accessibility
Cycling	Improve existing and extend cycling facilities, and identify areas where cycle facilities can be implemented.	Medium	Positive	Low	•	•	•	•	Better accessibility to the network to encourage more people to cycle throughout North Lincolnshire
Public Transport	Improve service levels, better facilities at bus stops, easier access and low floor buses	Medium	Positive	Low	•		•	•	To improve access to public transport

Table 5: Local Transport Plan

Transport Mode	Measures	Cost	Integration with other measures	Environmental impact	Other priorities which measures impact				Justification and Notes
					Cong-estion	Safer Roads	Accessib-ility	Air Quality	
	Develop working partnerships to deliver more services at a local level and reduce the need to travel	Low	Positive	Low	•		•	•	Increase bus patronage and make use of available resources throughout the authority and reduce carbon monoxide
	Make key services more accessible by public transport by ensuring ease of use and better integration	Low	Positive	Low	•		•	•	Give buses priority over other vehicles at key junctions
Motorcyclist	Reduce the number of motorcycling casualties by promoting awareness of motorcyclists and vulnerability	Medium	Positive	Low		•			Help achieve local and Government targets and raise awareness amongst other roads users
	Review the environmental impact of motorcycles compared to other modes of transport and how that effect air quality	Low	Positive	Low	•			•	To monitor how much motorcyclist contribute towards air quality and congestion in North Lincolnshire
Highways	To implement a Urban Traffic Control system to link signals and smooth traffic flows	High	Very Positive	Low	•	•	•	•	Reduce congestion which causes public transport delays
Freight	*Improve facilities for freight driver*	*Low*	*Low*	*Positive*	•	•	•	•	*Reduce unnecessary freight transport entering town centres*
	Reduce the impact of freight movements	*Low*	*Low*	*Positive*	•		•	•	*Reduce journeys times by road and integrate travel onto rail and waterways*

Table 5: Local Transport Plan

4 Analysis of Data

4.1 Annual Mean Objectives

In 2010 the North Lincolnshire Council Monitoring Network continued at all sites previously submitted within the 2009 USA. Allanby Street and the Scunthorpe Town Partisol ceased operation on the 31st March 2010. The results up to 2010 are as follows;

Location	Within AQMA?	Annual mean concentrations ($\mu g/m^3$)			
		2007	2008	2009	2010
Appleby Village	N	24	22	20	19
Low Santon	Y	51	38	39	33
High Santon	Y	31	31	27	23
Scunthorpe Town (AURN) TEOM	Y	25	21	21	22
East Common Lane	Y	28	25	22	23

Table 6: Annual Mean Data

Low Santon continues to be the only site close to the Annual Mean Objective and is the trigger for this Further Assessment. Although the last two years annual mean concentrations have demonstrated compliance a change in the calculation method raises questions over the validity of these results.

Data from 2008, 2009 & 2010 have been subject to the Volatile Correction Model. As a result of this, no sites breached the Annual Mean Objective for PM_{10} in 2010. Taking in to account previous data at the Low Santon monitoring site, the correction demonstrates a step change in results from 2007 and 2008 which is not reflected in the continued TEOM *1.3 correction;

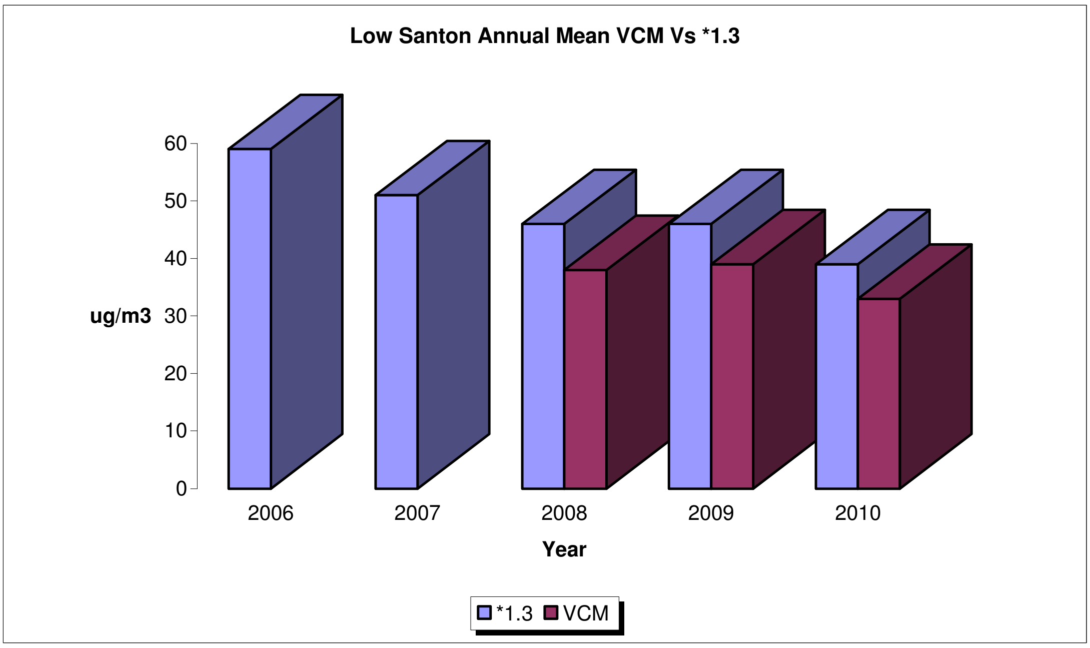


Figure 9: Low Santon VCM Vs 1.3 Annual Mean

For the 2008 & 2009 VCM North Lincolnshire Council did not have FDMS monitoring systems within its boundary. This has changed since January 2010 where the Scunthorpe Town AURN site had an FDMS 'C' installed and the Low Santon monitoring station, which had an FDMS 'C' installed in April 2010. Neither Scunthorpe sites were used for the 2010 correction because of data capture issues. All corrections from 2011 onwards will be made using the FDMS data within the North Lincolnshire network.

To complete the correction in 2008, 2009 & 2010 FDMS data was taken from Hull Freetown, Sheffield Freetown & Nottingham Centre. All 3 sites issued a warning over the data, stating insufficient data capture over both periods. The application of this FDMS data has led to an 18% reduction in the annual mean figures at Low Santon.

All of North Lincolnshire Councils data is collected by AEA Technology where the 1.3 correction is applied. This was to account for lost volatiles driven off in the TEOM measurement process. The reduction in concentration using the VCM correction can be attributed to the removal of the 1.3 correction. TEOM data is converted to a near 1:1 ratio suggesting that issues around the Integrated Works are not from sources releasing volatile matter and as suspected much of the issues occur from non volatile sources such as crushing, screening, lift off etc.

Early indications from the new FDMS sites show a reduction in the TEOM figures again alluding to the likelihood of the source not being an emitter of volatile materials. The results show a near 1:1 ratio with raw TEOM results and not those with the 1.3 correction applied. High spikes within the volatile component can be seen but these are not the norm and not what is being witnessed during the majority of daily exceedances.

Other sites within the Scunthorpe area also subject to the application of the VCM saw small decreases in their annual means in 2010;

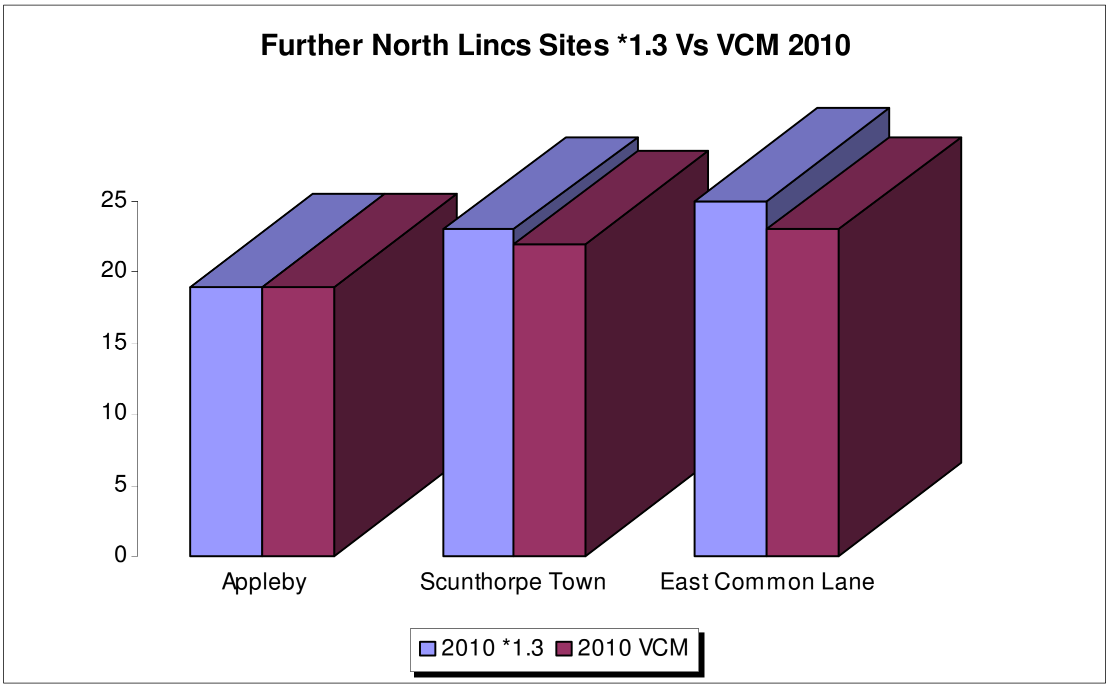


Figure 10: North Lincs Sites VCM Vs 1.3 Annual Mean

The introduction of FDMS monitoring within North Lincolnshire will eliminate the need to carry out the VCM at Low Santon and Scunthorpe as well as offering localised corrections to the other TEOM sites. At present we are treating these results with caution maintaining the AQMA and the issues there according to raw TEOM results as we have in previous rounds of review and assessment.

An important point of note within the results is the difference between Low Santon and High Santon.

Although the sites use different monitoring methods, an equivalent Partisol at High Santon and a TEOM at Low Santon, corrections applied ensure Low Santon meets gravimetric equivalence.

The sites sit only 300m apart and while they are shielded from one another by a number of natural boundaries High Santon reports compliant concentrations a little over the accepted background whereas Low Santon continues to report non-compliant numbers. Understanding of this situation at present is that the source of the issue must be localised and very close to the Low Santon Monitor. Concentrations of PM_{10} show a sharp decline as you move away from the source. This effect is the likely explanation for the large differences in what is in effect only 300m apart. This report will focus on sources close to the Low Santon monitoring Station

Data from the first full year of FDMS measurement in 2011 when reported should provide a clearer picture as to the concentrations of PM_{10} at Low Santon. It is anticipated these numbers will form the basis of the 2012 Updating and Screening Assessment.

4.2 Daily Mean Objectives

An AQMA was declared in 2005 for breaches of the Daily Mean Objective. Santon, Scunthorpe Town & East Common Lane were the sites measuring the highest concentrations;

Location	Within AQMA?	Data Capture 2009 [b] %	Number of Exceedances of daily mean objective (50 μg/m^3) If data capture < 90%, include the 90th percentile of daily means in brackets.			
			2007	2008	2009	2010
Appleby Village	N	97	8	5	5	2
Low Santon	Y	93	133	73 (59)	78	52
High Santon	Y	99	36	34 (51)	27	8
Scunthorpe Town (AURN) TEOM	Y	90	18	22	11	16
East Common Lane	Y	96	34	40	17	11

Table 7: Daily Mean Data

The data in 2008, 2009 and 2010 were subject to VCM, leading to a marked step change in concentration at Low Santon. Less exceedances were observed in 2010 compared to previous years. This may be attributable to the decrease in production output at the Integrated Steelworks at the end of 2008 in to the beginning of 2009. It is more likely that the application of the VCM at Low Santon reduced the number of Daily Exceedances. Components of the VCM in 2008, 2009 and 2010 included FDMS measurements from a distance in excess of 100km.

The application of the VCM can bring border line breaches in to compliance. Low Santon experiences exceedence days up to 200μg/m^3 and as a consequence the potential 20% reduction from the application of VCM is still insufficient to bring these ‘high’ exceedance days in to compliance. It has however still reduced the number of daily exceedences by a significant margin.

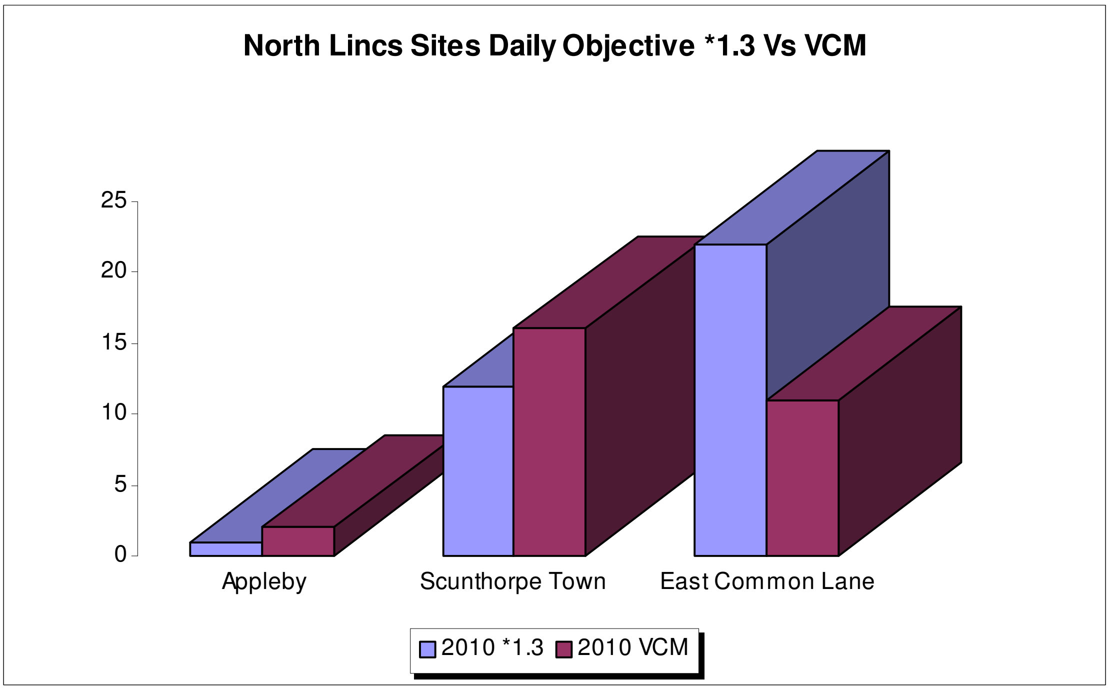


Figure 11: North Lincs Sites VCM Vs 1.3 Daily Mean

East Common Lane was the only site to exceed the Daily Mean Objective of all sites located to the West of the Integrated Steelworks since 2008. 2008 recorded 44 daily exceedances at East Common Lane, the application of the VCM reduced the number to 40 days, still above the objective. In 2009 all sites were compliant.

Evidence suggests that the sites to the West of the Integrated Steelworks likely to have a high proportion of daily exceedances within a year are more likely to see a reduction post VCM correction. Sites with fewer daily exceedances and concentrations more in line with their background locations see a slight increase probably due in part to the margins of these exceedance days.

Sites such as Appleby may have a few near misses. Dependant on the results from distant FDMS sites these may then become compliant or non-compliant as the scales can be tipped either way because of variations in the FDMS data. Sites such as East Common Lane with already high concentrations are not dependant due to the elevated concentrations from point sources.

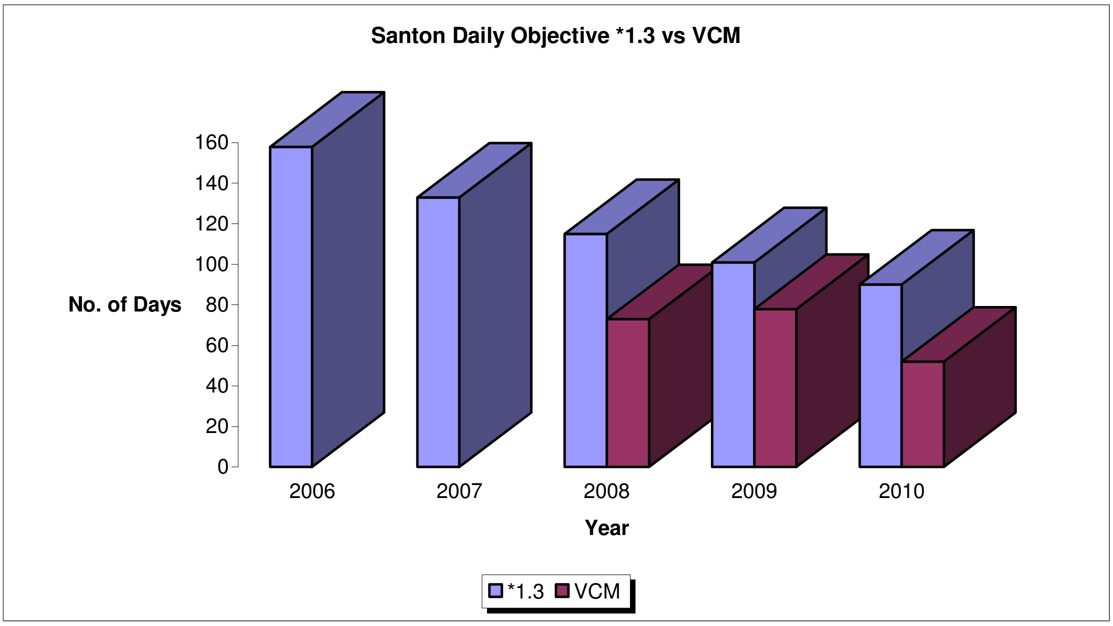


Figure 12: Low Santon VCM Vs 1.3 Daily Mean

Santon, as with other sites, was corrected using the VCM. Its reduction in the number of days is similar to the reduction in the Annual Mean Objective.

The trend for the number of daily exceedances is reducing. Every year from 2006 has seen an improvement. This is probably attributable to a better understanding of the sources likely to impact on Low Santon and the focused effort to reduce their collective impact.

The application of the VCM has reduced the number of daily exceedances by around 30%. Whilst the effect of the VCM brought the site in to compliance for the annual mean, the same is not true for the daily mean.

The reduction as discussed shows the lack of volatiles within the captured particulate at Low Santon. The application of the 1.3 correction at Santon may not be appropriate for this area due to its industrial sources. The near 1:1 TEOM results with the VCM corrected data confirm this.

The site continues to show improvements year on year. The introduction of a dynamic alert system, the buy in of all site operators and focused financial support has created a can do attitude in preventing a number of daily breaches. 2011 will be a real indication of how far the site has come after the implementation of all these measures and a NLC, DEFRA & EA endorsed Action Plan.

4.3 Low Santon TEOM

4.3.1 Low Santon PM_{10}

The introduction of the Openair Software, created by the University of Leeds, has enabled North Lincolnshire Council to analyse the large set of data collected at Low Santon since 2006.

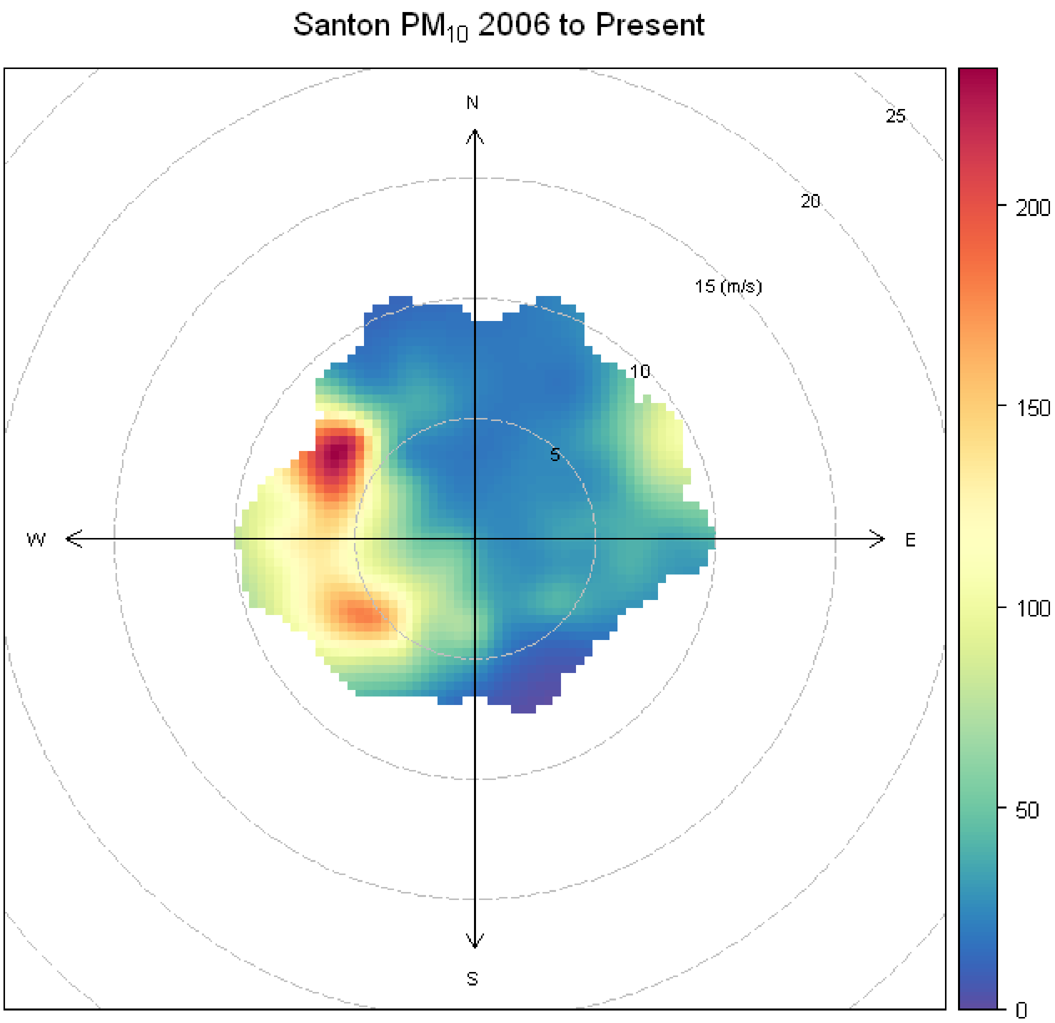


Figure 13: Low Santon PM_{10} Polar Plot

The polar plot above highlights wind speed, direction and concentration at the Low Santon monitoring station. A pixel is only filled if data has been recorded more than once (min.bin ="2") in the specific direction and speed. This removes the chance of anomalies skewing the overall trend. The general trend and understanding at Low Santon is that two specific ‘hotspots’ exist with a larger section of the compass rose showing a general increase in concentrations.

The plot demonstrates elevated concentrations of approximately 150µg/m^3 between sectors 210º to 240º . Between sectors 280º and 310º lies a second hotspot with concentrations over 200µg/m^3.

Areas within these hotspots measure average concentrations above the relevant Air Quality Objectives. The wind sectors of note contain a significant number of processes with the potential to emit PM_{10}. It is the intention of this study to investigate the hotspots in more detail with a view to identify the likely origin of the particulate.

The basic polar plot can be refined in a number of ways. Figure 14 shows the data as an hourly plot;

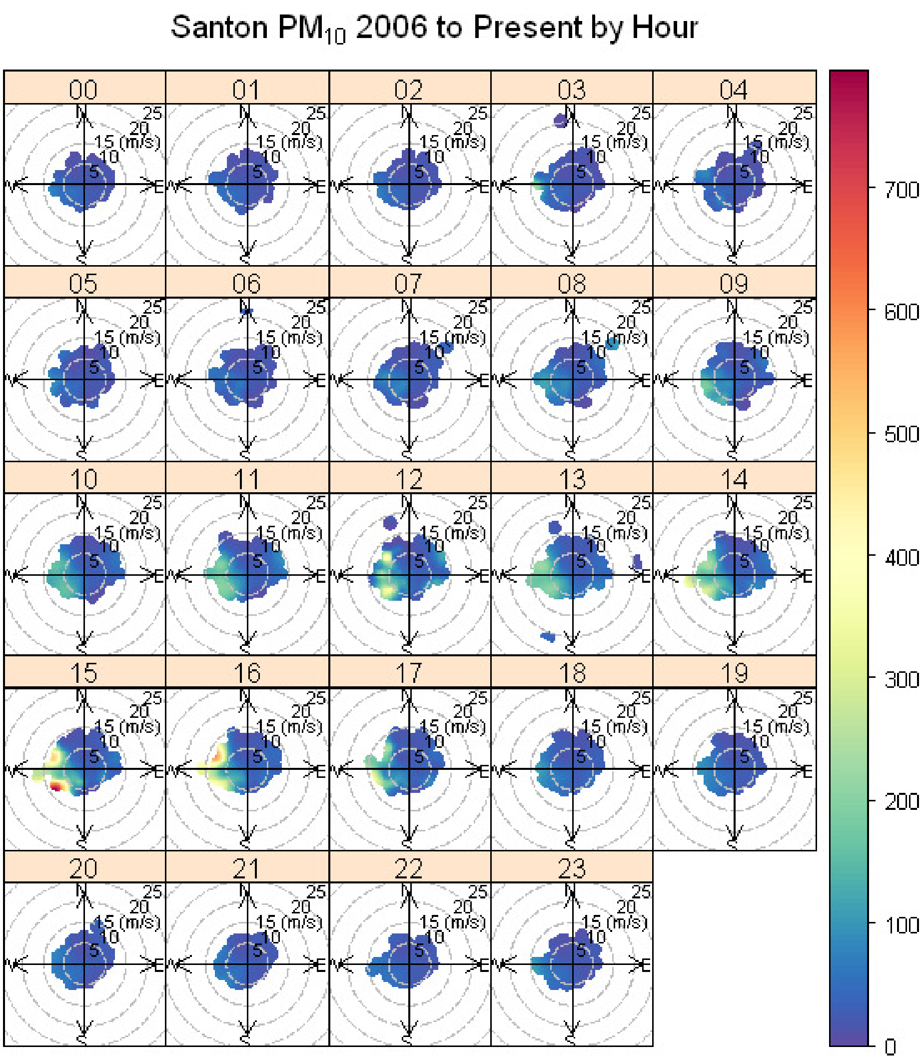


Figure 14: Low Santon Polar Plot by Hour

The polar plot by hour shows a breakdown of the total data capture in hourly sets. Trends using the hourly method show less pronounced hotspots. The hourly plot shows that concentrations in certain areas are higher during daytime operations. Plots after 18:00 and before 08:00 consistently record measurements within 100µg/m^3. Plots between 08:00 and 18:00 record higher results, spiking at well over 500µg/m^3.

By plotting the data in this way and producing 24 smaller plots rather than one, the data for each plot is effectively reduced by a factor of 24 (24 hours). By reducing the number of data points within the plots you increase the uncertainty. By increasing this uncertainty, anomalies have the ability to skew the trends making specific points during the day look like points of concern. The prolonged monitoring period of 5 years at Low Santon make this less of a concern.

The hourly polar plots mirror the total polar plot for Low Santon. The two hotspots remain at the same points but their effects can be seen to have the highest impact between 12:00 & 16:00. Additional meteorological factors also have the potential to affect concentrations at this point. Lower concentrations could be due to changes in solar radiation during seasonal norms preventing early moist ground conditions from being dried allowing for these patterns to emerge.

These results show it is highly unlikely that the source of the elevated concentrations is a continuous 24-hour operation, or at least a source not emitting sufficient quantities around the clock, ruling out large scale combustion plants within the area. That is not to say that continuous plants do not release high concentration events, although the increase throughout the day appears to point towards non-continuous operations, active during daylight hours.

A number of operators at Low Santon work 06.00 to 18.00 which does not enable straightforward identification of potential sources.

The Openair software enables the plotting of diurnal trends in a number of different visual formats. Figure 15 shows the diurnal pattern without reference to wind direction but also highlights an increase in PM_{10} concentrations throughout the day.

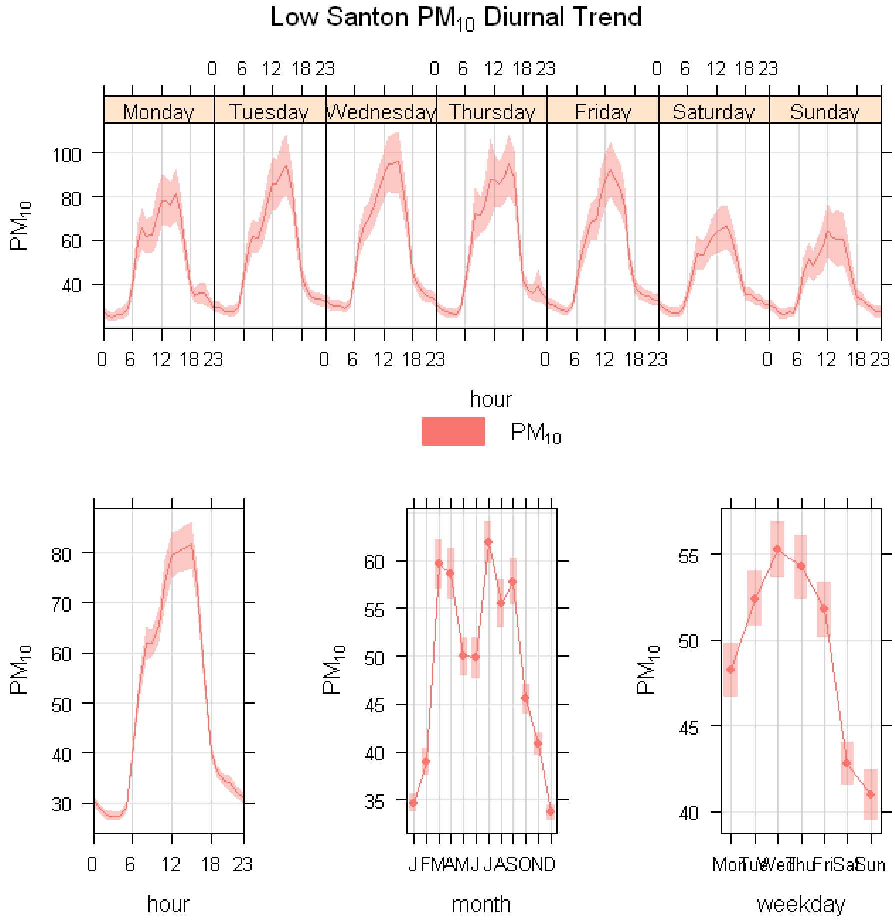


Figure 15: Low Santon PM_{10} Diurnal Plot

The diurnal trend confirms previous polar plots in highlighting a sharp increase throughout the day. Although lower overall levels are observed at the weekends the same pattern occurs.

The increases begin at 06:00 and decrease after 16:00. Between these hours the average concentrations are above the daily and annual objectives. Peaks at midday can reach levels of 100µg/m^3. This plot gives an average monthly concentration and appears to match that of expected weather conditions. It is possible that monthly mean concentrations may also be intrinsically linked to production data and this will be reviewed later in the report.

Year on year the months of October through to January appear have the lowest mean concentrations, probably due to wet and potentially frosty/snowy weather keeping fugitive PM_{10} on the ground. Higher concentrations in the summer months correlate with drier, hot weather likely to leave certain areas of the Integrated Steelworks exposed to dust lift off. A review of weather conditions against concentration will also be conducted in this report.

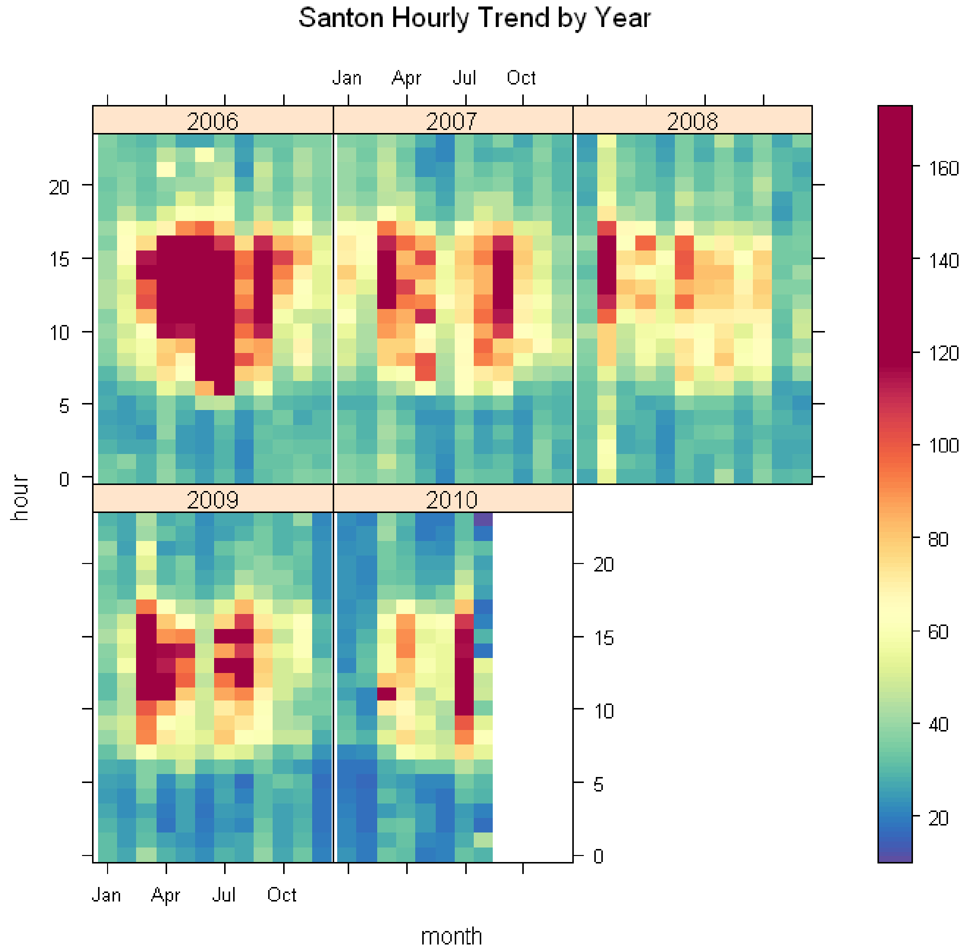


Figure 16: Low Santon Hourly Trend Plot

Data presented in an hourly trend for each year highlights the time signatures previously discussed with elevated concentration focused within the period between 06:00 & 16:00. Concentrations outside of these times are consistently on or below the relevant objective levels. The seasonal weather affect can also be seen as the winter months traditionally wetter/frostier/snowier look largely compliant.

Again this suggests non continuous sources. The above plots highlight the dependence on daily activities.

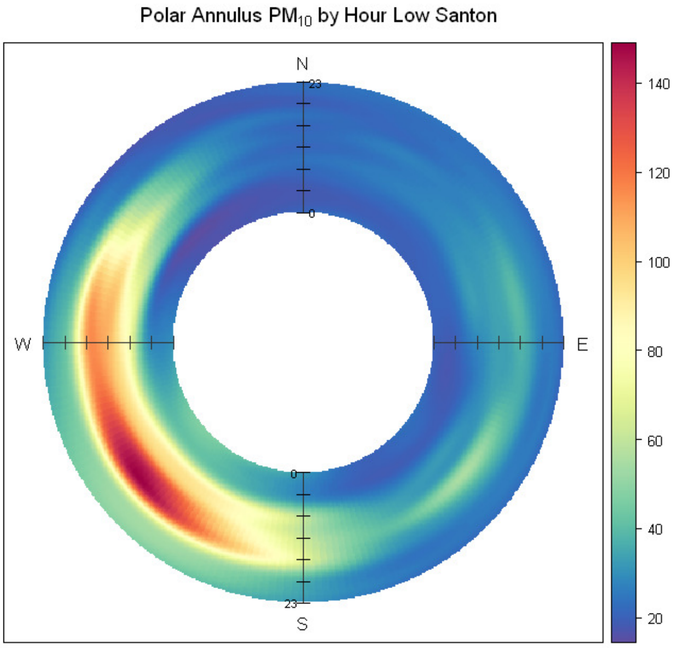


Figure 17: Low Santon Polar Annulus

The polar annulus plot provides a measure of the concentration (colour), time dependency (midnight inner edge of ring) and the wind direction (compass rose). Like many of the plots the zone to the South West represents the highest recorded levels of PM_{10}. Like the previous plot the concentration increases rapidly through the day. A number of operators work within these sectors and operate during these times. Tata run a continuous operation, whereas Tarmac and Harsco work 06.00 to 18.00. Certain areas on site controlled by Tata also work restricted hours, for example the Coal Handling Plant and the Redbourn Steel Stocking Area, these should not be discounted as potential sources.

Operating times are key to the identification of the sources responsible for the elevated concentrations of PM_{10} at Santon. In the absence of speciation evidence in which a number of inconclusive studies have been undertaken the strongest evidence falls upon particle size, wind direction, speed and the diurnal characteristics of the issues.

4.1.1 Low Santon PM_{10} – Conclusions

- Two significant hotspots have been identified in the area at sectors 210º to 240º and 280º to 310º.
- These areas are most active between 06:00 and 18:00.
- Higher concentrations occur between 12:00 and 16:00.
- Combustion sources within these sectors are unlikely to be responsible due to their continuous operation.
- Data identifies seasonal variation in concentration.

4.3.2 PM_{10} Relationship with $PM_{2.5}$ at Low Santon

A $PM_{2.5}$ TEOM was located at Low Santon from June 2008 until April 2010 as part of a joint study with the Environment Agency. Throughout the study the data showed compliance with the Annual Mean $PM_{2.5}$ objective.

Evidence suggests that the PM_{10} is the result of fugitive emissions rather than point sources. Results from the $PM_{2.5}$ TEOM confirm this. There are a number of large combustion plants within the vicinity of Low Santon but only a small percentage of fine PM_{10} ($PM_{2.5}$) was measured within the total suspended particulate. Combustion activities are known to be a significant source of $PM_{2.5}$ however the average finer fraction during an exceedance day was 27% of total PM_{10} making the total coarse PM_{10} 73%.

Using the emission factors produced by the Air Quality Expert Group Panel (AQEG) it is clear that $PM_{2.5}$ within PM_{10} on this scale is not likely to have directly originated from a combustion activity. It is possible that $PM_{2.5}$ results from the re-suspension of an earlier event linked to a combustion activity or an accumulation of re-suspended combustion deposits.

An absence of work carried out on the relative difference in dispersion characteristics of PM_{10} and $PM_{2.5}$ makes it difficult to identify potential sources using the emission factors. It is generally accepted that all particles with a mean aerodynamic diameter of less than 10 microns disperse in the same way. Localised combustion plants are all situated at varying distances from the monitoring station and as such will display different ambient concentrations at the monitor in comparison to concentrations close to stack releases. Whether the ratios are the same at both stack and ambient monitoring points remains to be seen and would form the basis of further work which would aid this study.

Overall it looks likely that the potential sources produce particulate within the coarse fraction of PM_{10}, it is generally accepted that such particulate originates from activities such as crushing, milling, screening and road lift off.

These processes are all incorporated within the day to day activities of Tarmac, Tata and Harsco operating at Low Santon.

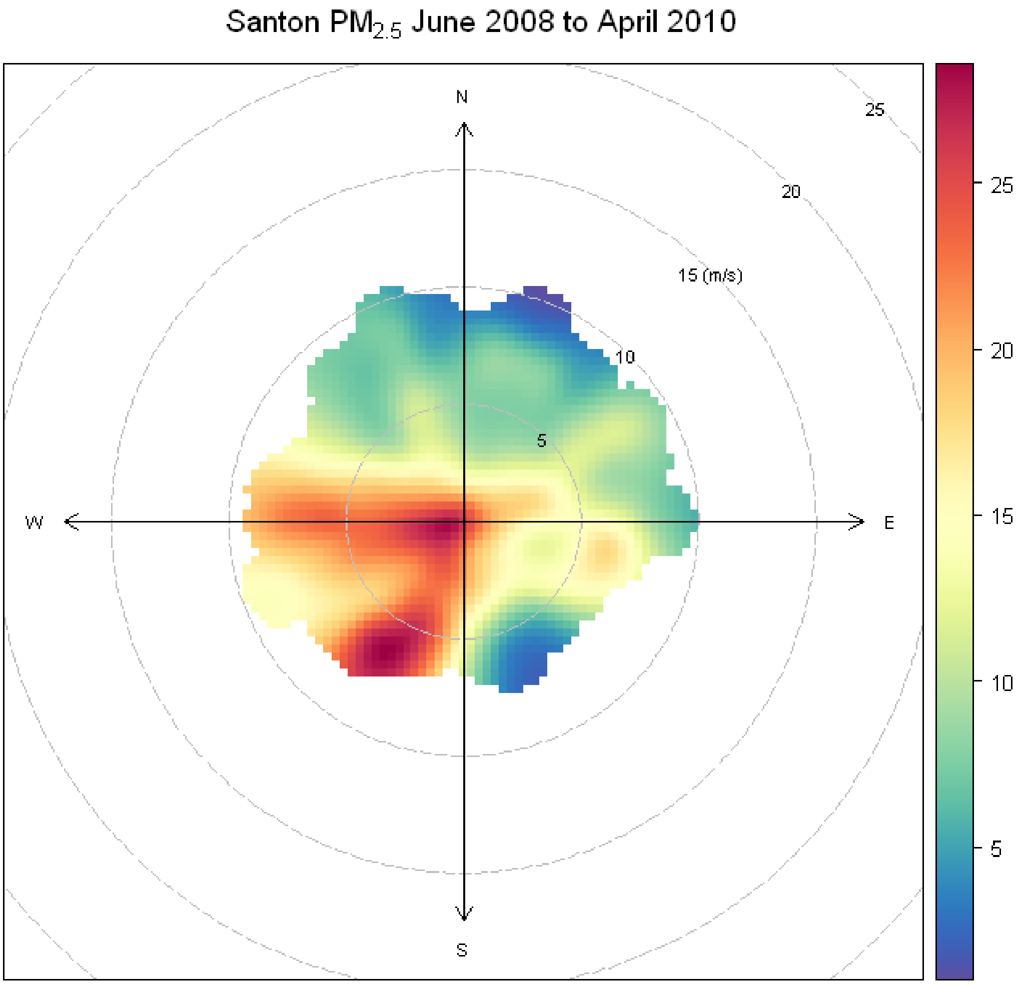


Figure 18: Low Santon $PM_{2.5}$ Polar Plot

If the above $PM_{2.5}$ polar plot is compared to the PM_{10} Polar Plot (min.bin = "2") the two identified 'hotspots' appear to correlate, with elevated concentrations arising from similar directions. The difficulty of apportionment arises due to the number of processes within these wind sectors. The major difference between the two plots is the concentration levels, whereby $PM_{2.5}$ is low and compliant. They also demonstrate differences at the wind speeds where the particulate fractions peak.

$PM_{2.5}$ is being emitted in greater quantities from combustion stacks than from ground level sources and as such is already airborne and consequently transported at all wind speeds. This is shown in Figure 18 through the proportionally high levels of $PM_{2.5}$ at low wind speeds moving consistently through to higher wind speeds. The PM_{10} concentration increase at higher wind speeds, as the point is reached in which particulate will be lifted from a stationary source and then transported to Low Santon.

$PM_{2.5}$ on the Integrated Steelworks is only marginally higher than background levels. Although the diurnal pattern of both size fractions is similar the magnitude of the increase is not. The identified hotspots do correlate with the Dawes Lane Coke Ovens (DLCO) and the Central area of combustion activity within the Integrated Steelworks.

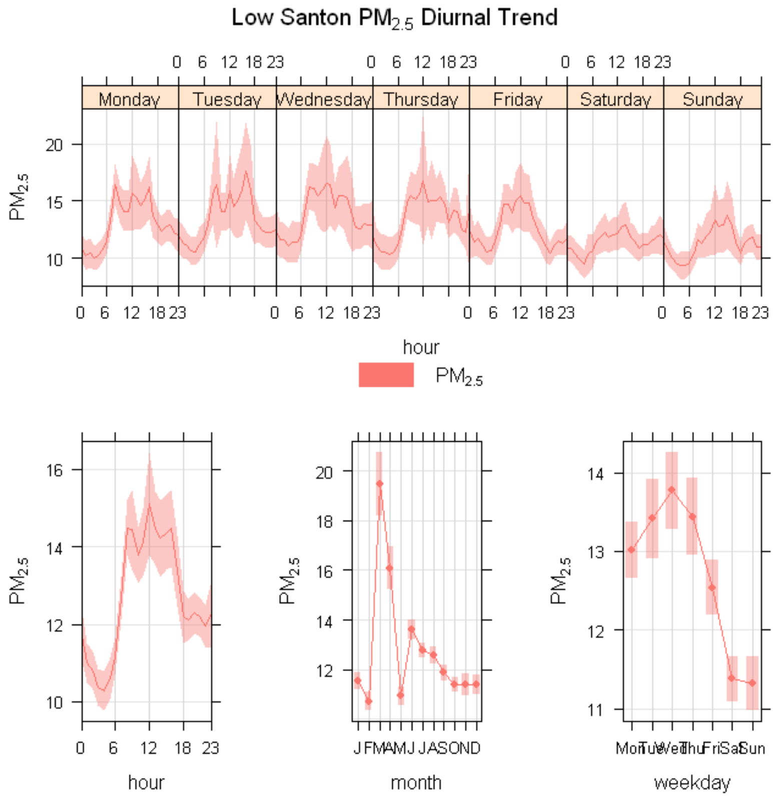


Figure 19: Low Santon $PM_{2.5}$ Diurnal Plot

The increase in concentration of both size fractions begins at 06:00 and falls off again at 16:00. The average levels of $PM_{2.5}$ are low and reference to AQEG work suggests that large combustion plants are unlikely to be the dominant source. It is likely that continuous emissions from these combustion processes are effectively abated therefore releasing lower levels of $PM_{2.5}$. The increase witnessed throughout the day may be due to the "lower ratio" PM_{10}:$PM_{2.5}$ releases occurring from low level sources other than combustion activities.

The results suggest that the majority of the PM_{10} is coarse. The diurnal pattern of the coarse and finer fractions are similar and therefore the source may be a low level fine particulate emitter possibly crushing, milling, screening and re suspension. The comparable peaks and consistent concentrations confirm this theory.

Whilst individual exceedence days may have been the result of a combustion event, it is unlikely that a large combustion plant is responsible for the persistent high concentrations seen at Low Santon.

4.1.2 PM_{10} Relationship with $PM_{2.5}$ at Low Santon - Conclusions

- Low levels of $PM_{2.5}$ within the PM_{10} demonstrates the dominance of the coarse fraction.
- Unlikely to be a continuous combustion plant stack release due to the coarse nature of PM_{10}.
- Two hotspots identified for $PM_{2.5}$, but within compliant levels at all wind speeds and sectors originating from areas of combustion activity.
- Likely to be small contribution of $PM_{2.5}$ from combustion point sources in addition to background concentration.
- $PM_{2.5}$ showing small increases throughout the day.

4.3.3 PM_{10} Relationship with other pollutants at Low Santon

A number of other pollutants are also measured at Low Santon. A comparison of these with PM_{10} emissions may enable identification of a point source contributing to the issues at Low Santon. It is important to remember that no other pollutants around the Integrated Steelworks breach Air Quality Objectives. By plotting these pollutants in polar plot format it is possible to identify if any of the gases and PM_{10} share a common source.

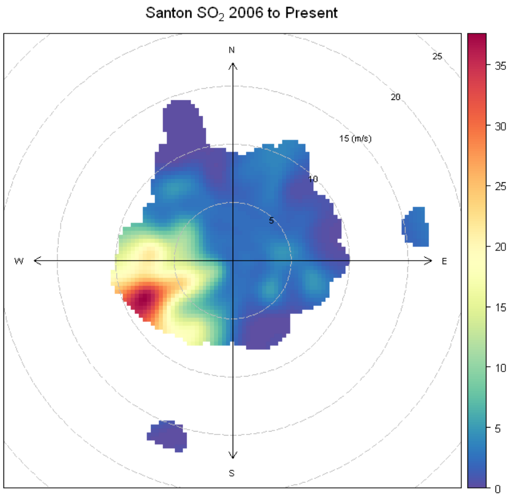


Figure 20: Low Santon SO_2 Polar Plot

The Integrated Steelworks is a complex site with a number of stacks emitting a variety of gases and particulate. Figures 20 and 21 show SO_2 and NO_2 respectively from differing sources and do not correlate with the PM_{10} and $PM_{2.5}$ plots. The SO_2 plot highlights the central combustion activity area of the works. The NO_2 plot highlights a number of potential sites.

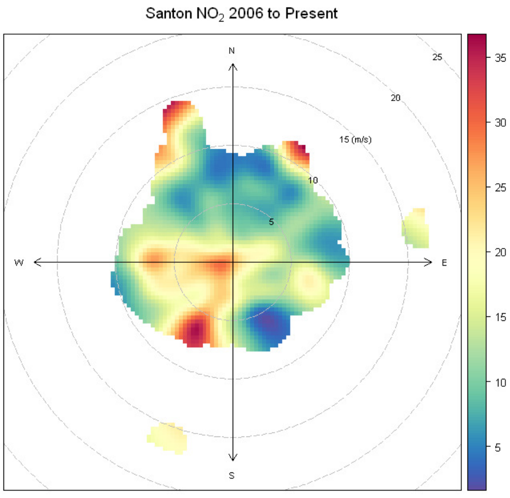


Figure 21: Low Santon NO_2 Polar Plot

By plotting all gaseous and particulate releases in a time series against PM_{10} it is possible to check each pollutants time dependency and their potential correlation with the PM_{10} concentration.

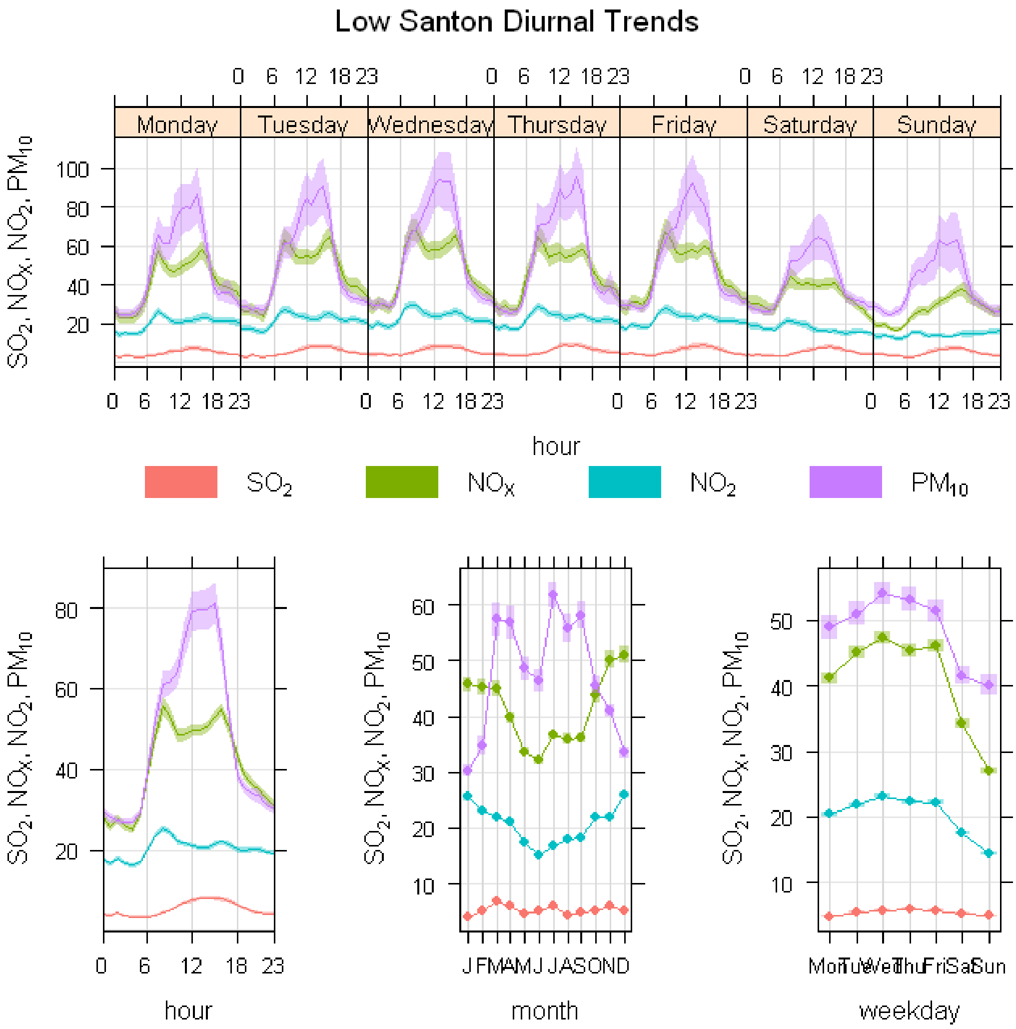


Figure 22: Low Santon Gaseous Diurnal Plot

A direct correlation with NOx emissions can be seen. NO_2 and SO_2 remain constant throughout the year, week and day. NOx shows a pattern expected from peaking traffic. Morning and afternoon NOx concentrations peak at the same time as PM_{10}. The peak at 06:00 increases at the same time as PM_{10}, this may be linked to increased road users travelling to work. The peak at 16:00 correlates with the reduction in PM_{10} as activity around Low Santon stops and Integrated Steelworks staff travel home.

At the start of each working day as people arrive at work, operational activity around Low Santon increases creating a rise in PM_{10} generating activities, such as raw material transport on the Slag Haul Road. NOx remains stable throughout the day with a slight peak at midday, relating to lunch time traffic and possibly shift change over. The peak then re-emerges at 16:00 with a sharp decrease immediately after, much like PM_{10}.

A possible method of fingerprinting process areas in a more reliable manner would be a speciation study. Although many of the onsite processes produce and use similar if not the same materials, there may be differences detectable using electro scan microscopy. This project is currently being carried out by the Environment Agency. Dependant on the success of this study it may be possible to extend this idea further when investigating specific exceedance days using Partisol filters.

4.1.3 PM_{10} Relationship with other pollutants at Low Santon - Conclusions

- All gases are compliant with objectives
- NO_2 showing sources in all directions, potential point sources but no obvious correlation with PM_{10}
- SO_2 from central area of activity are similar to $PM_{2.5}$ plots.
- NOx follows traffic patterns. Possible relationship between daily process finish and increased vehicles on localised roads.
- No strong correlation between gaseous pollutants and PM_{10} suggests fugitive activities are primary source.

4.4 Dawes Lane Coke Oven Osiris

4.4.1 Dawes Lane Coke Oven Osiris PM_{10}

The Dawes Lane Coke Oven Osiris (DLCO) has been in operation since November 2008. It was placed to assess the contribution of PM_{10} from the Dawes Lane Coke Ovens at Low Santon and as a triangulation tool with the Low Santon TEOM. Its placement to the West of the Tarmac site aids exceedance source identification during Westerly winds which were previously always attributed to the Tarmac Dawes Lane site.

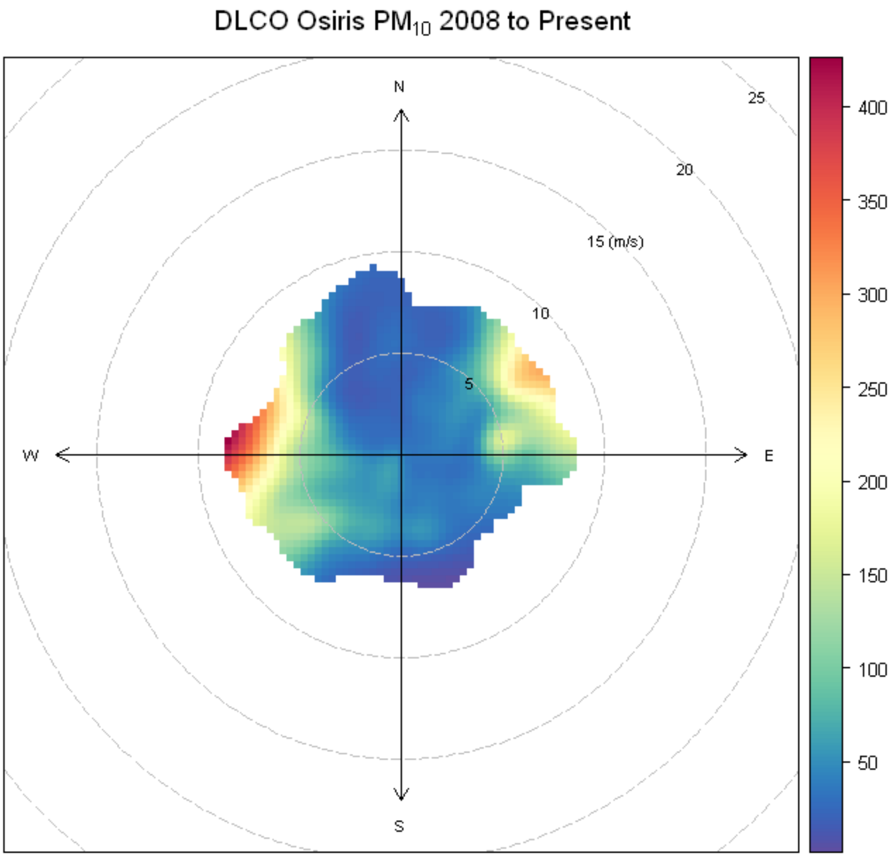


Figure 23: DLCO PM_{10} Polar Plot

The Polar Plot (min.bin="2") shows two hotspots at over 350µg/m^3. The hotspot to the North East is a potential match with the hotspot identified in the Low Santon Polar plot to the North West. The area of elevated concentration to the West of the DLCO Osiris could be from a number of sources for example the Tata Coal Handling Plant, Tata Dawes Lane Coke Ovens & Foundry Operations on Dawes Lane.

The most likely origin is the Dawes Lane Coke Ovens due to it's proximity to the monitor and it being the closest potential source with emissions from a number of vertical levels. If a relationship exists between $PM_{2.5}$ and PM_{10} then this will confirm DLCO as the likely source. This will be discussed in section 4.4.2 PM_{10} Relationship with $PM_{2.5}$ at DLCO Osiris.

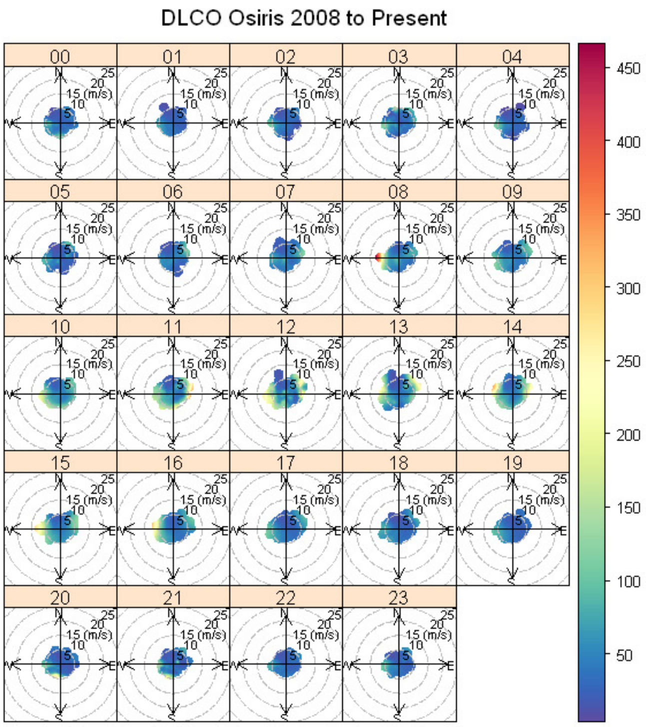


Figure 24: DLCO PM_{10} Polar Plot by Hour

The hourly polar plots in Figure 24 highlight a similar pattern to the Low Santon hourly polar plots in that the highest concentrations over the 24 hour period occur between 06:00 and 18:00. Higher concentrations are experienced during periods of both Easterly and Westerly winds.

The plots indicate higher concentrations when the wind originates from the East. As Tarmac is the only activity within this sector it seems likely that Tarmac is the origin of these elevated levels as it is unlikely that the surrounding farmland contributes to the problems.

The diurnal pattern at DLCO Osiris shows an almost identical situation to that of Low Santon with one difference. DLCO Osiris overnight levels are $10\mu g/m^3$ higher than the Low Santon TEOM. Taking account of the monitoring stations position it is quite possible that the additional $10\mu g/m^3$ is because of a 'micro' background around the Dawes Lane Coke Ovens. It suggests that the particulate loading is always higher due to the nature of the surrounding processes. The increasing daily trend then adds to this load showing a similar diurnal pattern to that of the Low Santon TEOM including lower weekend concentrations over weekday concentrations during periods of increased activity on the surrounding sites.

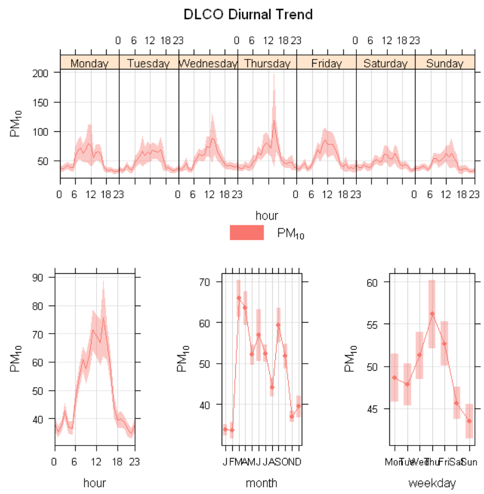


Figure 25: DLCO PM_{10} Diurnal Trend

Figure 25 shows the PM_{10} concentrations at DLCO Osiris increase through the day confirming previous evidence that sources operate during daytime hours. Although hotspots in Figure 24 point to the DLCO, the overall diurnal plot in Figure 25 suggests a non continuous activity. If the diurnal trend is plotted using data only captured when the wind is from the East (blowing across the Tarmac site) this pattern should be emphasised;

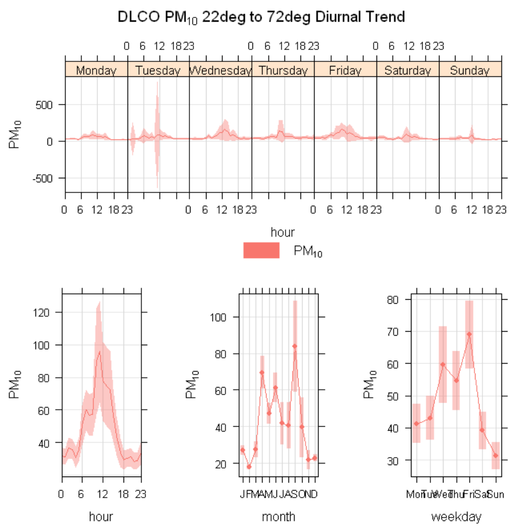


Figure 26: DLCO PM_{10} Filtered Diurnal Trend

By plotting data from limited sectors there is an increase in the uncertainty, this is compounded by the top plot as it presents the data for each day of the week rather than as a whole. The top plot has not been considered further on this basis. A sharp increase and decline throughout the day is observed in the plot on the left of the chart with the average concentration at midday around 100µg/m^3 during periods when the wind blows through the Tarmac site. To corroborate wind sectors of relevance can be compared against data from Low Santon (Figure 27).

This same plot also identifies a plateaux of concentrations at 10.00hrs on weekdays. This will be investigated further in Section 8: Tea Break Report.

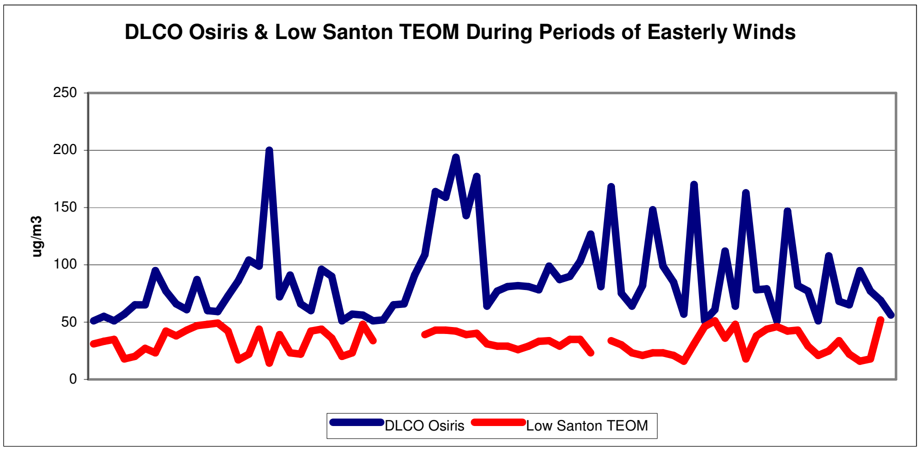


Figure 27: DLCO Easterly Wind Differences

Data presented in Figure 27 from both monitors was filtered to include all hours in which the wind blew from wind sectors between 80º & 100º where concentration of PM_{10} exceeded 50µg/m^3 at DLCO Osiris. The increase in concentration is visible in the chart and shows a clear trend of increased concentration as the wind blows through the Tarmac site. The average difference of the two measurements was calculated to 35µg/m^3.

This does not remove the importance of contributions to the West of the DLCO Osiris but does highlight the potential Tarmac has to cause an exceedance. If this exercise is repeated in the other direction; including all hours in which the wind blew between 260º & 280º with concentrations above 50µg/m^3 at Low Santon the effect is quite different.

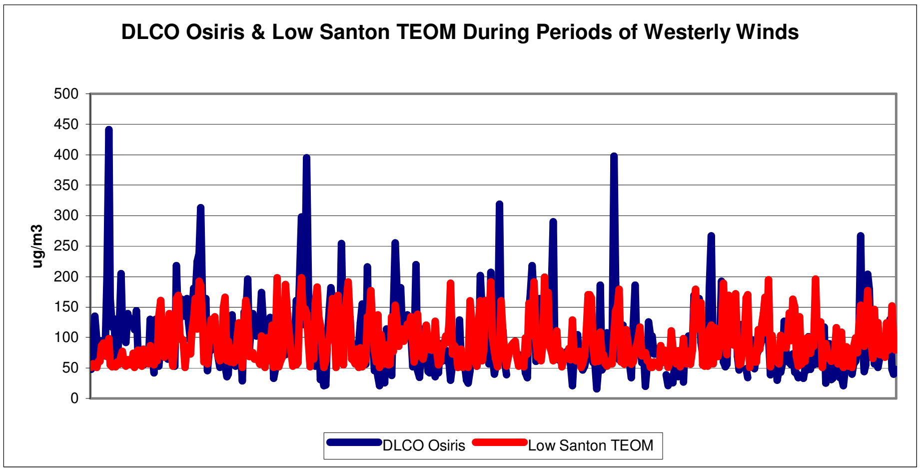


Figure 28: DLCO Westerly Wind Differences

The graph is more congested due to the wind direction and its prevalent status. The trend is less obvious as DLCO Osiris can capture data already above the objective before it passes over the Tarmac site. There are fewer occasions in which Tarmac is the obvious source due to the number of occasions where the Osiris already measures non compliant concentrations before the air flow has passed through the Tarmac Site.

A number of sources could be responsible for this; Part B Activities on Dawes Lane, The Dawes Lane Coke Ovens or the Tata Coal Handling Plant.

A review of this data has shown that during periods of Westerly winds and exceedance at Low Santon, the DLCO Osiris also exceeds for significant periods demonstrating that concentrations are elevated before it travels through the Tarmac site. These graphs have shown the role Tarmac can play in contributing to an exceedance day but also the importance of sources further upwind such as the Dawes Lane Coke Ovens and the Coal Handling Plant.

In order to better understand the major sources upwind it is important to assess PM_{10} against $PM_{2.5}$ from the large combustion plant to the West of the DLCO Osiris.

4.4.1 Dawes Lane Coke Oven Osiris PM_{10} - Conclusions

- North East hotspot at DLCO Osiris triangulates with North West hotspot at Low Santon.
- Higher concentrations at DLCO Osiris in the daytime similar to Low Santon. Higher between the hours of 08:00 & 17:00
- Obvious contribution from Tarmac during periods of Easterly winds.
- Difficult with existing data to apportion PM_{10} from sources during periods of westerly winds due to number of processes upwind of DLCO Osiris.

4.4.2 PM_{10} Relationship with $PM_{2.5}$ at DLCO Osiris

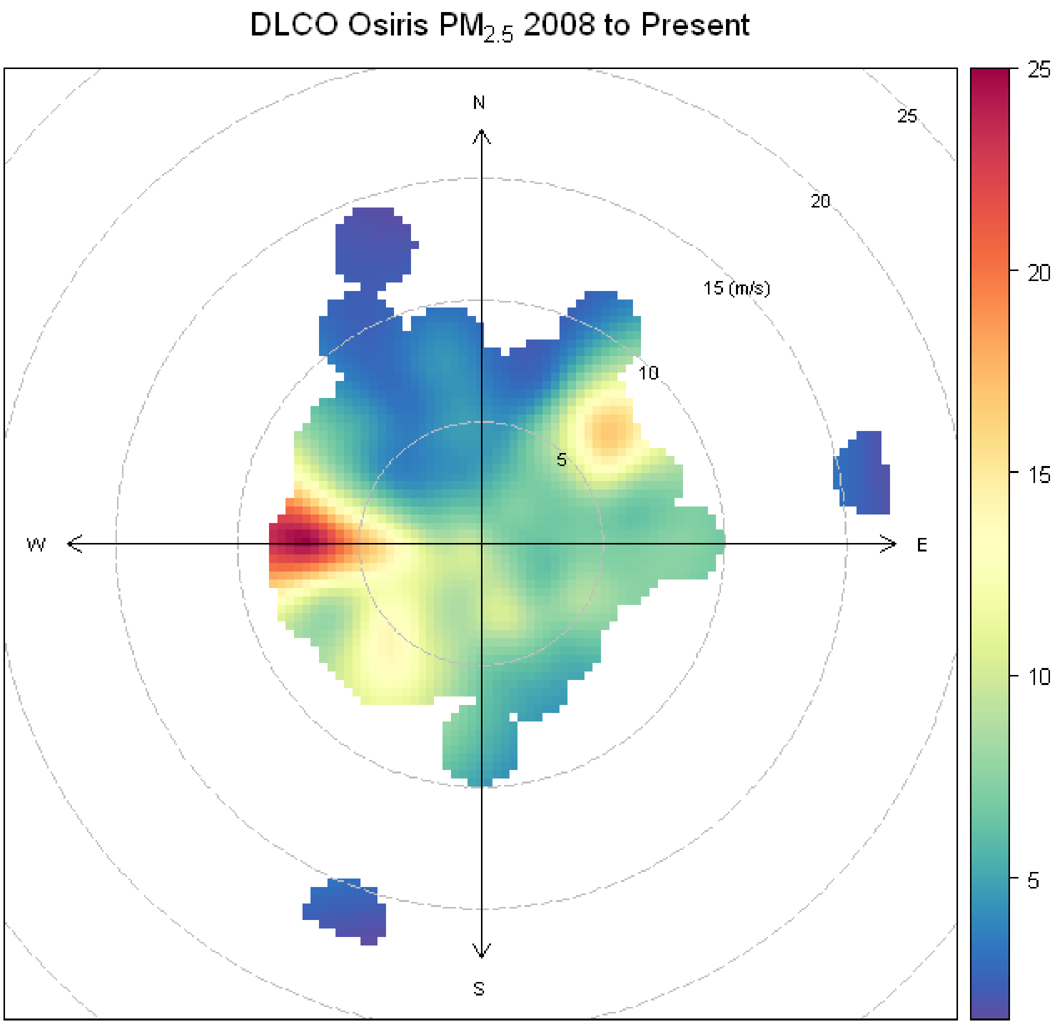


Figure 29: DLCO $PM_{2.5}$ Diurnal Plot

The Dawes Lane Coke Oven Osiris will almost certainly be affected by the Dawes Lane Coke Ovens. This is highlighted in the above polar plot. The elevated presence of $PM_{2.5}$ to the West confirms this. Although other processes operate beyond the Coke Ovens they do not operate on the same scale. This hotspot is replicated in the DLCO Osiris PM_{10} plot although the relative concentrations of $PM_{2.5}$:PM_{10} is lower than you would expect from a large combustion plant. This has previously been discussed in section 4.3.2 PM_{10} Relationship with $PM_{2.5}$ at Low Santon.

Figure 29 also shows a small but noticeable increase in $PM_{2.5}$ to the North-East originating from a similar position to that of the PM_{10} hotspot. This is to be expected from a fugitive particulate source however the scale of the $PM_{2.5}$ increase is much higher from the direction of a combustion source and comparatively lower when originating from areas of land connected to crushing and screening activities.

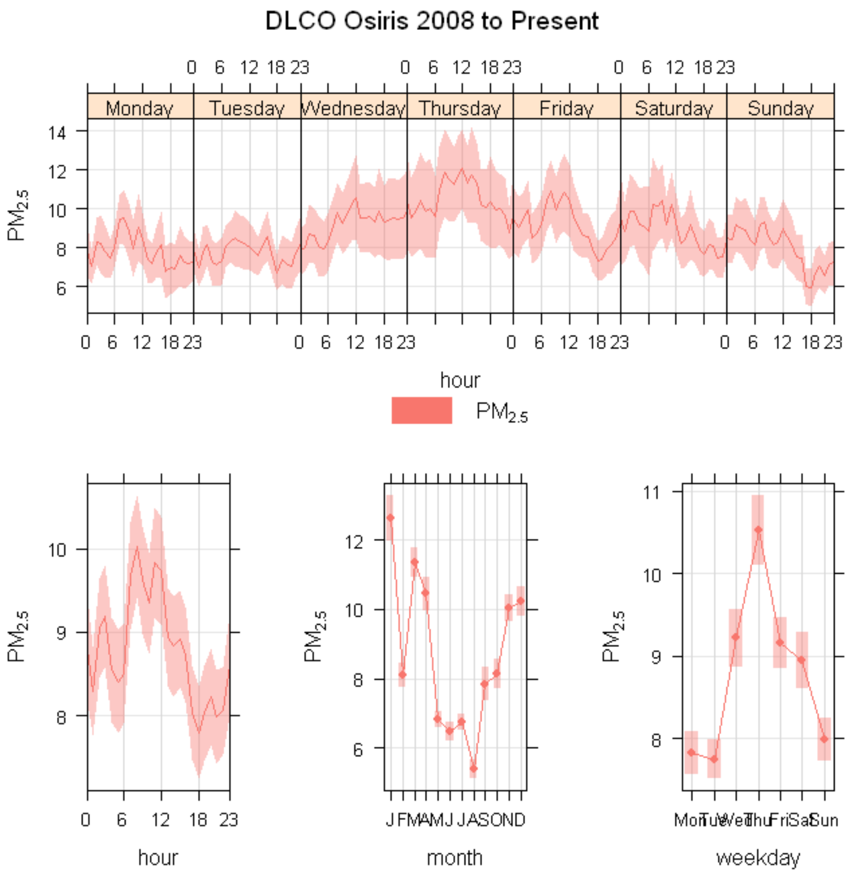


Figure 30: DLCO $PM_{2.5}$ Diurnal Plot

Figure 30 shows that $PM_{2.5}$ from the Osiris is fairly constant with a small increase through the day averaging marginally above background. The weekend concentrations are not lower than weekdays suggesting the source is constant. The main contributor to $PM_{2.5}$ concentrations at the DLCO Osiris are the coke ovens themselves.

It should be noted that the concentrations are not close to the objectives and do not threaten compliance. The understanding of high temperature combustion releases would expect Coke Ovens to emit a high percentage of fine dust. Results from monitoring conducted at Low Santon and DLCO do not show this. Although individual events from the Coke Ovens may contribute to the annual mean and be responsible for individual exceedance days it would appear that crushing type activities play an important role.

4.4.2 PM_{10} Relationship with $PM_{2.5}$ at DLCO Osiris - Conclusions

- Weekend concentrations are similar to weekdays suggesting the $PM_{2.5}$ source is constant
- $PM_{2.5}$ measured in much lower concentrations compliant with relevant AQ Objectives
- Hotspots on the polar plots almost certainly include the Dawes Lane Coke Ovens to the West and the Tarmac site to the North East

4.4.3 DLCO Osiris Triangulation with Low Santon

Polar plots for PM_{10} have been imposed onto a map for the purposes of triangulation. The area to the North East on the DLCO Plot can be triangulated with Low Santon and in doing this a picture can be drawn of where potential issues arise. Lines are drawn from the centres of both plots to encompass those areas of concern. The lines are extended to see how and where they intersect. The areas of intersection may hold clues to areas of the site that contribute to elevated levels of particulate.

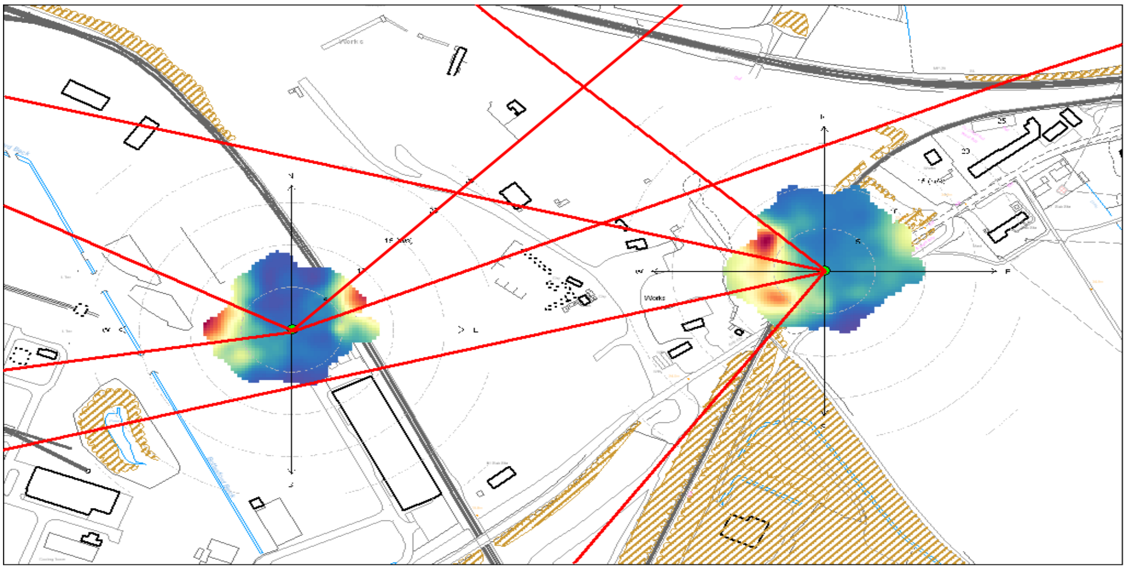


Figure 31: DLCO & Low Santon Triangulation

Both plots in Figure 31 highlight a central area (see also Figure 32) within the Tarmac site as a potential issue. Further work may clarify its contribution with placement of a monitoring station to the North of the Tarmac site. This would enable us to refine the contributions made by this area of concern. When a satellite image of the site is used and the area is imposed on to the image activities occurring within this zone can be identified.

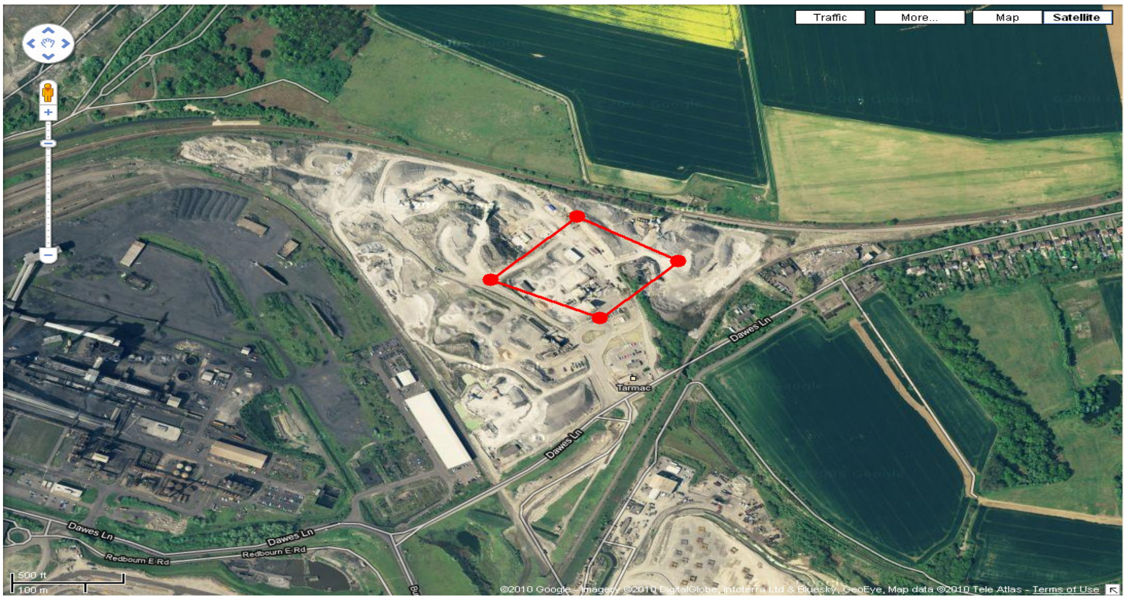
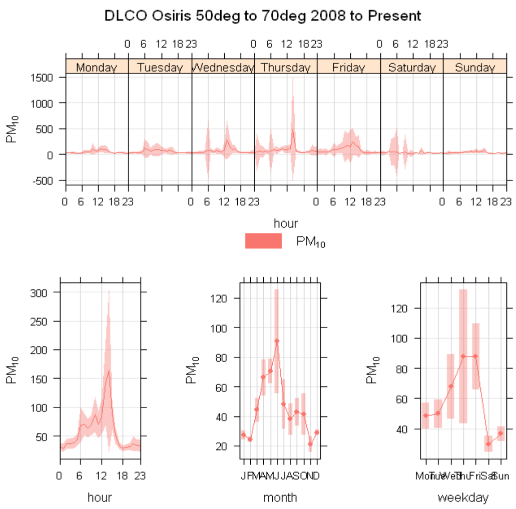


Figure 32: Satellite Image of Hotspot

The Tarmac roadstone coating operation is concentrated within this area and is the point at which all previous processing activities meet prior to final process .

Should the results from DLCO Osiris in the sectors of interest follow a similar diurnal pattern to the Low Santon Monitoring Station we can start to identify the signatures of specific equipment and eliminate and identify areas of focus.

This overall data can be refined further by producing plots where the wind directions have been filtered to the sectors of interest.



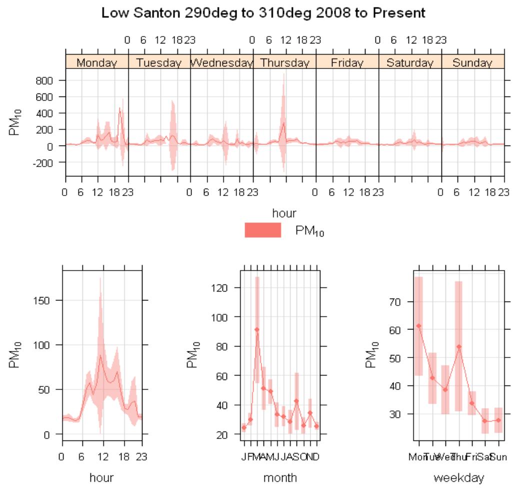
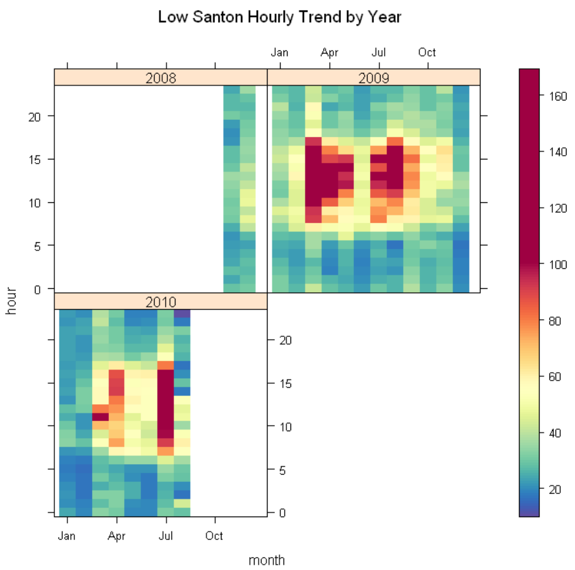


Figure 33: Filtered Hotspot Diurnal Plots

Similarities between the two diurnal plots by hour are not immediately apparent. The most obvious point is the lower concentrations seen at the weekend. Both hour of the day plots reveal three distinct spikes during the day, the magnitude of these spikes differs between the plots but their measurement at the same points during the day indicates a similar if not the same source area.

It is difficult to compare the two monthly plots due to variations in weather conditions. The UK prevailing wind direction is South-Westerly, a factor which contributes to the issues at Low Santon and the identification of Tarmac as a source. The changes in wind direction throughout the year may account for the differences in the monthly average plot. Westerly winds may have been more prevalent in the autumnal and winter periods and Easterly winds during spring and summer. This will be explored further in the weather assessment of this report.



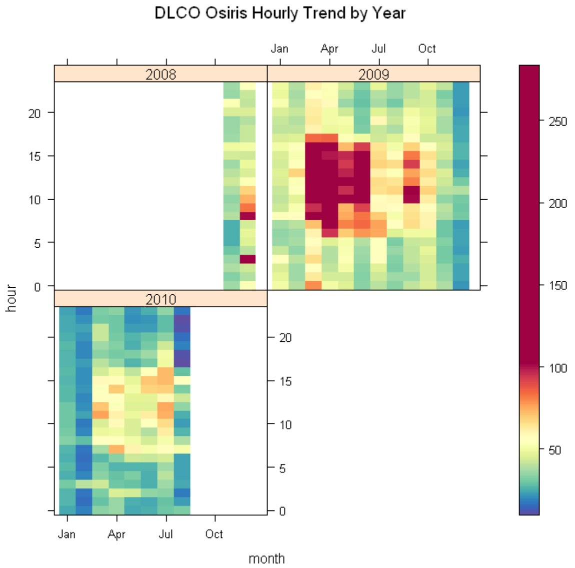


Figure 34: Low Santon & DLCO Trends by Hour

Still considering only data from the wind sectors of interest plots showing the trend by hour were produced. Data is limited as the Osiris was not installed until 2008. The plots show correlated results for 2008 and 2009 between the monitoring sites in that they both show higher concentrations during the day linking to the operating hours of Tarmac. However Harsco and some Tata operations also work during these times. These include; crushing, screening, raw material movements etc.

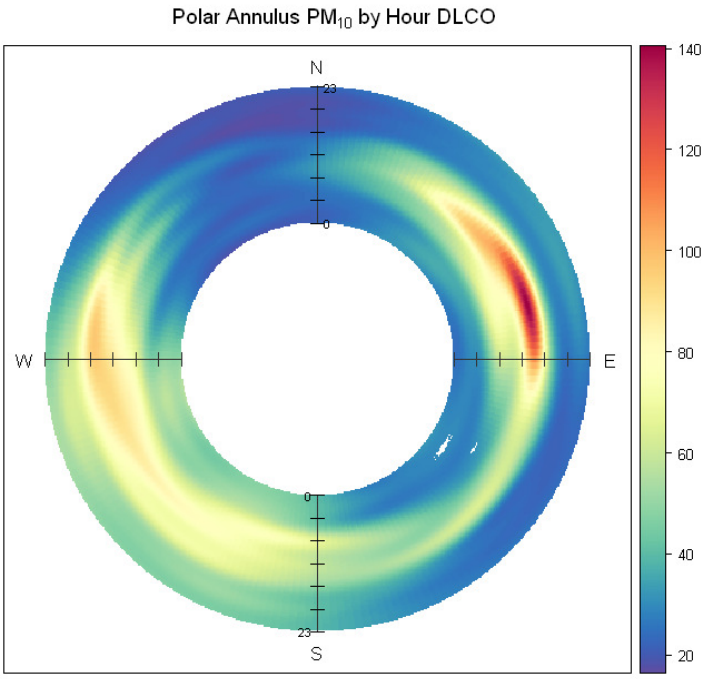


Figure 35: DLCO Polar Annulus

Figure 35 is produced using the whole data set for DLCO Osiris and like the earlier Low Santon polar annulus plot (Figure 17), concentrations to the North East are greater during daylight hours. The elevated concentrations are particularly dominant between 12.00 and 16.00 as demonstrated in Figure 14.

As Figure 35 does not show a continuous source to the South West it indicates that the Dawes Lane Coke Ovens are not a major contributor although the PAH situation at Santon contradicts this. The relationship between PM_{10} and PAH will be reviewed later in this report.

Beyond the Coke Ovens to the West are a number of Part B processes regulated by North Lincolnshire and the Part A Tata operated Coal Handling Plant. These may also play a role in the elevated levels.

4.4.3 DLCO Osiris Triangulation with Low Santon

- Hotspots between the two sites triangulate over the Tarmac Roadstone Coating Plant.
- Both demonstrate noticeable lower weekend concentrations

4.5 Low Santon TEOM Relationship with High Santon

4.5.1 High Santon Partisol Data

North Lincolnshire Council operates two PM_{10} monitoring stations within the Santon area. A TEOM within the Groundhog at Low Santon, the area of exceedence, and a Partisol at High Santon 300m to the East.

Despite the relatively short distance between the two sites, Low Santon continues to measure non-compliant concentrations of PM_{10} whereas High Santon has demonstrated compliance over the last few years;

Site ID	Location	Within AQMA?	Data Capture for full calendar year 2009 [b] %	Annual mean concentrations (µg/m³)		
				2008	2009	2010
7a	Low Santon	Y	93	38 (VCM)	39 (VCM)	33 (VCM)
7b	High Santon	Y	99	31	27	23

Table 8: High Santon Annual Mean Data

Site ID	Location	Within AQMA?	Data Capture 2009 [b] %	Number of Exceedances of daily mean objective (50 µg/m³) If data capture < 90%, include the 90th percentile of daily means in brackets.		
				2008	2009	2010
7a	Low Santon	Y	93	73 (59), (VCM)	78 (VCM)	52 (VCM)
7b	High Santon	Y	99	34 (51)	27	8

Table 9: High Santon Daily Mean Data

High Santon is a row of 38 semi detached properties. The Partisol is located within the front garden of one of these properties 330m to the East of the Low Santon TEOM and 800m to the East of the DLCO Osiris. The High Santon monitor lies on higher ground above both the other monitoring sites and is protected to an extent by woodland between Low & High Santon. This may act as natural wind break preventing much of the particulate reaching High Santon.

The drop in concentration between the two sites appears excessive for the distance involved. It has previously been suggested that the Coal Handling Plant may have a part to play in the elevated concentrations at Low Santon, it is difficult to see how having travelled 800m from a ground level source to Low Santon it would then not continue another 330m to High Santon. If the Coke Ovens were responsible the same issues would be raised. Consequently it is assumed that the source affecting Low Santon is sufficiently localised as not to affect a gravimetric sampler 300m to the East.

Figure 36: High/Low Santon Satellite Image

Both sites sit at either side of Dawes Lane. Dawes Lane is subject to approximately 2450 vehicle movements per day of which 13.2% (323) of those movements are HGV's. Pollution roses plotted using the High Santon Partisol data do not however appear to point towards Dawes Lane as a dominant source. In between the sites is a small industrial estate housing a road sweeping firm, a garage and a café.

Separating both sites is a small area of woodland which surrounds nearby farmland, this is likely to act as a windbreak and natural protection for High Santon, and could form a justification for the sharp decrease in concentration. A railway track passes the North of the Low Santon monitoring site and continues past High Santon.

If we look at the exceedances at High Santon and compare them against Low Santon we can build a picture of the areas most likely to be affecting the Partisol and clues as to what has the potential to travel further distances leading to exceedances affecting both High & Low Santon.

4.5.1 High Santon Partisol Data

- A distance of 300m separates the High and Low Santon monitoring stations
- A distance of 800m separates High Santon & Dawes Lane Coke Oven Osiris
- There is a significant reduction in PM_{10} concentration between Low Santon & High Santon resulting in compliance at the High Santon monitor.

4.5.2 High Santon Partisol & Low Santon Data

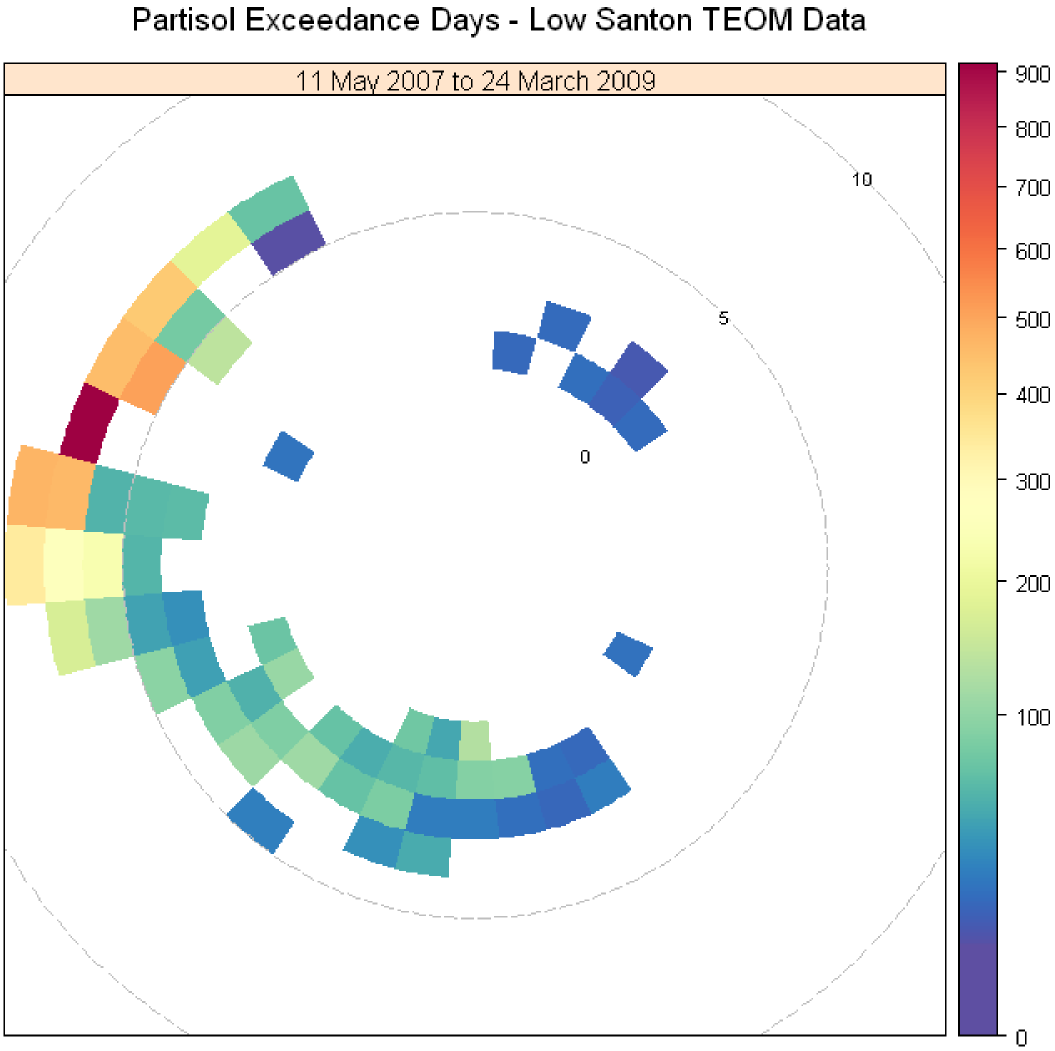


Figure 37: Partisol Exceedance Polar Frequency

Exceedence days occurring at the Partisol were identified over the monitoring period since installation in 2007. Once the dates were known corresponding data for the Low Santon TEOM was plotted. The Partisol only provides a single data point for the 24 hour period unlike the TEOM which produces a 15 minute average. By plotting data from the TEOM on Partisol exceedence days it allows us to explore sources around Low Santon that are active on High Santon exceedence days. When looking at the results an obvious hot spot is identified at wind speeds greater 5 m/s from the North West, the average concentration of 900µg/m^3 will have the potential to travel the additional 300m to High Santon. A total windrose for the periods of exceedance shows that the wind does not exclusively blow in one direction.

Interestingly, higher wind speeds are observed during these periods from the North West, correlating with the hotspot in the above polar frequency. The large PM_{10} emitters of note within this sector would include;

- Tarmac
- Coal Handling Plant
- Dawes Lane Coke Ovens

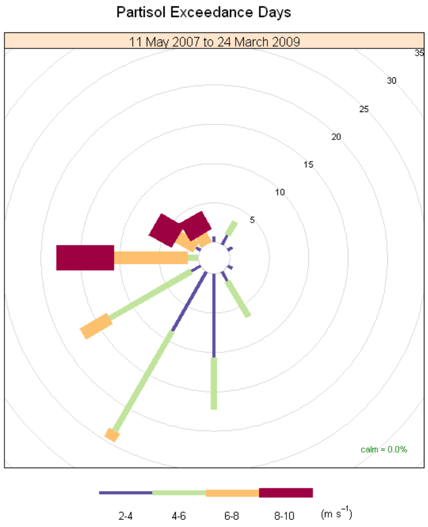


Figure 38: Partisol Exceedance MET Data

Although higher wind speeds would aid the transport of particulate from any source i.e. lift off from roads, crushing etc. it could be that the wind has reached a critical speed leading to a lift off from stockpiles. Should this be the case two of the largest storage facilities on the integrated works lie within this sector.

Tarmac and the Coal Handling Plant have been identified a number of times in various reports. As the stockpiles remain stationary all day it may be that the breaches at the Low Santon TEOM on Partisol exceedences are not dependant on time of the day. This is different to the majority of Low Santon TEOM breaches which follow a diurnal pattern. It should be noted however that the frequency of higher windspeeds also increase during the daytime because of solar radiation.

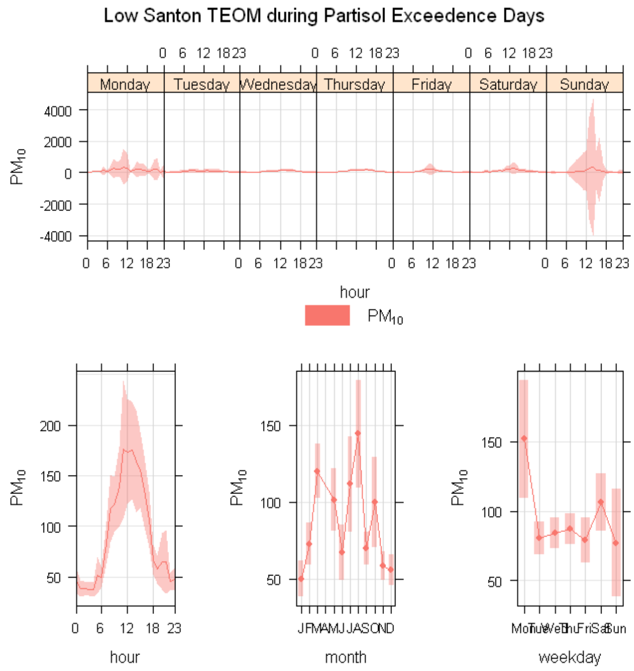


Figure 39: Partisol Exceedance Diurnal Plot

The average TEOM plots during periods of Partisol exceedance follow a diurnal pattern similar but not the same as TEOM exceedances. It appears that unlike most exceedance days at Low Santon the concentrations at High Santon start to increase before 6:00am until 1:00/2:00pm where they begin to fall. Reference to the plot for weekday shows that levels remain consistent across the seven days of the week.

Figure 40 below shows the relationship between wind speed and PM_{10} concentration and indicates that higher wind speeds produce elevated concentrations of PM_{10}. The critical windspeed is 5m/s above which concentrations rise disproportionately . The higher concentrations are observed during higher wind speeds in sectors that stock large amounts of materials.

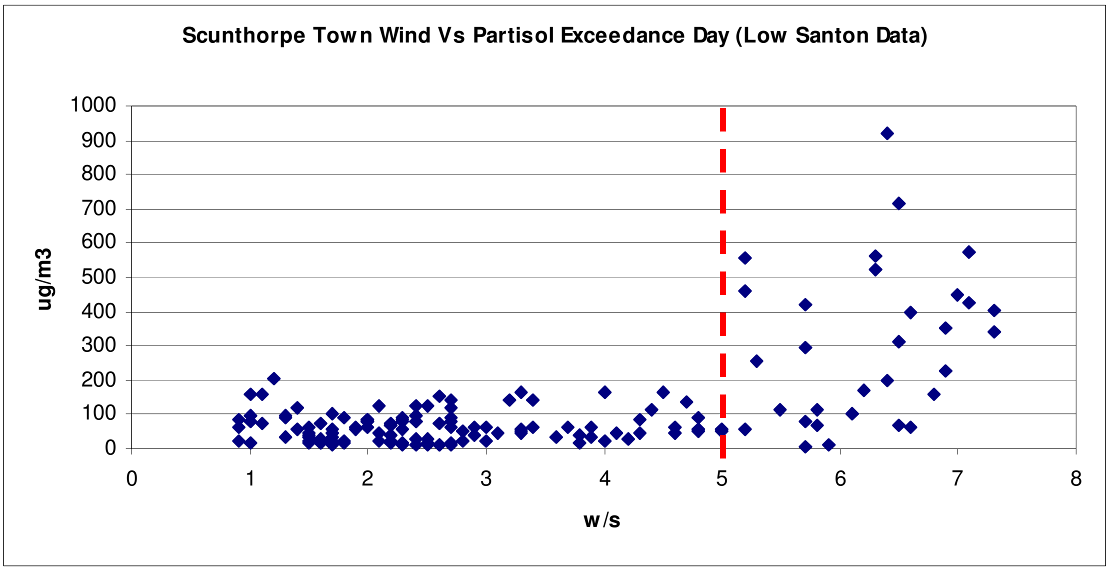


Figure 40: Partisol Exceedance Wind Dependency

4.5.2 High Santon Partisol & Low Santon Data

- Highest concentrations occur when the wind blows NW over large areas of stockpiles
- Higher concentrations at higher wind speeds with the potential to reach the High Santon Partisol
- Partisol exceedances still diurnally dependant when using data from the Low Santon TEOM

4.5.3 High Santon Partisol Data Triangulation with TEOM & DLCO Osiris

Figure 41 shows how the wind sectors measuring the highest concentrations at the TEOM and Osiris on Partisol exceedence days are extended to identify a common source. The Coal Handling Plant is highlighted as playing a major role in elevating concentrations during periods of higher wind speeds.

Concentrations at the Dawes Lane Coke Oven Osiris appear to have originated exclusively from the Coal Handling Plant. The Low Santon TEOM sectors of interest incorporates the Coal Handling Plant & Tarmac.

This exercise has suggested that a culmination of higher wind speeds and wind sectors incorporating the Coal Handling Plant will lead to an exceedance at the High Santon Partisol and most probably the Low Santon TEOM.

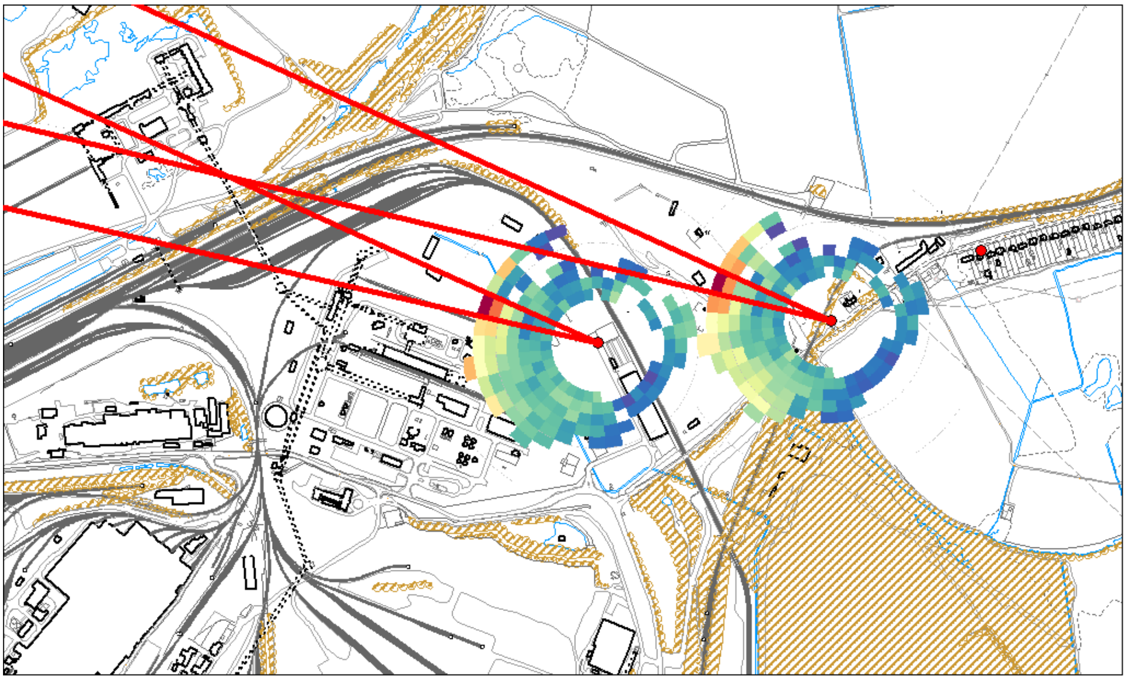


Figure 41: TEOM & Osiris Triangulation

4.5.3 High Santon Triangulation with TEOM & DLCO

- The Tata Coal Handling Plant is a potential source of elevated concentrations
- The hotspots are reflected in both the Dawes Lane Osiris & Low Santon TEOM

4.6 Additional Monitoring within Low Santon

4.6.1 FDMS Data to Date

As previously mentioned an FDMS has been in place since June 2010 at Low Santon. This monitor has been funded by DEFRA in order to establish the volatile component of the particulate in and around Low Santon.

The FDMS measurement system is considered to be an equivalent method and would provide a more robust measurement of particulate levels. The North Lincolnshire Council FDMS had a number of issues in its first few months of operation primarily related to high temperatures within the enclosure. These have now been resolved and it is hoped that data capture for 2011 can warrant it's inclusion in review and assessment reporting.

To date FDMS data has shown a reduction in overall levels. Early indications are that a near 1:1 ratio is being achieved with raw TEOM results much like the VCM correction which has been applied since 2008.

Monitoring Equipment	Monitoring Period	Daily Mean Objective	Annual Mean Objective
Low Santon FDMS	01/06/2010 to 31/12/2010	**12 Days**	**27.6** µg/m^3
Low Santon TEOM	01/06/2010 to 31/12/2010	**17 Days**	**31.6** µg/m^3

Table 10: Low Santon FDMS Data

A number of operations on the Integrated Steelworks have the potential to give rise to the volatile fraction of PM_{10} measured by the FDMS. Only a few sites on the Integrated Steelworks would have the materials present to cause a volatile rich particulate release. These include:

- The Coal Handling Plant
- Dawes Lane Coke Ovens
- Appleby Coke Ovens

Other than vehicle emissions and the sites listed above it is unlikely that volatiles are released from other operations in noticeable quantities. Although exceedance days do not show the levels of volatiles expected with emissions from the above plants a lack of understanding around dispersion of volatiles exists. The volatile to non volatile ratio is unlikely to be the same at the release point and at the FDMS monitoring point. As more results are collected from the FDMS this will be investigated further.

4.6.2 PAH Measurements at Low Santon

North Lincolnshire Council has had a Digitel PAH Sampler in Santon since 2007. Results to date have exceeding the UK Objective of 0.25ng/m^3 and unless there are interventions the European Objective is unlikely to have been met by 2012.

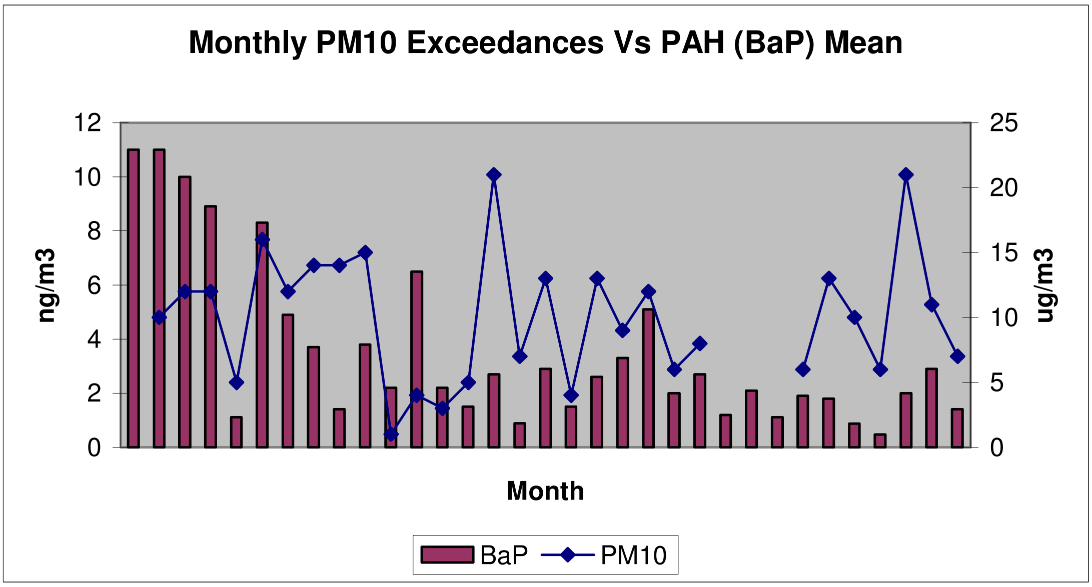


Figure 42: Monthly PM_{10} Exceedances Vs PAHs

The measurement of PAHs are reported in monthly batches. 14 filters are changed fortnightly allowing for a new filter each day. Although daily filters are used only a monthly average is produced.

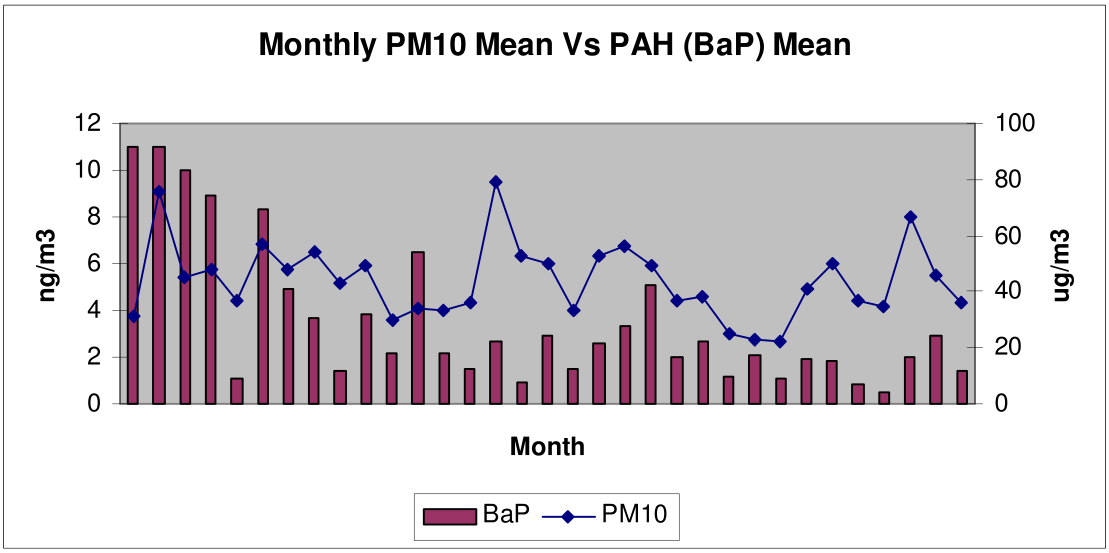


Figure 43: Monthly PM_{10} Means Vs PAHs

The above graphs do not demonstrate any correlation between monthly B(a)P concentrations and PM_{10} data at Low Santon. The graphs have been plotted using daily exceedance frequency and period means.

Results show that Low Santon experiences some of the highest concentrations of PAHs in the UK. The North Lincolnshire AURN site also records very high numbers of PAHs. Port Talbot also experiences numbers comparable with the potentially non compliant North Lincolnshire sites.

It is generally accepted that the most likely contributor will be the two Coke Ovens on the Integrated Steelworks site. As the two Scunthorpe PAH monitoring stations sit close to the Integrated Steelworks higher concentrations are seemingly inevitable. The operation of the works is currently being reviewed by the Environment Agency with the view of bringing the sites in line with BAT.

4.6.2 PAH Measurements at Low Santon

- No real correlation between PAHs and PM_{10} exceedances.
- PAH data only available as a monthly average.
- Very high B(a)P results attributable to Appleby & Dawes Lane Coke Ovens.

4.6.3 Heavy Metal Measurements at Low Santon

Heavy Metals monitoring has been undertaken at Low Santon since March 2008. Monitors are located at the Scunthorpe Town AURN Site and the Low Santon monitoring station.

Heavy metal monitors in Scunthorpe much like the Port Talbot steelworks measures high concentrations of Iron and Manganese. The concentrations of Iron and Manganese are much higher in Scunthorpe than they are compared to the rest of the UK with the exception of Port Talbot.

It is difficult to compare Heavy Metal measurements with PM_{10} results at Low Santon. The Heavy Metal Partisols measure by exposing a filter for a 7 day period. These are then analysed to give a weekly total. For the purposes of reporting these are presented as a monthly average.

The monthly totals have been compared against two factors, monthly PM_{10} means at Low Santon and monthly daily exceedances at Low Santon. The results are shown in Figures 44 and 45.

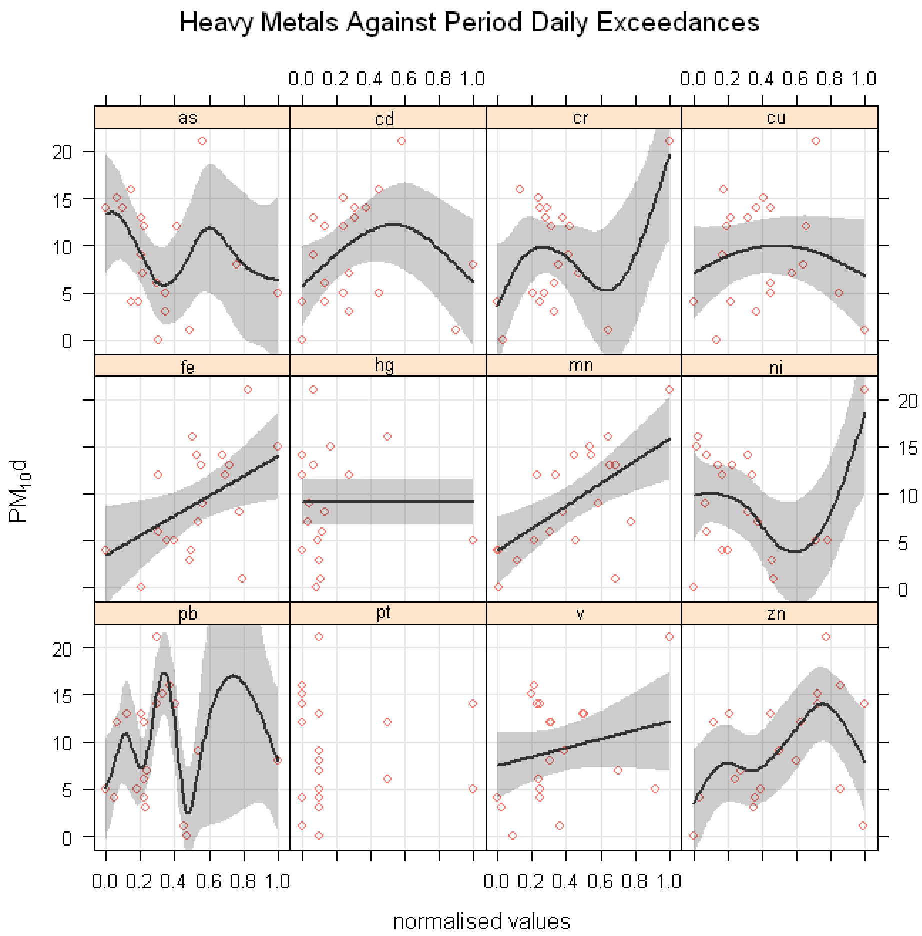


Figure 44: Monthly PM_{10} Exceedances Vs Heavy Metals

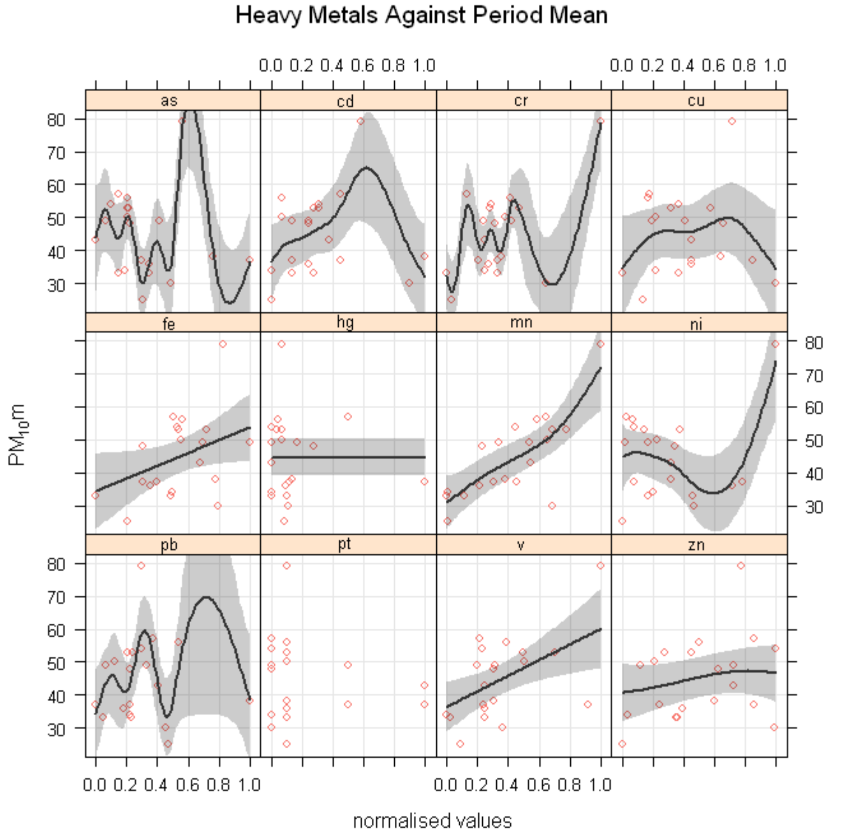


Figure 44: Monthly PM_{10} Means Vs Heavy Metals

The plots highlight a strong correlation between PM_{10} and Manganese, as the number of exceedences and average concentration increases so does the concentration of Manganese. Other metals also indicate a relationship such as Iron and Zinc. The strong manganese correlation may provide further evidence in identifying a source close to Low Santon and this is currently under investigation.

Contaminants		Location				
	Individual Compounds	Coke Making	Iron Making	Steel Making	Casting	Rolling and Finishing
Metal & Metalloids	Iron		✓	✓	✓	✓
	Aluminium					✓
	Arsenic			✓		
	Chromium			✓		✓
	Lead		✓	✓		✓
	Manganese			✓		✓
	Molybdenum			✓		✓
	Nickel			✓		✓
	Tin					✓
	Vanadium					✓
	Zinc		✓	✓		✓

Table 11: Iron & Steel Making Contaminants

Table 11 shows the Environment Agency Industrial Profile document and details the likely releases from a number of industrial processes. Iron and steel making is broken down in to its component parts.

The scatter plots suggest that a strong correlation exists between Manganese and the PM_{10} exceedances. The industrial profiles suggest that Manganese is a significant release in steel making but not iron making. Although these processes will have an overall effect on Low Santon they are situated some distance away. The slag which these processes produce is the most probable connection to the iron and steel making processes, the associated storage of both blast furnace and BOS steel slag close to the Low Santon Monitoring Station may be relevant in any future work.

As both BOS steel slag and blast furnace slag is stored at Low Santon this may be evidence to suggest that steel slag stockpiles are a greater contributor to the issues. This will require further investigation.

4.6.3 Heavy Metals Measurements at Low Santon

- High iron and manganese measurements at Low Santon.
- Heavy metal releases associated with metal production.
- Strong correlation with Manganese and PM_{10}.
- Manganese is a significant release in steel making but not iron making.

5 MET Conditions

5.1 North Lincolnshire Council MET Data

North Lincolnshire Council operates a MET Station at Normanby Hall approximately 6km to the North West of Low Santon. This site is operated in partnership with the MET Office and measures;

- Total Cloud Cover
- Wind Direction
- Wind Speed
- Visibility
- Dry Bulb
- Wet Bulb
- Maximum Air Temperature
- Min Air Temperature
- Rainfall

North Lincolnshire Council also measures Wind Speed and Wind Direction at Scunthorpe Town AURN site. A rain gauge has also recently been installed. This data is viewed as representative of MET conditions on the Integrated Steelworks. The Scunthorpe Town AURN site was checked and calibrated by the MET Office to ensure accuracy within the results.
The following extract is taken from the Met Office report submitted to the Council.

"The report shows that the Anemometry at the Rowland Road site, over a capture period of 15 minutes performed well within expected Met Office tolerances, and although we could never call this a true equipment calibration, in terms of functionality, your equipment matched the readings taken from our Calibrated equipment faithfully"

The full report can be found within the appendix of this report.

Low Santon also has a wind speed and direction sensor installed although concerns have been raised over the validity of these results. Accuracy can not be guaranteed because of the location of this MET mast. It sits in a dip, sheltered from all sides. For this reason a decision was taken by North Lincolnshire Council to use Scunthorpe Town AURN site data in all its investigations.

Tata also operate a MET station above their Environmental Services Building which they use when analysing results.

5.1 North Lincolnshire Council MET Data

- Data from Scunthorpe Town AURN site considered to be the best available data for the purposes of data interrogation.

5.2 Historical MET Data

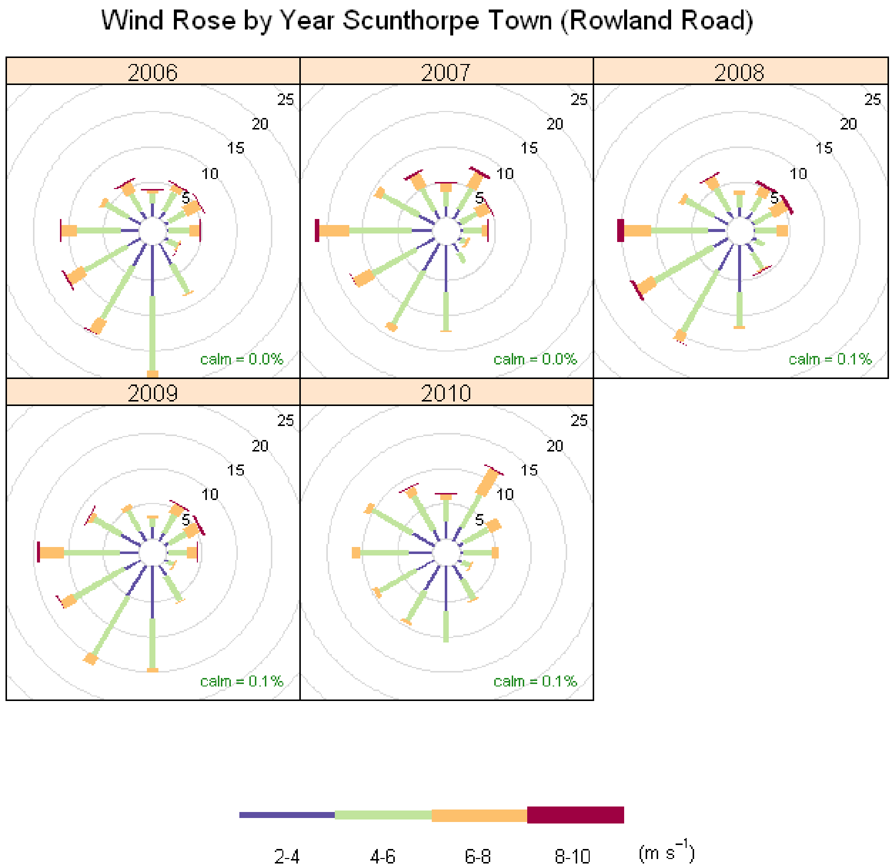


Figure 46: Historical MET Data

Figure 46 shows the annual Wind Roses for Scunthorpe Town AURN site. As expected each year follows a similar pattern of South Westerly winds which is consistent with the UK prevailing wind direction .

2010 data shows a marked difference in the number of North Easterlies. The start of 2010 saw a particularly cold period resulting in extended periods of snow coverage. During this period Low Santon measured lower concentrations of PM_{10} than previously years. There were discussions at the time as to whether this period of uncharacteristic weather was resulting in a lowering of overall concentrations of PM_{10} at Low Santon. At the same time Tarmac suspended the operation of their Dry Handling Plant.

The combination of these events did have an impact between December 2009 and February 2010 resulting in no exceedance days being recorded.

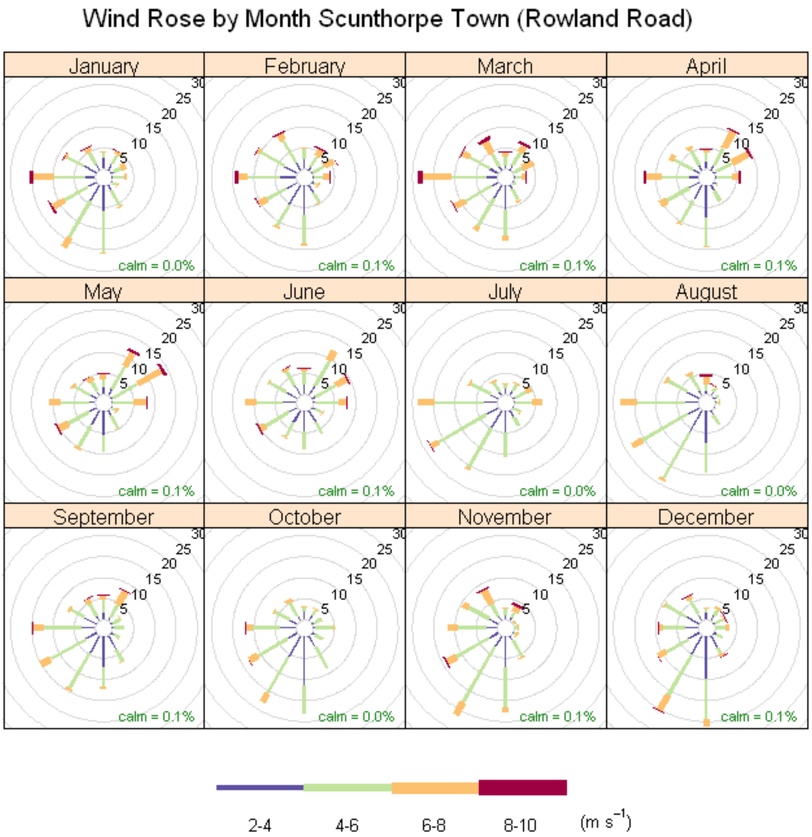


Figure 47: Wind Roses by Month

Figure 47 shows the average wind conditions by month for the whole data set since 2005. The patterns do not differ greatly by month although a number of months do stand out as having a higher percentage of winds from different directions.

Normally January, February and March all show a higher frequency of Westerly winds at higher speeds. In 2010 unusual conditions were experienced at the start of the year with a higher frequency of Easterly winds. April and May show a higher frequency of North Easterly winds at higher wind speeds. June shows a range of winds at similar frequencies and for the rest of the year South Westerly winds prevail.

Using the wind direction frequency we can build up a picture of the dependence of an exceedance day on the wind. Low Santon is unique in that almost 270º of the compass rose covers industrial activity. By looking at the frequency an exceedance risk can be developed aiding plans to produce an Air Quality Alert System investigated later in this report.

5.2 Historical MET Data

- No unusual wind events occur at the Scunthorpe Town AURN site.
- Prevailing winds are South Westerly.
- Noticeable reduction in exceedence days during periods of NE winds i.e. Dec 2009 to Feb 2010

5.3 Wind characteristics of an exceedance day

A major factor on an exceedance day is the meteorological conditions that exist and the location of dusty operations relative to the monitoring station.

In Scunthorpe monitoring stations are located to the west of the Integrated Steelworks and therefore Easterly winds tend to lead to exceedences of air quality objectives. As discussed previously in this report the monitoring station at Santon exceeds more often when wind comes from particular sectors, which are the predominant prevailing wind directions.

Table 12 below shows the percentage wind direction frequency broken down into the length of time the wind was in each sector over a 12 month period. Data for the year 2010 is provided only until September 2010.

Year	%N	%NE	%E	%SE	%S	%SW	%W	%NW
2006	4	10	5	10	21	27	11	12
2007	5	8	12	4	12	27	17	17
2008	4	12	15	6	12	20	15	14
2009	2	12	5	7	20	25	15	14
2010	7	19	5	7	11	20	12	19

Table 12: Yearly % Wind Sectors

As expected the predominant direction correlates with the UK prevailing direction of South West. In 2008 and 2010 lower frequencies of South Westerly winds were recorded. In 2007 and 2008 there was a marked increase in Easterly winds with increases of 200% over the other years in the period.

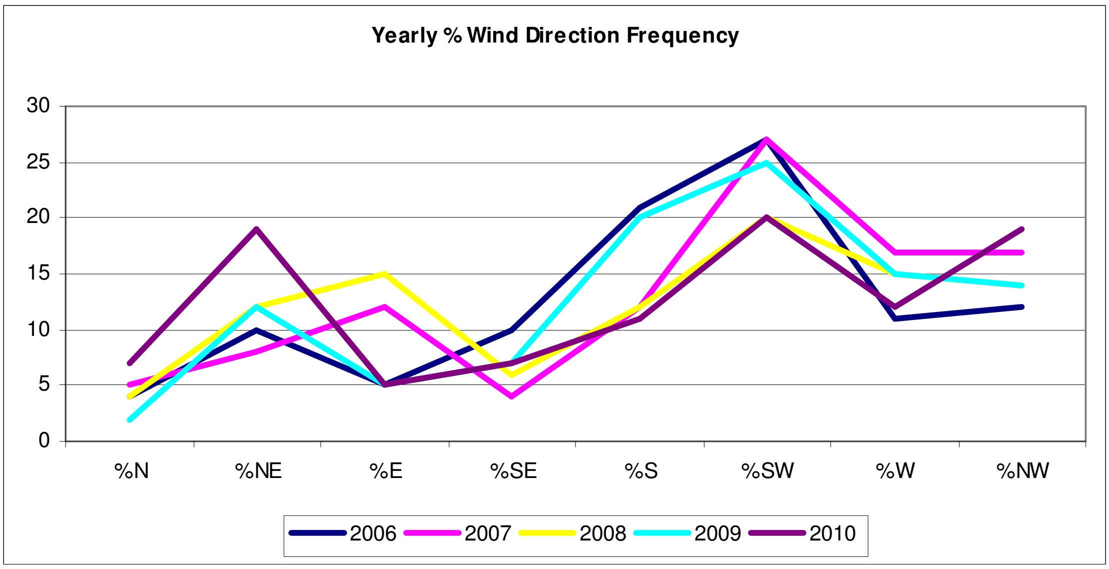


Figure 48: Wind Direction Frequency

Reference to the differences in wind conditions highlight the dependence of wind direction on the daily mean objective results. As discussed earlier, monitoring stations within Scunthorpe are only subject to exceedance days when Easterly winds are recorded. As 2007 and 2008 saw a much higher frequency of Easterly winds a higher number of daily mean breaches were recorded.

Location	**Number of Exceedances of Daily Mean Objective (50 µg/m^3)**				
	2006	2007	2008	2009	2010
Appleby Village	4	8	5	1	0
Broughton	2	5	3	0	0
Killingholme	8	6	9	4	1
Low Santon	158	133	115	101	86
High Santon					
Scunthorpe Town (AURN) TEOM	37	36	22	14	9
Scunthorpe Town Partisol					
Lincoln Gardens	17	14	21	7	2
East Common Lane	43	34	44	22	19
Allanby Street	23	11	12	2	1

Table 13: Daily Mean Exceedances by Year

East Common Lane and Scunthorpe Town both experienced higher frequencies of exceedance days during 2007 and 2008. This is connected to the frequency of Easterly winds experienced during these years.

It is difficult to correlate Low Santon with changes in the wind direction frequency because of it’s reducing trend in PM_{10} exceedence since 2006, which may result from interventions by local operators.

5.3 Wind Characteristics of an Exceedance Day

- Unusual wind patterns affect exceedance day frequency.
- Increases in Easterly winds cause more exceedances at monitoring stations in Scunthorpe and fewer at Santon

Daily Episode Reviews

Overview

North Lincolnshire Council are currently conducting daily exceedance reviews in respect of the daily mean breaches at Low Santon. These are then communicated to operators in the Low Santon area as soon as possible to enable them to identify reasons for the breach.

This has been in place since the start of October 2010 and involves reviewing the previous days data. If an exceedance is identified a report is sent to staff at Tata, Tarmac, Harsco, Banner Contracts and The Environment Agency.

Examples of these reports can be found within the appendix of this document. The reports consist of;

- A brief summary of the days concentration data
- A summary of the days met conditions
- A wind rose
- A period wind rose imposed on to a GIS map
- Potential source identification using triangulation between Low Santon and Dawes Lane Coke Oven Osiris

The triangulation between Low Santon and the Dawes Lane Osiris is a simple concept. Both data sets are plotted as a 15 minute time series and the data is checked for periods of difference;

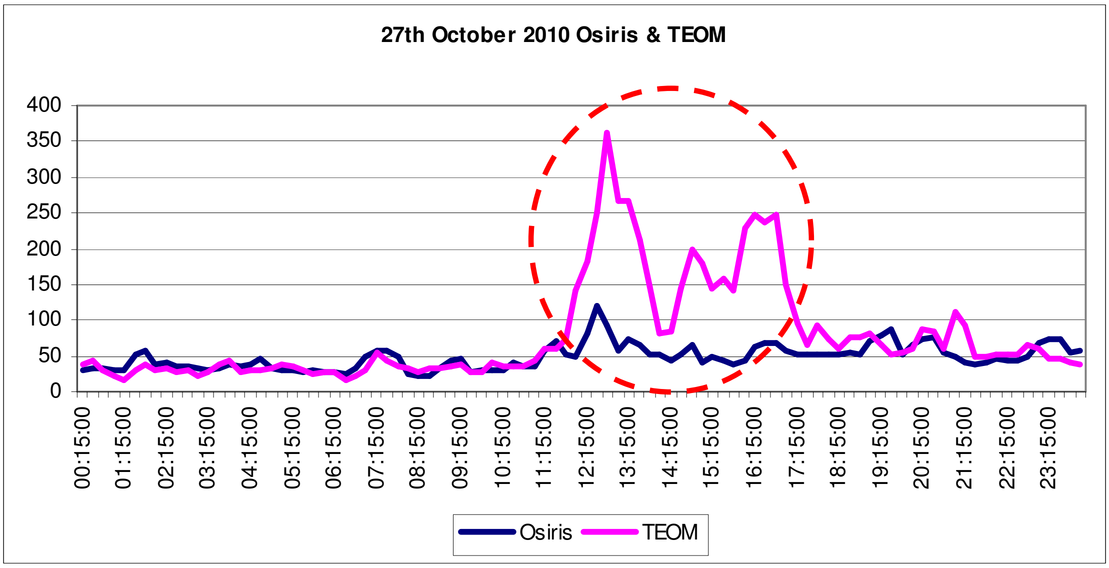


Figure 49: Review Example Time Series

The wind data is then plotted for this period, Figure 49 shows an example whereby the period 12:00 to 17:00 demonstrates a difference between the two monitoring locations. The range of wind directions for the period of interest are then imposed on to a map.

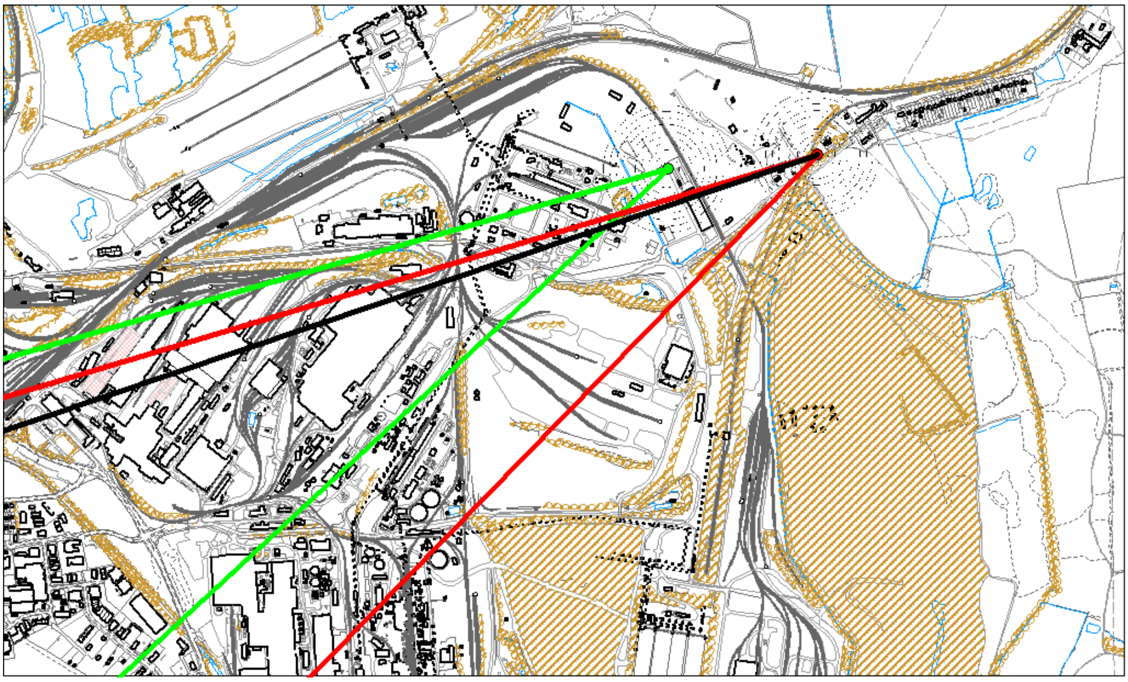


Figure 50: Review Example Directional Analysis

The above map shows the Low Santon TEOM (indicated by the red lines) and the DLCO Osiris (indicated by the green). The black line shows the wind direction which generated the highest PM_{10} concentration recorded during the 5 hour period of focus. The black line is drawn in the red sector as this was the site that breached.

The area within the red sector identifies all possible operations that may contribute to the exceedence at Low Santon. The area within the green sector identifies all possible operations that may contribute to PM_{10} concentrations at DLCO Osiris. If DLCO Osiris did not breach but Low Santon did then it can be assumed that sources within only the green area were not significant enough to cause an exceedence. By a process of elimination it can be assumed therefore that the area between the lower green and lower red line are likely to contain sources that are impacting at Low Santon.

The area identified includes

- Tarmac
- Redbourn Site

The emails are sent as soon as possible after the event, interested parties then reply providing information on activities at those sites during the period of focus.

6.1 Overview

- Reviews designed provide a prompt overview of an exceedence to interested parties in order to identify a source.
- Simple idea triangulating Low Santon and Dawes Lane Coke Oven Osiris with wind range imposed on a map.
- General ground conditions also included with time series of concentrations.

6.2 Results to date

Although still a relatively small study combining a small data set, a number of processes have started to emerge as likely contributors. A simple bar chart was plotted highlighting the frequency in which certain areas of plant have been identified in the process of the reviews.

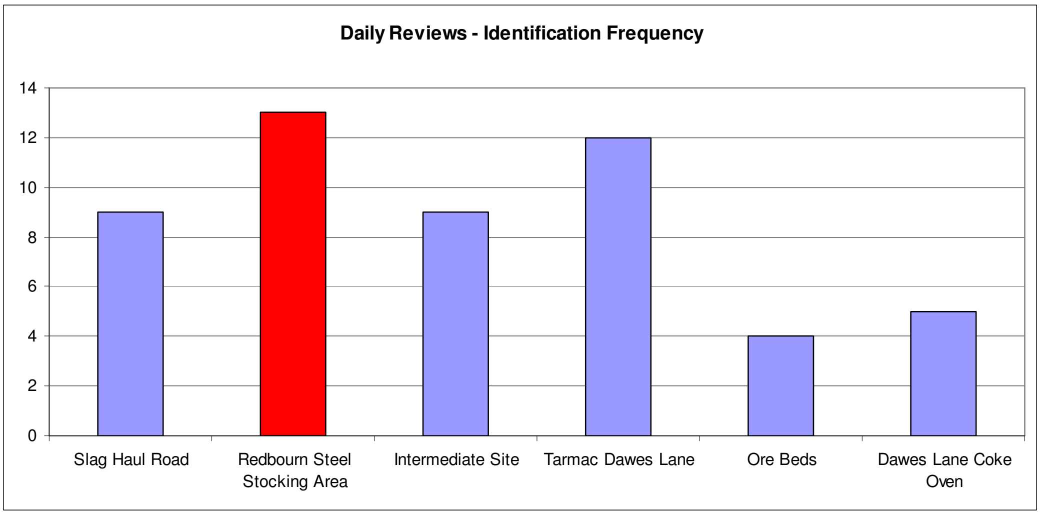


Figure 50: Review Results to Date

The Redbourn Steel Stocking Area was identified in the study as the highest potential source. Much of this will be due to the area in which it is located and its correlation with the prevailing wind direction. The use of the Dawes Lane Coke Oven Osiris is beneficial as it reduces the area of investigation focusing much of the attention exclusively at this area.

Tarmac also features highly relative to other areas due to its location and proximity to the Low Santon monitor. When plotting the days in which these sites have exceeded as a time series, a pattern begins to emerge of the exceedence events;

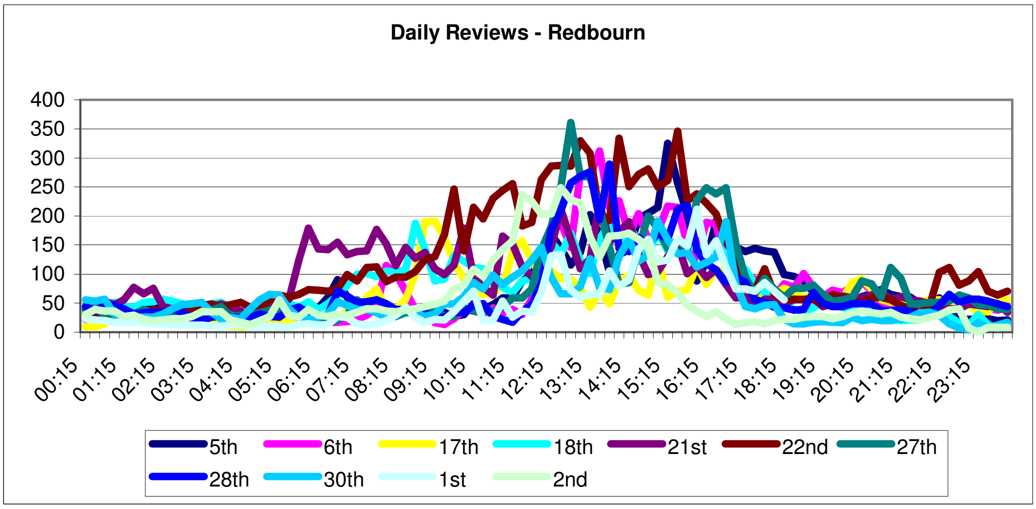


Figure 52: Review Time Series to Date

The above plot using data from the Low Santon TEOM shows all days in which the Redbourn Site was identified as potentially responsible for the exceedances at Low Santon. Although a large amount of data on one graph you see a pattern in the times of the increase and decrease in concentration.

The above graph can be compared to data from the DLCO Osiris which shows a continuous source such as the Dawes Lane Coke Ovens on days in which it has been identified as a possible source.

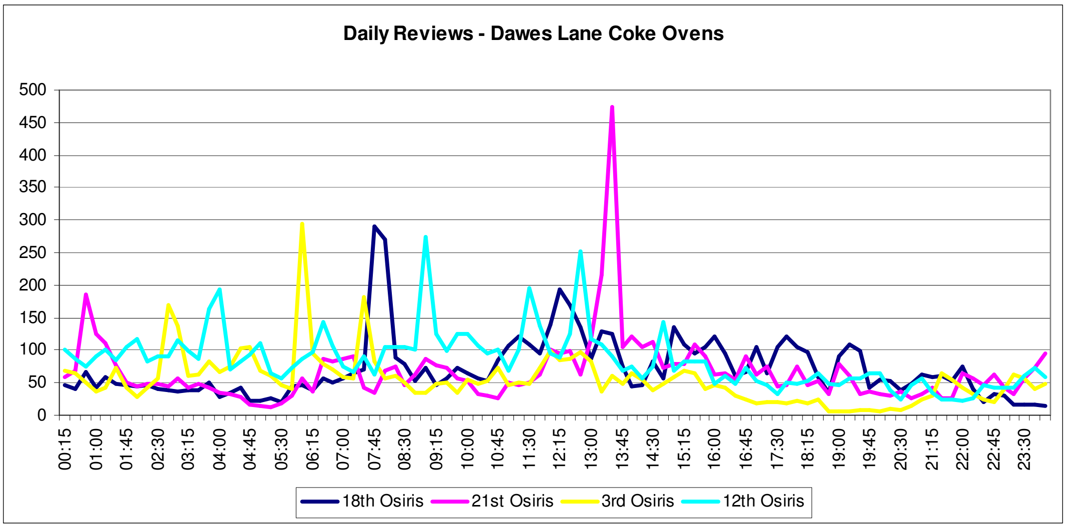


Figure 53: DLCO Review Time Series to Date

The Dawes Lane Coke Ovens produce large spikes in the data within consistent elevated concentrations correlating well with the 24 hour continuous process.

This exercise will continue until Tata take over the daily reporting responsibilities.

6.2 Results to Date

- Redbourn Steel Stocking Area identified as major source during this period.
- Redbourn area – high volumes of vehicle movements on unmade ground and loading of vehicles.
- Tarmac identified.
- Tarmac and Redbourn may feature due to their location in many wind sectors.

7 Development of a Risk Assessment at Low Santon

A risk based system to inform interested parties on the Integrated Steelworks was proposed by members of the Technical Working Group. The starting point for this was to determine the historical monthly risk by considering exceedences in previous years data. This enabled a weighted score to be attributed to each month. This score was devised by focusing on actual exceedances within each month and monthly Met trends since the start of the monitoring programme.

Exceedances within each month were considered in two ways:

Month	2005	Days	%	2006	Days	%	2007	Days	%
January	0	31	**0**	5	31	**16**	13	31	**42**
February	0	28	**0**	10	28	**36**	6	28	**21**
March	0	31	**0**	12	31	**39**	24	31	**77**
April	0	30	**0**	15	30	**50**	10	30	**33**
May	0	31	**0**	18	31	**58**	12	31	**39**
June	0	30	**0**	18	30	**60**	6	30	**20**
July	0	31	**0**	22	31	**71**	18	31	**58**
August	0	31	**0**	11	31	**35**	8	31	**26**
September	0	30	**0**	16	30	**53**	16	30	**53**
October	12	31	**39**	14	31	**45**	13	31	**42**
November	21	30	**70**	13	30	**43**	10	30	**33**
December	9	31	**29**	7	31	**23**	2	31	**6**

Month	2008	Days	%	2009	Days	%	2010	Days	%
January	0	31	**0**	3	31	**10**	0	31	**0**
February	10	28	**36**	5	28	**18**	0	28	**0**
March	12	31	**39**	21	31	**68**	6	31	**19**
April	12	30	**40**	7	30	**23**	13	30	**43**
May	5	31	**16**	13	31	**42**	10	31	**32**
June	16	30	**53**	4	30	**13**	6	30	**20**
July	12	31	**39**	13	31	**42**	21	31	**68**
August	14	31	**45**	9	31	**29**	11	31	**35**
September	14	30	**47**	12	30	**40**	7	30	**23**
October	15	31	**48**	6	31	**19**	10	31	**32**
November	1	30	**3**	8	30	**27**	3	30	**10**
December	4	31	**13**	0	31	**0**	0	31	**0**

Table 14: Monthly Exceedance by Month Breakdown

The above tables show the total number of breaches within each month year on year and the percentage of days which exceeded within that month to give a percentage chance of exceedance. Having reviewed this data July stands out as a month which has a higher risk of exceeding than others.

This data has been used to form a risk assessment designed to help with daily action planning at an operational level. It is intended that the risk assessment will be available to view the day before the assessed period.

As previously discussed July stands out as a month of concern. The combination of longer working hours and drier, hotter ground conditions make this the major exceedance month.

Month	Combined %
January	11
February	18
March	40
April	32
May	31
June	28
July	46
August	28
September	36
October	38
November	31
December	12

Table 15: Combined Monthly Exceedance Average

Shown below is the pie chart from which the overall monthly risk was calculated showing months such as August and September which present a higher likelihood of exceedance and months with a much lower overall chance e.g. December and January.

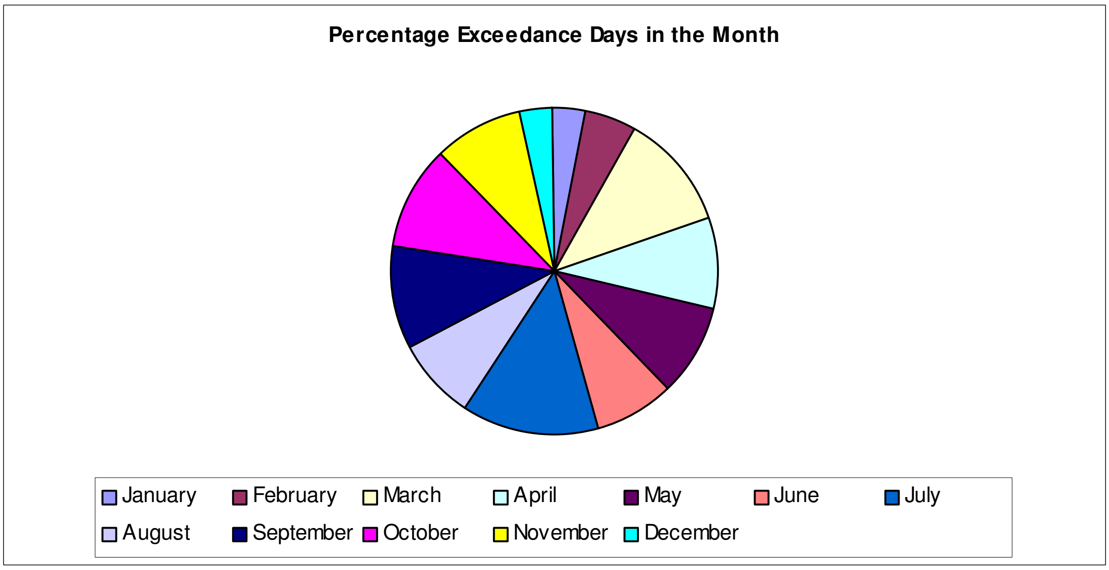


Figure 54: Exceedance Day Pie Chart by Month

The Risk Assessment contains many individual components and it is not intended to discuss them all in detail within this report. However further justification can be found within the appendix of this document.

Below is an overview of the completed risk assessment currently being tested to prove its accuracy:

Risk Assessment for Low Santon PM_{10} Exceedance - Score Sheet

Completed by ____ For ________

Component 1 - Forecasted Wind Direction	Possible Scores	Score Awarded
(A) High - SSW, SW, WSW, W, WNW	30	
(B) Moderate - SE, S, NW	15	
(C) Low - N, NNE, NE, ENE, E, ESE, SSE, NNW	5	

Component 2 - Forecasted Wind Speed (should the wind direction fall within high & moderate risk)	Possible Scores	Score Awarded
(A) High - >5m/s	20	
(B) Moderate - 2-5m/s	12	
(C) Low - 0-2m/s	5	
(1mph = 0.45m/s)		

Component 3 - Forecasted Rainfall/Snow	Possible Scores	Score Awarded
(A) High - No	15	
(B) Moderate - Yes am	5	
(C) Moderate - Yes pm	5	
(D) Low - Yes all day	-10	

Total Met Conditions		0

Component 4 - Month	Possible Scores	Score Awarded
(A) High - March, July, October, November	15	
(B) Moderate - April, May, June, August, September	10	
(C) Low - January, February, December	5	

Component 5 - Weekday	Possible Scores	Score Awarded
(A) High - Tuesday, Wednesday, Thursday, Friday	15	
(B) Moderate - Monday, Saturday	10	
(C) Low - Sunday	5	
(D) Bank Holidays	0	

Total Weekday/Month	0

	Possible Scores		
Component 6 - Site Activity Exceptions	**Yes**	**No**	**Tarmac**
(A) Known increase in production demand	10	0	
(B) Reduced control ability e.g. bowsers down	10	0	
(C) Changes on site likely to increase risk	10	0	

Total Site Activity	

	Possible Scores		
Component 7 - Additional Info	**Yes**	**No**	**Score Awarded**
(A) Similar conditions as yesterday resulting in a breach	5	0	
(B) Ground conditions - persistent snow	-25	0	
(C) Ground condition - persistent frost	-10	0	
(D) Sunshine hours - all day	10	0	
(E) Sunshine hours - am or pm	5	0	
(F) Sunshine hours - none	-5	0	

Total Additional Info	0
Total Risk Score	**0**

Score <40	Low Risk
Score >40 & <80	Moderate Risk
Score >80	High Risk

Table 16: Low Santon PM_{10} Risk Assessment

7. Development of a Low Santon Risk Assessment

- Provisional Risk Assessment tool currently showing high level of accuracy.
- Definite higher risk in some months relative to others.
- High risk wind directions as well as high risk days if the week.
- Further contributions required from Local Operators to ensure accuracy.

8 Production Data

Tata supplied the council with monthly production data. It was hoped that this monthly data may hold clues as to what processes may be responsible for the high concentrations at various Scunthorpe monitoring sites.

Production at the Integrated Steelworks has reduced over the past few years due to the economic downturn. The production downturn of 2009 vastly reduced production output at much of the works. Data was received showing monthly Iron, Coke & Steel making which are the major production outputs at the Integrated Steelworks. Monitoring sites were selected which were considered to be representative of ambient concentrations and the closest to major plants on site. Data for both daily mean and annual mean concentrations were plotted against production data. These sites were:

- Scunthorpe Town AURN
- Low Santon
- East Common Lane

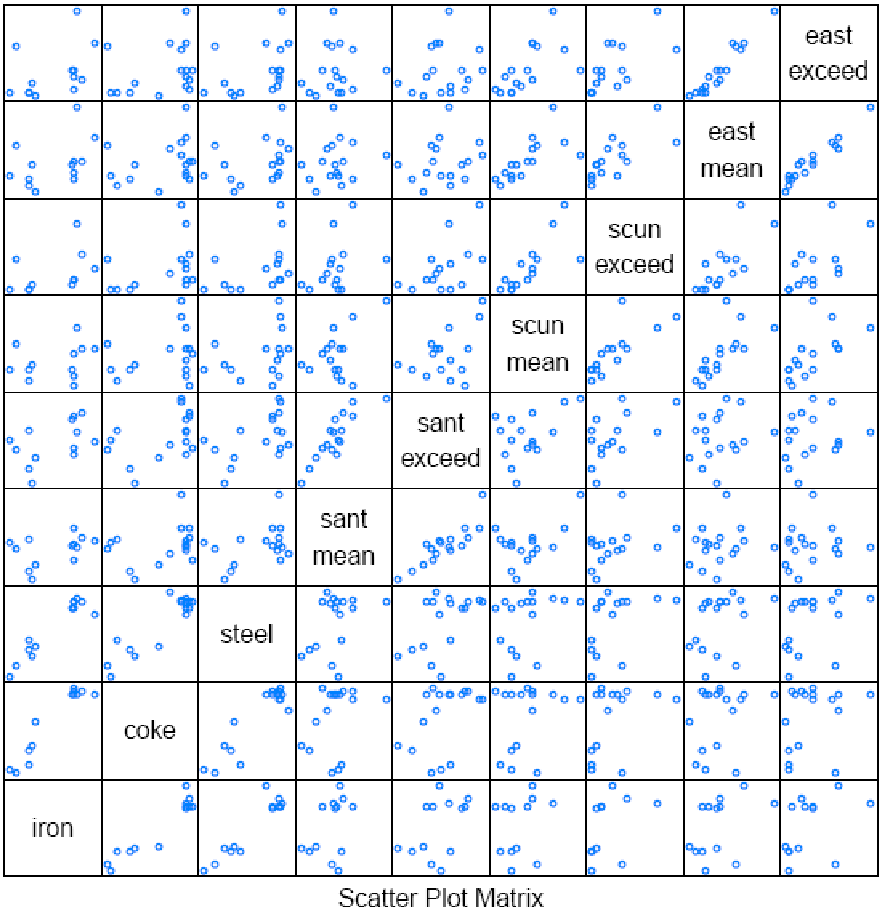


Figure 55: Production SPLOM

The data was plotted in a SPLOM plot shown above using Openair Tools in the R Software. Having reviewed the plots no obvious relationships emerged.

The only correlations which were identified occurred between the three distinct processes as they are intrinsically linked. Coke forms part of the iron making process and iron is a raw material of steel.

There was a direct relationship between both objectives.

This is an area of work that could be explored further. Investigations are ongoing during periods of plant shutdown. A reduction in a plant signal may eliminate it from further investigation or may provide sound evidence for it to be included in a list of sources responsible for the elevated levels of PM_{10} at Low Santon.

8. Production Data

- More data required to further this work at higher time resolution.
- Investigations ongoing into plant shutdowns and their effect on overall levels at Low Santon

9 AEA Modeling

9.1 AEA Executive Summary

European Ambient Air Quality Directives are in place to ensure that Member States achieve specific standards for ambient air quality. The first Daughter Directive and the more recent CAFE (Clean Air For Europe) Directive (EC/2008/50) set limit values for PM_{10} to be achieved from 2005 onwards. The limit values are: 40 µg m^3 as an annual mean; 50 µg m^3 as a daily mean not to be exceeded on more than 35 occasions in a year.

Measurements of PM_{10} concentrations at the Low Santon site indicate that the limit values for the annual mean concentration and the daily mean concentration were exceeded in 2007 and 2008. Various studies involving the analysis of monitoring data and dispersion modelling have previously been carried out by North Lincolnshire Council, Tata UK Ltd, Lancaster University, AEA Technology and Leeds University. These studies have attributed the high concentrations to emissions from the Tata steelworks, fugitive emissions from the Tarmac slag handling operation and fugitive emissions from the unpaved haul road between the Tata works and the Tarmac slag handling operations.

Defra wish to assess the site's suitability for affiliation into the Automatic Urban and Rural Network (AURN). One consideration is whether the site meets the macroscale siting criterion set out in the Directive that the sampling site should be representative of an area of at least 250 m × 250 m (62,500 m^2) at industrial sites, where feasible.

The report described a dispersion modelling study to estimate the area of exceedance of the limit values in the vicinity of the Low Santon site. The dispersion model ADMS4.1 was used to predict the contributions to ground level concentrations from the Tata plant and from fugitive emission sources, based on initial estimates of fugitive emissions derived using the methods described in the US Compilation of Air Pollutant Emission Factors, AP42. The model was adjusted to initial estimates of fugitive emissions to give "best" agreement with the monitoring results taking account the effects of wind direction and wind speed. The model performance compared to the measurements was acceptable when tested against a range of criteria:

- CAFÉ Directive data quality objective for the annual mean
- FAIRMODE Relative Directive Error for the daily mean values
- AEA Model Intercomparison Protocol Normalised Mean Bias
- AEA Model Intercomparison Protocol Factor of 2
- Scatter plots of measured vs. modelled daily mean values
- Wind speed and direction dependence.

The model indicates that the following sources make the greatest contributions to annual mean concentrations in the vicinity of the Low Santon monitor.

- Tata steelworks
- Tarmac north aggregate handling
- Tarmac north wind erosion;
- Haul road
- Track out onto Dawes Lane

Taken together, the operations at the Tarmac site make the largest contributions to annual mean concentrations at the monitoring site. Emissions from the Tata steelworks and fugitive emissions associated with the Tarmac operation both add substantially to the modelled number of exceedances of the daily mean limit value.

The model indicates that the daily mean limit value of 50 µg m^3 will be exceeded more than 35 times in a year over an area greater than 150,000 m^2 outside of the boundaries of the Tata and Tarmac sites. The area can be compared with the macroscale siting criterion given in the CAFÉ Directive that the sampling site should be representative of an area of at least 250 m × 250 m (62,500 m2) at industrial sites, where feasible.

The modeling also indicates that the annual mean limit value is exceeded at the Low Santon site. The area of exceedance is much smaller than that for the daily mean.

6.1 AEA Executive Summary

- The model confirms 2007 and 2008 exceedance levels.
- The area of exceedance beyond the Tata steelworks boundary is greater than the Café directive criteria for macroscale siting and is likely to include Low Santon in the AURN network.

9.2 Model Inputs

AEA inputted a number of localised sources in to the model. The following processes on site were included.

- Tata Steelworks
  Tata submitted information on all point sources. All point sources on site are coded and can be viewed in Table 4 of the modelling report in the Appendix of this document

- Fugitive emission sources
  All fugitive sources were included; unloading raw materials from trucks; Loading of products into trucks; Wind erosion from the feed stockpile; Wind erosion from cleared parts of the stockpile area; Wind erosion from the working area of the stockpile; Trucks on unpaved roads.

- Emissions from aggregate handling
  Including; Harsco; Windrows; Tarmac south; Tarmac north; Asphalt east; Asphalt west; Coal beds; Iron ore.

- Wind erosion from stockpiles
  Calculated using the material particle size; the number of disturbances per year; the period between disturbances; wind conditions and stockpile area.

The location of the modelled sites are shown in ***Section 9.3 Model Output.*** Model accuracy is dependant on the inputs. North Lincolnshire Council believe that while the majority of the areas of concern are modelled a few areas have been missed and will be reviewed with ***Section 9.4 North Lincolnshire Council Observations.***

6.2 Model Inputs

- Tata Steelworks
- Fugitive emission sources
- Emissions from aggregate handling
- Wind erosion from stockpiles

9.3 Model Output

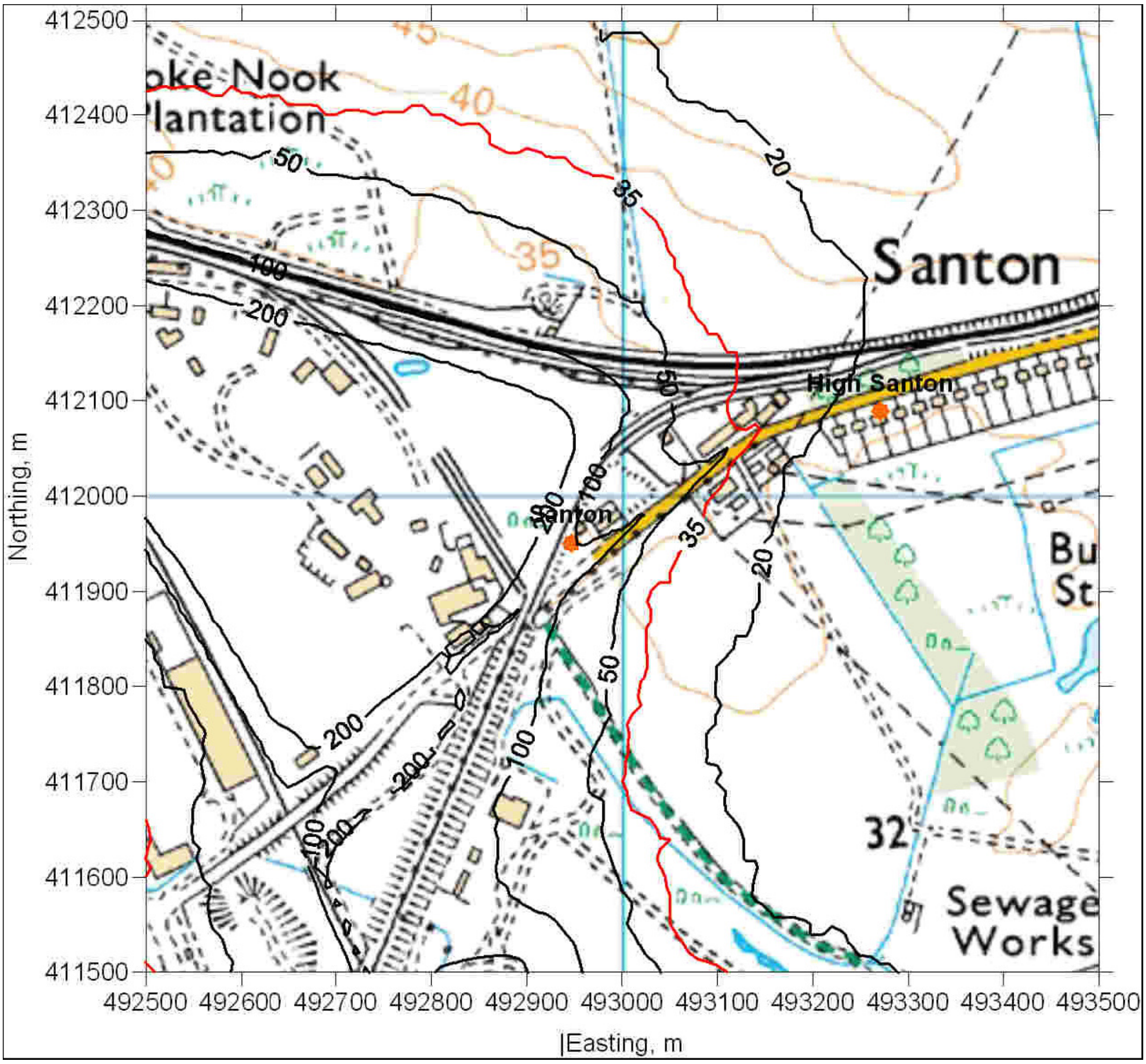


Figure 56: Model Output 1

Figure 56 shows the modelled number of daily exceedances greater than 50µg/m^3 at a 10m resolution. Low Santon is shown to fall within the 100 day contour and would therefore exceed on more than 100 occasions. The modelled data uses MET data from 2008. In 2008 112 daily exceedances were actually recorded.

The High Santon Partisol falls outside of the 20 day contour demonstrating the sharp decline being witnessed between the two sites. Data from the High Santon Partisol in 2008 reported 34 daily exceedances. The model predicts a much sharper decline than has actually occurred. Much of the monitoring data suggests a very localised source and the model agrees however it over predicts this decline placing greater emphasis on localised sources such as Tarmac.

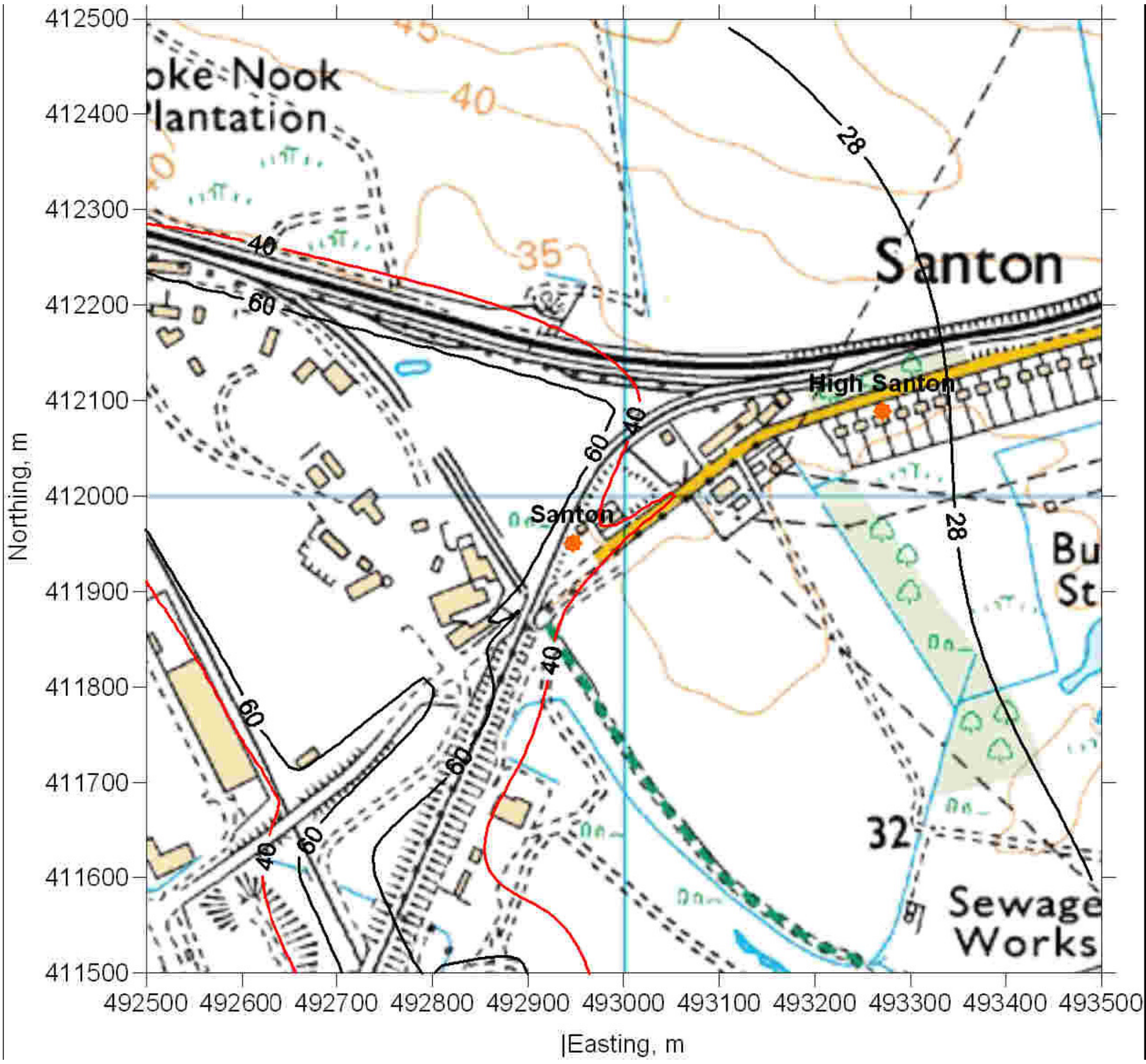


Figure 57: Model Output 2

Figure 57 shows the modelled annual mean concentration at a 10m resolution using met conditions in 2008. Again Low Santon falls within 40µg/m^3 contour. The actual annual mean was 38 µg/m^{3}after a VCM correction was applied. An FDMS system has been in place for six months and suggests that the correction ratio for FDMS to VCM TEOM is near 1:1 at Low Santon.

The High Santon Partisol correlates well with the model, reporting an annual mean of 28µg/m^3 in 2008.

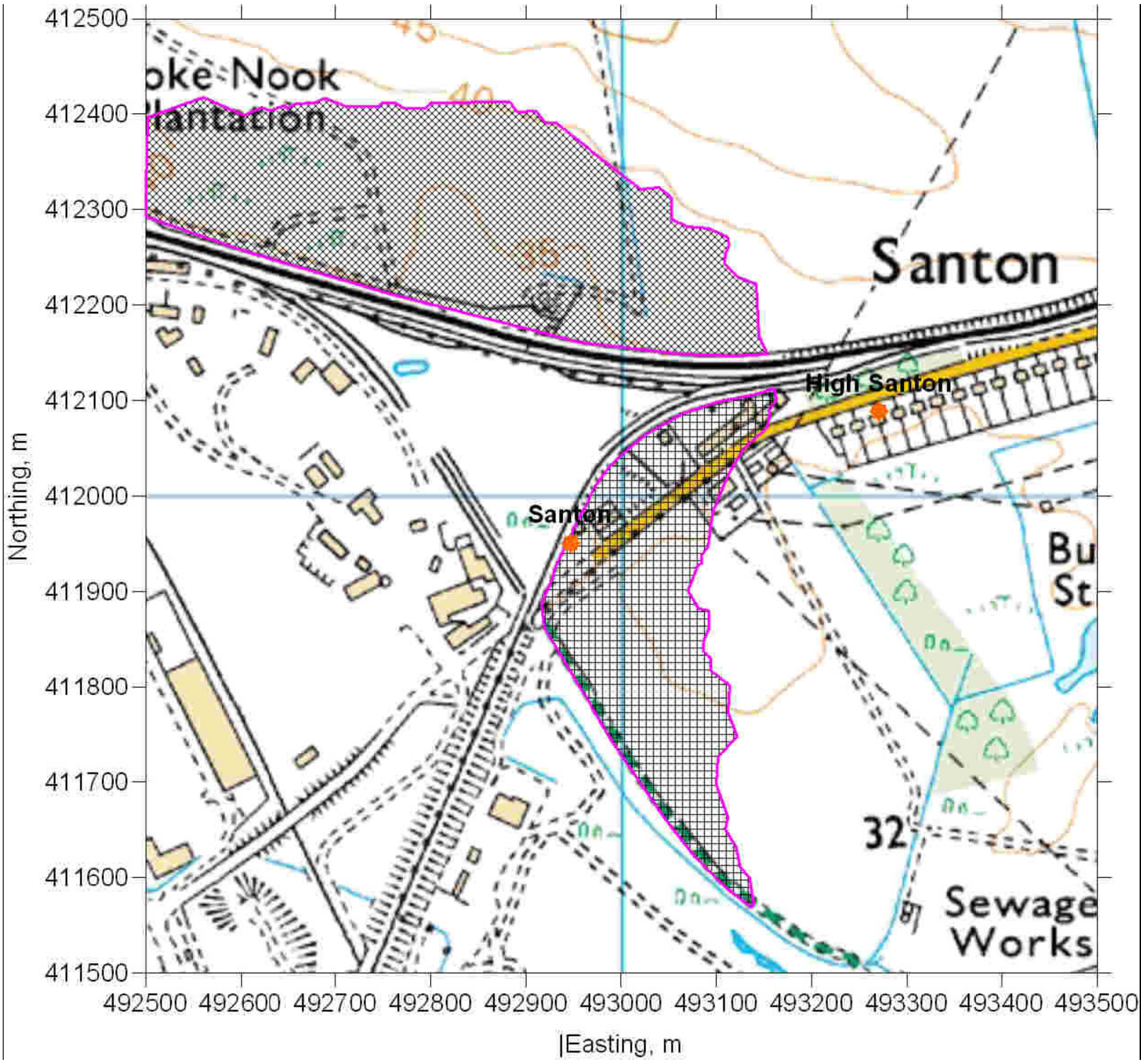


Figure 58: Model Output 3

Measurements of PM_{10} concentrations at the Low Santon monitoring site have exceeded both the annual mean and daily mean objectives. The modelling indicates that the daily mean limit value of 50 µg/m^3 is exceeded more than 35 times in a year over much of the Tata site including near the coal beds and the iron ore beds and also near the Tarmac and Harsco operations. The model shows the Low Santon monitor as an area of exceedance outside the boundaries of the integrated steelworks. The area to the north of the Tarmac site is 104,750 m^2. The area to the south of the Tarmac north site is 54,450 m^2. The area to the north is agricultural and there is no public access by road or footpath. The area to the south includes residential properties, common land, Dawes Lane, agricultural areas, a public footpath, a haulage yard and part of an industrial estate.

6.3 Model Output

- Area of exceedance beyond Tata boundary 160,000m^2
- Model over estimates the number of exceedances.

9.4 North Lincolnshire Council Observations

North Lincolnshire Council has reviewed the AEA modelling report. The model identifies key areas likely to be major sources of particulate and the cause of the objective breaches.

- Tata steelworks;
- Tarmac north aggregate handling;
- Tarmac north wind erosion;
- Haul road;
- Track out onto Dawes Lane

North Lincolnshire Council through investigations covered in ***Section 6 Daily Episode Reviews*** have identified an additional area on site which has not been included in the model inputs.

The Redbourn Steel Stocking Area is a large area of land which lies within a central area of the integrated steelworks. It is an unmade area of ground which is constantly driven on by various vehicles. It is the location of much of the final product steel leading to the loading of road and rail transport.

The daily episode review has identified the Redbourn site on a number of occasions leading North Lincolnshire Council to believe that this should be included in the model inputs as an area source of ground level fugitive emissions as well being including in the wind erosion section.

A further issue identified within the model is the inclusion of two roadstone coating facilities at Low Santon. Tarmac operated two roadstone coating plants until 2008, the Barber Greene Plant and the Parker Plant. Tarmac now operate a single plant.

Should this modelling be revisited it is important that the input from roadstone coating plants be reduced to one otherwise emissions from roadstone coating operations at Tarmac Santon are being effectively double counted.

A further observation is the actual area in which the exceedance has been modelled beyond the boundary of the integrated works. The model indicates that the daily mean limit value of 50 $\mu g/m^3$, or the relevant air quality objective for Local Air Quality Management (LAQM) purposes will be exceeded more than 35 times in a year over an area greater than 150,000 m^2 outside of the boundaries of the Integrated Steelworks. The area meets the macroscale siting criterion given in the CAFÉ Directive in that the sampling site should be representative of an area of at least 250 m × 250 m (62,500 m^2) at industrial sites, where feasible.

The area of exceedence to the north of the Tarmac site is 104,750 m^2, the area to the south of the Tarmac north site is 54,450 m^2. The area to the north is agricultural with some public footpaths, however there would be no relevant exposure over the averaging time of the objective and therefore this area is not considered for LAQM purposes. This reduces the actual area relevant to LAQM to 54,450m^2.

10 Source Apportionment

Source apportionment on an Integrated Steelworks can be difficult given the number of processes on the site as a whole. Many processes lie within the same wind sectors away from the Low Santon monitoring station. Plans have been agreed through the Technical Working Group for Tata UK Ltd to locate further Osiris units within the Integrated Steelworks in-between selected plants believed to be the main contributors to the problem. These units were due for installation by Tata in mid 2010.

In the absence of a measurement both upwind and downwind of individual plants it is difficult to ascertain the contribution from respective plants. Monitors surrounding the site can take a measurement before the travelling air passes through the site and again beyond the boundary, which as a general rule given the prevailing wind direction is the Low Santon station.

A total works contribution can be divided using data from the AEA model:

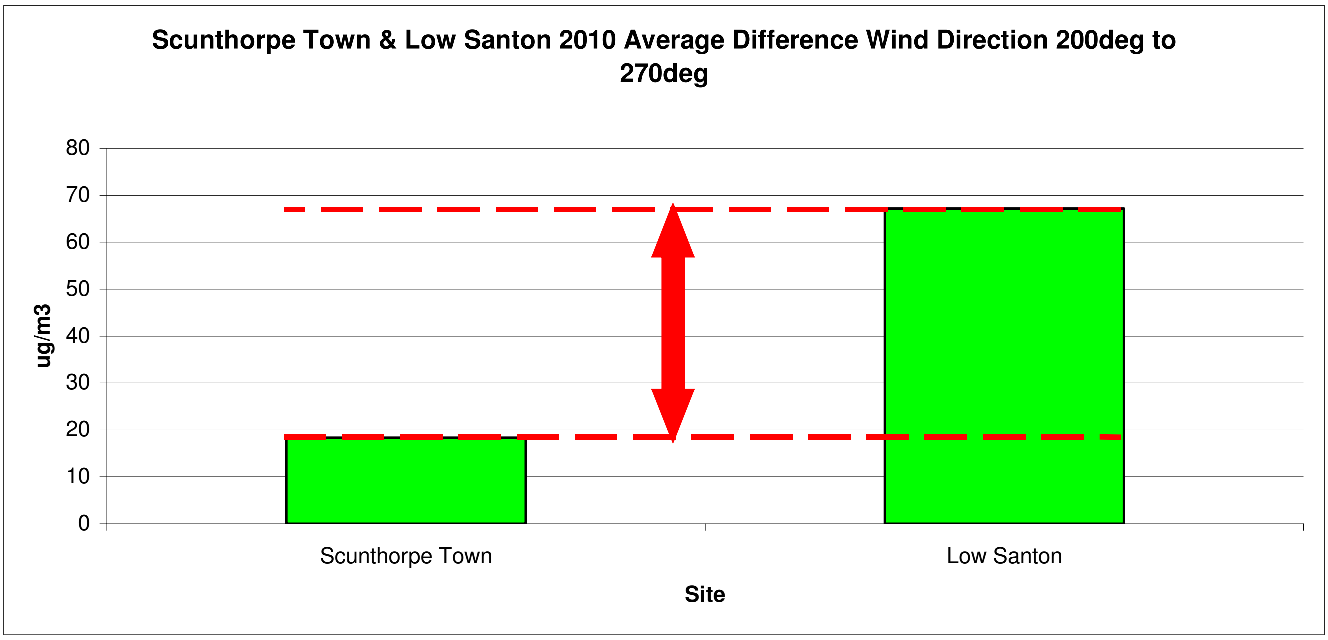


Figure 59: integrated Works Increase from Scunthorpe Town to Low Santon

Using 2008 data from the Scunthorpe Town and Low Santon monitoring sites within the wind sectors 200º and 270º an estimate of the pollution burden on the air passing over the Integrated Steelworks can be determined . A clear increase can be seen between the two sites that indicates a significant increase in PM_{10} levels in air that has passed over the Integrated Steelworks

The increase of 48.8µg/m^3 is much higher than the model suggests at 26.1µg/m^3. The report does offer explanations as to why the modelled concentrations maybe lower than recorded results which can be viewed within the modelling report in the appendix of this report.

The measured data effectively doubles the modelled data. If the same correction is applied to the modelled data contributions the results are as follows:

Process Area	Process Specific	2008 Modelled Data	% Contribution	2008 Corrected Data	% Contribution
Tata		6.97	26.72	12.96	26.72
Aggregate Handling	Multiserv	0.27	1.03	0.50	1.03
	Windrows	0.06	0.23	0.11	0.23
	Tarmac South	0.17	0.65	0.32	0.65
	Tarmac North	4.03	15.45	7.50	15.45
	Asphalt East	1.23	4.71	2.29	4.71
	Asphalt West	1.3	4.98	2.42	4.98
	Coal Bed	0.02	0.08	0.04	0.08
	Iron Ore	0.17	0.65	0.32	0.65
Wind Erosion	Multiserv	0.04	0.15	0.07	0.15
	Windrows	0.05	0.19	0.09	0.19
	Tarmac South	0.03	0.11	0.06	0.11
	Tarmac North	1.81	6.94	3.37	6.94
	Asphalt East	0.07	0.27	0.13	0.27
	Asphalt West	0.13	0.50	0.24	0.50
	Coal Bed	0.01	0.04	0.02	0.04
	Iron Ore Bed	0.09	0.34	0.17	0.34
Unpaved Roads	Multiserv	0.03	0.11	0.06	0.11
	Windrows	0.01	0.04	0.02	0.04
	Tarmac South	0.02	0.08	0.04	0.08
	Tarmac North	1.47	5.63	2.73	5.63
Haul Road S to N	1 (237m)	0.17	0.65	0.32	0.65
	2 (160m)	0.21	0.80	0.39	0.80
	3 (67m)	0.16	0.61	0.30	0.61
	4 (50m)	0.18	0.69	0.33	0.69
	Total	0.72	2.76	1.34	2.76
Track Out E to W	1	0.62	2.38	1.15	2.38
	2	2.4	9.20	4.46	9.20
	3	0.3	1.15	0.56	1.15
	4	0.02	0.08	0.04	0.08
	Total	3.33	12.76	6.19	12.76
	Overall Total	**26**µg/m^3	**100%**	**49**µg/m^3	**100%**

Table 17: Corrected Model Output

If each operator is considered in isolation for their respective plant areas the following summary is produced.

Operator	% Contribution
Tata	27.83
Tarmac	39.79
Harsco	1.30
Haul Road	15.52

Table 18: Corrected Model Overview

The overall contributions from each operator is dependant on a number of factors. Tarmac is the closest operator to the Low Santon Monitoring Station and therefore is likely to have the highest impact. It is unfortunate in its positioning because it surrounds the site and the prevailing wind direction.

Tata is perhaps the most surprising of the contribution results because of its distance from the monitoring station. The contribution will increase if further area sources are included in the model inputs such as the Redbourn Site identified by the daily exceedance reviews.

Harsco's main contribution would come from movement of slag from the BOS plant on the Slag Haul Road.

Tarmac would appear to be the largest contributor to the issues at Low Santon. It is important that the modelling is revisited in order to ensure that this evidence is robust and that appropriate interventions are instigated by a number of operators. All relevant sites should be remodelled in order to achieve the most accurate results which will enable decisions to be made on the best way forward.

10 Source Apportionment

- Using 2008 data a gain of 48.8µg/m^3 was picked up across the site
- Double counting of Tarmac contribution as only one roadstone plant.
- Redbourn site not modelled even though identified in daily reviews
- Using AEA data Tarmac is making the greatest contribution

11 AQ Alert System

North Lincolnshire Council is proposing to offer a PM_{10} alert service to relevant companies operating around Low Santon including:

- Tata Steel
- Tarmac
- Harsco

Consideration is also being given to informing companies who operate on site to reduce dust levels e.g. sweeping and bowsering.

The idea of these alerts is to offer companies an opportunity to react to elevated levels of PM_{10} by notifying them at the first opportunity that a day shows the signature of an exceedance. It is anticipated that these alerts will arrive before 12:00 noon allowing sufficient time for the operators to make the necessary operational changes to reduce elevated PM_{10} concentrations at Low Santon. The previous hours wind speed and direction will accompany the alert to allow individual plant areas to identify the likely origin of the problem.

An hourly time series plot of exceedance day data revealed that there is a significant step in concentrations after 07:00. This significant change highlights the beginning of an exceedance day signature whereby a level of 80µg/m^3 at 08:00 is likely to lead to an exceedence.

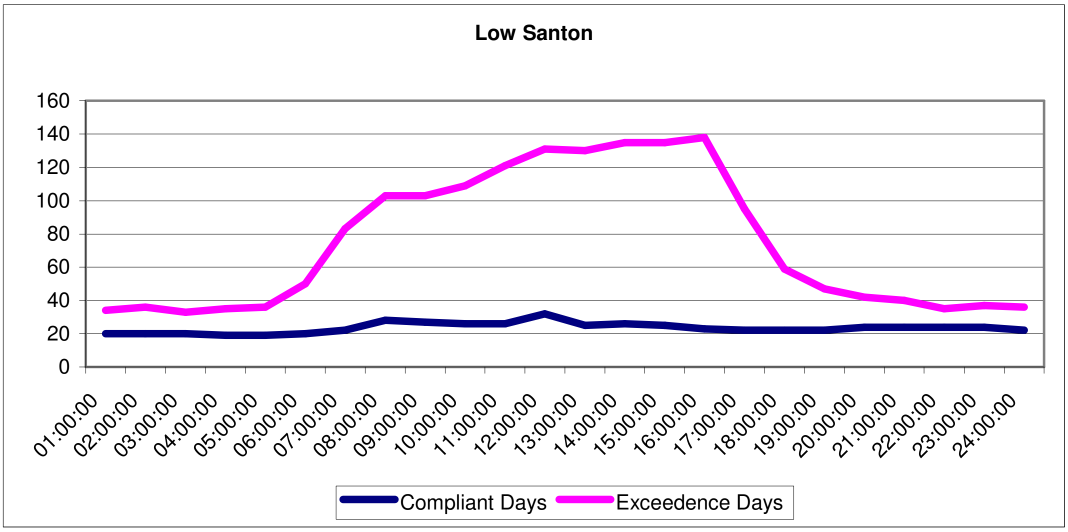


Figure 60: Exceedance Time Series

Using Figure 60 as an indicator further work was carried out in order to choose an appropriate threshold which would not overload recipients with messages, lessening the impact, whilst providing a threshold designed to capture the majority of exceedance days.

A check exercise was carried out looking at levels of 70µg/m^3, 80µg/m^3, 90µg/m^3 and 100µg/m^3 in 2009. Days were noted in which these levels were recorded at any point during the 24hr period and at any point before midday. These days were then cross referenced against days when an exceedance occurred, presenting a percentage exceedance chance for the day. The results were as follows;

Threshold	Days with Data within 24hr Period	% Exceedance Chance	Days with Data before 12:00	% Exceedance Chance	% Exceedance Missed
>70µg/m^3			167	56%	5%
>80µg/m^3	196	52%	144	65%	7%
>90µg/m^3	174	58%	131	66%	15%
>100µg/m^3	158	61%	120	70%	17%

Table 19: Alert System Justification

This exercise was to ensure that messages were kept to a minimum without missing exceedance days. 70µg/m^3 appears too low as 167 messages would have been sent in 2009 compared to an actual exceedence rate of 101 days. Although only 5% of exceedence days would have been missed, only 56% of the days would have gone on to be an exceedance.

80µg/m^3 shows a significant step in the exceedance chance. Of the 144 days with a concentration of 80µg/m^3 before midday 65% went on to be an exceedance day. A 9% increase on a 70µg/m^3 threshold but only a 2% increase in the chance of missing an exceedance day.

$90µg/m^3$ and $100µg/m^3$ show a reduction in the number of days with data above the threshold before midday but with marginal increases in the chances of these days going on to be exceedances. The major change at these higher concentrations is the likelihood of missing exceedance days with a near 10% increase on the lower levels.

North Lincolnshire Council propose to set the threshold at **$80µg/m^3$**. This can be changed should it prove another figure be more valuable.

11 AQ Alert System

- Set to trigger at $80µg/m^3$ before midday and produce an alert only once a day.
- System should identify 65% of exceedance days and only miss 7%.
- Due to be in operation from February 2011.

12 Tea Break Report

Using the Openair Software a number of Diurnal Plots were created using data captured at the Low Santon monitoring station. The monitoring period under consideration was 1st January 2006 to 31st December 2009. The hourly profile was plotted for each day, PM_{10} and wind speed follow an almost identical pattern increasing from 6am through to 3pm where a sharp decrease is observed. It is important to determine whether wind speed is a major factor in the increased PM_{10} concentrations. GMT and BST data were plotted together to see if the concentration data shifted by one hour, if this was the case wind speed can be eliminated as a major influence on concentration.

After plotting GMT and BST an almost exact one hour shift can be seen. The effect of the clocks going forward is that non-continuous plants operating only in the day-time effectively begin one hour later in the summer months. Atmospheric processes would remain unaffected by the clock change and follow the same patterns throughout the year regardless of the shift to BST.

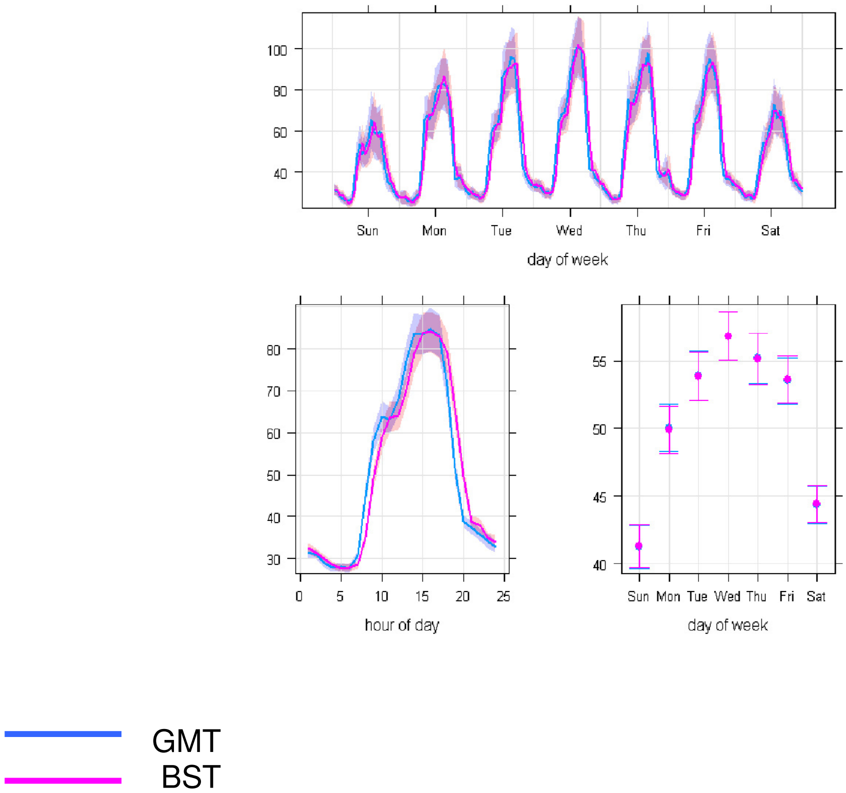


Figure 61: GMT Vs BST

The one hour shift highlighted a drop in concentration between 10:00am and 11:00am (GMT). The presence of this reduction in both time scales suggests that this may be process related.

North Lincolnshire Council undertook an exercise using the Diurnal Plot tool to plot captured data from the Low Santon monitoring station in 10 degree sectors. These plots are available on request a sample of which can be seen within the appendix. The plots were studied for similar reductions in mid morning concentrations. Two sectors were singled out as showing similar patterns;

The areas between 170° & 190° and 210° & 240° away from Santon were both subject to noticeable reductions between 10:00am & 11:00am (GMT).

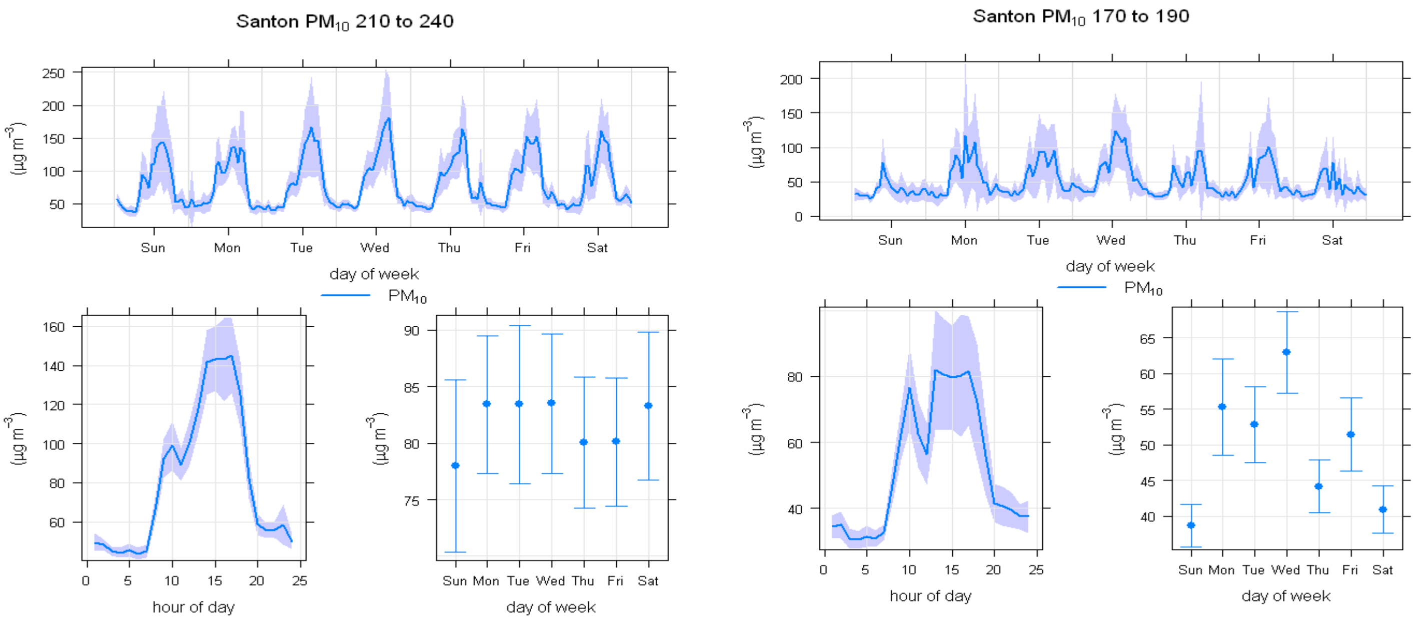


Figure 62 & 63: Filtered Santon PM_{10}

The area between 170° & 190° incorporates a number of activities likely to be contributing to the higher concentrations at Low Santon. These include;

- Tarmac operations at the Yarborough Site
- Harsco Metal Recovery Plant
- BOS Plant

The area between 210° & 240° also covers a number of activities likely to be contributing to the problem;

- Tarmac and Harsco operations at the Intermediate Site
- Redbourn Site
- OPP
- Blast Furnaces
- Sinter Plant

Due to the nature of the Diurnal Plot tool, it is difficult to quantify the actual concentrations involved. Below is an excel plot of the mean hourly PM_{10} concentrations at Santon for reference.

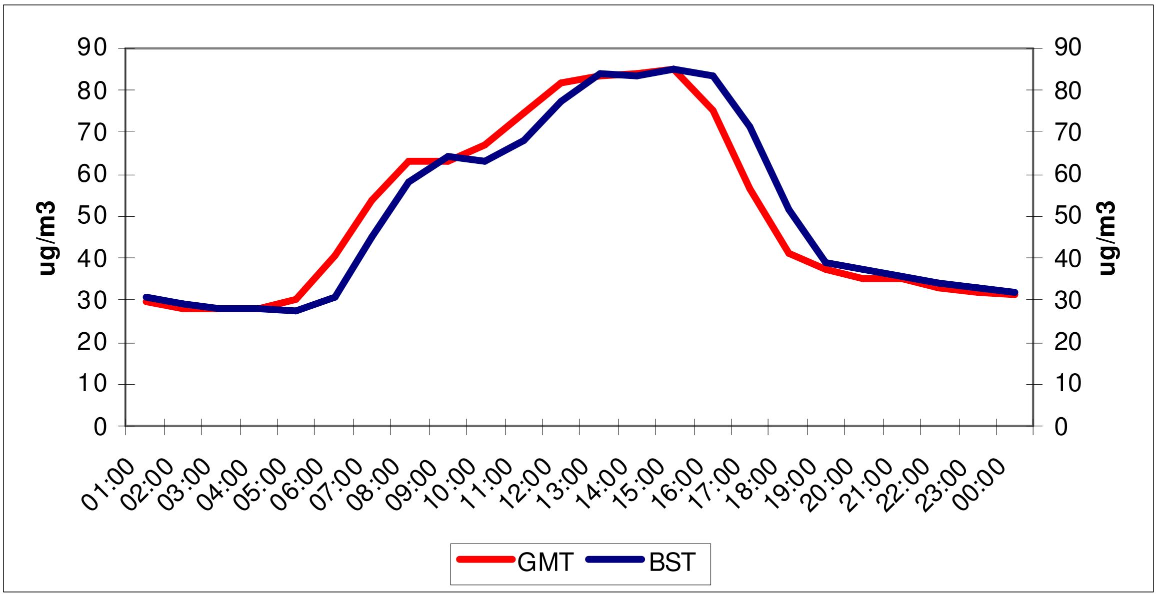


Figure 64: GMT Vs BST Average

The levelling in concentration mid-morning appears to be earlier than the Diurnal plots suggest. The excel graph using the same data shows a levelling at between 9:00am and 10:00am although the hour shift between GMT & BST remains the same.

The effect of this mid-morning event is a marked slow down in the standard day time increase at Santon. 9.00am & 10:00am record concentrations of 65µg/m^3 before the levels return to the same rate of increase as early morning and the start of work.

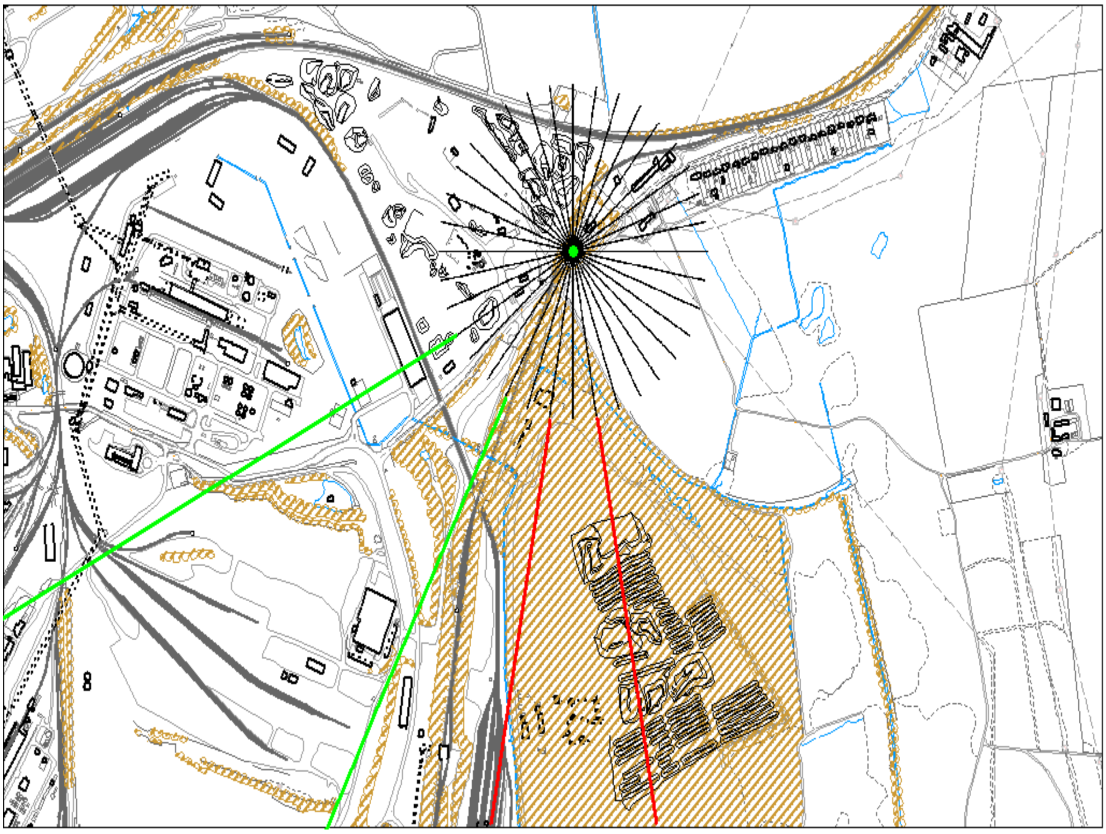


Figure 65: Sectors of Interest During Tea Breaks

North Lincolnshire Council requested that the operators involved investigate these events. Our understanding now is that there is a tea break at 10:00am mirrored in most non-continuous operations on site. During this time the movement of raw materials around site stops accounting for the drop in concentrations

This report informed the Low Santon Technical Working Group who have investigated these findings and suggested further work to help progress this. Details of the Technical Working Group can be found within section 12 of this report

12. Tea Break Report

- Drop in concentration during both BST & GMT periods therefore process related
- Raw material transport stops at 10:00am
- Awaiting activity data from Tata and Harsco

13 Technical Working Group

13.1 Low Santon Technical Working Group

North Lincolnshire Council has been participating in a joint working group with the Environment Agency, Defra, local industry and interested consultancies. The purpose of this group was to coordinate and share monitoring data and better understand the processes responsible for the breaches of both PM_{10} Objectives at Low Santon. This will assist local industry in knowing where to focus resources and capital expenditure to best tackle the issues.

Many initiatives have come out of this group, moving forward understanding of the issues at Low Santon. North Lincolnshire Council has offered a number of reports to this group including;

- Low Santon alert threshold investigation (Section 10)
- Low Santon tea break report (Section 11)
- Daily reviews (Section 6)
- Low Santon AQ alerts (Section 7)

It is the Technical Working Groups (TWG) priority to operate and inform interested parties at a strategic level. A further sub group was set up to inform the TWG of current data understanding designed to further the knowledge base and allow TWG participants the knowledge to advise strategically.

13.1 Low Santon Technical Working Group

- Ongoing meeting to identify trends in data pool

13.2 Technical Sub Group

A further sub group was set up to work through technical issues and inform the original TWG. Members of the sub group include;

- North Lincolnshire Council Environmental Protection
- The Environment Agency Air Quality
- The Environment Agency Monitoring & Assessment
- The Environment Agency Site Regulation
- Tata Environmental Services
- Tata Research & Development

This group meets quarterly and sets actions for each party to investigate. The group has an online forum designed to update each member with ongoing works;

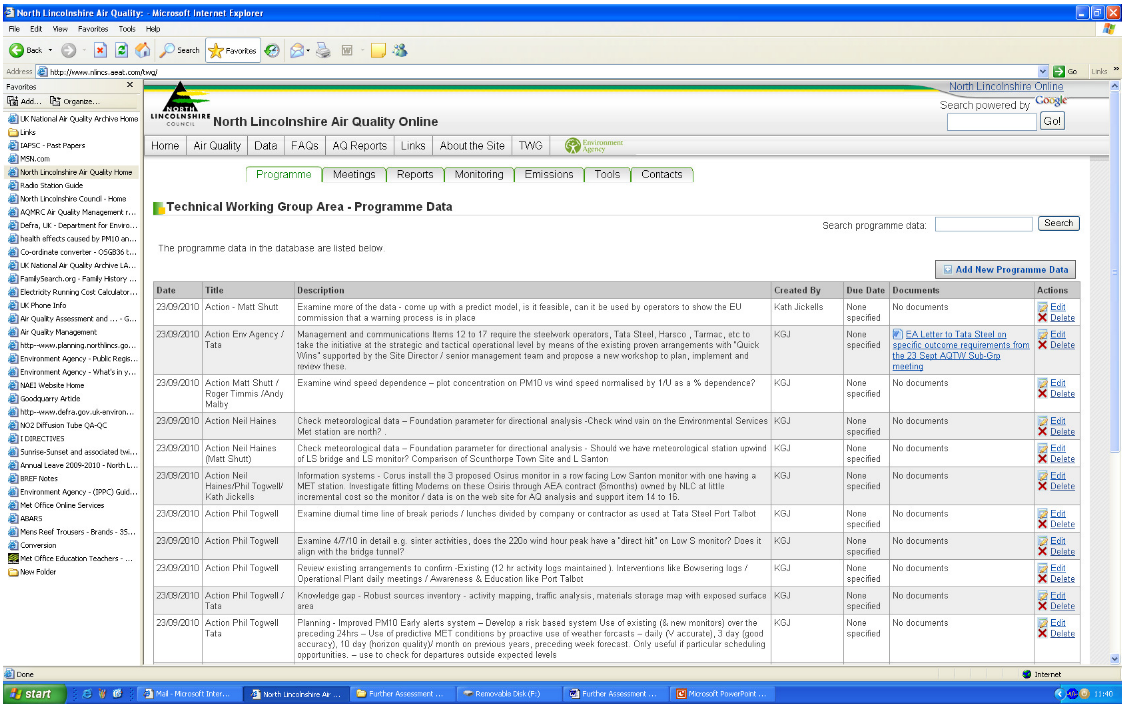


Figure 66: Technical Working Group Web Portal

The group are currently investigating a number of actions agreed at previous meetings. Following the completion of an action, data can be uploaded to the site for review at the next sub group meeting. Actions currently being investigated include;

Specific Analysis Tasks

- Examine more of the data - come up with a predict model, is it feasible, can it be used by operators to show the EU commission that a warning process is in place

- Examine diurnal time line of break periods / lunches divided by company or contractor as used at Tata Steel Port Talbot

- Examine weekly time line of down time - e.g. Tarmac hebdomadal (weekly!) and do Sundays stand out as a pattern of PM_{10} monitored levels vs. Activities

- Examine the risk of exceedance - 5 year monthly assessment – month by month risk of exceedance

- Examine the risk of exceedance - Variations in risk , Monthly meteorological analysis to identify extra or low risk for the same month / year e.g. weather conditions March 2005, 2006 … 2010

- Examine 4/7/10 in detail e.g. sinter activities, does the 220^o wind hour peak have a "direct hit" on Low S monitor? Does it align with the bridge tunnel?

- Examine wind speed dependence – plot concentration on PM_{10} vs. wind speed normalised by 1/U as a % dependence?

- Examine Osiris (DLCO Store) vs. Teom (L Santon) on 10^o sector (wind tunnels). Sector (10^o) of Osiris – Teom. Normalise signal in the middle

- Examine July 4th (worst event) - 10^o sector (wind tunnels) wind speed dependence from 180 – 280^o to check if L Santon bridge has enhanced dependence. Rate at which PM_{10} ramps up relative to other sectors

- Check meteorological data – Foundation parameter for directional analysis - Should we have meteorological station upwind of LS bridge and LS monitor? Comparison of Scunthorpe Town Site and L Santon

Risk System improvements

- **Review existing arrangements** to confirm -Existing (12 hr activity logs maintained). Interventions like Bowsering logs / Operational Plant daily meetings / Awareness & Education like Port Talbot

- **Knowledge gap - Robust sources inventory** - activity mapping, traffic analysis, materials storage map with exposed surface area

- **Planning - Improved PM_{10} Early alerts system** – Develop a risk based system Use of existing (& new monitors) over the preceding 24hrs – Use of predictive MET conditions by proactive use of weather forecasts – daily (V accurate), 3 day (good accuracy), 10 day (horizon quality)/ month on previous years, preceding week forecast. Only useful if particular scheduling opportunities. – use to check for departures outside expected levels

- **Do- Intervention system** - What tactical options exist: Formalise interventions at a tactical operational level based on knowledge from 13 and 14. Can existing low level interventions (e.g. bowsering, road cleaning, latexing materials) be more focussed to specific site area? Can "batch" like activities be delayed (e.g. vehicle movements, material movement), Can activities be stopped, do it another day?

- **Review – learn lessons** – Tata Steel as lead Operator, to investigate and report on any TEOM PM_{10} daily exceedances (>50µg/m^3) at the Scunthorpe Town monitor and Low Santon, only daily mean >100µg/m^3 as a workable threshold, within 48hrs of event. Beyond such a period, the opportunity is lost. Aim what questions to ask plant managers and where to direct questions to establish causes / source apportionment

- **Information systems** - Tata install the 3 proposed Osiris monitor in a row facing Low Santon monitor with one having a MET station. Investigate fitting Modems on these Osiris through AEA contract (6months) owned by NLC at little incremental cost so the monitor / data is on the web site for AQ analysis and support item 14 to 16.

14 Environment Agency Action Plan

The Environment Agency undertook a review of the Tata Permit in January 2010. The purpose of this review was to determine inconsistencies in regulation of the permits making up the Tata site. As a result of this review an action plan was produced in order to tackle the issues being experienced at Low Santon.

The action plan referred to the PM_{10} review linking relevant sections of the report to specific actions. The action plan covers the following

- Boundary Review
- Caparo Permit
- Tata Permit
- Landfill Permits
- Multiserv Permits
- Integrated Steel Work Comparison
- Improvement Program
- PM_{10} Performance
- Air Quality Evidence
- Future Monitoring
- Quick Wins
- Partnership Working

This action plan will form the basis for the North Lincolnshire Council Action Plan prepared as a result of this Further Assessment. A copy of the Action Plan can be found within the Appendix of this document.

14. Environment Agency Action Plan

- Environment Agency action plan will form the basis of the North Lincs Annual Mean action plan for Low Santon.
- Full EA action plan available in the appendix of this report

15 Exceedance Scale & Expected Compliance Date

An expected compliance date is difficult to estimate given the scale of the exceedances at Low Santon. Using data from the AEA modelling report covered in section 9 of this report we can estimate a reduction in concentration given the removal of certain processes. As previously discussed, this work is being revisited by Tata, the accuracy will be improved in these estimates.

Exceedances at Low Santon occur at differing scales. A large percentage of exceedances come in at just over the objective and could be considered as a near miss. Should improvements on the Integrated Steelworks result in a 10µg/m^3 reduction a large change in the number of exceedance days would be observed.

Exceedance Scale	2006 (ug/m3)	%	2007 (ug/m3)	%	2008 (ug/m3)	%	2009 (ug/m3)	%	2010 (ug/m3)	%
50-59	44	27	38	28	33	29	24	24	30	34
60-69	24	15	26	19	32	28	17	17	15	17
70-79	15	9	20	15	19	17	17	17	18	20
80-89	16	10	14	10	13	11	8	8	8	9
90-99	10	6	8	6	8	7	9	9	8	9
100-150	39	24	28	20	8	7	24	24	9	10
150-200	12	7	3	2	2	2	0	0	1	1
>200	1	1	0	0	0	0	0	0	0	0
Total	161	100	137	100	115	100	99	100	89	100

Table 20: Exceedance Scale Breakdown

Year on year exceedances between 50µg/m^3 and 69µg/m^3 account for 40% of total exceedences, therefore by removing 19µg/m^3, the equivalent contribution from Tarmac, the annual totals would be much closer to the objective

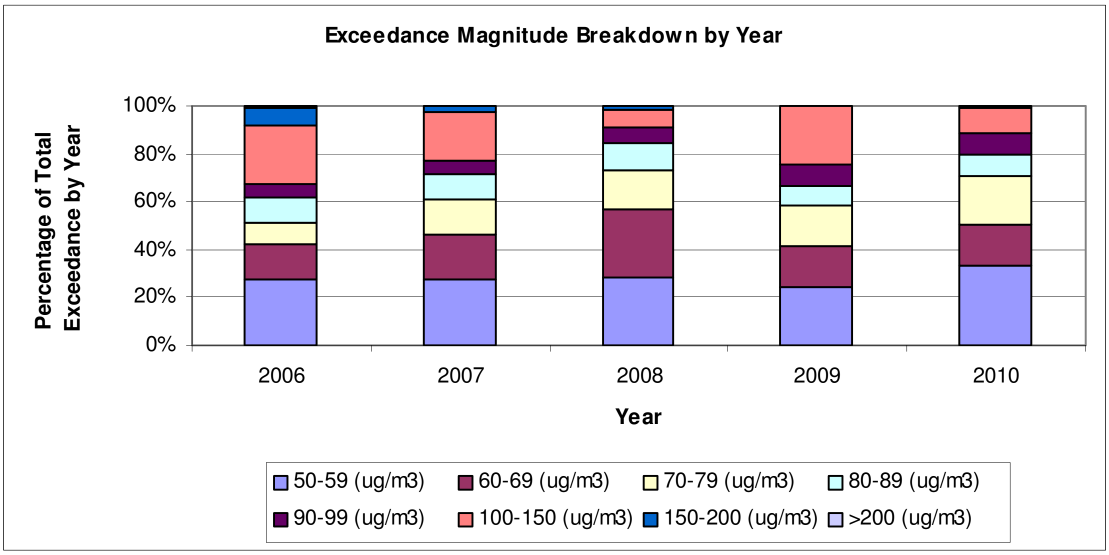


Figure 67: Exceedance Scale Breakdown

Figure 67 shows the number of daily exceedences in selected concentrations bands over the period 2006 to 2010.

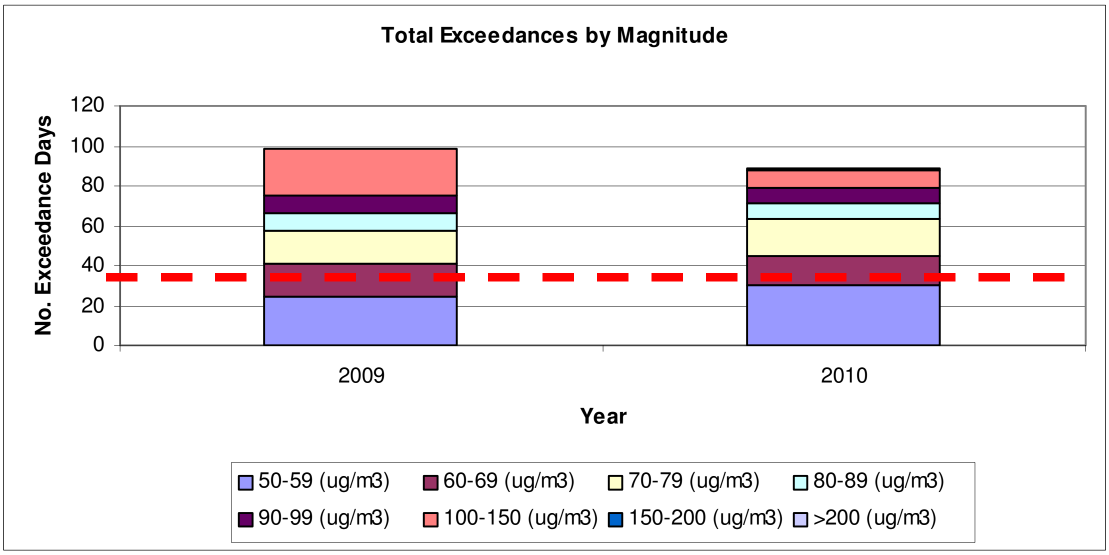


Figure 68: 2009 & 2010 Exceedance Scale Breakdown

Figure 68 shows the number of daily exceedences in selected concentrations bands over the period 2009 to 2010.

In order to see the a significant step change it is useful to remove 'near misses' those within bands 50ug/m3 – 59ug/m3 and 60 ug/m3 to 69 ug/m3. This can be seen in Figure 69.

In 2009 101 exceedances of the daily man objective were recorded. Of the 101 exceedances 41 were within the banding 50µg/m^3 & 69µg/m^3. 2010 recorded 90 exceedances of the daily mean objective of which 45 fell within 50 & 69µg/m^3 banding. By removing the 'near misses' in these two bands equivalent to 19µg/m^3 the yearly totals demonstrate near compliant levels:

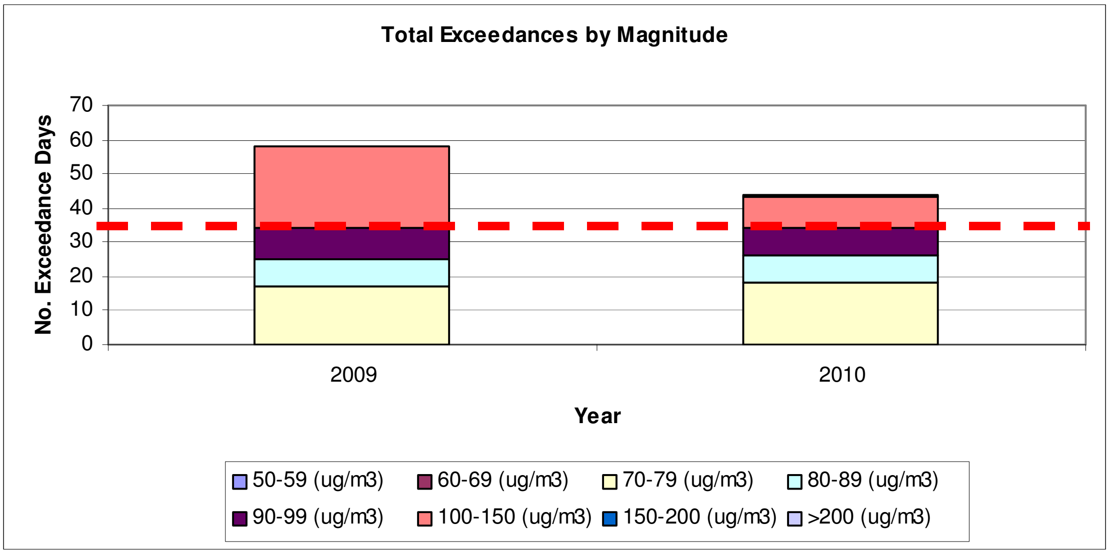


Figure 69: Source Removal 2009 & 2010

The modelling identified a contribution by Tarmac of 19.11µg/m^3 at Low Santon. Figure 69 demonstrates near compliance to the daily mean objective or at least a step change in results. It should be noted however that North Lincolnshire Council would expect the Tarmac contribution to reduce because of the issues reported in section 9.4 and Tatas overall contribution to increase.

North Lincolnshire Council expect to see a reduction in the number of exceedences of the daily mean objective due to the installation of the FDMS. For the purposes of this report North Lincs have used TEOM *1.3 data currently available on www.nlincsair.info.

North Lincolnshire Council is unable to comment on an expected compliance date but is aware of the importance that Low Santon needs to show compliance with the European Directive. Current changes to regulation relating to companies around Low Santon should ensure that a marked step change will be observed over the coming months.

14 Exceedance scale and expected compliance date

- Large percentage of total exceedances 'near misses'
- Expected reduction in concentration next year because of change in measurement method
- Unable to comment on expected compliance date. Ideally by completion of EA action plan.

16 Conclusions

This study has identified a number of key factors designed to focus work in which to reduce the annual and daily mean PM_{10} concentrations at Low Santon. This study was originally undertaken as a result of the Low Santon AQMA declaration. As this is the second AQMA within North Lincolnshire and due to it's location within the original AQMA both objectives have been considered.

Since the December 2008 declaration of the Low Santon AQMA, a change in equivalence and PM_{10} calculation have resulted in compliant Annual Mean results. These changes have been met with caution. The introduction of the VCM resulted in Low Santon demonstrating compliant annual means since 2008. 2010 has seen a compliant result without the application of the VCM. Daily mean breaches are showing a general downward trend but still present large numbers of exceedance days beyond the objective limit of 35.

DEFRA have funded a FDMS TEOM at Low Santon so that North Lincolnshire Council will have equivalent results without the need for any corrections. FDMS data to date has shown a reduction in overall levels at Low Santon with a near 1:1 ratio with TEOM results questioning the continuous application of the *1.3 correction factor.

Low Santon remains a priority and has seen investment in it's monitoring station with the site identified as critical in the service and maintenance contract. This is essential to identifying sources within the area although this study has proved that there are a number of sources operated by a number of companies contributing to the issue.

This study has looked at a number of factors likely to influence the elevated concentrations being recorded at Low Santon including:

- Location of the monitoring stations
- Method of measurement
- Historical MET data
- Particle size fractions
- Relationships with other pollutants
- Triangulation with other monitoring stations
- Directional analysis

This study has also reviewed and highlighted ongoing work designed to inform interested parties of exceedance risk and ongoing area contributions including:

- North Lincolnshire Council Tea Break Report
- North Lincolnshire Council Daily Review Analysis
- North Lincolnshire Council PM_{10} Alert System
- North Linciolnshire Council Low Santon PM_{10} Risk Assessment
- AEA Low Santon Modelling Report
- Environment Agency PM_{10} Action Plan

Due to the scale of the issues at Low Santon it has proved difficult to identify a single source. A number of sources around the Integrated Steelworks contribute to the problem. This study has identified a number of key elements which will prove to inform Operators local to Low Santon including:

- Concentrations increase from compliant concentrations overnight to non compliant concentrations during the daytime focused between 06:00 & 16:00.
- Concentrations consist of predominantly coarse material and not finer material associated with combustion processes.
- Elevated levels are sufficiently localised as not to create an exceedance at a further monitoring station 300m to the East of Low Santon
- Many of the exceedances are near misses and a small reduction in concentrations may well demonstrate a large step change
- PM_{10} hotspots do not correlate with other gaseous sources suggesting releases are primarily PM_{10}
- Correlation between PM_{10} exceedance days and Manganese concentrations courtesy of the Heavy Metals Network
- Higher windspeeds lead to increase concentrations from wind sectors housing large storage areas
- AEA modelling report suggesting Tarmac is the highest contributor to the issues although removing Tarmac does not show compliance. Issues have also been raised over the inputs of this model.