Draft Report on Turnkey Osiris Particle Results at the Market and Havre des Pas Sites in Jersey for 2009

Mr A M Irving
Environmental Health Officer

Contents **Page No**

1.	Executive Summary	v
2.	Air Quality and Health	1
3.	Particles: Sources and Health Effects	2 - 3
4.	Background	4 - 6
5.	Results	7 -14
6.	EU and UK Guidelines	15 -17
7.	Improvements in particle levels in Jersey	18 -19
8.	Conclusions	20
9.	Recommendations	21
10.	Appendix 1: The Turnkey Osiris Particle Monitor	22 - 23
11.	Appendix 2: UK Air Quality Objectives for protection of human health, July 2007	24 - 26
12.	Appendix 3: Relationship between the European transfer reference sampler and other PM10 sampling methods [9]	27
13.	Appendix 4: Sources of Particles	28
14.	Appendix 5: TES Bretby Ltd Test reports and scanning electron micrographs.	29 - 30
15.	Appendix 6: The Importance of Weather and Air Quality	31 - 32
16.	References	33 - 34

Glossary

1. µg m^{-3} Micrograms per cubic metre

2. Expert Panel on Air Quality Standards (EPAQs): The Expert Panel on Air Quality Standards (EPAQS) was set up in 1991 to provide independent advice on air quality issues, in particular the levels of pollution at which no or minimal health effects are likely to occur.

3. Polycyclic aromatic hydrocarbons (PAHs) are chemical compounds that consist of fused aromatic rings. PAHs occur in oil, coal, and tar deposits, and are produced as byproducts of fuel burning (whether fossil fuel or biomass). As a pollutant, they are of concern because some compounds have been identified as carcinogenic, mutagenic, and teratogenic.

4. AEA Technology: AEA is a world leading energy and climate change consultancy delivering outstanding technical advice, policy support and project and programme management services.

5. The Airborne Particles Expert Group (APEG) studied particles and their source apportionment ie primary and secondary particles and the proportion of emissions from Europe and UK.

6. GSM Modem for sending and receiving data, SMS text messages, GPRS data over the GSM wireless network

7. Turnkey's Air Q 32 Software: allows officers from Health Protection to use a computer and dial up modem at Le Bas Centre and download data from the two Osiris units remotely.

8. Scanning Electron Microscopy (SEN)

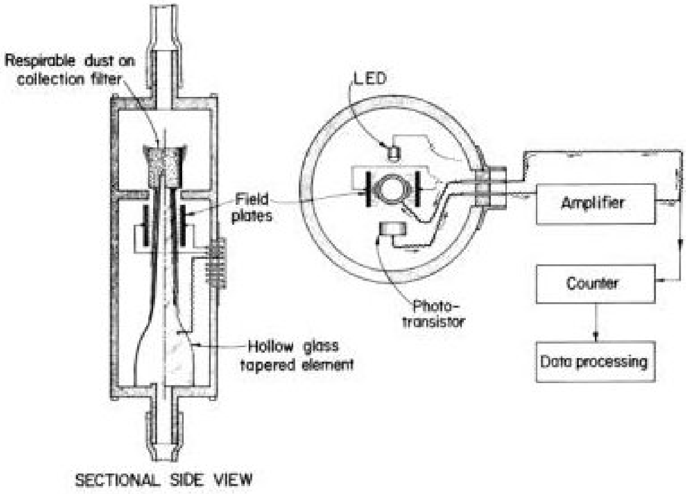
   A very widely used technique to study surface topography. A high energy (typically 10keV) electron beam is scanned across the surface. The incident electrons cause low energy secondary electrons to be generated, and some escape from the surface. The secondary electrons emitted from the sample are detected by attracting them onto a phosphor screen. This screen will glow and the intensity of the light is measured with a photomultiplier.

9. Energy Dispersive X Ray analysis

   This technique is used in conjunction with SEM and is not a surface science technique. An electron beam strikes the surface of a conducting sample. The energy of the beam is typically in the range 10-20keV. This causes X-rays to be emitted from the point the material. The energy of the X-rays emitted depend on the material under examination.

10. Tapered Element Oscillating Microbalance TEOM:

A TEOM detector consists of a substrate (usually a filter cartridge) placed on the end of a hollow tapered tube. The other end of the tube is fixed rigidly to a base. The tube with the filter on the free end is oscillated in a clamped-free mode at its resonant frequency. This frequency depends on the physical characteristics of the tube and the mass on its free end. A particle laden air steam is drawn through the filter where the particles deposit and then through the hollow tube. As particles deposit, the mass of the filter cartridge increases and the frequency of the system decreases. By accurately measuring the frequency change, the accumulated mass is measured.
Combining this accumulated mass with the volume of air drawn through the system during the same time period yields the particle mass concentration.



11. Euro 2/3: European emission standards define the acceptable limits for exhaust emissions of new vehicles sold in EU member states. The emission standards are defined in a series of European Union directives staging the progressive introduction of increasingly stringent standards.

12. Bio-diesel: refers to a vegetable oil- or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, propyl or ethyl) esters. Biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, animal fat (tallow)) with an alcohol. Environmematal benefits include reductions in greenhouse gas emissions, deforestation, pollution and the rate of biodegradation

1. Executive Summary

Poor air quality reduces life expectancy in the UK by an average of seven to eight months, with equivalent health costs estimated to be up to £20 billion a year. Improvements between 1990 and 2001 have helped avoid an estimated 4,200 premature deaths a year, and 3,500 hospital admissions a year. The main source of particles is from road transport (ie combustion of petrol and diesel, brake and tyre wear) which is responsible for up to 70% of air pollutants in UK urban areas[16]

As part of Health Protection's Air Quality function, two Turnkey Osiris Particle Monitors (OSIRIS: Optical Scattering Instantaneous Respirable Dust Indication System) were purchased in 1999 and 2002. They are designed to continuously monitor particle levels, in particular Total Suspended Particles (TSPs), PM_{10} (Particles with an aerodynamic diameter of 10 microns) $PM_{2.5}$ and $PM_{1.0}$. The Osiris units sample particles and provide a 15 minute average level. This report presents the results of the 8th consecutive year of monitoring, calendar year 2009 covered by the monitoring period January 2009 to December 2009.

Particles are associated with a range of health effects. These include effects on the respiratory and cardiovascular systems, asthma and mortality. The Expert Panel on Air Quality Standards (EPAQS) concluded that particle air pollution episodes are responsible for causing excess deaths among those with pre-existing lung and heart disease. EPAQS also believe that any risk of lung cancer from the concentrations found in the streets of the UK is likely to be exceedingly small. However prolonged exposure for example 20 - 30 years to particles, which are likely to be combined with Polycyclic Aromatic Hydrocarbons (PAH) originating from unburnt or partially burnt fuel, is likely to be carcinogenic[2]. The main air quality issues in Jersey relates to the impact of traffic on local air quality.

Jersey's local air quality management has been recently reported on by the UK consultancy AEA Technology. They have produced the draft document States of Jersey Air Quality Report dated July 2009.

PM_{10} concentrations in Jersey were generally higher than the UK comparison sites[5] but broadly similar to those found in London and Bristol. Levels at the Havre Des Pas and the Market sites are broadly what could be expected at a roadside location in the UK.

Concentrations of all pollutants appear to be falling over time. This is likely to be due to improved fuel composition and engine design. However, directive limits are becoming tighter and more health information is readily available.

2. Air Quality and Health

As stated in the current Air Quality Strategy for England, Scotland, Wales and Northern Ireland[1], poor air quality reduces life expectancy in the UK by an average of seven to eight months, with equivalent health costs estimated to be up to £20 billion a year. Improvements between 1990 and 2001 have helped avoid an estimated 4,200 premature deaths a year, and 3,500 hospital admissions a year. The UK Air Quality Strategy aims to reduce the reduced life expectancy impact to five months by 2020. It should be remembered that health effects do not relate solely to the direct impacts of air pollution. By encouraging the use of non-motorised means of transport, such as cycling and walking, as a means of reducing local emissions of pollutants, measures in air quality action plans can help directly improve the health and fitness of local populations. In turn, this may also help individuals to be more resilient to direct ill-effects from air pollution.

The July 2007 Air Quality Strategy acknowledges that there will often be co-benefits for air quality and climate change policies where certain measures are taken. Furthermore in the light of current Government policy, it is particularly important that climate change and air quality policies are joined up. There will be situations where policies to reduce greenhouse gas emissions will have benefits for air quality, and vice-versa. However, there may be situations where potential actions and policies do not necessarily achieve these win-win situations. Technology used to reduce greenhouse gas emissions should always be used in the right circumstances, and not in an area where such technology will impact on the ability of the local authority to pursue the achievement of air quality objectives.[2] All measures should be given careful consideration to ensure that the benefits for local air quality and climate change are maximised, where they can be. Where practicable, synergistic policies beneficial to both air quality and climate change should be pursued.[3]

Air quality and the environment

Poor air quality also impacts on the environment, harming ecosystems and biodiversity. Measures to tackle air quality, such as speed restrictions, may also have a beneficial impact on noise pollution, and vice-versa. [2].

Air Quality in Jersey

The States of Jersey Strategic Plan 2006-2011 contains a commitment to improving air quality with a move towards international air quality standards. This has been followed up by scrutiny of Air Quality function in June 2008. Following this AEA have produced a draft Air Quality Report which brings together the data since 1997 and also considers the impacts of the developments on the Waterfront eg Castle Quays, Esplanade Quarter and the Energy from Waste plant.

1 Air Quality Strategy for England, Scotland, Wales and Northern Ireland-
http://www.defra.gov.uk/environment/quality/air/airquality/strategy/index.htm
www.defra.gov.uk/Environment/climatechange/uk/energy/renewablefuel/pdf/ukbiomassstrategy-0507.pdf
3 Air Quality Expert Group report on air quality and climate change

3. Particles: Sources and Health Effects

Particles in the atmosphere originate from a wide variety of sources. They take the form of dust; smoke or very small liquid or solid particles called aerosols. Particles may be either emitted directly into the atmosphere (ie primary particles) or formed subsequently by chemical reactions (ie secondary particles). PM_{10}, (particles are defined as having an average particle size of 10 microns in diameter (10 millionths of a metre), and have well documented respiratory effects on human health. These include effects on the respiratory and cardiovascular systems, asthma and mortality. PM_{10} particles are composed of primary combustion derived carbon-centred particles e.g. ultrafines, secondary particles from atmospheric chemistry eg ammonium nitrate, natural minerals e.g. soil, wind-blown, biological e.g. spores, bacteria and metals. (See Appendix 4)

Studies have shown that most of the inflammation in the lungs could be explained by the mass of particle instilled, however, mass could not account for all of the variability in the data. It is believed the presence of metals such as iron, zinc, lead and nickel content of PM_{10} had the best association with inflammation out of all of the compositional measurements analysed. Primary particulate content of PM_{10} was also positively associated with inflammation.[4]

The Expert Panel on Air Quality Standards (EPAQS) concluded that particle air pollution episodes are responsible for causing excess deaths among those with pre-existing lung and heart disease. European Agency data showed particle pollution causes up to 24,000 premature deaths in the UK each year. EPAQS also believe that any risk of lung cancer from the concentrations found in the streets of the UK is likely to be exceedingly small. However prolonged exposure, for example 20 - 30 years to particles, which are likely to be combined with Polycyclic Aromatic Hydrocarbons (PAH) originating from unburnt or partially burnt fuel, is likely to be carcinogenic. The European Commission has begun legal action against the UK because it says the government has failed to produce a coherent plan to control pollution levels. The UK is not on track to meet the EU limit values for particulate matter PM10 or Nitrogen Dioxide NO2 which expire at the end of 2010. The UK government has asked for an extension but this has been rejected.

There is a wide range of human activities that produce particle emissions, including; motor vehicles (mainly diesel), solid fuel burning, industrial processes, power stations, incinerators and construction activity. The main sources of anthropogenic (ie man made) particles in Jersey are from transport, the incinerator and domestic fuel burning. The oil fired power station in Jersey only runs for a few months a year and approx 97% of Jersey's energy comes from France via two under sea cable links.

Emissions from mainland Europe may make a significant contribution to secondary particles in Jersey. The UK Airborne Particles Expert Group's findings suggest that in a typical year with typical meteorology, about 15% of the UK's total annual average PM_{10} concentrations (about 50% of secondary particles) are derived from mainland Europe. In years of higher frequency of easterly winds, with large movements of air from mainland Europe, emissions in mainland Europe account for a considerably higher proportion of PM_{10} concentrations, particularly in south and east England. No work has been carried out to try and establish the contribution of secondary particles originating from Europe onto Jersey.[5]

A UK government Air Quality Strategy Objective and a European Community Directive regulates concentrations of PM_{IO} in the UK (see section 6). The States of Jersey has agreed to work towards the limits set out in the European Daughter Directive 99/30/EC which deals with particles, sulphur dioxide, nitrogen dioxide, and lead. The main issues around air quality in Jersey relate to local air quality and the health impacts associated with high levels monitored mainly at road junctions and along canyon streets[1].

4. Adverse Health Effects of Particulate Air Pollution V. Stone, J.H. Lightbody, L. Hibbs, C.L.Tran, M. Heal, and K. Donaldson. Napier University, University of Edinburgh
5. Report: Particles a problem or not in St Helier 2001- A M Irving

4. Background

Two Turnkey Osiris Particle Monitors (OSIRIS: Optical Scattering Instantaneous Respirable Dust Indication System) (see photograph 1 below) were purchased in 1999 and 2002. They are designed to continuously monitor particle levels, in particular Total Suspended Particles (TSPs), PM_{10} (Particles with an aerodynamic diameter of 10 microns) $PM_{2.5}$ and PM $_{1.0}$. The Osiris units sample particles and provide a 15 minute average level. This report presents the results of the 7th consecutive year of monitoring, calendar year 2009 covered by the monitoring period January 2009 to December 2009[6]. The particle monitoring discussed in this report also forms part of a wider Air Quality monitoring strategy which includes Nitrogen Dioxide passive diffusion tubes, a Nitrogen Dioxide real time chemiluminescant analyser sited at Jersey's market and Volatile Organic compound (VOC) passive diffusion tubes.

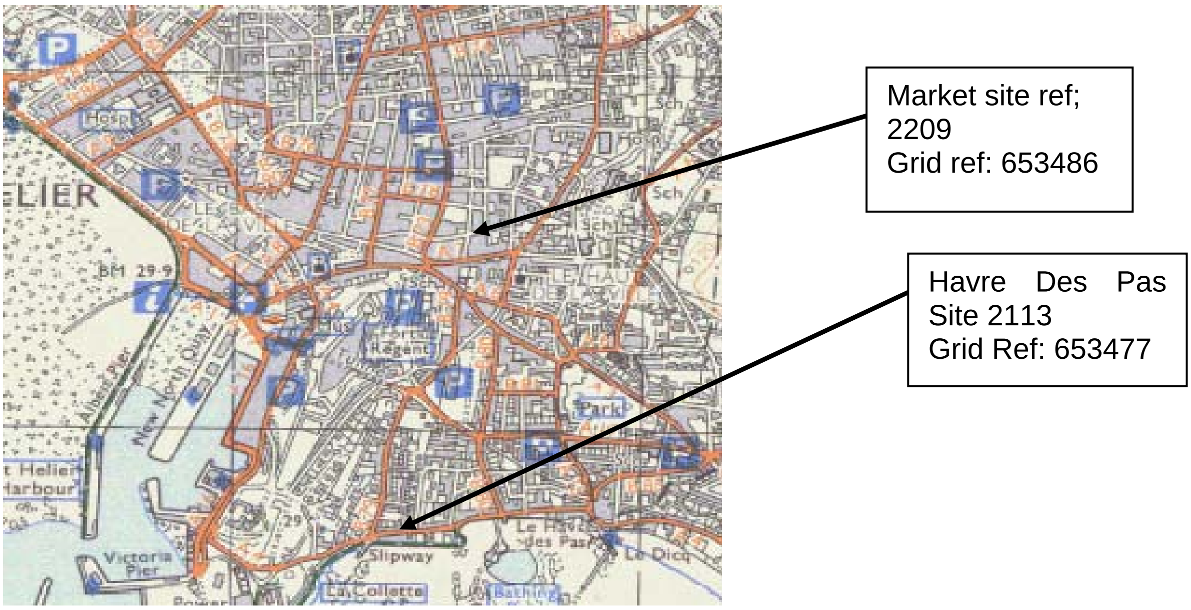
Jersey's local air quality management has been recently reported on by the UK consultancy AEA Technology and the draft document Air Quality Report dated July 2009.[7]

Jersey's Air quality has also been recently considered by a Parliamentary Scrutiny committee (ie Environment Scrutiny Panel Air Quality Review Presented to the States on 10th June 2008 S.R.8 /2008[8]) Ref:
http://www.scrutiny.gov.je/reports.asp?showyear=2008

A response from Health Protection was made in August 2009 ie Environment Scrutiny Panel Air Quality Review: Ministerial Response (MD-HSS-2009-0045) Introduction A decision made (18.08.2009) to approve and present to the States, the Ministerial response to the Environment Scrutiny Panel Air Quality Review[9].

Ref:http://www.gov.je/StatesGreffe/MinisterialDecision/HealthSocialServices/2009/mdhss20090045.htm

Figure 1: The sampling sites in St Helier town centre[10]



6. Reports on the Turnkey Osiris Particle monitors results for Jersey 2002 – 2008
7. AEA Technology and the draft document Air Quality Report dated October 2009.
8. Environment Scrutiny Panel Air Quality Review Presented to the States on 10th June 2008 S.R.8 /2008
9. Environment Scrutiny Panel Air Quality Review: Ministerial Response (MD-HSS-2009-0045)
10. Jersey's Official OS Leisure Map 1:25 000 States of Jersey Planning and Environment Department

Photograph 1: The Turnkey Osiris Unit

The Turnkey Osiris units are not type approved as per the reference method specified in the the Air Quality Standards Regulations 2007 ie EN 12341: 1998 “Air Quality — Field Test Procedure to Demonstrate Reference Equivalence of Sampling Methods for the PM10 fraction of particulate matter”. See Appendix 3 for the relationship between the European transfer reference methods[11].

The measurement principle is based on the collection on a glass fibre filter of the PM10 fraction of ambient particulate matter and the gravimetric mass determination. The Osiris units provide a useful screening tool to determine if further more detailed measurement is required.

Each Osiris unit is served by a GSM modem which allows Officers from Health Protection to dial them up at any time and download the previous 24 hours results using Turnkey’s Air Q 32 Software. The data from the sites is emailed daily to the Jersey Meteorological Department and for use on their website ie www.jerseymet.gov.je. This enables public access to the data albeit 24 hours old.

The Osiris units are also fitted with a filter, which traps particles and allows them to be analysed, sized and counted. The filter analysis allows the weight of particles to be determined and compared with the Osiris' computer calculated weight (ie to assess the accuracy of the Osiris). The analysis of the filter is carried out by a UK company Environmental Services Group TES Bretby. This analysis also allows an indication of the sources of the particles and a percentage source contribution. The results are provided in section 5 and Appendix 5.

The Osiris unit at the central market is sited approximately 4m above the pavement and approximately 3m from Halkett Place. This road is used by up to 10,000 vehicles per day with up to 1000 per hour at rush hour periods. The peak hours are around 8.00 am and between 12.00 pm and 5 .00pm each day (see the photograph 2 below). Previous work has shown that particle levels follow traffic numbers, mix and speed closely. The site is also a busy pedestrian area. The unit is co-located with a NOx chemiluminescant analyser and 3 external diffusion tubes. See AEA’s Diffusion tube report 2009 for more information on Nitrogen Dioxide results[12].

11. The relationship between the European transfer reference methods
12. Air Quality monitoring in Jersey; Diffusion Tube surveys 2008 AEA

Photograph 2: The Position of the Osiris Unit at the Central Market, Halkett Place, St Helier

The second unit was moved to the Havre Des Pas site in September 2006 and sited on the De La Plage apartments. It measures particle levels associated with vehicular traffic driving along the coast road Havre Des Pas. It is designed to provide indicative background levels for screening purposes. This information assists the Transport and Technical Services Department (TTS) by providing data for the Health Impact Assessment associated with the proposed Energy from Waste plant (EFW) proposed for La Collette. Information is required on air pollution levels before during and after the energy from waste plant is constructed and operating.

Photograph 3: Position of the Osiris unit at Havre Des Pas

5. Results

The particle exceedances (ie PM_{10}) and air pollution results are presented below.

The results are as follows:

1. The Market site from 1st January 2009 to 31st December 2009 (36 days the unit was out of commission for repair/servicing: 90% data capture) inclusive showed the EC and UK Air Quality objectives was exceeded 20 times during this period[13].

2. The Havre Des Pas site results for the period 1st January to 31st December 2009 107 days the unit was out of commission for repair/servicing: 70% data capture) showed the EC and UK Air Quality objectives was exceeded 17 times.

The EU objectives (ie Stage 2) only allow 7 exceedances per calendar year and should be complied with by 2010 in the UK. In a recent UK Government consultation on the National Air Quality Strategy[1], it was noted that the European Commission is developing a new Air Quality Directive and that the Commission has recognised that continuing to pursue the indicative 2010 limit values for particles is unlikely to generate a cost effective improvement in air quality. Therefore, it seems unlikely that the 2010 objectives will ever be included in UK legislation.

Figure 3 below shows an example of particle levels over a 24 hour period on Tuesday 1st December 2009 at both sites. At the Havre Des Pas site levels of particles increase up to 10.00 am with rush hour traffic and again in the evening. At the market site at Halkett Place levels increase at approximately 06.30 with early morning deliveries and rush hour traffic. Correspondence has occurred in the past with the market requesting they require vehicles not to leave their engines idling. Levels tend to decrease at lunchtime at the market site as this is a busy town centre shopping area. Levels increased up to 23.30 at Halkett Place. This may have been taxis passing this area.

Particle levels at the market site have reduced generally since the road layout changed in this area. Traffic can now turn right up Halkett Place thereby avoiding the area by the monitor plus the provision of two pedestrian crossings on Beresford Street has meant that traffic congestion is now worse on Beresford Street and has improved traffic movement along Halkett Place. Particle levels follow traffic volume, mix and are influenced by traffic speed (ie congestion and meteorological conditions).

Figure 2: Map showing the direction vehicles travel at the market site on Halkett Place

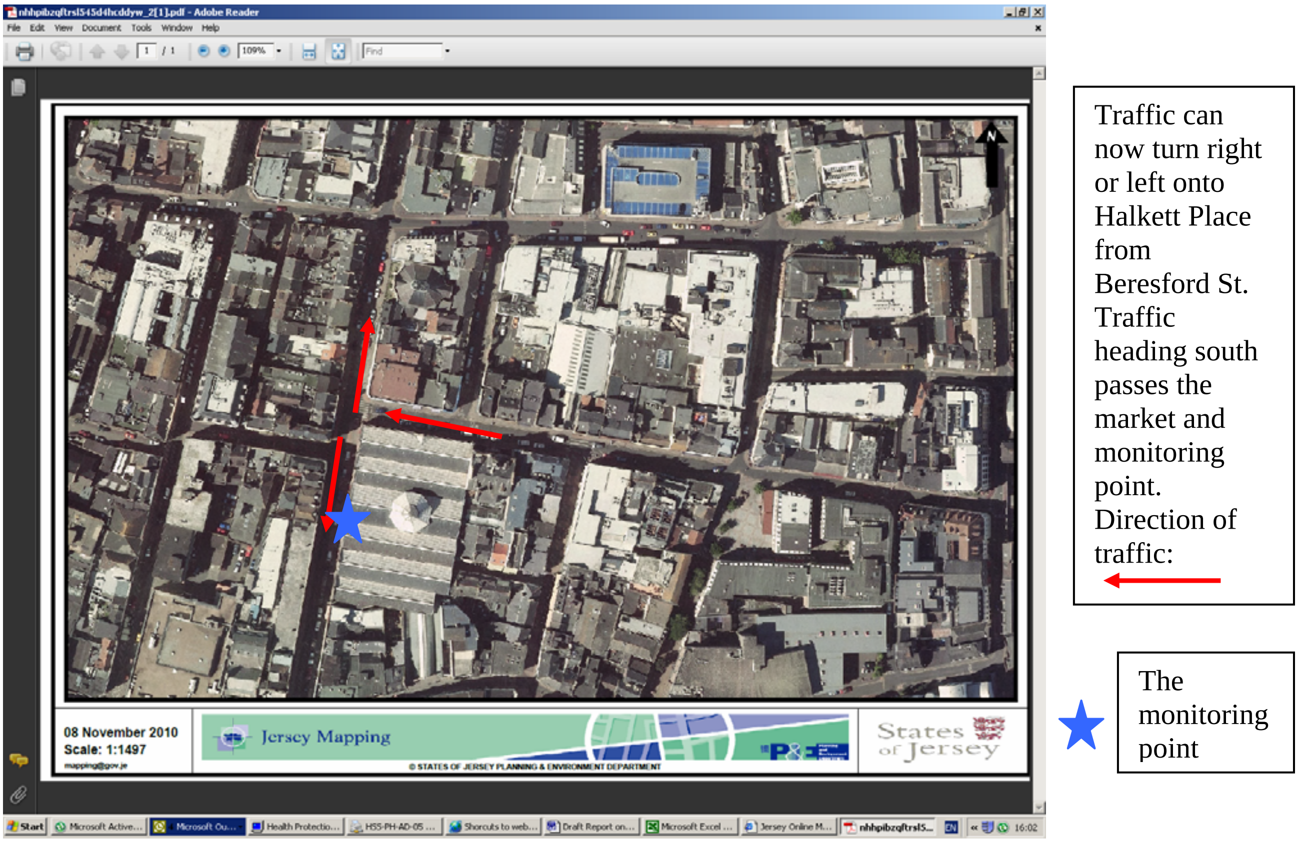
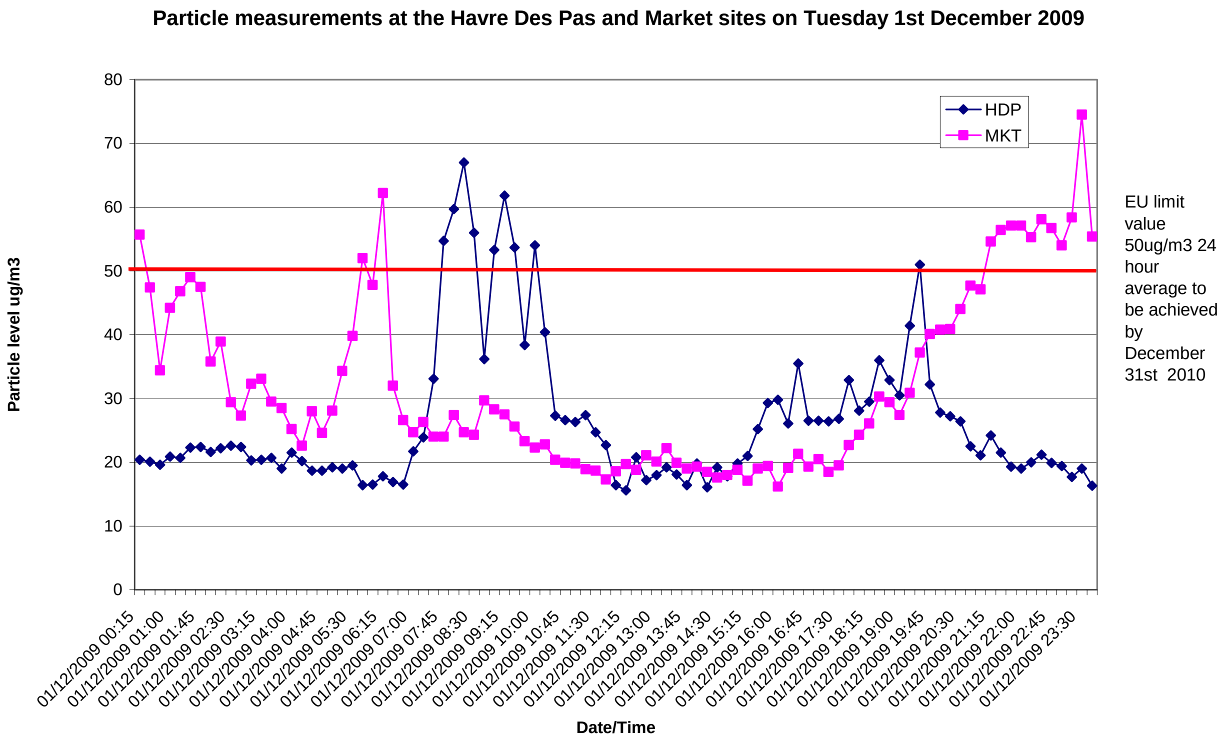


Figure 3: Particle measurements at the Havre Des Pas and Market sites on Tuesday 1st December 2009



The Turnkey Osiris Particle Monitor uses a heated inlet (50ºC) to evaporate water vapour particles which would otherwise result in inaccurately high readings. However it is now accepted that evaporation of volatiles/particles also occurs; resulting in lower than expected results. Research has suggested that such results should be increased by up to 30% to increase their accuracy. However, there are uncertainties as to whether 30% is appropriate in all cases and all geographical areas. Details of the Turnkey Osiris Units are provided in Appendix 1.

The relationship between meteorological conditions and particle levels is not clear. As wind speed increase particle levels reduce. The monitor at the Market site is in a street canyon which reduces the dispersion/dilution of particles. As wind passes over the top of the buildings an eddy effect occurs which causes circular dispersion. See Appendix 6 for the importance of weather on air quality.

At the market site, levels of particles spike early morning and this can explained by the presence of delivery/refuse vehicles close to the measurement site resulting in high levels of air pollution.

The Osiris monitor at the Havre Des Pas site is also in a street canyon but the site is within 20m of the sea and the prevailing wind direction (SW) means the wind will pass along Havre Des Pas aiding dispersion and dilution but may also aid re-suspension. However, due to the presence of a number of hotels along Havre Des Pas traffic congestion often occurs due to parked vehicles etc. Traffic congestion will increase particle levels. The proximity of the sea to this site means that sea salt and sand are likely to be a significant source of particles as well.

The European Union reference method for measurement uses of a gravimetric (filter based) system to measure compliance; the UK has suggested that its preferred Tapered Element Oscillating Microbalance (TEOM) measuring devices are adequate if the results are multiplied by up to 1.3 (30%). Although the Osiris is not as accurate as the TEOM or gravimetric particle measurement methods it provides useful indicative results. See Appendix 3 for the Relationship between the European transfer reference sampler and other PM10 sampling methods [11]

1. Air Pollution Bandings:	As a running 24 Hour mean	Market (days)	Havre Des Pas
Low Air Pollution:	<50 µg/m^3	309	285
Moderate Air Pollution:	50 - 74 µg/m^3	20	14
High Air Pollution:	75 - 99 µg/m^3	0	3
Very High Air Pollution:	>= 100 µg/m^3	0	0

According to the above bandings air pollution levels were low at both sites but there were 20 and 14 days of moderate pollution respectively with 3 days of high air pollution at the Havre Des Pas site. See Appendix 2 for explanation of the terms low moderate high and very high air pollution.

	Market	Havre Des Pas
2. 24 Hour daily mean: 50 µg/m3 not to be exceeded more than 35 times per calendar year by 2004 and 7 times per calendar year by 2010.	20	17
3. Calendar Year Annual Mean: 40 µg/m3 (Stage 2: 20 µg/m3)	27.15 (329 days)	23.55 (285 days)

The tables above show that PM_{10} particle results exceeded the 24 Hour daily mean of 50µg/m3 17 times at Havre Des Pas. This did not exceed the 35 allowable exceedances to be achieved by the end of 2005 but did exceed the 7 exceedances to be achieved by end of December 2010[13]. There were 20 exceedances at the Market site which also did not exceed the 35 allowable exceedances to be achieved by the end of 2005 but exceeded the 7 exceedances allowed per year to be achieved by end of December 2010[14]. Stage 2 limits allow only 7 exceedances of 24 Hour daily mean 50µg/m3 per year however this limit is under review.

Although both the sites comply with the Stage 1 annual mean value of 40µg/m3 both sites fail the Stage 2 annual mean objective of 20µg/m3 **(Note: The annual mean results provide a guide as a full calendar year of results were not obtained**).

13. The Air Quality Standards Regulations 2007 http://www.opsi.gov.uk/si/si2007/uksi_20070064_en_1
14. EU Daughter Directive 99/30/EC.

4. Calendar Year Annual Mean: 40 mg/m^3		No	No
5. The EU Directive also details an: (24 hour limit value)			
Upper Assessment threshold: 60% of the limit value (30µg/m^3) not to be exceeded more than 7 times in any calendar year.		Yes	Yes
Lower Assessment threshold: 40% of the limit value (20 µg/m^3) not to be exceeded more than 7 times in any calendar year.		Yes	Yes

The upper and lower Assessment thresholds are presently being exceeded. Improvement in traffic management flow reduction will be needed to ensure the upper and lower Assessment thresholds (UAT) are not exceeded in 2010.

Filter Analysis:

The glass fibre filters in the Havre Des Pas and Market units were analysed in 21st October 2009.

The results from the Havre Des Pas filter analysed by TES Bretby Ltd are summarised below. The examination procedure (ie Scanning Electron Microscopy and Energy Dispersive X Ray analysis) is based on the assessment of approximately 40 individual particles selected at random. The estimated percentage is based on a comparison of the relative number of particles counted in each category. (See Appendix 5 for the test reports and scanning electron micrographs).

Note: Care must be taken interpreting theses results as only a very small number of particles were analysed. Unfortunately the costs are prohibitive for greater in depth analysis.

The results are as follows:

a. Havre Des Pas Site : Examination revealed that the collected deposit was mainly carbonaceous matter (50%) associated with vehicular emissions. Other materials present included: Sodium/Chlorine rich (10%) which is an indicator of sea salt, Aluminium/Silicon rich (10%) and Iron rich (5%) which is an indicator of general dirt, Calcium rich (2%) and Silicon rich ie sand (15%).

b. Market site: Examination revealed that the collected deposit was mainly carbonaceous matter (65%) associated with vehicular emissions. Other materials present included: Sodium/Chlorine rich 10%) which indicates sea salt, Calcium (5%) and Aluminium/Silicon rich (20%) ie sand.

Interestingly, the percentage of particles from vehicular emissions is higher at the Market site than Havre Des Pas site. This is to be expected as traffic volume is greater at Halkett Place. The levels of Sodium/Chlorine particles are similar at both sites suggesting sea salt travels inland in aerosol form as at the coast. The percentage of sand particles is higher at Havre Des Pas due to its proximity to the beach and they are heavier and fall out quicker.

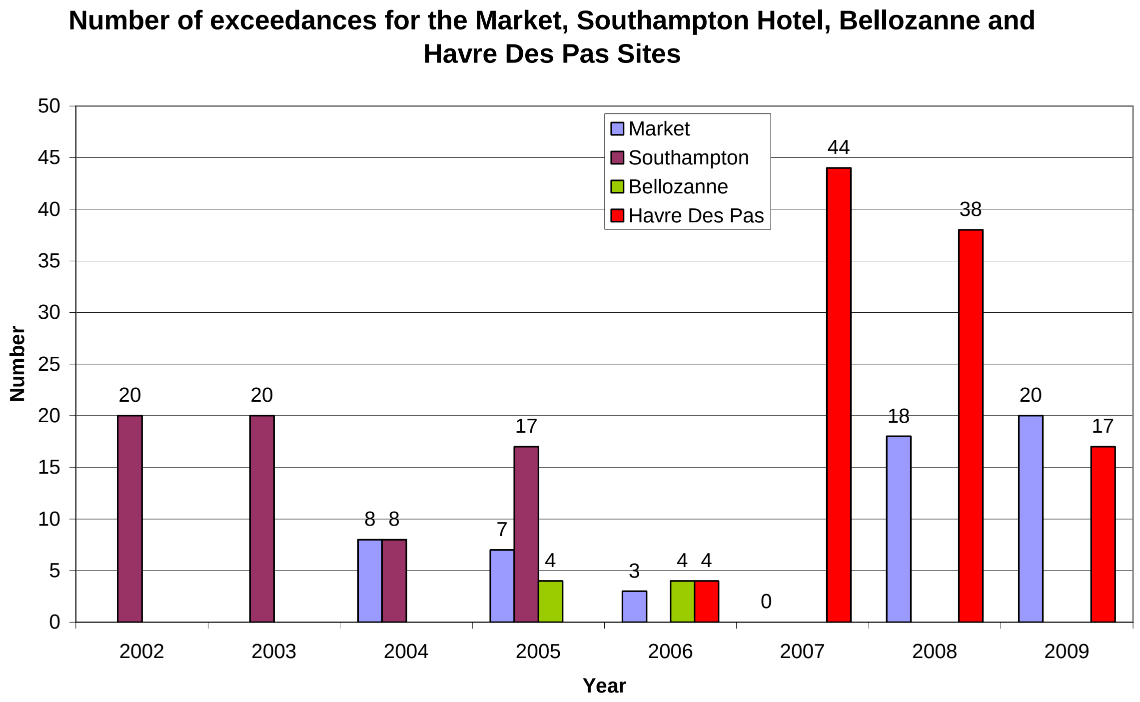
Levels of particles increased at Havre Des Pas in high winds and this is likely to be due to sand and salt particles. It was also felt that the Jersey Electricity Company oil fired power station chimney which is approx 300 m away may be affecting the results. Analysis of a filter in April 2008 by AEA Technology [14] suggested there was little or no interference from the power station however the most significant sources were sea salt and sand. There were two interesting observations made by AEA technology:

1. The presence of Lanthanum particles in trace quantities. It is found in catalytic converters assisting converting NO_2 to Nitrogen and in flints for cigarette lighters. It does occur naturally but in very small quantities in the earth's crust.

2. No Vanadium was detected, suggesting that either the power station was not operational, or not an influence for this exposure period.

15. AEA Technology report Ref Brian Stacey Analysis of Particulate matter (dust) on filter using SEM and EDX April 2008

Figure 4: Comparisons with the 2002 to 2009 data



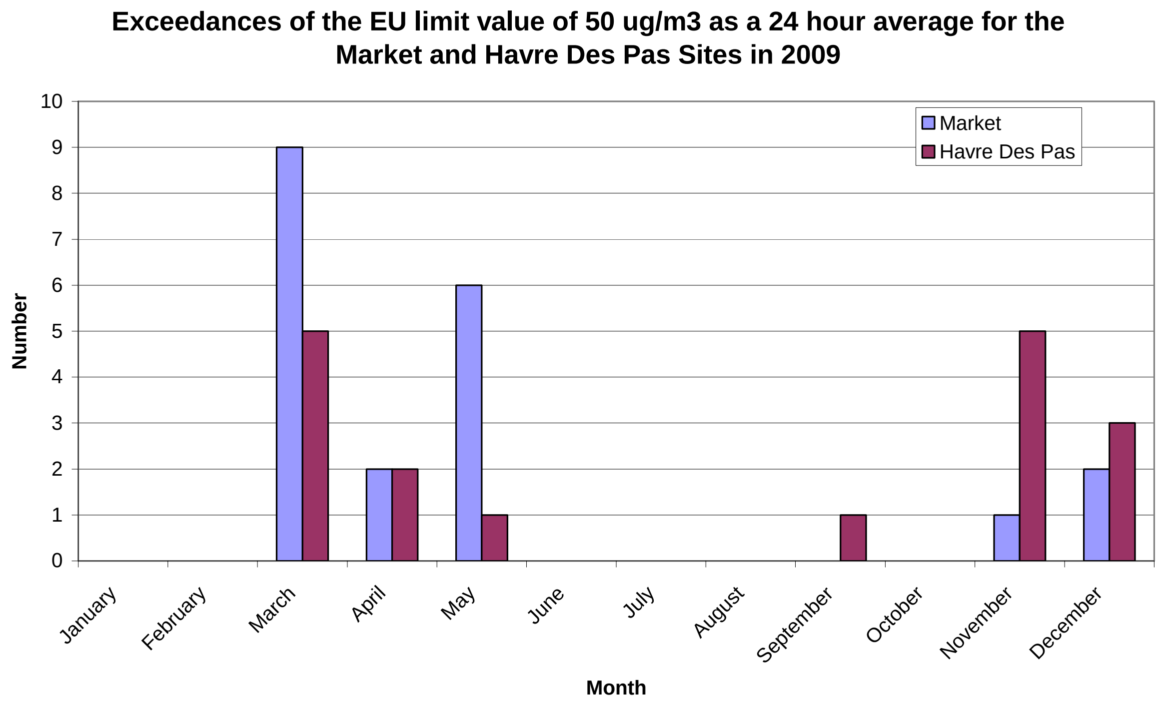
The graph above shows that the number of exceedances for the historic sites from 2002 – 2007 (ie Southampton Hotel Weighbridge, Bellozanne valley). The number of exceedances for the Market and Havre Des Pas sites is for the years 2006 - 2009. These are lower than in previous years. There were a large number of exceedances for the Havre Des Pas site in 2007 and 2008 (44 and 38) which may be due in part to salt and sand particles. The number of exceedances for 2009 for both sites dropped compared to 2007/8 however part of this can be explained as the unit at Havre Des Pas only captured 70% of the annual data. There were issues with the market unit reading low in August and September. Care needs to be taken in direct comparison as the measurement periods varied.

Figure 5 below shows the months when there were exceedances in 2009 at both monitoring sites and they highlight that poor air quality is associated with the winter months. This is characterised by long nights, clear skies, dry air, little or no wind resulting in temperature inversions (ie an increase in temperature with height). This results in trapping moisture and pollutants in the surface air layer. See Appendix 6 for the importance of weather and air quality.

The UK Climate Impacts change programme suggests that the effect of climate change on general weather patterns will lead to a change in the seasonal balance of the UK's air quality. The programme expects the winter season to become wetter and windier, leading to the dispersion and washing out of pollutants, while the summer season is expected to be hotter and sunnier leading to increased ozone smog[16].

16. Air Quality Management issue 170 page 9 National Audit Office Briefing, Rob Bell

Figure 5: A graph to show in which months the exceedances occurred



6. EU and UK Guidelines

In Jersey the States have agreed to work towards the European Union Directive objectives[17]. However in the UK, air quality standards and objectives for the major pollutants are described in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland July 2007 (The National Air Quality Strategy, or NAQS)[1]. Appendix 2 provides details of the UK Air Quality Objectives for protection of human health.

The NAQS includes air quality objectives defined under European Directives, specifically the Air Quality Framework Directive (96/62/EC) and the four so-called Daughter Directives (1999/30/EC, 2000/69/EC, 2002/3/EC and 2004/107/EC), as well as objectives derived from work by the Expert Panel on Air Quality Standards (EPAQS) These are implemented in the UK Air Quality Standards Regulations 2007[13] which came into force on 15 February 2007, replacing the previous Air Quality Limit Values Regulations 2003. The NAQS makes a clear distinction between "standards" and "objectives".

The Air Quality Framework Directive, First; Second; and Third Air Quality Directives; and give effect to the latest Fourth Air Quality Daughter Directive too. The Regulations apply to England with the exception of Regulation 29 (relating to reporting requirements) which applies to the entire UK. and the four so-called Daughter Directives (1999/30/EC, 2000/69/EC, 2002/3/EC and 2004/107/EC), as well as objectives derived from work by the Expert Panel on Air Quality Standards (EPAQS).The NAQS makes a clear distinction between "standards" and "objectives".

- *Standards* are the concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on assessment of the effects of each pollutant on human health including the effects on sensitive subgroups; and

- *Objectives* are policy targets generally expressed as a maximum ambient concentration to be achieved, either without exception or with a permitted number of exceedences, within a specified timescale.

Under the EC Air Quality Framework Directive (96/62/EC), all Member States have to assess their existing air quality and implement a programme of monitoring, dependent upon population, population density, emission sources and proximity of the general public to these sources.

Under the Framework Directive, a Member State MUST undertake continuous monitoring (using appropriate instrumentation) at least ONE site.

The EU Directive also details an: (24 hour limit value)

(a) **Upper Assessment threshold**: 60% of the limit value (30µg/m^3) not to be exceeded more than 7 times in any calendar year.

(b) **Lower Assessment threshold**: 40% of the limit value (20µg/m^3) not to be exceeded more than 7 times in any calendar year.

The upper and lower Assessment thresholds are presently being exceeded. Improvement in traffic management flow reduction will be needed to ensure the Upper Assessment threshold (UAT) is not exceeded in 2010[18].

In the recent UK Government consultation on the air quality strategy, it was noted that the European Commission is developing a new Air Quality Directive and that the Commission has recognised that continuing to pursue the indicative 2010 limit values for particles is unlikely to generate a cost effective improvement in air quality. Therefore, it seems unlikely that the 2010 objectives will ever be enacted in legislation.

The EU and UK guidelines include:

1. Air Pollution Bandings:	As a running 24 Hour mean
Low Air Pollution:	<50 µg/m^3
Moderate Air Pollution:	50 - 74 µg/m^3
High Air Pollution:	75 - 99 µg/m^3
Very High Air Pollution:	>= 100 µg/m^3

2. 24 Hour daily mean: 50 µg/m3 not to be exceeded more than 35 times per calendar year by 31.12.2004 and 7 times per calendar year by 31.12. 2010. (NB Stage 2 Limits are under review)

3. Calendar Year Annual Mean: 40 µg/m3 (Stage 2: 20 µg/m3 to by achieved by 31.12.2010)

The UK's has notified the European Commission to secure additional time to meet the limit values for PM10 for eight UK zones/agglomerations in accordance with Council Directive 2008/50/EC on ambient air quality was submitted on 24 April 2009. The notification was subject to public consultation which closed on 10 March 2009. The European Commission have refused the requested time extension and the UK government may now be prosecuted for not meeting the limits.

The purpose of the notification is to secure, for eight zones/agglomerations in the UK, an exemption from the obligation to apply the limit values for PM10 until 2011, as provided for under the Directive. The notification, comprising a series of completed Forms and an accompanying technical report, covers those zones/agglomerations where exceedences have been reported since the limit value came into force in 2005, and sets out in detail how, on the basis of current and future plans, we will achieve compliance across the UK by 2011[20].

Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe came into force on June 11th 2008.

The New Directive merges four existing Directives and one Council Decision into a single Directive on air quality. It also sets new standards and target dates for reducing concentrations of fine particles, which together with coarser particles known as PM_{10} already subject to legislation, are among the most dangerous pollutants for human health.

Under the Directive Member States are required to reduce exposure to $PM_{2.5}$ in urban areas by an average of 20% by 2020 based on 2010 levels. It obliges them to bring exposure levels below 20 micrograms/m^3 by 2015 in these areas. Throughout their territory Member States will need to respect the $PM_{2.5}$ limit value set at 25 micrograms/m^3. This value must be achieved by 2015 or, where possible, already by 2010.[21] $PM_{2.5}$ will be considered in the 2009 report.

Appendix 2 provides details of the UK Air Quality Objectives for protection of human health.

17. An Air quality Strategy for Jersey, April 2003. NETCEN
18. http://www.defra.gov.uk/environment/quality/air/airquality/eu-int/eu-directives/airqual-directives/notification.htm
19. Air Quality Monitoring , St Helier, February to March 2000. NETCEN
20. EU Directive 96/62/EC on Ambient Air Quality Assessment and Management (The Air Quality Framework Directive)
21. Ref: http://ec.europa.eu/environment/air/quality/legislation/directive.ht

7. Improvements in particle levels in Jersey

Road transport is responsible for up to 70% of air pollutants in UK urban areas[16] PM_{10} concentrations in Jersey were generally higher than the UK comparison sites but broadly similar to those found in London and Bristol. Levels at the Havre Des Pas and Market sites are broadly what could be expected at a roadside location in the UK.

Air quality should improve as the benefits of improved engine design Euro 4/5 are seen. Further road changes as part of the St Helier Life program and general town centre improvements may assist in improving air quality. The States of Jersey Air Quality Report and the TTS Sustainable Traffic and Transport Plan will raise the profile of Air Pollution and suggests measures needed to reduce it.[18]

Particle levels from other sources such as the power station have reduced with the use of the two cable links to France (ie 97% of electricity used in Jersey originates from France).

The Easylink coach service began on the 19th April 2003. There are 10 to 15 buses operating with poor emissions compared to the cleaner Connex buses which have Euro 3 & 4 engines. When these engines are used in conjunction with low-sulphur diesel, emissions are very much lower. An aim should be to fit continuously regenerating particulate traps to Euro 2 and earlier diesel engines. (The cost is up to £3,500 per vehicle but 90% of particles can be removed). Parking is free in St Helier for smaller cars producing less CO_2. In Jersey, there were more than 3 million passenger journeys on the myBus network in 2009, and the number of passenger journeys is rising steadily year on year. Ref: http://mybus.je/connex

Other options available are to move towards gaseous fuels such as the vehicles operated by Jersey Gas. The availability of bio-diesel in Jersey in the near future should lead to improvements. In London, the trialling of water diesel emulsion is occurring which is claimed to halve particle emissions and cut Oxides of Nitrogen (NOx) by 23%.

Other schemes that benefit air quality include:

(A) The installation of two new cremators which comply with the UK Environmental Protection Act 1990 Process Guidance notes

(B) The commissioning of a new Energy from Waste (EFW) plant in 2011.

(C) New Building Byelaw Part L to improve insulation in domestic properties improving reducing fuel consumption by improving the thermal insulation of new build properties.

(D) The provision of a third electricity link to France will reduce the need to run the JEC oil fired power station.

(E) The growth in the use of solar panels, wind generators and ground and air source heat pumps will reduce the reliance on traditional fossil fuels; thereby reducing particle emissions from domestic premises.

(F) The Transport and Technical Services Department have produced the second Sustainable Transport policy (STP) which aims to minimise the environmental impact of our travel and encourage Islanders to make convenient, sustainable and healthy travel choices.

To reduce peak hour traffic levels to and from St Helier by at least 15% by 2015

Sub-targets for travel to and from work:

100% increase in bus travel
100% increase in cycling
20% increase in walking
20% increase in school bus use 100% increase in cycling to school [22]
http://www.gov.je/Government/Pages/StatesReports.aspx?ReportID=432

(G) The draft Island Plan promotes Sustainable Development, Travel & Transport (reducing the need to travel & car dependency) and aims to protect the Environment. These policies should positively impact on air quality.[23]
http://www.gov.je/PlanningEnvironment/IslandPlanReview/default.htm

22. Sustainable Transport Policy Consultation Document Making Greener Travel Choices: Transport and Technical Services
23. Draft (2009) Island Plan White Paper consultation

8. Conclusions

1. The Turnkey Osiris particulate monitors were set up at the Central Market on Halkett Place and Havre Des Pas, St Helier. The units measure particles in real time (ie Total Suspended Particles (TSP), particles of a mean aerodynamic diameter of 10 microns (PM_{10}), and particles of a mean aerodynamic diameter of 2.5 microns ($PM_{2.5}$) and particles of a mean aerodynamic diameter of 1 micron ($PM_{1.0}$) as 15 minute averages.

2. Particles are associated with a range of health effects. These include effects on the respiratory and cardiovascular systems, asthma and mortality. The Expert Panel on Air Quality Standards (EPAQS) concluded that particle air pollution episodes are responsible for causing excess deaths among those with pre-existing lung and heart disease. EPAQS also believe that any risk of lung cancer from the concentrations found in the streets of the UK is likely to be exceedingly small. However prolonged exposure for example 20 - 30 years to particles, which are likely to be combined with Polycyclic Aromatic Hydrocarbons (PAH) originating from unburnt or partially burnt fuel, is likely to be carcinogenic.

3. The Osiris has a glass fibre filter which collects particle material, which was further analysed to determine the sources of the particles and percentage contribution. Examination revealed in 2009 that the collected deposit was varied including sea salt, sand, general dirt and carbonaceous matter with particle size of <10 microns associated with vehicular emissions. Care must be taken interpreting these results as only a very small number of particles (40) were analysed.

4. PM_{10} concentrations in Jersey were generally higher than the UK comparison sites but broadly similar to those found in London and Bristol. Levels at the Havre Des Pas and the Market sites are broadly what could be expected at a roadside location in the UK.

5. Concentrations of all pollutants appear to be falling over time. This is likely to be due to improved fuel composition and engine design[5]. However, directive limits are becoming tighter and more health information is readily available.

6. Particle levels from other sources, such as the power station, have reduced with the use of the two cable links to France (ie up to 97% of electricity used in Jersey originates from France).

7. The main air quality issues in Jersey relates to the impact of traffic on local air quality.

9. Recommendations

1. Further long term research (until at least 2010) should be carried out to assess levels of PM_{10}/$PM_{2.5}$ in Jersey associated with traffic numbers, its mix, and speed and meteorological conditions to establish trends and assess compliance with the European Union Daughter Directive objectives. This forms part of the integrated Air Quality Strategy. Further monitoring should involve the use of EU type approved measurement equipment to be meaningful and allow direct comparison with the UK.

2. Traffic data (eg volume, mix and speed) should be made available to allow more meaningful comparison with particle results.

3. Further work is needed to assess the relationships between meteorological data and particle levels.

4. Comparison between TEOM monitoring of PM10 and the Osiris units to determine if a factor is needed to account for the loss of volatiles from the heated sampling head.

5. Work is needed in conjunction with other stakeholders to promote measures to reduce particles.

6. The States of Jersey Air Quality Report 2009 is published and taken to the States for approval and implementation.

7. The States of Jersey Air Quality Report 2009 should provide evidence for other strategies ie Island Plan and Sustainable Transport Plan.

8. It is recommended that Local Air Quality Management legislation is introduced to formalise the process of management of Air Quality in Jersey.

10. Appendix 1: The Turnkey Osiris Particle Monitor

Osiris stands for *Optical Scattering Instantaneous Respirable Dust Indication System*.

The Osiris is an investigational instrument that fulfils the dual role of a portable instrument or permanent installation.

The instrument is housed in a sturdy die cast metal box with internal rechargeable battery. The external power source was connected for the long term monitoring. The internal memory was used to record PM_{10}, $PM_{2.5}$, $PM_{1.0}$ and Total Suspended Particles (TSP) as 15 minute averages for the monitoring periods. Each 24 hour period is saved in a folder for downloading to a computer and analysing with the Air Quality Programme for Windows. The Air Quality programme allows the data to be graphed and copied into Microsoft Excel for further analysis.

The instrument measures and records the concentration of airborne particles using a proprietary laser (nephelometer). An internal pump continuously draws an air sample through the nephelometer which analyses the light scattered by individual particles as they pass through a laser beam. These same particles are then collected on the reference filter. The nephelometer's dedicated microprocessor can analyse the individual particles even if there are millions of them per litre. This allows the size fractions to be determined at concentrations up to several milligrams/m^3.

The light scattered by the individual particles is converted into an electrical signal which is proportional to the size of the particle. A unique feature of the Turnkey nephelometer is that only light scattered through very narrow angles 10 degrees or less is measured. At this narrow angle the amount of light scattered is virtually the same for say black diesel or white limestone particles of the same size. That is, it doesn't depend on the material composition of the particle. On the other hand, the easier to measure right angle 90° scatter used by some earlier scattering instruments is highly dependant on material composition with white particles apparently scattering much more light than black ones of the same size.

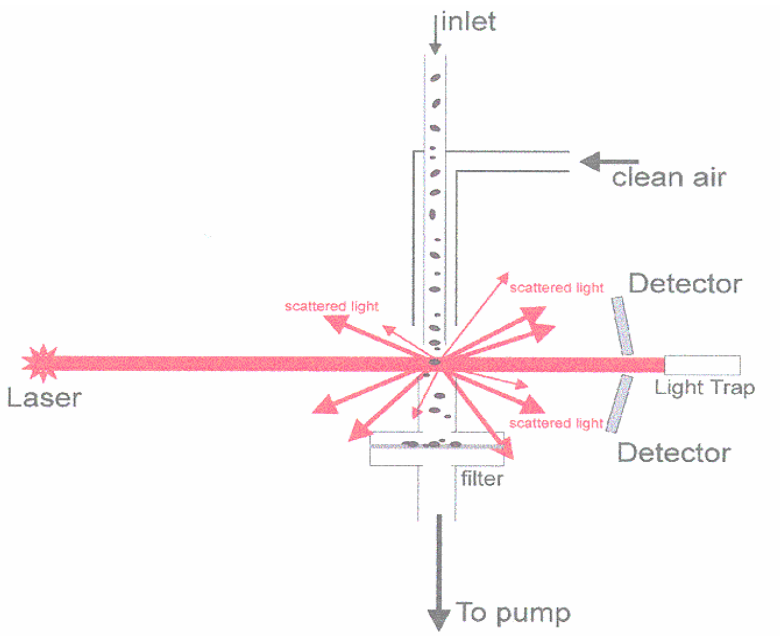
The light scattered by airborne particles can be thought of as consisting of three components. Light reflected from the surface of the particle, light refracted through the particle and light which is diffracted from its original path by the presence of the particle. The intensity of the light scattered by reflection or refraction strongly depends on the type of particle. Thus a white limestone particle will reflect much more light than a black diesel fume particle of the same size. On the other hand, the diffracted component depends only on the size of the particle and is independent of its material composition.

For irregularly shaped particles, light, which is reflected and refracted, tends to be scattered over all possible directions. The diffracted component, however, tends to be scattered only through very small angles. For example, for a 5 micron diameter particle, 90% of the diffracted light is scattered by less than 10 degrees from the original direction of the light beam.

The intensity of the light pulse is therefore an indicator of particle size, from this the microprocessor is able to calculate the expected mass of the particle. It assumes the material density of the particle is 1.5 grams per cc, which for most airborne dusts is a good approximation but the mass calibration factor can be adjusted to compensate for different material types.

Having evaluated the mass of the particle, the microprocessor then evaluates the likely chance of deposition of the particle according to the sampling convention being used (PM_{10}, thoracic, and so on) as shown in figure 19 below. Thus for the thoracic convention a 6 micron particle has an 80.5% chance of deposition, hence only this percentage of its evaluated mass is accumulated.

Figure 6: Diagram of the Osiris particle monitor



11. Appendix 2: UK Air Quality Objectives for protection of human health, July 2007[15]

UK Air Quality Objectives for protection of human health, July 2007 - New objectives highlighted in shading			
Pollutant	**Air Quality Objective**		**To be achieved by**
	Concentration	**Measured as**	
Benzene			
All authorities	16.25 µg m^{-3}	Running annual mean	31 December 2003
England and Wales Only	5.00 µg m^{-3}	Annual mean	31 December 2010
Scotland and N. Ireland	3.25 µg m^{-3}	Running annual mean	31 December 2010
1,3-Butadiene	2.25 µg m^{-3}	Running annual mean	31 December 2003
Carbon Monoxide			
England, Wales and N. Ireland	10.0 mg m^{-3}	Maximum daily running 8-hour mean	31 December 2003
Scotland Only	10.0 mg m^{-3}	Running 8-hour mean	31 December 2003
Lead	0.5 µg m^{-3}	Annual mean	31 December 2004
	0.25 µg m^{-3}	Annual mean	31 December 2008
Nitrogen Dioxide	200 µg m^{-3} not to be exceeded more than 18 times a year	1-hour mean	31 December 2005
	40 µg m^{-3}	Annual mean	31 December 2005
Particles (PM10) (gravimetric)			
All authorities	50 µg m^{-3}, not to be exceeded more than 35 times a year	Daily mean	31 December 2004
	40 µg m^{-3}	Annual mean	31 December 2004
Scotland Only	50 µg m^{-3}, not to be exceeded more than 7 times a year	Daily mean	31 December 2010
	18 µg m^{-3}	Annual mean	31 December 2010
Particles (PM2.5) (gravimetric) *	25 µg m^{-3} (target)	Annual mean	2020
All authorities	15% cut in urban background exposure	Annual mean	2010 - 2020
Scotland Only	12 µg m^{-3} (limit)	Annual mean	2010
Sulphur dioxide	350 µg m^{-3}, not to be exceeded more than 24 times a year	1-hour mean	31 December 2004
	125 µg m^{-3}, not to be exceeded more than 3 times a year	24-hour mean	31 December 2004

	266 µg m^{-3}, not to be exceeded more than 35 times a year	15-minute mean	31 December 2005
PAH *	0.25 ng m^{-3}	Annual mean	31 December 2010
Ozone *	100 µg m^{-3} not to be exceeded more than 10 times a year	8 hourly running or hourly mean*	31 December 2005

*** not included in regulations at present Shaded data shows new objectives**

UK Air Quality Objectives for protection of vegetation and ecosystems, July 2007 - New objectives highlighted in shading			
Pollutant	**Air Quality Objective**		**To be achieved by**
	Concentration	**Measured as**	
Nitrogen dioxide (for protection of vegetation & ecosystems) *	30 µg m^{-3}	Annual mean	31 December 2000
Sulphur dioxide (for protection of vegetation & ecosystems) *	20 µg m^{-3} 20 µg m^{-3}	Annual mean Winter Average (Oct - Mar)	31 December 2000
Ozone *	18000 µg m^{-3}.h	AOT40+, calculated from 1h values May-July. Mean of 5 years, starting 2010	01 January 2010

*** not included in regulations at present**

+ AOT 40 is the sum of the differences between hourly concentrations greater than 80 µg m^{-3} (=40ppb) and 80 µg m^{-3}, over a given period using only the 1-hour averages measured between 0800 and 2000. Shaded data shows new objectives

Air Pollution Information Service

Index and Bands

In the UK most air pollution information services use the index and banding system approved by the **Committee on Medical Effects of Air Pollution Episodes** (COMEAP). The system uses 1-10 index divided into four bands to provide more detail about air pollution levels in a simple way, similar to the sun index or pollen index.

- **1-3** (Low)
- **4-6** (Moderate)
- **7-9** (High)
- **10** (Very High)

The overall air pollution index for a site or region is calculated from the highest concentration of five pollutants:

- Nitrogen Dioxide
- Sulphur Dioxide

- Ozone
- Carbon Monoxide
- Particles < 10µm (PM10)

Air Pollution Forecasts

Air Quality Forecasts are issued on a regional basis for three different area types:

- In towns and cities near busy roads
- Elsewhere in towns and cities
- In rural areas

Forecasts are based on the prediction of air pollution index for the **worst-case** of the five pollutants listed above, for each region.

Health Advice

Latest studies report that:

- When air pollution is LOW (1-3) effects are unlikely to be noticed even by those who are sensitive to air pollution.
- When air pollution is MODERATE (4-6) sensitive people may notice mild effects but these are unlikely to need action.
- When air pollution is HIGH (7-9) sensitive people may notice significant effects and may need to take action.
- When air pollution is VERY HIGH (10) effects on sensitive people, described for HIGH pollution, may worsen.

Air pollution can cause short-term health effects to sensitive individuals (people who suffer from heart disease or lung diseases, including asthma). Effects on sensitive people can be reduced by spending less time outdoors. 'Reliever' inhalers should lessen effects on asthma sufferers.

More details on effects, including long-term, are available in a free leaflet **'Air Pollution - what it means for your health'.**

Air Pollution Bandings and Index and the Impact on the health of People who are Sensitive to Air Pollution

Banding	Index	Health Descriptor
Low	**1, 2, or 3**	Effects are unlikely to be noticed even by individuals who know they are sensitive to air pollutants
Moderate	**4, 5, or 6**	Mild effects, unlikely to require action, may be noticed amongst sensitive individuals.
High	**7, 8, or 9**	Significant effects may be noticed by sensitive individuals and action to avoid or reduce these effects may be needed (e.g. reducing exposure by spending less time in polluted areas outdoors). Asthmatics will find that their 'reliever' inhaler is likely to reverse the effects on the lung.
Very High	**10**	The effects on sensitive individuals described for 'High' levels of pollution may worsen.

13. http://www.airquality.co.uk/standards.php

12. Appendix 3: Relationship between the European transfer reference sampler and other PM10 sampling methods [9]

Monitoring of PM10 in the UK networks has, to date, been largely founded on the use of the TEOM analyser. A concern with the TEOM instrument is that the filter is held at a temperature of 50°C in order to minimise errors associated with the evaporation and condensation of water vapour. This can lead to a loss of the more volatile particles (such as ammonium nitrate etc).

The EU limit values and the UK objectives are based upon measurements carried out using the European transfer reference sampler, or equivalent. This is a gravimetric sampler, where the particulate material is collected onto a filter, and subsequently weighed. The filter is therefore held at fluctuating ambient conditions during the period of exposure. Whilst there will inevitably be some losses of volatile species from the filter (dependant upon the ambient temperature), these will be less than from the TEOM.

The Government and the Devolved Administrations have been investigating the relationship between the TEOM and the reference sampler, using co-located instruments at 6 sites in the UK. These studies have shown that the TEOM adjustment factor is site specific, and varies both from season to season, and from year to year. Because of this **an interim default adjustment factor of 1.3** has been proposed for the UK. This approach is supported by other studies carried out in other EU countries, and appears to also apply to ß-attenuation instruments with a heated manifold.

For the purpose of the next round of review and assessment, authorities should bear in mind the issues set out below:

- Measurements of PM10 concentrations carried out using the European transfer reference sampler, or equivalent, are directly comparable with the UK objectives and EU limit values, and no data correction is necessary. There are however, important QA considerations to bear in mind, regarding the handling and weighing of filters.

- Measurements of PM10 concentrations carried out using a TEOM or ß-attenuation instrument, operating with a heated manifold, should be adjusted by multiplying the data by 1.3 to estimate gravimetric equivalent concentrations.

- Measurements of PM10 concentrations carried out using other sampling methods (e.g. optical analysers, or gravimetric samplers that have not been certified as ‘equivalent’) will need to be considered carefully, particularly if they are being used in a Detailed Assessment, and the concentrations measured are close to the objectives. Authorities with such analysers are advised to contact the relevant Helpdesk .

- It is not recommended that authorities carry out local intercomparison studies between the transfer reference sampler and other samplers for the purpose of review and assessment. Where such studies are carried out, it is **essential** to carry out the comparison over at least 6 months, including a summer and winter period. Any adjustment factors derived may be both season and site specific, and cannot simply be used to adjust data at other sites, in other years.

- The method of sampling is **critical** to the result. In all cases, authorities should explicitly state the method of sampling, and report all original and ‘adjusted’ data.

13. Appendix 4: Sources of particles

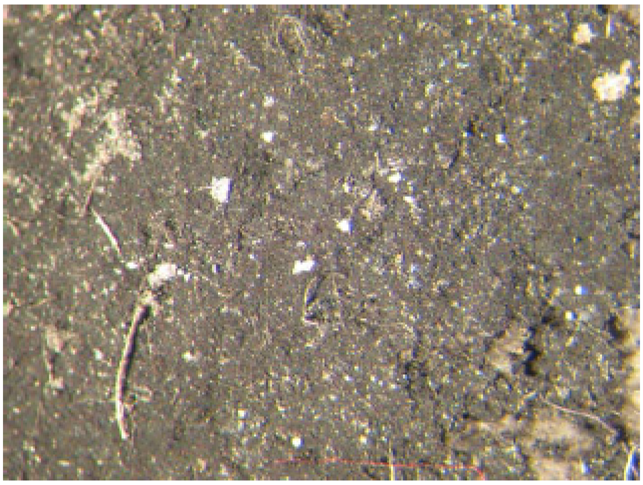
Box 8.1: Approximate contributions to PM_{10} concentrations (2002)

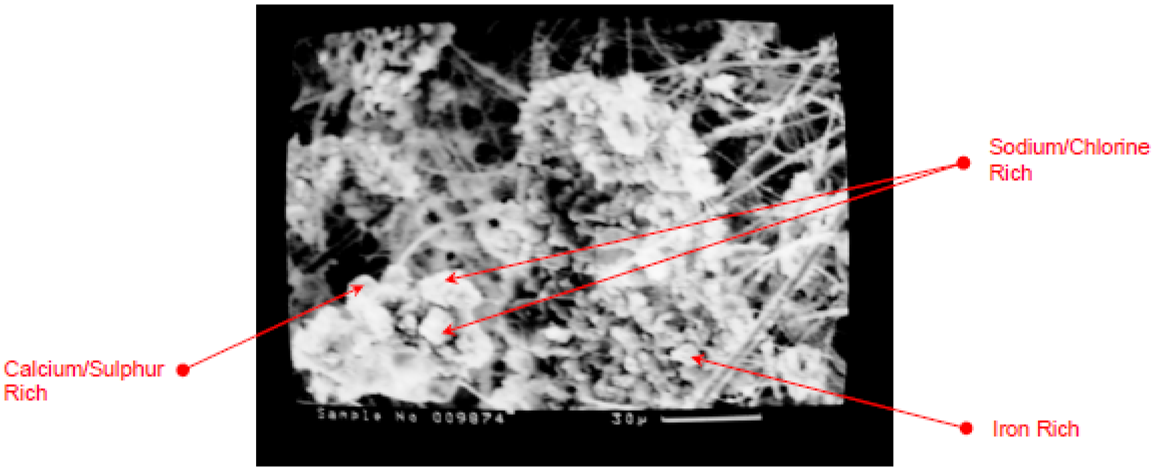
Type of particle	Source location	Main source categories	Main source types	Typical contribution to annual mean concentration (µg/m³ gravi.)
Coarse 2.5-10µm	Immediate local (very close)	Traffic	resuspended dusts tyre wear	1 - 6
		Industry	fugitive dusts stockpiles quarries construction	variable, up to 5
	Urban background	Traffic	resuspended dusts tyre wear	1 - 2
		Industry	fugitive dusts stockpiles quarries construction	variable, up to 2
	Regional (including distant sources)	Natural	resuspended dust/soil sea salt biological	2 - 3 1 - 2 1
Fine <2.5µm	Immediate local (very close)	Traffic	vehicle exhaust	1 - 4
		Industry	combustion industrial processes	variable
		Domestic	coal combustion	variable
	Urban background	Traffic	vehicle exhaust	1 - 4
		Industry	combustion industrial processes	variable, up to 8
		Domestic	coal combustion	variable, up to 8
	Regional (including distant sources)	Secondary	power stations industrial processes vehicles	4 - 8
		Primary (Imported)	power stations vehiclesw industrial processes	1 - 2
		Natural	sea salt	<1

14. Appendix 5: Environmental Services Group ESG TES Bretby Ltd test reports and scanning electron micrographs showing the percentage characterisation.

a. Central Market/Halkett Place Site:

Optical microscopy showed the material to be composed mainly of a variety of fine particles with some opaque crystals. Some coloured fibrous material was also present.



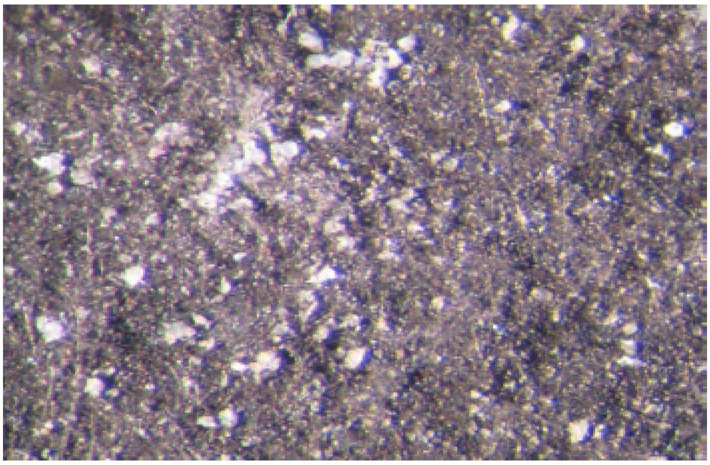


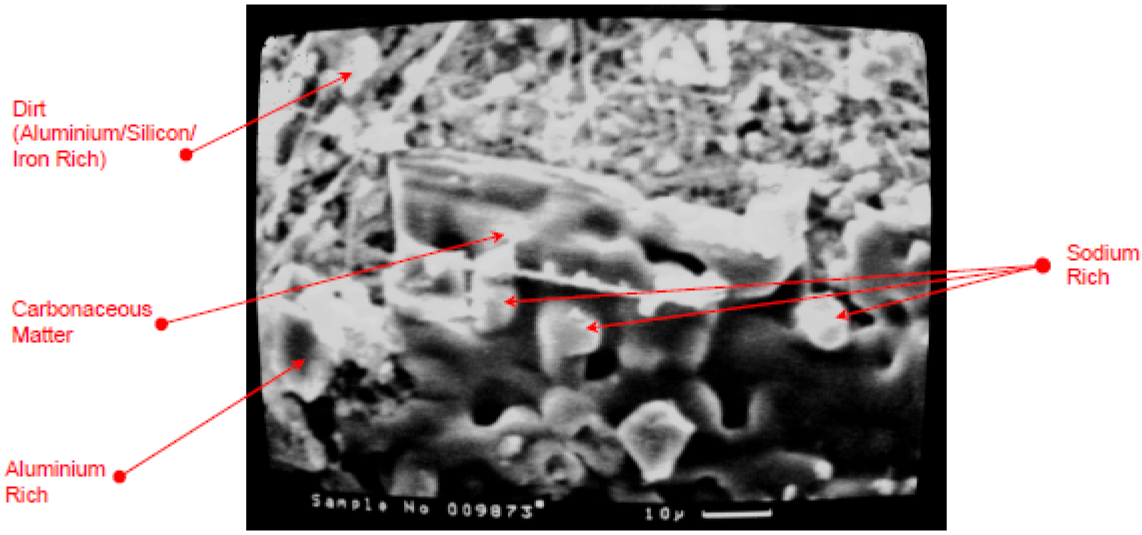
Forty particles were analysed individually; the results are shown below.

Category	Estimated %	Category	Estimated %	Category	Estimated %
Carbonaceous matter	65	Sodium/chlorine rich	8	Aluminium rich	2
Silicon rich	10	Calcium rich	5		
Aluminium/silicon rich	8	Sodium rich	2		

b. Havre Des Pas site

A general area analysis could not be conducted as the filter was made from glass fibres.





Identification of Dust Gauge / Environmental Deposits by SEM-EDS Method Number SEMDG7

Forty particles were analysed individually; the results are shown below.

Category	Estimated %	Category	Estimated %	Category	Estimated %
Carbonaceous matter	50	Iron rich	5	Silicon rich	3
Aluminium rich	20	Sodium rich	5	Calcium rich	2
Aluminium/silicon rich	10	Sodium/chlorine rich	5		

15. Appendix 6: The Importance of Weather and Air Quality[1]

The eventual fate of most pollutants emitted to atmosphere is chiefly governed by the weather. Wind speed and direction are crucial, as is the stability of the atmosphere as this will govern how well the pollutant mixes in with cleaner air. A further important feature of the lowest levels of the atmosphere is the boundary layer. This effectively 'caps' the atmosphere by impeding the upward movement of pollutants. Therefore, the volume of air available to mix and dilute the pollutant is governed by the height of the boundary layer. When the boundary layer height (BLH) is low there is a less available clean air and so higher pollution concentrations are likely. The BLH varies with climatic conditions, with the lowest BLH typically occurring in still, cold conditions, such as cloudless winter nights, and highest BLH normally occurs at midday in summer. Thus, the BLH can vary on a diurnal as well as an annual cycle.

Once in the atmosphere the released pollutant is free to interact with other pollutants and will sometimes form secondary pollutants (e.g. ozone). These secondary pollutants can be formed through a variety of chemical reactions and/or by the action of incident sunlight. The speed of these reactions will depend on the temperature, humidity, amount of sunlight, and wind speeds.

Different pollutants stay in the atmosphere for different lengths of time (i.e. they have different atmospheric residence times) depending on a range of factors. Their eventual removal from the atmosphere occurs as a result of quite complex deposition processes.

Some pollutants can be entrained within the processes of cloud formation and then removed from the atmosphere in falling rain. Alternatively, these pollutants may be washed out of the atmosphere by rain falling and literally knocking them out of the atmosphere. Both of these processes are known as "wet deposition".

Those pollutants that are not wet deposited can be dry deposited due to gravitational settling as the pollutant comes into contact with the ground, by reaction on surfaces, or through take up by living organisms. The rate at which this happens is governed by characteristics of the pollutant, the ground surface or organism type and the weather.

For example, plants form an important mechanism for removing ground level ozone from the atmosphere, but the rate at which they do so is influences by temperature, humidity, soil moisture, wind speed and so on. Examples of the influence of weather conditions on typical air quality include:

- There is a diluting effect of **wind speed**: at London Hillingdon, an approximate halving of NO_x concentrations with a doubling of wind speed from 5 to10 $m.s^{-1}$ has been shown.

- $PM_{2.5}$ decreases when **wind speed** increases due to dilution but PM $_{coarse}$ increases with wind speed due to re-suspension. These effects show the different sources of PM components.

- Daily maximum ozone concentration is highly sensitive to **temperature**, particularly where this rises above around 24-25^{o}. At Lullington Heath in Sussex, between 1993 and 1998, a rise from 25-30^{o} typically produced a rise in ozone peak of around 60 $\mu g.m^{-3}$, compared to 13 $\mu g.m^{-3}$ for a 10-15^{o} rise (Anderson *et al*. (2001).

- **Precipitation** can reduce PM concentrations dramatically, although other weather factors are also associated with rainfall, such as wind speed. Around a 6 $ug.m^{-3}$ difference in PM_{10} has been observed in Edinburgh between days with with no rainfall and those with >20mm rainfall.

- The incidence of certain **wind directions** can also lead to high pollution concentrations.

1. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland Volume 2 July 2007 DEFRA

16. References

1. Air Quality Strategy for England, Scotland, Wales and Northern Ireland - www.defra.gov.uk/environment/airquality/strategy/index.htm

2.www.defra.gov.uk/Environment/climatechange/uk/energy/renewablefuel/pdf/ukbiomassstrateg y-0507.pdf

3. Air Quality Expert Group report on air quality and climate change

4. Adverse Health Effects of Particulate Air Pollution V. Stone, J.H. Lightbody, L. Hibbs, C.L.Tran, M. Heal, and K. Donaldson. Napier University, University of Edinburgh

5. Report: Particles a problem or not in St Helier 2001 - A M Irving

6. Reports on the Turnkey Osiris Particle monitors results for Jersey 2002 – 2008

7. AEA Technology and the draft document Air Quality Report dated October 2009.

8. Environment Scrutiny Panel Air Quality Review Presented to the States on 10th June 2008 S.R.8 /2008

9. Environment Scrutiny Panel Air Quality Review: Ministerial Response (MD-HSS-2009-0045)

10. Jersey's Official OS Leisure Map 1:25 000 States of Jersey Planning and Environment Department

11. The relationship between the European transfer reference methods

12. Air Quality monitoring in Jersey; Diffusion Tube surveys 2008 AEA

13. The Air Quality Standards Regulations 2007
http://www.opsi.gov.uk/si/si2007/uksi_20070064_en_1

14. EU Daughter Directive 99/30/EC.

15. AEA Technology report Ref Brian Stacey Analysis of Particulate matter (dust) on filter using SEM and EDX April 2008

16. Air Quality Management issue 170 page 9 National Audit Office Briefing, Rob Bell

17. An Air quality Strategy for Jersey, April 2003. NETCEN

18. http://www.defra.gov.uk/environment/quality/air/airquality/eu-int/eu-directives/airqual-directives/notification.htm

19. Air Quality Monitoring, St Helier, February to March 2000. NETCEN

20. EU Directive 96/62/EC on Ambient Air Quality Assessment and Management (The Air Quality Framework Directive)

21. Ref: http://ec.europa.eu/environment/air/quality/legislation/directive.ht

22. Sustainable Transport Policy Consultation Document Making Greener Travel Choices: Transport and Technical Services

23. Draft (2009) Island Plan White Paper consultation States of Jersey Planning and Building Services Department