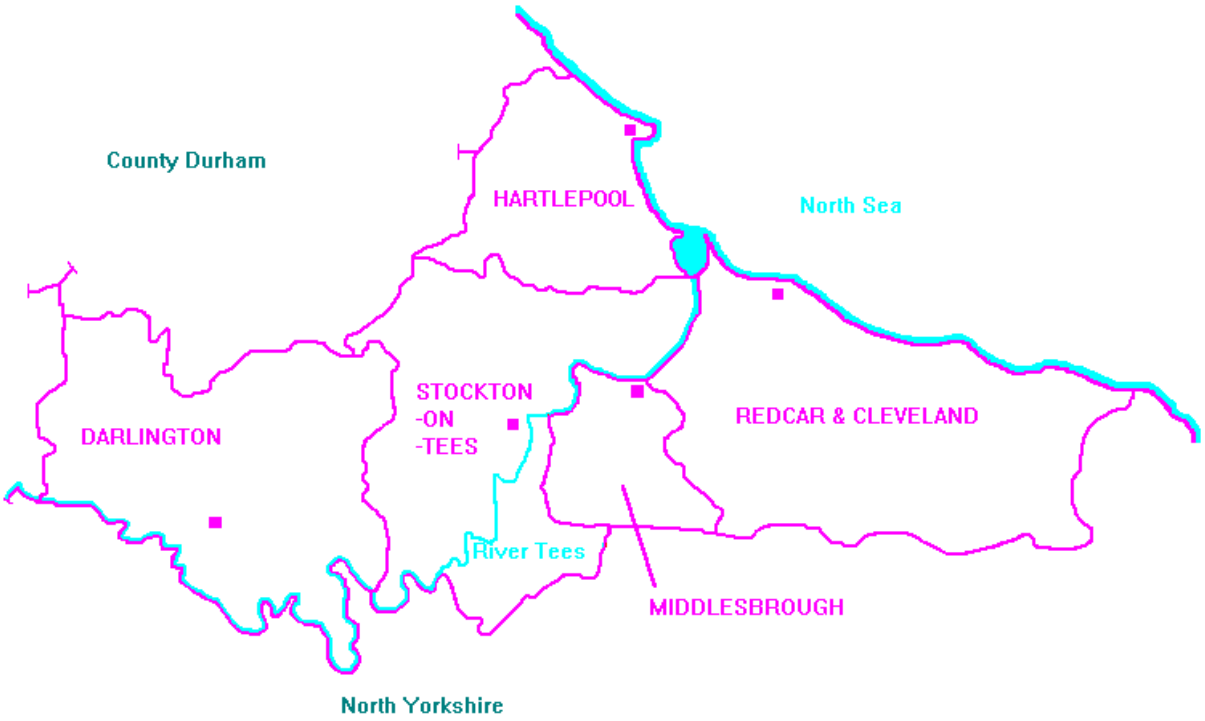
TEES VALLEY ENVIRONMENTAL PROTECTION GROUP

ANNUAL REPORT 2016

AIR QUALITY

in the

TEES VALLEY 2012 – 2015



a comparison with

National Air Quality Objectives

Published by the Tees Valley Environmental Protection Group - July 2016

Contents

SUMMARY

The UK Government has regulated for thirteen air quality objectives covering seven air pollutants, against which local authorities are required to measure local air quality. A further three air pollutants have objectives set, but these are not yet part of regulation.

If any regulated objective is unlikely to be met by its due date, in any areas where there may be relevant public exposure, a local authority is obliged to declare an Air Quality Management Area (AQMA), and draw up an action plan to reduce air pollution.

The five Tees Valley Councils have annually reviewed their air quality since year 2000, and have each concluded that air quality was sufficiently good not to require any AQMA within their boundaries. The Department for Environment, Food and Rural Affairs (Defra) has accepted these findings.

This report is a joint Council annual report recording all air quality monitoring carried out within the Tees Valley over the period 2012 – 2015, and comparing the results with the air quality objectives. Historical trend graphs and air quality banding analysis are also provided. The report supports the 2016 Annual Status Report for each of the Tees Valley Councils, as required by Defra.

The latest (2015) air quality data confirms that air quality in the Tees Valley continues to meet the regulated objectives, and there is no need for any Air Quality Management areas.

In particular, those air pollutants mainly associated with industry, such as sulphur dioxide, benzene and 1,3 butadiene, have stabilised at historically low levels. Those pollutants mainly associated with road transport, nitrogen dioxide and particulates, have also stabilised, with any reduction in emission levels per vehicle being largely offset by increases in traffic flow. Indeed, any change in concentrations year on year is usually associated with weather variations, for example long periods of high pressure can lead to a build-up of pollutants in the atmosphere, particularly alongside congested roadside areas.

Two of the three unregulated pollutants, ozone, and polycyclic aromatic hydrocarbons (PAHs), are less likely to meet their objectives, although PAH levels should significantly reduce following the closure of the steel works and coke ovens in October 2015.

Ozone is formed by the chemical reaction of other air pollutants in the atmosphere, particularly during the summer months. High levels are recorded along the coastal areas, usually as a result of easterly winds transporting air pollutants from the continent. In areas of high traffic flow, ozone levels are reduced by further chemical reaction, so that inland urban areas tend to show lower ozone concentrations. Even so, in years of good summer weather, much of the Tees Valley is likely to show an exceedance of the ozone objective. It is recognised by Defra that there is little action that can be taken at local authority level to change this, and pan-European action is required to reduce all primary air pollutants.

PAH is a term for a range of hydrocarbon pollutants associated with coal and wood burning. Monitoring at ground level only started in 2008, and results suggest that an exceedance of the objective is possible in areas along the south side river Tees estuary. This has been confirmed by the recent modelling carried out on behalf of Defra (see reference 5). However, the two coke ovens and the steel blast furnace closed during October 2015, which will ultimately have a significant impact on PAH levels. Continuing PAH monitoring is required. PAH is a potential problem associated with other industrial areas of the UK where coke ovens are situated, and further investigation is being carried out by Defra and the Environment Agency in respect of accuracy of measurement, and emission source.

The objective for the third unregulated pollutant, particulate $PM_{2.5}$, will be readily met.

This report is held by each Tees Valley Council on their web-site under air quality.

Starting 2016, the UK Air Quality Regulations have been revised, with the emphasis on just three pollutants, nitrogen dioxide, particulate $PM_{2.5}$, and sulphur dioxide, and a simplified annual reporting system, the Annual Status Report, or ASR. This TVEPG annual report will be discontinued.

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INTRODUCTION

NATIONAL AIR QUALITY STRATEGY POLLUTANTS 2007

POLLUTANT	OBJECTIVE (maximum)	Maximum Exceedances / year	DUE DATE
Regulated pollutants			
nitrogen dioxide (NO_2)	40 µg/m³ as an annual mean	no exceedances	31.12.2005
	200 µg/m³ as a 1 hour mean	18 exceedances	31.12.2005
particulate PM_{10} (PM_{10})	40 µg/m³ (gravimetric) as an annual mean	no exceedances	31.12.2004
	50 µg/m³ (gravimetric) as a 24 hour mean	35 exceedances	31.12.2004
sulphur dioxide (SO_2)	125 µg/m³ as a 24 hour mean	3 exceedances	31.12.2004
	350 µg/m³ as a 1 hour mean	24 exceedances	31.12.2004
	266 µg/m³ as a 15 minute mean	35 exceedances	31.12.2005
carbon monoxide (CO)	10 mg/m³ as an 8 hour running mean	no exceedances	31.12.2003
benzene (BEN)	16.25 µg/m³ as a running annual mean	no exceedances	31.12.2003
	5.00 µg/m³ as an annual mean	no exceedances	31.12.2010
1,3-butadiene (BUT)	2.25 µg/m³ as a running annual mean	no exceedances	31.12.2003
lead	0.5 µg/m³ as an annual mean	no exceedances	31.12.2004
	0.25 µg/m³ as an annual mean	no exceedances	31.12.2008
Unregulated pollutants			
particulate $PM_{2.5}$ ($PM_{2.5}$)	*25 µg/m³ as an annual mean*	*no exceedances*	*31.12.2020*
	with a target of 15% reduction in concentrations at urban background locations measured as a 3-year mean		*Between 2010 and 2020*
polycyclic aromatic hydrocarbons (PAHs)	*0.25 ng/m³ as an annual mean*	*no exceedances*	*31.12.2010*
ozone (O_3)	*100 µg/m³ as an 8 hour running mean*	*10 day exceedances*	*31.12.2005*

INTRODUCTION

UK AIR QUALITY POLICY (to end 2015)

The UK Government has set air quality objectives for ten air pollutants against which local authorities can monitor and judge the quality of air (reference 1 inside back cover).

The pollutants are :

pollutant	regulated	unregulated
nitrogen dioxide	2 objectives	
particulate PM_{10}	2 objectives	
sulphur dioxide	3 objectives	
carbon monoxide	1 objective	
benzene	2 objectives	
1,3-butadiene	1 objective	
lead	2 objectives	
particulate $PM_{2.5}$	-	1 objective
polycyclic aromatic hydrocarbons	-	1 objective
ozone	-	1 objective
	----------	----------
	13 objectives	3 objectives

Details of the regulated objectives and proposed objectives are shown opposite.

Thirteen objectives are regulated, and local authorities are obliged to review air quality to see if the objectives will be met by the due date, ranging from December 31st 2003 and December 31st 2010. If any objective is unlikely to be met by the due date, in any area where relevant public exposure may realistically exist (see 'Relevant Public Exposure' section over page), a local authority is obliged to declare an Air Quality Management Area for that area, and draw up an action plan with all interested parties to reduce the level of air pollution.

All five Tees Valley Councils have completed six full review and assessments of air quality against these objectives (2000, 2003, 2006, 2009, 2012 and 2015), with Progress Reports in intermediate years, and have concluded that there is no need to declare Air Quality Management Areas. The Department for Environment, Food & Rural Affairs (DEFRA) has accepted this.

This report is the TVEPG 2016 annual report providing details of the latest monitoring information within the Tees Valley, and historical trend graphs, and is based on the revised UK Air Quality Strategy as published by Defra in July 2007.

Four other air pollutants are also being considered within the UK and the EU, and are likely to be included in the UK air quality strategy at a later date. Relevant monitoring data is also included for information.

The pollutants are:

cadmium arsenic nickel mercury

Starting January 2016, the UK Air Quality Strategy has been further simplified with statutory reporting now limited to three pollutants, nitrogen dioxide, particulate $PM_{2.5}$ and sulphur dioxide. Details are provided in the next section.

For further information, see the DEFRA air quality web-site (reference 2 inside back cover).

UK AIR QUALITY POLICY (from January 2016)

Following a two year consultation on how the UK Air Quality Strategy should develop, a new Air Quality Policy and Technical Guidance was published in April 2016, with the aim of simplifying the process of Local Air Quality management..

Local authorities will continue to have a central role in achieving improvements in air quality. Through the Local Air Quality Management (LAQM) system local authorities will also continue to be required to assess air quality in their area and designate Air Quality Management Areas (AQMA) if improvements are necessary. Where an AQMA is designated, local authorities will still be required to produce an air quality Action Plan describing the pollution reduction measures it will put in place.

However, the new approach has been designed to maximise the public health benefits of local authority action, in particular on priority pollutants such as NO2 and Particulate Matter (PM_{10} / $PM_{2.5}$). While it is expected that the quality of information is retained, the reporting requirements should be more consistent, simpler, with a focus on local actions that are or will be taken. Since statutory reporting on air quality began in year 2000, there has not been any AQMA needed to be declared within the Tees Valley, and on current evidence, this is likely to the case for the future.

A new annual report, the Annual Status Report (ASR), will replace the Updating and Screening Report and intervening Progress Reports, and provide a more public-facing summary. The core requirements of the ASR are:

- To report progress on the implementation of measures in the local air quality action plan and other measures and their impact in reducing concentrations below air quality objectives
- To provide a summary of monitoring/modelling data (either locally retrieved and/or from the national network) in order to assess the air quality situation in your area and likelihood of air quality breaches, and to provide the necessary evidence base for the impact of air quality measures
- To report on significant new developments that might affect local air quality
- To present information in a public-facing executive summary for the lay reader so that the local public can more easily engage with local air quality issues and measures taken to improve it

In particular, Local Authorities in England are expected to report on the currently regulated pollutants, nitrogen dioxide, particulate PM_{10} and sulphur dioxide, as standard within their ASRs, but are not expected to report annually on the remaining four regulated pollutants, benzene, 1,3-butadiene, carbon monoxide and lead, as objectives for these pollutants have been met for several years within the UK and are well below limit values. This is also the case within the Tees Valley.

The ASR will also, in addition to the objectives set in Regulations, provide Local Authorities with a new, flexible role in working towards reducing emissions and concentrations of $PM_{2.5}$. Local Authorities will not be required to carry out any additional local review and assessment (including monitoring) but will be expected to make use of the national network monitoring of $PM_{2.5}$, of which there is one monitor within Middlesbrough at Breckon Hill, and two monitors within Stockton-on-Tees, at Eaglescliffe and next to the A1035 road in central Stockton. Policy guidance does not prescribe what the local authority role should be; it is for the local authority in consultation with its public health officials and others to consider how it wishes to define this role. This will take time to develop.

Overall, air quality matters because improving air quality can reduce both the short term and the long term effects on people's health. It will have benefits to those who may find their conditions are made worse through exposure to air pollution, for example people with heart or lung conditions or breathing problems. Indeed the evidence associating NO2 with health effects has strengthened substantially in recent years, as noted by the Committee on the Medical Effects of Air Pollutants, and particulate $PM_{2.5}$ is now recognised as an important Public Health issue.

RELEVANT PUBLIC EXPOSURE

Within the UK, air quality objectives only apply to areas where there may be relevant public exposure. The definition of this depends on the averaging period of the objective, with a short 15 minute averaging period affecting a wider range of the public than an annual average.

Government guidance is as follows:

Averaging Period (relevant pollutants)	Objectives should apply at:	Objectives should generally not apply at:
Annual Mean (nitrogen dioxide, particulate PM10, particulate PM2.5, benzene, 1,3-butadiene, lead, polycyclic aromatic hydrocarbons)	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
24-hour mean and 8-hour mean (particulate PM10, sulphur dioxide, carbon monoxide, ozone)	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties, in particular around seating or play areas, but garden boundary extremities or front gardens are less likely..	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-hour mean (nitrogen dioxide, sulphur dioxide)	All locations where the annual mean and 24-hour and 8-hour mean objectives would apply. Kerbside sites (e.g. pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc., which are not fully enclosed, where the public might reasonably be expected to spend 1 hour or more. Any outdoor locations to which the public might reasonably be expected to spend 1 hour or longer.	Kerbside sites where the public would not be expected to have regular access.
15-minute mean (sulphur dioxide)	All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.	

HEALTH EFFECTS

The air quality objectives have been set at levels of pollution that are unlikely to cause harm to the vast majority of the public, based on current world-wide health advice available to the Government. If pollution levels exceed the objective levels, there is increasing risk to the public, with those suffering from existing health problems such as lung and heart disease, at greatest risk. Three of the ten air quality strategy pollutants are known carcinogens, for which it is acknowledged there are no completely safe limits. The objectives set in these cases have a 10 fold safety factor built in, and are at levels where there is considered to be minimal risk to members of the public.

The health effects of excess pollution attributable to each of the pollutants is summarised as follows:

Pollutant (objective averaging periods)	**Health effects**
Nitrogen dioxide (annual mean, 1 hour mean)	Nitrogen Dioxide can irritate the lungs and lower resistance to respiratory infections such as influenza. Continued or frequent exposure to concentrations much higher than those normally found in the ambient air may cause increased incidence of acute respiratory illness in children.
Particulate PM_{10} / $PM_{2.5}$ (annual mean, 24 hour mean)	Particles are measured in a number of size fractions according to their mean aerodynamic diameter. Most current monitoring is currently focused on PM_{10}, but the finer fractions such as $PM_{2.5}$ and PM_1 are becoming of increasing interest in terms of health effects. Fine particles can be carried deep into the lungs where they can cause inflammation and a worsening of the condition of people with heart and lung diseases. In addition, they may carry surface-absorbed carcinogenic compounds into the lung.
Sulphur dioxide (24 hour mean, 1 hour mean, 15 minute mean)	Even moderate concentrations may result in a fall in lung functions of asthmatics. Tightness in the chest and coughing occur at high levels, and lung function of asthmatics may be impaired to the extent that medical help is required. Sulphur dioxide pollution is considered more harmful when particulate and other pollution concentrations are high.
Carbon Monoxide (8 hour mean)	This gas prevents the normal transport of oxygen by the blood. This can lead to a significant reduction in the supply of oxygen to the heart, particularly in people suffering from heart disease.
Benzene (annual mean)	Possible chronic health effects include cancer, central nervous system disorders, liver and kidney damage, reproductive disorders, and birth defects.
1,3-butadiene (annual mean)	Possible chronic health effects include cancer, central nervous system disorders, liver and kidney damage, reproductive disorders, and birth defects.

HEALTH EFFECTS (continued)

Pollutant (objective averaging periods)	**Health effects**
Lead (annual mean)	Even small amounts of lead can be harmful, especially to infants and young children. In addition, lead taken in by the mother can interfere with the health of the unborn child. Exposure has also been linked to impaired mental function, visual-motor performance and neurological damage in children, and memory and attention span.
Ozone (8 hour mean)	Exposure to high levels of ozone is associated with slight irritation to the eyes or nose. Very high levels of exposure (in excess of 10 times the proposed objective level) over several hours can cause damage to the airway lining followed by inflammatory reaction. At levels of ozone above 200 µg/m³ as an eight hour concentration (2 times the proposed objective), an effect in healthy individuals has been clearly demonstrated.
Polycyclic Aromatic Hydrocarbons (PAHs) (annual mean)	Exposure to polycyclic aromatic hydrocarbons is associated with an increased incidence of tumours of the lung, skin, and other sites, with lung cancer most obviously linked to exposure through inhaled air. The objective level of 0.25 ng/m³ as an annual average is considered to represent a risk to health so small as to be undetectable.

AIR QUALITY MONITORING in the TEES VALLEY

This report records the air quality results, from 2012 - 2015, at all of the monitoring stations across the Tees Valley, and compares them with the thirteen regulated objectives and the three proposed objectives of the 2015 National air quality strategy. **All results are final ratified results** (see Appendix 1).

Particulate $PM_{2.5}$ monitoring started at Middlesbrough (Breckon Hill) and Stockton (Eaglescliffe) AURN stations towards the end of 2008, with the first full year of results in 2009.

The majority of results are from continuous monitoring stations, which are the most accurate. Three fixed continuous monitoring stations are part of the national Automatic Urban and Rural Network (AURN stations), with a fourth effectively starting from 2015. Results from these stations are published on the Internet (reference 3 inside back cover). The remaining six (2015) fixed continuous monitoring stations are Local stations, results from which are held by the local authority.

Non-continuous monitoring equipment is also used to measure nitrogen dioxide (annual), benzene, and polycyclic aromatic hydrocarbons, and has in the past been used to measure lead, and heavy metals. The results from these are also included.

The locations of the monitoring sites, and pollutants measured, are as follows:

National network (AURN) continuous monitoring stations 2015

station	start year	pollutants measured	site description
Middlesbrough (Breckon Hill)	1993 / 5 / 2008	NO_2, PM_{10}, $PM_{2.5}$, SO_2, O_3, (CO to 2012)	urban industrial
Stockton, Billingham (Cowpen Depot)	1987	NO_2	urban industrial
Stockton (Eaglescliffe)	2008 / 9	NO_2, PM_{10}, $PM_{2.5}$	roadside
Stockton Centre (Nelson Terrace)	2014 (December)	NO_2 (Particulate $PM_{2.5}$ started February 2016))	roadside

Local continuous monitoring stations 2015

station	start year	pollutants measured	site description
Stockton, Billingham (Cowpen Depot)	1996 / 8	PM_{10}, SO_2, (O_3 to 2008)	urban industrial
Redcar (Dormanstown)	2012	NO_2, PM_{10}, SO_2, O_3	suburban industrial
Redcar (Corporation Road *)	1998 (as AURN) 2007 - 2011 (as Local)	NO_2, PM_{10}, SO_2, O_3, (CO to 2010)	suburban
Hartlepool (Stockton Road)	2003 and 2010	NO_2, PM_{10} (no data 2006 – 2009)	roadside
Hartlepool (Town Wall)	2010	PM_{10}	harbour
Middlesbrough (MacMillan College)	2000	NO_2, PM_{10} (closed 31st October 2015, re-opened April 2016)	urban background
Middlesbrough (Elm Street)	2001 / 3	NO_2, PM_{10} (closed 31st March 2016, transferred to MacMillan College)	roadside
Darlington (St Cuthberts Way)	2001	NO_2, PM_{10}, (no results 2015)	kerbside
Darlington **(closed 2012)** (Cockerton Bridge)	2004 – April 2012	NO_2, PM_{10}, (site closed April 2012)	roadside
Stockton (Eaglescliffe)	2008 – 2014	O_3, (site closed December 2014)	roadside

* following a Defra review of the AURN network, Redcar Corporation Road was removed from the AURN network from October 2007, but continued as a Local station operated by Redcar & Cleveland Council until 2011. The station was moved to Dormanstown early in 2012.

National network hydrocarbon diffusion tube sites 2015 (benzene pumped diffusion tube) - non-continuous
(1,3-butadiene monitoring using a standard diffusion tube system at Middlesbrough ended September 2007)

station	start year	pollutant	site description
Middlesbrough, Breckon Hill	February 2002 April 2003	benzene 1,3-butadiene (to September 2007)	urban industrial
Stockton, Eaglescliffe	Q4 2008	benzene	roadside

Nitrogen Dioxide Diffusion tube sites 2014 (nitrogen dioxide annual mean) - non-continuous

Diffusion tubes are non-continuous monitoring equipment used to measure the annual mean for nitrogen dioxide at a range of mainly roadside locations. Some locations were part of a national Diffusion Tube network, whose results were published on the Internet (reference 3) until 2005. Other locations are Local sites, results from which are held by the local authority. Year 2015 sites are listed below.

Middlesbrough had not used diffusion tubes since 2002, preferring continuous monitoring. A new network was established for 2015, and has continued into 2016.

Redcar & Cleveland has not used diffusion tubes on a regular basis, preferring continuous monitoring. A yearlong survey in partnership with the sustainable transport charity 'Sustrans' and the 'Get Moving' Redcar & Cleveland' project commenced in July 2014 and continued through 2015. A reduced survey (without 'Sustrans') has continued into 2016.

Hartlepool reviewed their monitoring requirements early in 2011, and commissioned three new locations of relevant public exposure from September 2011 on the busiest roads close to housing. A further tube was added in September 2012, with one removed at the end of December 2014.

Stockton has a triple tube co-location study at their Eaglescliffe and Billingham continuous monitors. The Eaglescliffe study was transferred from Yarm High Street in Q4 2008. The bias factors derived from these results is used to correct Stockton and Hartlepool diffusion tube readings. Middlesbrough and Redcar & Cleveland also each have a triple tube co-location study to derive a tube bias factor.

Darlington reviewed their locations for 2011, and set back two sites (* below) from kerbside to better represent relevant public exposure. Darlington diffusion tube readings are corrected using tube supplier bias factors.

site	Darlington (Gradko)	Hartlepool (to March 2009) ESG (Didcot)	Stockton ESG (Didcot)
National	Northgate Salters Lane Darlington College Arts Centre	Victoria Road 1 Victoria Road 2 Granville Avenue Torquay Avenue	Prince Regent Street kerbside Wellington Street Dovecot Street Clifton Avenue
Local	Woodland Road * Blackwell Bridge * North Road Station Haughton Green Yarm Road Middleton-One-Row	Hart Lane Stockton St central Stockton St Owton **(from September 2011)** Powlett Road Catcote Road (closed Dec 2014) Fens Crescent **(from September 2012)** King Oswy Drive	Prince Regent Street (set back) Yarm High Street kerbside Yarm High Street (set back) Eaglescliffe (3) Thornaby Road Cowpen Depot boundary fence Cowpen Depot, Billingham (3) New Road, Billingham Long Newton Norton BASF (Seal Sands)

site	Middlesbrough (from January 2015) (Gradko)			Redcar & Cleveland (from July 2014) (Gradko)	
Local	Alphonsus Street	Background		Westgate, Guis	Roadside
	Saxon Close	Near Road		Redcar Rd, Guis	Roadside
	White Street	Near Road		Loftus Library	Roadside
	Alexander Terrace	Near Road		Carlin Howe P S	Suburban
	Marton Side Way	Near Road		Saltburn Library	Roadside
	School flagpole Marton	Near Road		Saltburn Police St	Roadside
	School façade, Marton	Near Road		Marske School	Roadside
	The Croft, Marton	Roadside		New Marske	Roadside
	Finchley Court	Near Road		Plantation Road	Roadside
	Acklam Road	Near Road		Kirkleatham Lane	Roadside
	Ashford Avenue	Near Road		KL Redcar Residence	Roadside
	West Lane	Near Road		KL Redcar Road Sign	Roadside
	Dunlane Close	Near Road		Trunk Road Redcar	Roadside
	Linthorpe/Granville Road	Roadside		Cleveland G C	Industry
	Borough Rd Medical Cntre	Near Road		C of E Prim Sch	Suburban
	Crown Square	Near Road		Cherry Trees, Coatham	Suburban
	Centre Square, Albert Rd	Near Road		Wilton Prim Sch	Urban/Industrial
	Newport Road/Wilson Street	(2016)		Barnaby Hse, Eston	Suburban
	Ladgate Lane nr Parkside	(2016)		Cedar Court, Normanby	Suburban
	Breckon Hill AURN	Co-location		Golden Boy Green	Roadside
	Breckon Hill AURN	Co-location		Grangetown C C	Suburban
	Breckon Hill AURN	Co-location		Ormesby Prim Sch	Roadside
				South Bank Trunk Rd	Roadside
				West Lane, Grangetown	Roadside
				Ripon Road, Redcar	Roadside
				Dormanstown	Co-location
				Dormanstown	Co-location
				Dormanstown	Co-location

Lead monitoring stations (annual mean) - non-continuous

There is a National network of heavy metal monitoring stations, mainly based in the major cities but also around known industrial metal processing sites. Upstream / downstream heavy metal monitors were installed during 2008 around the Redcar steelworks, and the lead results from these were given in earlier annual reports, along with a wider selection of results for comparison purposes. These two monitors were removed by Defra at the end of 2013.

Stockton used to monitor airborne lead levels, using a pump and special filter system, at three locations as part of a heavy metal monitoring programme until 2007. The locations were Redmarshall, Eaglescliffe, and Seal Sands. Results were included in earlier annual reports.

National network Polycyclic Aromatic Hydrocarbon (PAH) Station – digital non-continuous

station	start year	comment
Middlesbrough, Breckon Hill	Q4 2007	Measures polycyclic aromatic hydrocarbons (PAHs)

Reporting started January 2008.

PAH was monitored at Longlands College, Middlesbrough, from 1995 to 2007 as part of the National TOMPS (Toxic Organic Micro Pollutants) network. The monitor was in an elevated location and was not a public exposure location, whereas the Breckon Hill location is a public exposure location.

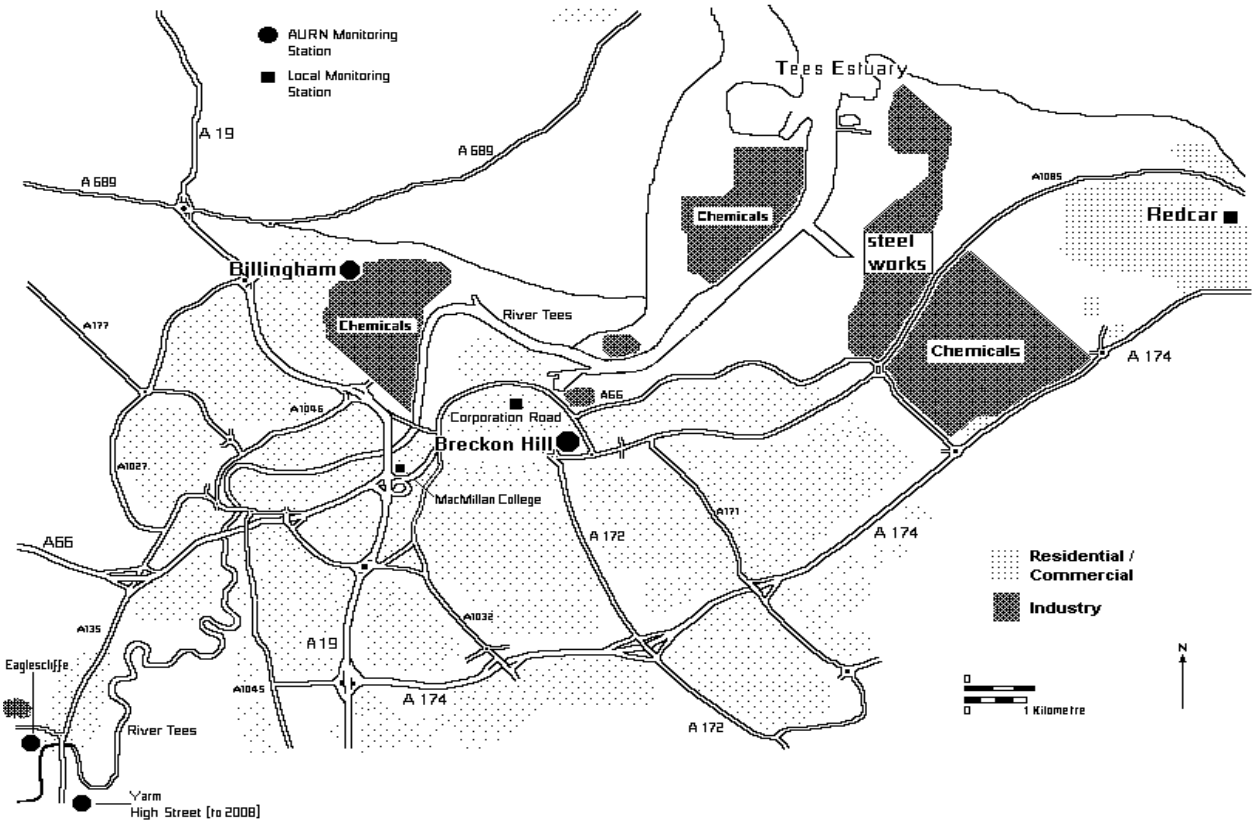
Cadmium, Arsenic, Nickel, Mercury

These elements are not yet part of the UK national air quality strategy, and do not have set UK objectives. The EU has set targets for Cadmium, Arsenic and Nickel.

There is a national network of twenty four industrial and major city sites monitoring annual concentrations in air for up to 13 metals, including Cadmium, Arsenic, Nickel, and Mercury. Following a review of site requirements in 2007, Defra introduced two monitoring locations within the Redcar & Cleveland Council boundary of the Tees Valley, operational from January 2008. The locations are generally upwind and downwind of the main steelworks complex. Defra removed the two monitoring locations at the end of 2013.
A selection of the other results is given for comparative purposes.

Stockton monitored airborne levels of the four elements, Cadmium, Arsenic, Nickel, Mercury, using a pump and special filter system, at three locations as part of a heavy metal monitoring programme until 2007. The locations were Redmarshall, Eaglescliffe, and Seal Sands. Results were included in earlier reports.

STOCKTON, MIDDLESBROUGH and REDCAR



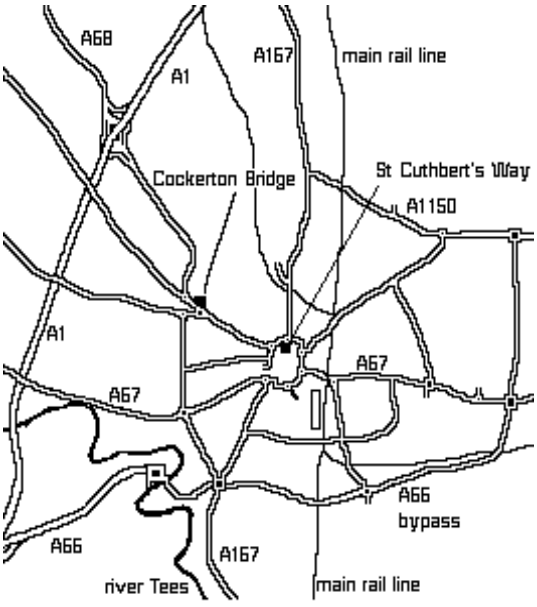
6 stations

Stockton Council
Billingham (AURN / Local)
(Yarm High Street (to October 2008))
Eaglescliffe (AURN / Local from 2009)
A1035 (AURN) from January 2015

Middlesbrough Council
Breckon Hill (AURN)
MacMillan College (Local)
Elm Street, Corporation Road (Local) (to end March 2016)

Redcar & Cleveland Council
(Corporation Road (to December 2011) new monitors 2011)
Dormanstown (Local) from 2012

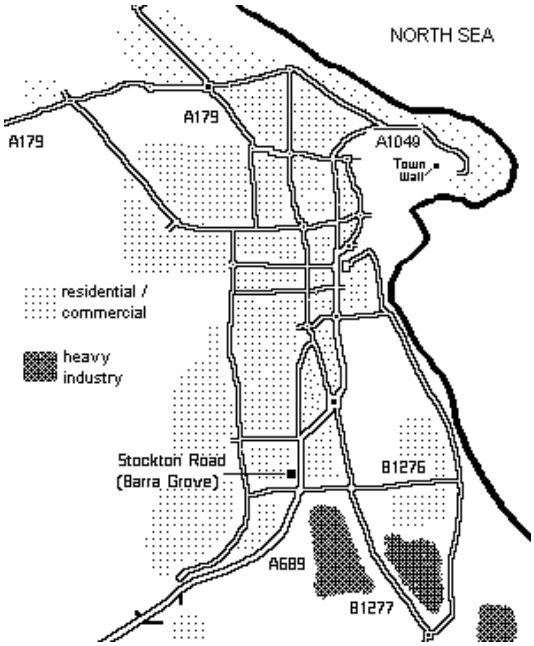
DARLINGTON CENTRAL AREA



local stations – NO2, PM10

St Cuthbert's Way	2000 – 2003, 2005 - 2014
Cockerton Bridge	2004 – 2012

HARTLEPOOL CENTRAL AREA



2 local stations – NO2 (Stockton Road), PM10

Stockton Road	2003 –2007, 2011 -
Headland (Town Wall)	2011 -

LOCATIONS OF FIXED CONTINUOUS MONITORING STATIONS

The maps opposite show the general locations of the fixed monitoring sites relative to residential / commercial properties, and to heavy industry. Darlington does not have any significant heavy industry, and most of the area shown covers residential / commercial land-use.
The sites are generally described below. The older sites have been located close to industrial sites, as they were seen as the major source of air pollution. More recent sites have concentrated on monitoring road traffic emissions, which are now recognised as the main source of air pollution at ground level.

Stockton Council area

Billingham (Cowpen Depot) is one of the earliest AURN nitrogen oxide stations in the country, starting in 1987. It is located in a Council building close to one of the older chemical manufacturing areas that specialises in nitrogen-based technology. The unit is based between the industrial boundary and residential properties, but is not an area of relevant public exposure. Early in 2012, the inlet for the continuous monitor was moved a short distance to minimise the influence of site heavy vehicle movements.
Pollutants monitored as a Local station now also include particulate $PM_{10,}$ and sulphur dioxide, with historical results for ozone to end 2008.

Eaglescliffe started as an AURN station in Q4 2008, having been moved approximately 1 km from the Yarm High Street location. The site is an area of relevant public exposure within school grounds. As an AURN station, the site monitors nitrogen oxides, along with particulates PM_{10} and $PM_{2.5}$. As a Local station, the site monitored ozone to end 2014. The national network pumped diffusion tube monitor for benzene has also been relocated.

A 1035 (Stockton Centre) is a new AURN station started in December 2014. It is a roadside location in an area of relevant public exposure. The site monitors NO_2, and had a particulate $PM_{2.5}$ monitor installed in starting March 2016.

Middlesbrough Council area

Breckon Hill is a long standing (1993) AURN station originally measuring nitrogen oxides, particulate PM_{10}, sulphur dioxide, carbon monoxide and ozone, along with a national network continuous hydrocarbon monitor measuring benzene and 1,3-butadiene amongst others. The hydrocarbon monitor was closed in 2000, replaced by a pumped diffusion tube system monitoring benzene in 2002, and a standard diffusion tube system monitoring 1,3-butadiene in 2003.
In Q4 2008, the station was upgraded to monitor particulate PM_{10} and particulate $PM_{2.5,}$ using gravimetric equivalent instruments (TEOM FDMS).
Following a Defra review of hydrocarbon and PAH monitoring sites in 2007, 1,3-butadiene diffusion tube monitoring was discontinued in August 2007. PAH monitoring started during Q4 2007.
Carbon monoxide monitoring was discontinued by Defra at the end of 2012.

The site is in school grounds and is an area of relevant public exposure. It lies on a north / north-easterly wind direction from the main industrial areas, with a wind from this direction expected about 15% of the year, and contributes to evidence of industrial emissions in addition to traffic emissions. The school is in a residential area, which is surrounded by busy commuter roads.

MacMillan College is a Local station measuring nitrogen oxides and particulate PM_{10}. It is in the grounds of a school, and is an area of relevant public exposure. The site is within 250 metres of the main A19 and A66 trunk routes, which have high, but relatively free flowing, traffic flows.
Industrial sources of pollution are a few kilometres away. The site was temporarily closed at the end of October 2015, but re-opened for April 2016 using the Elm Street monitors.

Elm Street (Corporation Road) is a Local station measuring nitrogen oxides and particulate PM_{10}. It is in the heart of Middlesbrough, close to the town hall and shopping centre, but is only an area of relevant public exposure for the nitrogen dioxide 1 hour mean. Road traffic is slow moving, and levels measured are typical of the town centre.
Industrial sources of pollution are a few kilometres away. The site was closed in March 2016, with the monitors transferred to MacMillan College above, which has relevant public exposure.

LOCATIONS OF FIXED CONTINUOUS MONITORING STATIONS (continued)

Redcar & Cleveland Council area

Dormanstown is the new (2012) location for Redcar & Cleveland monitoring following the closure of the local college on Corporation Road, approximately 1.5 km to the east. The site is classed suburban / industrial, is within school grounds and is an area of relevant public exposure. It has relatively light traffic, but is generally on the prevailing (70% of the year) wind direction and is within 4 km of the main industrial chemical and steel complexes. It is a key site for monitoring industrial source pollution and for coastal ozone levels.
The station monitors nitrogen oxides, particulate PM_{10} (TEOM to October 2012), sulphur dioxide and ozone. The unmodified TEOM failed beyond repair at the end of September 2012, and has been replaced with a new BAM monitor early in 2013.

Corporation Road was a long standing (1997) AURN station measuring nitrogen oxides, particulate PM_{10}, sulphur dioxide, carbon monoxide and ozone. It was later expanded (1998) as a Local station with a continuous hydrocarbon monitor measuring benzene and 1,3-butadiene amongst others. The site was in the grounds of a local college (now closed) and was in an area of relevant public exposure. The area was suburban, with relatively light traffic, but was generally on the prevailing (70% of the year) wind direction and within 4 km of the main industrial chemical and steel complexes. It was a key site for monitoring industrial source pollution.
Following a Defra review of AURN stations in 2007, this site was removed from the AURN network at the end of September 2007. Redcar & Cleveland Council continued the site as a Local site, monitoring nitrogen oxides, particulate PM_{10} (TEOM), sulphur dioxide and ozone, with carbon monoxide monitoring discontinued in April 2010.
The hydrocarbon Local monitor had operational and resource problems during 2005 – 2007, with no results available. The monitor was finally closed in January 2008.

Darlington Council area

St Cuthbert's Way is a Local station measuring nitrogen oxides and particulate PM_{10}. The site is on the edge of the main shopping area, at a kerbside location on the busy inner ring road where traffic is generally slow moving at a major roundabout. The site is an area of relevant public exposure for the nitrogen dioxide 1hour mean. Early in January 2015, the two monitors failed and there have been no results for 2015. The future of the station is under review.

Cockerton Bridge was a Local station measuring nitrogen oxides and particulate PM_{10} from 2004 to 2012. It was a roadside location on one of the main radial routes to the town centre. Traffic is heavy, but relatively free flowing. It was not in an area of relevant public exposure, but lay between the kerbside and residential property set further back. Early in April 2012, the two monitors failed beyond economical repair and the station has been closed. A nearby roadside NO_2 diffusion tube on Woodland Road continues to operate.

Hartlepool Council area

Stockton Road (Barra Grove) started May 2003, having been moved from a Seaton Carew site. The station originally measured nitrogen oxides, particulate PM_{10}, sulphur dioxide and carbon monoxide, and is a roadside location on the main dual carriageway into town centre. Traffic is relatively heavy, but free flowing. It is not an area of relevant public exposure, but lies between the kerbside and residential property set further back.

The site has had a series of operational difficulties since 2005, with limited results for 2006 / 7 and no results for 2008 or 2009. This station was replaced in November 2010 with a new nitrogen oxides / particulate PM_{10} (BAM) unit. Following commissioning work, results started January 2011.

Town Wall (Headland) is a new Local station started November 2010 monitoring particulate PM_{10} (BAM) on Town Wall, which is opposite the working area of the port. Following commissioning work, results started January 2011.

AIR QUALITY BANDING 2012

pollutants

health effects

banding boundaries

analysis by readings

analysis by percentage of total readings

AIR QUALITY BANDING (as modified for 2012 onwards)

Air pollution forecasting uses a low – moderate – high banding system (see below) to advise the public of potential health risks associated with five common air pollutants. Any short-term air pollutant concentration forecast in the moderate band or above associated with these air pollutants may pose a health risk to sensitive individuals, although only forecasts in the high band would require action by the individual.
Actual pollution concentrations over a year also form part of the air quality indicator published by the Government, which provides a measure of annual air quality and trends, and it is this analysis of Tees Valley monitoring results which is shown here.

The five pollutants are:

Pollutant	**Averaging Period**
nitrogen dioxide	1hour mean
sulphur dioxide	15minute mean
particulate PM_{10}	24hour mean
particulate $PM_{2.5}$	24hour mean
ozone	8hour running mean

Of these five pollutants, particulate PM2.5 is a recent pollutant in the Air Quality Strategy and is not yet a regulated pollutant. Ozone is also not regulated in view of the complexity of its formation within the atmosphere.

Health Effects

Band	**Index**	**Health Effects**
Low	1 - 3	Effects are unlikely to be noticed even by individuals who know they are sensitive to air pollutants.
Moderate	4 - 6	Mild effects, unlikely to require action, may be noticed amongst sensitive individuals.
High	7 - 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

Banding Boundaries for each pollutant

Index	**Ozone**	**Nitrogen Dioxide**	**Sulphur Dioxide**	**PM_{10} Particles**	**$PM_{2.5}$ Particles**
	8 hourly or hourly mean	**hourly mean**	**15 minute mean**	**24 hour mean**	**24 hour mean**
	μgm^3	μgm^3	μgm^3	μgm^3 (gravimetric equivalent)	μgm^3 (gravimetric equivalent)
	2012	**2012**	**2012**	**2012**	**2012**
1	0-33	0-66	0-88	0-16	0-11
2	34 - 65	67-133	89-176	17-33	12-23
3	66 - 99	134-199	177-265	34-49	24-34
4	100 - 120	200-267	266-354	50-58	35-41
5	121 - 140	268-334	355-442	59-66	42-46
6	141 - 159	335-399	443-531	67-74	47-52
7	160-187	400-467	532-708	75-83	53-58
8	188-213	468-534	709-886	84-91	59-64
9	214-239	535-599	887-1063	92-99	65-69
10	240 or more	600 or more	1064 or more	100 or more	70 or more

The banding analysis for 2015 is shown below, and compared with the analysis of data for the previous three years.

		Nitrogen Dioxide 1hr Mean			
		2015	2014	2013	2012
No of Monitors		8	8	8	9
Readings		62048	60078	68296	69830
Low	1	61345	59052	65622	67237
	2	702	1021	2502	2275
	3	1	5	168	104
	Total	62048	60078	68292	69628
Moderate	4	0	0	4	2
	5	0	0	0	0
	6	0	0	0	0
	Total	0	0	4	2
High	7	0	0	0	0
	8	0	0	0	0
	9	0	0	0	0
	Total	0	0	0	0
Very High	10	0	0	0	0

		Sulphur Dioxide 15min Mean			
		2015	2014	2013	2012
No of Monitors		3	3	3	3
Readings		100596	96023	93964	91550
Low	1	100593	95997	93894	91523
	2	3	24	70	27
	3	0	2	0	0
	Total	100596	96023	93964	91550
Moderate	4	0	0	0	0
	5	0	0	0	0
	6	0	0	0	0
	Total	0	0	0	0
High	7	0	0	0	0
	8	0	0	0	0
	9	0	0	0	0
	Total	0	0	0	0
Very High	10	0	0	0	0

		Particulate PM_{10} 24hr Mean			
		2015	2014	2013	2012
No of Monitors		8	9	9	10
Readings		2702	2987	3048	2937
Low	1	1323	1349	1189	1322
	2	1154	1299	1473	1244
	3	179	283	313	289
	Total	2656	2931	2975	2855
Moderate	4	29	29	35	53
	5	13	16	15	20
	6	4	7	9	7
	Total	46	52	59	80
High	7	0	3	11	2
	8	0	0	3	0
	9	0	0	0	0
	Total	0	3	14	2
Very High	10	0	1	0	0

		Particulate $PM_{2.5}$ 24hr Mean			
		2015	2014	2013	2012
No of Monitors		2	2	2	2
Readings		651	700	619	707
Low	1	467	457	519	501
	2	135	167	82	146
	3	29	54	12	39
	Total	631	678	613	686
Moderate	4	8	11	0	8
	5	2	2	5	9
	6	6	2	1	1
	Total	16	15	6	18
High	7	1	4	0	1
	8	1	2	0	2
	9	0	0	0	0
	Total	2	6	0	3
Very High	10	1	1	0	0

		Ozone 8hr Running Mean			
		2015	2014	2013	2012
No of Monitors		2	3	3	3
Readings		16738	24607	21981	24722
Low	1	3358	6318	3987	5170
	2	10575	14415	12045	14114
	3	2719	3778	5912	4144
	Total	16652	24511	21944	24627
Moderate	4	62	90	37	90
	5	23	6	5	5
	6	1	0	0	0
	Total	86	96	37	95
High	7	0	0	0	0
	8	0	0	0	0
	9	0	0	0	0
	Total	0	0	0	0
Very High	10	0	0	0	0

Comment:

Sulphur dioxide and nitrogen dioxide levels are consistently in the low band.

Particulate PM_{10} and $PM_{2.5}$ levels are mainly in the low band, with some excursions into the moderate band at times of particulate episodes, normally continental in origin, that affect large parts of the UK from time to time on easterly winds. An occasional excursion into the high / very high band may occur.

Ozone levels are also mainly in the low band, with some excursion into the lower end of the moderate band at times of hot sunny weather.

In terms of percentages of total readings, the analysis becomes

%		Nitrogen Dioxide 1hr Mean			
		2015	2014	2013	2012
No of Monitors		8	8	8	9
Readings		62048	60078	68296	69830
Low	1	98.86	98.29	96.08	96.29
	2	1.13	1.70	3.66	3.26
	3	<0.01	<0.01	0.25	0.17
	Total	100.00	100.00	99.99	99.71
Moderate	4	0	0	<0.01	<0.01
	5	0	0	0	0
	6	0	0	0	0
	Total	0	0	<0.01	<0.01
High	7	0	0	0	0
	8	0	0	0	0
	9	0	0	0	0
	Total	0	0	0	0
Very High	10	0	0	0	0

%		Sulphur Dioxide 15min Mean			
		2015	2014	2013	2012
No of Monitors		3	3	3	3
1550Readings		100596	96023	93964	91550
Low	1	100.00	99.97	99.93	99.97
	2	<0.01	0.02	0.07	0.03
	3	0	<0.01	0	0
	Total	100.00	100.00	100.00	100.00
Moderate	4	0	0	0	0
	5	0	0	0	0
	6	0	0	0	0
	Total	0	0	0	0
High	7	0	0	0	0
	8	0	0	0	0
	9	0	0	0	0
	Total	0	0	0	0
Very	10	0	0	0	0

%		Particulate PM_{10} 24hr Mean			
		2015	2014	2013	2012
No of Monitors		8	9	9	10
Readings		2702	2987	3048	2837
Low	1	48.96	45.16	39.01	45.01
	2	42.71	43.49	48.33	42.36
	3	6.62	9.48	10.27	9.84
	Total	98.30	98.13	97.47	97.21
Moderate	4	1.07	0.97	1.15	1.80
	5	0.48	0.54	0.49	0.68
	6	0.15	0.23	0.30	0.24
	Total	1.70	1.74	1.94	2.72
High	7	0	0.10	0.36	0.07
	8	0	0	0.10	0
	9	0	0	0	0
	Total	0	0.10	0.46	0.07
Very High	10	0	0.03	0	0

%		Particulate $PM_{2.5}$ 24hr Mean			
		2015	2014	2013	2012
No of Monitors		2	2	2	2
Readings		649	700	619	707
Low	1	71.96	65.29	83.84	70.86
	2	20.80	23.86	13.25	20.65
	3	4.47	7.71	1.94	5.52
	Total	97.23	96.86	99.03	97.03
Moderate	4	1.23	1.57	0	1.13
	5	0.31	0.29	0.81	1.27
	6	0.92	0.29	0.16	0.14
	Total	2.46	2.15	0.97	2.55
High	7	0.15	0.57	0	0.14
	8	0.15	0.29	0	0.28
	9	0	0	0	0
	Total	0.30	0.86	0	0.42
Very High	10	0	0.13	0	0

%		Ozone 8hr Running Mean			
		2015	2014	2013	2012
No of Monitors		2	3	3	3
Readings		16738	24607	24722	20926
Low	1	20.06	25.68	18.14	20.91
	2	63.18	58.58	54.80	57.09
	3	16.24	15.35	26.90	21.61
	Total	99.48	99.61	99.83	99.62
Moderate	4	0.37	0.37	0.17	0.36
	5	0.14	0.02	0	0.02
	6	<0.01	0	0	0
	Total	0.51	0.39	0.17	0.38
High	7	0	0	0	0
	8	0	0	0	0
	9	0	0	0	0
	Total	0	0	0	0
Very High	10	0	0	0	0

Comment:

Nitrogen dioxide and sulphur dioxide air quality is consistently very good, with no significant impact on public health, even for sensitive individuals.

Ozone levels have less than 0.6% of days in the lower end of the moderate band, and with no high band readings. While mild effects may be felt during good weather summers by sensitive individuals, no action is needed.

Particulate concentrations have more of a spread across the bands, with up to 3% days in the moderate band, and an occasional excursion into the high bands. This spread is due to the wider range of sources, some natural, and a greater dependency on prevailing weather conditions. The moderate / high band levels tend to be associated with episodes affecting much of the UK, and are normally well publicised nationally.

MONITORING RESULTS AND ANALYSIS

nitrogen dioxide annual mean
nitrogen dioxide 1 hour mean
particulate PM_{10} annual mean
particulate PM_{10} 24 hour mean
particulate $PM_{2.5}$ annual mean
sulphur dioxide 24 hour mean
sulphur dioxide 1 hour mean
sulphur dioxide 15 minute mean
carbon monoxide 8 hour running mean
benzene running annual mean
1,3-butadiene running annual mean
lead annual mean

ozone 8 hour running mean and day exceedance
polycyclic aromatic hydrocarbons (PAHs) annual mean

NITROGEN DIOXIDE

Annual mean objective (2005) **maximum 40 µg/m³** **no exceedances**

Continuous monitoring stations - all results µg/m³ as the annual mean

AURN Stations	2015	2014	2013	2012
Stockton, Billingham (1987) (Cowpen Depot)	19	22	20	21
Middlesbrough (1993) (Breckon Hill)	16	17 #	16	18
Stockton (2009) (Eaglescliffe)	14	16	16	18
Stockton (2015) (A1035)	19	-	-	-

2014 annual mean modified from 20 to 17 in September 2015 due possible monitor fault February to June 2014

Local Stations	2015	2014	2013	2012
Darlington (2001) (St Cuthbert's Way) No results 2015	-	36	**48**	**45**
Darlington (2004 - 2012) (Cockerton Bridge) **closed**	-	-	-	30
Hartlepool (2003 – 2007, 2010) (Stockton Road)	16 *	20 *	20	19
Middlesbrough (2000) (MacMillan College)	25	25	21	20
Middlesbrough (2001) (Elm Street)	22	23	22	25
Redcar (2012) (Dormanstown)	13	13	13	16

* - less than 6 months data. Data annualised using Redcar Dormanstown; Stockton Eaglescliffe and Middlesbrough MacMillan continuous monitors.

NITROGEN DIOXIDE **continuous monitors**

Objective 1 of 2: Annual mean of 40 µg/m³ (21 ppb) maximum, with no exceedances

Relevant Exposure is where members of the public may be exposed to levels of nitrogen dioxide above 40 µg/m³ as an annual mean by December 31st 2005.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence; gardens of residential properties; kerbside sites (as opposed to locations at the building façades), or any other location where public exposure is likely to be short term.

Sources

Nitric oxide (NO) is mainly derived from road transport emissions and other combustion processes such as the electricity supply industry. Nitric oxide is not considered to be harmful to health. However, once released to the atmosphere, NO is usually very rapidly oxidised, mainly by ozone (O_3), to nitrogen dioxide (NO_2), which can be harmful to health. NO_2 and NO are both oxides of nitrogen and together are referred to as nitrogen oxides (NO_x).

Results (see opposite)

The results from the fixed AURN and Local monitors show a good degree of consistency on a year by year basis, but with no clear signs that nitrogen dioxide levels are reducing. 2015 results have generally shown similar levels to 2014, with variations entirely due to changes in weather conditions.

The Darlington (St Cuthbert's Way, closed December 2014) site was the only town centre kerbside site within the Tees Valley, and continued to demonstrate the significant effect that slow moving, heavy traffic has on ground level concentrations of nitrogen dioxide. The Darlington site showed a significant exceedance of the objective in 2013 as a result of Q1 weather conditions in the area, but is not an area of relevant public exposure, the nearest one being over 20 metres away. Earlier DMRB modelling of the nearest public exposure location comfortably demonstrated no exceedances, and the LAQM distance calculator indicated a maximum 2014 annual mean of 29 µg/m^3, well within the objective level. 2014 levels fell below the objective level for the first time, mainly due to the poor weather conditions.

The Middlesbrough (Elm Street), Darlington (Cockerton Bridge, closed April 2012), and Stockton (Eaglescliffe) sites are also close to heavy traffic, but are set back from kerbside towards the building line. The results show that nitrogen dioxide levels normally quickly fall with distance from kerbside as long as there is a generally open aspect. This is confirmed by results at the Middlesbrough Breckon Hill and MacMillan College sites, both of which are public exposure locations in areas generally surrounded by roads with heavy traffic, but with lower nitrogen dioxide levels which are comfortably within the objective level.

The Redcar (Dormanstown) site is an urban background site with significantly less traffic in the vicinity, reflected in the lower nitrogen dioxide levels. These levels, at around half of the objective level, are likely to represent those to be found at most public exposure locations in the Tees Valley. The Redcar site also shows no sign of any significant contribution to ground level concentrations from industrial sources along the river estuary.

Overall, road traffic is the major source of nitrogen dioxide at ground level within the Tees Valley. The generally open aspect of the road system and trunk road corridors means that areas where public exposure may be present will have nitrogen dioxide levels well below the objective.

Health effects : Long term exposure to nitrogen dioxide may affect lung function, and enhance the response to allergens in sensitised individuals.

NITROGEN DIOXIDE (diffusion tube sites Darlington, Hartlepool and Stockton-on-Tees)

Annual mean objective (2005) maximum 40 µg/m³ no exceedances

Diffusion tube sites - all results µg/m³ as the annual mean. Darlington 2015 results adjusted by laboratory overall bias factor (June 2015). Stockton and Hartlepool results adjusted by two triple co-location studies at Stockton. Tubes all 50% TEA in acetone.

			2015	2014	2013	2012
Darlington (Gradko Laboratory)		bias factor	0.96	0.98	1.01	1.02
National Survey sites						
	D1 Northgate	kerbside	33	34	36	**40**
	D4 Salters Lane	kerbside	30	31	34	37
	D2 Darlington College	background	13	17	18	19
	D3 Arts Centre	background	11	14	14	14
Local sites						
	D5 Woodland Road	roadside *	25	29	29	33
	D6 Blackwell Bridge	roadside *	38	38	35	32
	D7 North Road Station	kerbside	35	31	33	33
	D8 Haughton Green	kerbside	33	36	36	38
	D9 Yarm Road	kerbside	24	27	26	29
	D10 Middleton One-Row	kerbside	8	9	10	10

* Diffusion tube location set back from kerbside from 2011 to be more representative of relevant public exposure

		2015	2014	2013	2012
Hartlepool (ESG Harwell)	bias factor	0.82	0.80	0.75	0.77
Local sites					
H1 Powlett Road	roadside	14 (5mths)	14(5mths)	15 (9mths)	19 (5mths)
H2 Catcote Road	roadside	-	18 (5mths)	19 (9mths)	25 (5mths)
H3 Fens Crescent	roadside	16 (6mths)	14 (6mths)	17 (9mths)	21 (5mths)
H4 King Oswy Drive	roadside	15 (6mths)	14 (6mths)	18 (4mths)	-

2014 data annualised using Redcar Dormanstown; Stockton Eaglescliffe AURN; Middlesbrough MacMillan College continuous monitoring satations.

			2015	2014	2013	2012
Stockton (ESG Harwell)		bias factor	0.82	0.79	0.75	0.77
National Survey sites						
	S13 Prince Regent Street	kerbside	**44**	**41**	**41**	**45**
	S15 Wellington Street	kerbside	21	24	22	25
	S12 Dovecot Street	background	20	23	21	23
	S16 Clifton Avenue	background	14	14	14	17
Local sites						
	S1 Yarm High Street kerbside	kerbside	29	32	35	35
	S2 Yarm High Street set back	shop front	29	29	28	28
	S5 Thornaby Road	roadside	16	17	16	17
	S14 Prince Regent Street set back		27	31	30	31
	S20 New Rd (Billingham)		20	21	19	20
	S22 Long Newton		14	15	15	15
	S23 Norton (South Road)		26	27	30	29
	BASF3 BASF (Seal Sands)		23	22	21	23
	S4c Cowpen Depot Perim.		18	20	19	20
	S3 Eaglescliffe AURN (3)*	roadside	15	16	16	18
	S4 Billingham AURN (3)*		19	22	20	21
	(* Triple collocation studies with continuous monitor)					

NITROGEN DIOXIDE **diffusion tubes (**sites Darlington, Hartlepool and Stockton-on-Tees)

Objective 1 only : Annual mean of 40 µg/m³ (21 ppb) maximum, with no exceedances

Relevant Exposure is where members of the public may be exposed to levels of nitrogen dioxide above 40 µg/m³ as an annual mean by December 31st 2005.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence; gardens of residential properties; kerbside sites (as opposed to locations at the building façades), or any other location where public exposure is likely to be short term.

Sources

Nitric oxide (NO) is mainly derived from road transport emissions and other combustion processes such as the electricity supply industry. Nitric oxide is not considered to be harmful to health. However, once released to the atmosphere, NO is usually very rapidly oxidised, mainly by ozone (O_3), to nitrogen dioxide (NO_2), which can be harmful to health. NO_2 and NO are both oxides of nitrogen and together are referred to as nitrogen oxides (NO_x).

Results (see opposite)

Diffusion tubes are inherently less accurate than continuous monitors, but are a cost-effective way to measure annual averages of nitrogen dioxide over a wider area. Within the Tees Valley, they are mainly used to identify potential hot-spots of air pollution for further investigation. There is evidence that diffusion tubes at kerbside sites tend to read up to 20% higher than continuous monitors, and tend to be affected by prolonged calm weather conditions.

These three Tees Valley Councils have used diffusion tubes for many years.

Kerbside sites, where there tends to be slow moving or frequently stationary traffic, show the highest levels. While some site measurements show an exceedance of the objective level, they are not areas of relevant public exposure. However, the sites were further investigated using the DMRB air quality model in 2005. Results consistently showed that kerbside diffusion tubes read significantly higher than continuous monitors. The highest kerbside site reading in 2014 (full year results) was Prince Regent Street in Stockton centre at 42 µg/m³. A new diffusion tube site was set back towards residential areas in 2007, and for 2014 has again shown a substantially lower reading of 31 µg/m³. This confirms the quick fall off in NO_2 concentrations away from kerbside. This is also reflected in the 2015 Darlington results. Two diffusion tube sites were moved from kerbside to roadside (approximately 5 metres) at the end of 2010, and the annual mean at one site has since fallen by up to 5 µg/m³ to a level well below the objective level.

Other roadside and intermediate sites, which are set back further from the kerbside and more representative of relevant public exposure, have lower levels that are comfortably within the objective level. These results were also closer to continuous monitor levels than those from the kerbside sites.

Background sites tend to be consistently well below the objective level.

Overall, the results from each Council are similar at the various category of site. With diffusion tubes tending to read high, particularly at kerbside sites, and the expectation of reducing nitrogen oxide emissions from vehicles, there have been no areas of relevant public exposure identified where the objective will be exceeded.

Health effects : Long term exposure to nitrogen dioxide may affect lung function, and enhance the response to allergens in sensitised individuals.

NITROGEN DIOXIDE (diffusion tube sites Middlesbrough and Redcar & Cleveland)

Annual mean objective (2005) **maximum 40 µg/m³** **no exceedances**

Diffusion tube sites - all results µg/m³ as the annual mean. Middlesbrough and Redcar & Cleveland results are adjusted by triple co-location studies. Tubes all 50% TEA in acetone.

		2015	2014	2013	2012
Middlesbrough (Gradko Laboratory)	bias factor	0.945	-	-	-

Local sites						
M1	Alphonsus Street	Background	15.5	-	-	-
M2	Saxon Close	Near Road	17.9	-	-	-
M3	White Street	Near Road	26.6	-	-	-
M4	Alexander Terrace	Near Road	21.4	-	-	-
M5	Marton Side Way	Near Road	14.9	-	-	-
M6	School flagpole Marton	Near Road	17.1	-	-	-
M7 #	School façade, Marton	Near Road	17.6	-	-	-
M8	The Croft, Marton	Roadside	17.8	-	-	-
M9	Finchley Court	Near Road	17.5	-	-	-
M10	Acklam Road	Near Road	15.6	-	-	-
M11	Ashford Avenue	Near Road	22.5	-	-	-
M12	West Lane	Near Road	22.0	-	-	-
M13	Dunlane Close	Near Road	22.9	-	-	-
M14	Linthorpe/Granville Road	Roadside	27.3	-	-	-
M15	Borough Rd Medical Cntre	Near Road	19.8	-	-	-
M16	Crown Square	Near Road	33.2	-	-	-
M17	Centre Square, Albert Rd	Near Road	24.3	-	-	-
M18(2016)	Newport Road/Wilson Street	-	-	-	-	-
M19(2016)	Ladgate Lane nr Parkside	-	-	-	-	-
M20 *	Breckon Hill AURN	Background	16.3	-	-	-
M21 *	Breckon Hill AURN	Background	15.5	-	-	-
M22 *	Breckon Hill AURN	Background	16.7	-	-	-
(* Triple collocation studies with continuous monitor, calculated bias factor 0.945)						
# Data annualised using three continuous monitoring locations, see 2016 Annual Status Report for 2016						

		2015	2014 #	2013	2012
Redcar& Cleveland (Gradko Laboratory)	bias factor	1.014	1.05	-	-

Local sites						
RO1	Westgate, Guis	Roadside	15.0	16.7	-	-
RO2	Redcar Rd, Guis	Roadside	12.2	12.8	-	-
RO3	Loftus Library	Roadside	12.9	13.9	-	-
RO4	Carlin Howe P S	Suburban	7.8	8.9	-	-
RO5	Saltburn Library	Roadside	14.2	19.8	-	-
RO6	Saltburn Police St	Roadside	11.0	11.4	-	-
RO7	Marske School	Roadside	14.5	15.3	-	-
RO8	New Marske	Roadside	12.3	12.5	-	-
RO9	Plantation Road	Roadside	29.8	33.1	-	-
R10	Kirkleatham Lane	Roadside	23.0	22.6	-	-
R11	KL Redcar Residence	Roadside	17.2	18.6	-	-
R12	KL Redcar Road Sign	Roadside	18.4	22.1	-	-
R13	Trunk Road Redcar	Roadside	21.4	22.8	-	-
R14	Cleveland G C	Industry	13.0	15.6	-	-
R15	C of E Prim Sch	Suburban	15.4	16.4	-	-
R16	Cherry Trees, Coatham	Suburban	15.9	16.2	-	-
R20	Wilton Prim Sch	Urban/Industrial	10.5	12.7	-	-
R21	Barnaby Hse, Eston	Suburban	14.0	13.4	-	-
R22	Cedar Court, Normanby	Suburban	13.2	14.4	-	-
R23	Golden Boy Green	Roadside	17.6	21.9	-	-
R24	Grangetown C C	Suburban	12.9	14.7	-	-
R25	Ormesby Prim Sch	Roadside	12.7	14.5	-	-
R26	South Bank Trunk Rd	Roadside	21.9	23.1	-	-
R27	West Lane, Grangetown	Roadside	30.0	30.6	-	-
R28	Ripon Road, Redcar	Roadside	8.0	10.9	-	-
R17 *	Dormanstown	Co-location	12.7	-	-	-
R18 *	Dormanstown	Co-location	12.5	-	-	-
R19 *	Dormanstown	Co-location	12.2	-	-	-
(* Triple collocation studies with continuous monitor, calculated bias factor 1.014)						
# Data annualised using three continuous monitoring locations, see 2015 Updating and Screening report for Redcar & Cleveland						

NITROGEN DIOXIDE **diffusion tubes (**sites Middlesbrough and Redcar & Cleveland)

Objective 1 only : Annual mean of 40 µg/m³ (21 ppb) maximum, with no exceedances

Relevant Exposure is where members of the public may be exposed to levels of nitrogen dioxide above 40 µg/m³ as an annual mean by December 31st 2005.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence; gardens of residential properties; kerbside sites (as opposed to locations at the building façades), or any other location where public exposure is likely to be short term.

Sources

Nitric oxide (NO) is mainly derived from road transport emissions and other combustion processes such as the electricity supply industry. Nitric oxide is not considered to be harmful to health. However, once released to the atmosphere, NO is usually very rapidly oxidised, mainly by ozone (O_3), to nitrogen dioxide (NO_2), which can be harmful to health. NO_2 and NO are both oxides of nitrogen and together are referred to as nitrogen oxides (NO_x).

Results (see opposite)

Diffusion tubes are inherently less accurate than continuous monitors, but are a cost-effective way to measure annual averages of nitrogen dioxide over a wider area. Within the Tees Valley, they are mainly used to identify potential hot-spots of air pollution for further investigation. There is evidence that diffusion tubes at kerbside sites tend to read up to 20% higher than continuous monitors, and tend to be affected by prolonged calm weather conditions.

The remaining two Tees Valley Councils, Redcar & Cleveland in July 2014 and Middlesbrough in 2015, have undertaken significant surveys across their area, and this will be continued, with some modifications, for 2016.

Under latest diffusion tube location guidance, kerbside sites are generally replaced by roadside locations which are more representative of relative public exposure. Those roadside sites where there tends to be slow moving or frequently stationary traffic, as expected, show the highest levels, but all locations have shown no exceedance of the objective. Indeed, many of the locations were investigated using the DMRB air quality model in 2005 and confirmed a quick fall off in NO_2 concentrations away from kerbside.

Other intermediate sites, which are set back further from the roadside and more representative of relevant public exposure, have lower levels that are comfortably within the objective level. These results were also closer to continuous monitor levels than those from the roadside sites.

Background sites tend to be consistently well below the objective level.

Overall, the results from each Council are similar at the various category of site. With the expectation of reducing nitrogen oxide emissions from vehicles, there have been no areas of relevant public exposure identified where the objective will be exceeded.

Health effects : Long term exposure to nitrogen dioxide may affect lung function, and enhance the response to allergens in sensitised individuals.

NITROGEN DIOXIDE

1 hour mean objective (2005) **maximum 200 µg/m³** **maximum 18 exceedances / year**

Continuous monitoring stations - all results µg/m³ as the maximum of 1 hour means

(any exceedances are shown in brackets)

Figures shown below the 1 hour maximums are the 99.8th percentile of the 1 hour means, which provides a direct comparison with the objective level.

AURN Stations		2015	2014	2013	2012
Stockton, Billingham (1987) (Cowpen Depot)	99.8 %ile	134 89	146 90	196 102	205 (1) 119
Middlesbrough (1993) (Breckon Hill)	99.8 %ile	84 69	87 65 #	111 78	96 78
Stockton (2009) (Eaglescliffe)	99.8 %ile	114 84	132 93	116 91	157 103
Stockton (2015) (A1035)	99.8 %ile	124 88	- -	- -	- -

2014 99.8th percentile modified from 72 to 65 in September 2015 due possible monitor fault February to June 2014

Local Stations		2015	2014	2013	2012
Darlington (2001) (St Cuthbert's Way) No results 2015	99.8 %ile	- -	159 (0) 98	256 (3) 172	214 (1) 166
Darlington (2004 - 2012) (Cockerton Bridge) **closed**	99.8 %ile	- -	- -	- -	107 * 97
Hartlepool (2003 – 2007, 2010) (Stockton Road)	99.8 %ile	89 * 78	95 * 72	94 81	93 78
Middlesbrough (2000) (MacMillan College)	99.8 %ile	107 80	101 80	122 92	111 80
Middlesbrough (2001) (Elm Street)	99.8 %ile	122 94	124 86	118 90	124 92
Redcar (2012) (Dormanstown)	99.8 %ile	75 55	75 59	94 62	86 72

*** - less than 6 months data**

NITROGEN DIOXIDE **continuous monitors**

Objective 2 of 2: 1 hour mean of 200 µg/m³ (105 ppb) maximum, with up to 18 exceedances per year

Relevant Exposure is where members of the public may be exposed to levels of nitrogen dioxide above 200 µg/m³ as a 1 hour mean by December 31st 2005.

This includes all outdoor locations where members of the public might be regularly exposed, the gardens of residential properties, any outdoor locations to which the public might reasonably be expected to spend one hour or more, kerbside sites (eg pavements of busy shopping streets), those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, and the building façades of residential properties, schools, hospitals, care homes, hotels etc.

Generally excluded are kerbside sites where the public would not be expected to have regular access.

Sources

Nitric oxide (NO) is mainly derived from road transport emissions and other combustion processes such as the electricity supply industry. Nitric oxide is not considered to be harmful to health. However, once released to the atmosphere, NO is usually very rapidly oxidised, mainly by ozone (O_3), to nitrogen dioxide (NO_2), which can be harmful to health. NO_2 and NO are both oxides of nitrogen and together are referred to as nitrogen oxides (NO_x).

Results (see opposite)

1 hour means can only be measured by continuous monitors.

Although an occasional exceedance of the objective level is seen from time to time at the Stockton (Eaglescliffe) and Darlington (St Cuthbert's Way) roadside / kerbside sites, the frequency is low and shows that high traffic volumes in open locations rarely cause a 1 hour exceedance. The Stockton (Billingham) site however is now a well-used HGV depot, very much influenced by stationary vehicles early morning, which causes a rapid build-up of NO2 levels when the weather is cold. This site is not an area of relevant public exposure. For 2012, the monitor inlet has been moved to an area less influenced by truck movements, reflected in significantly lower concentrations since then.

A better measure is to look at the 99.8th percentile of the 1 hour means. This is the level above which there would have been 18 higher values over the year, and is thus a direct comparison with the objective level. Most stations have seen erratic results due to weather conditions, but all have the 99.8th percentile comfortably within the objective level, with those away from roadside locations less than half of the objective level.

The Darlington (St Cuthbert's) Way site is the worst case kerbside site for the whole of the Tees Valley, and shows that while road traffic can cause elevated 1 hour means, concentrations remain well within the objective.

The Stockton (Billingham) site has historically shown the highest percentiles. This has now been confirmed as being due to the adjacent HGV depot having a significant influence, particularly in cold weather. As mentioned above, the monitor inlet was moved a short distance starting 2012 (approved by the AURN network) in order to minimise the influence of local HGV movements, resulting in significantly lower percentiles.

The results from the Middlesbrough (Breckon Hill) and Redcar (Dormanstown) stations confirm that nitrogen oxide emissions from tall stacks along the estuary do not impact greatly on ground level concentrations.

Health effects : Short term exposure to high levels of nitrogen dioxide can cause inflammation of the airways, and enhance the response to allergens in sensitised individuals.

PARTICULATE PM_{10}

Annual mean objective (2005) **maximum 40 µg/m³ (gravimetric)** **no exceedances**

Continuous monitoring stations - all results µg/m³ (gravimetric) as the annual mean

AURN Stations	2015	2014	2013	2012
Gravimetric method	TEOM FDMS	TEOM FDMS	TEOM FDMS	TEOM FDMS
Middlesbrough (1993) (Breckon Hill)	17	16 *	20	17
Gravimetric method	BAM	BAM	BAM	BAM
Stockton (2008) (Eaglescliffe)	16	17	17	16

* - 9 months data only. Data annualised using Stockton Eaglescliffe AURN continuous monitor.

Local Stations	2015	2014	2013	2012
Gravimetric method	VCM Hartlepool / Redcar BAM	VCM Hartlepool / Redcar BAM	VCM Hartlepool / Redcar BAM	VCM Hartlepool / Redcar BAM
Stockton, Billingham (1998) (Cowpen Depot)	16	17	16	17
Darlington (2000) (St Cuthbert's Way) No results 2015	-	22 *	25	25 #
Darlington (2004 - 2012) (Cockerton Bridge) **closed**	-	-	-	23
Hartlepool (2003 – 2005, 2010) (Stockton Road)	26	29	28	27
Hartlepool (2010) (Town Wall Headland)	27	28	32	31
Middlesbrough (2000) (MacMillan College)	17	18	18	17
Middlesbrough (2003) (Elm Street)	16	17	18	17
Redcar (2012) (Dormanstown)	16	16	19	18 #

* - 10 months data. Data annualised using Stockton Eaglescliffe AURN station.
\# - 8 months data. Data annualised using Stockton Eaglescliffe AURN station.

Note : GRAVIMETRIC METHOD

For 2012, the local station at Redcar Dormanstown was fitted with a BAM monitor, providing direct gravimetric equivalence.

For 2011- 2015, the remaining local station unmodified TEOM results were adjusted using the Volatile Correction Model (vcm), giving generally slightly lower concentrations to the earlier 1.3 factor.

PARTICULATE PM_{10} **continuous monitors**

Objective 1 of 2 : **Annual mean of 40 µg/m³ (gravimetric) maximum, with no exceedances**

Relevant Exposure is where members of the public may be exposed to levels of particulate PM_{10} above 40 µg/m³ (gravimetric) as an annual mean by December 31st 2004.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes, etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence, gardens of residential properties; kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is likely to be short term.

Sources

There are a variety of primary sources of particulate PM_{10}, which are very fine particles of less than 10 micron in size. Fine particles are composed of a wide range of materials from a variety of sources including:
Combustion sources (such as road traffic); *secondary particles*, mainly sulphate and nitrate formed by chemical reactions in the atmosphere, and often transported from far across Europe; c*oarse particles*, suspended soils and dusts (eg, from the Sahara), sea salt, biological particles, and particles from construction work.

Results (see opposite)

The results from the fixed AURN and Local monitors show a good degree of consistency on a year by year basis, and are generally well within the objective level, with no exceedances recorded.

The Darlington (St Cuthbert's) Way site is a town centre kerbside location, and clearly shows the influence of slow moving traffic on annual means. There is no public exposure issue present at this type of location, but levels remain well below the objective. Eaglescliffe, a busy roadside location and an area of relevant public exposure, continues to show a substantial reduction in particulate levels away from the earlier Yarm High Street kerbside location.

The Middlesbrough (Breckon Hill and MacMillan College) sites are public exposure locations in areas generally surrounded by high traffic roads. The annual means are significantly lower than the kerbside site above, indicating that roadside sources quickly fall with distance as long as there is a generally open aspect.

The Middlesbrough (Elm Street) and Redcar monitors generally show that typical urban background levels, even a short distance from congested roads, are well below the objective.

The replacement Hartlepool (Stockton Road) BAM monitor was commissioned during the last month of 2010, as was a new Town Wall Headland BAM monitor for the working port area. The 2015 results at the Stockton Road roadside site continue to be well within the objective level. 2015 results at the new Hartlepool working port location, while still comfortably within the objective level, demonstrate some impact from fugitive emissions from ship loading / unloading activities, and from natural coastal sources, particularly during the winter months.

Health effects : Exposure to particulate PM_{10} is associated with a range of effects on health, including effects on the respiratory and cardiovascular systems, asthma and mortality. Those members of the public with pre-existing lung and heart disease are particularly at risk.

PARTICULATE PM_{10}

24 hour mean objective (2004) **maximum 50 µg/m³ (gravimetric)**

maximum 35 exceedances / year

Continuous monitoring stations - all results µg/m³ (gravimetric) as the maximum of 24 hour means

(any exceedances are shown in brackets)

Figures shown below the 24 hour maximums are the 90th percentile of the 24 hour means, which provides a direct comparison with the objective level.

AURN Stations		2015	2014	2013	2012
	Gravimetric method	TEOM FDMS	TEOM FDMS	TEOM FDMS	TEOM FDMS
Middlesbrough (1993) (Breckon Hill)	90th %ile	58 (6) 27	64 (4) 31	79 (5) 32	72 (9) 32
	Gravimetric method	BAM	BAM	BAM	BAM
Stockton (2008) (Eaglescliffe)	90th %ile	55 (4) 28	74 (7) 30	74 (5) 29	67 (4) 29

Local Stations		2015	2014	2013	2012
	Gravimetric method	VCM Hartlepool/Redcar BAM	VCM Hartlepool/Redcar BAM	VCM Hartlepool/Redcar BAM	VCM – Hartlepool BAM
Stockton, Billingham (1998) (Cowpen Depot)	90th %ile	56 (7) 29	65 (6) 30	56 (2) 27	61 (5) 32
Darlington (2000) (St Cuthbert's Way) No results 2015	90th %ile	- -	80 (6) 37	85 (10) 40	81 (17) 43
Darlington (2004 - 2012) (Cockerton Bridge) **closed**	90th %ile	- -	- -	- -	54 (2) 39
Hartlepool (2003 -2005, 2010) (Stockton Road) *	90th %ile	68(13) 38	79 (11) 42	83 (13) 41	62 (6) 39
Hartlepool (2010) (Town Wall Headland) *	90th %ile	71 (12) 39	73 (9) 41	101 (25) 47	70 (20) 46
Middlesbrough (2000) (MacMillan College)	90th %ile	48 (0) 26	123 (6) 33	75 (3) 29	66 (7) 31
Middlesbrough (2001) (Elm Street)	90th %ile	60 (4) 30	64 (2) 31	75 (3) 30	64 (7) 30
Redcar (2012) (Dormanstown)	90th %ile	68 (4) 26	66 (3) 27	80 (7) 30	69 (3) 29

Note : GRAVIMETRIC METHOD

For 2009, the AURN station at Middlesbrough was fitted with a TEOM FDMS monitor, providing direct gravimetric equivalence.

For 2009, the AURN station at Stockton Eaglescliffe was fitted with a BAM monitor, providing direct gravimetric equivalence.

For 2010, the two local stations at Hartlepool were fitted with BAM monitors, providing direct gravimetric equivalence.

For 2012, the local station at Redcar Dormanstown was fitted with a BAM monitor, providing direct gravimetric equivalence.

For 2010 - 2015, the remaining local station unmodified TEOM results were adjusted using the Volatile Correction Model (vcm), giving generally slightly lower concentrations to earlier 1.3 factor.

PARTICULATE PM_{10} continuous monitors

Objective 2 of 2 : 24 hour mean of 50 µg/m³ (gravimetric) maximum, with up to 35 exceedances per year

Relevant Exposure is where members of the public may be exposed to levels of particulate PM_{10} above 50 µg/m³ (gravimetric) as a 24 hour mean by December 31st 2004.

This includes all locations where members of the public might be regularly exposed, gardens of residential properties, and the building façades of residential properties, schools, hospitals, care homes, hotels, etc.

Generally excluded are kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.

Sources

There are a variety of primary sources of particulate PM_{10}, which are very fine particles of less than 10 micron in size. Fine particles are composed of a wide range of materials from a variety of sources including:
Combustion sources (such as road traffic); *secondary particles*, mainly sulphate and nitrate formed by chemical reactions in the atmosphere, and often transported from far across Europe; c*oarse particles*, suspended soils and dusts (eg, from the Sahara), sea salt, biological particles, and particles from construction work.

Results (see opposite)

The 24 hour percentile results from the fixed AURN and Local monitors for 2015 show a good degree of consistency on a year by year basis, and are generally well within the objective level, with no exceedances recorded.

The Darlington (St Cuthbert's) Way site is a town centre kerbside location, and clearly shows the influence of slow moving traffic on 24 hour levels, with this type of location normally having the highest levels and number of exceedances from traffic, but there are no public exposure issues at this type of location.

The Stockton (Yarm) kerbside site was moved to Eaglescliffe (about 1 kilometre distant) during Q3 2008. Eaglescliffe is a public exposure location, and results continue to confirm a substantial reduction in particulate levels further away from kerbside.

The Middlesbrough (Breckon Hill and MacMillan College) sites are public exposure locations in areas generally surrounded by high traffic roads. Levels tend to be lower with fewer exceedances.

The Middlesbrough (Elm Street), Darlington (Cockerton Bridge) and Stockton (Billingham) monitors generally show that typical urban background levels, even a short distance from congested roads, have levels comfortably below the objective.

The Redcar (Dormanstown) site is a background site with generally low levels, although fugitive emissions from nearby industrial areas may be picked up from time to time.

The replacement Hartlepool (Stockton Road) BAM monitor was commissioned during the last month of 2010, as was a new Town Wall Headland BAM monitor for the working port area. Stockton Road is a classic roadside site with 2015levels below the objective. The Town Wall site demonstrates issues connected with the port activities, but is also strongly influenced by natural coastal sources, particularly during winter months.

Health effects : Exposure to particulate PM_{10} is associated with a range of effects on health, including effects on the respiratory and cardiovascular systems, asthma and mortality. Those members of the public with pre-existing lung and heart disease are particularly at risk.

PARTICULATE $PM_{2.5}$ New objective, not yet included in regulation

Annual mean objective (2020) **maximum 25 µg/m³ (gravimetric)** **no exceedances**

Target 15% reduction at urban background between 2010 and 2020

Two AURN stations, Middlesbrough Breckon Hill, and Stockton (Eaglescliffe), were installed with new monitors for particulate PM_{10} and $PM_{2.5}$, and became operational in Q4 2008.

The Middlesbrough Breckon Hill site is based on TEOM FDMS monitors for both PM_{10} and $PM_{2.5}$.

The Stockton Yarm site is based on BAM technology for both PM_{10} and $PM_{2.5}$.

AURN Stations		2015	2014	2013	2012
	Gravimetric method	TEOM FDMS	TEOM FDMS	TEOM FDMS	TEOM FDMS
Middlesbrough (Q4 2008) (Breckon Hill)		11	13	11	10
	% PM_{10}	63 %	83 %	55 %	59 %
	Gravimetric method	BAM	BAM	BAM	BAM
Stockton (Q4 2008) (Eaglescliffe)		11	11	10	11
	% PM_{10}	68 %	66 %	60 %	70 %

Based on the full year results since 2011, it is expected that particulate $PM_{2.5}$ levels at locations with unmodified TEOM PM_{10} monitors, for which results are adjusted to gravimetric equivalence using vcm, should not exceed 70% of the adjusted PM_{10} level, and is more likely to be around 65% of the adjusted PM_{10} level.

Taking the worst case (roadside) 2015 annual mean for PM_{10} (see page 20) of 26 µg/m³ (BAM) at the Hartlepool Stockton Road location, $PM_{2.5}$ levels in the Tees Valley should not exceed 18 µg/m³ (gravimetric) as an annual mean at any location, comfortably below the objective level. At most locations, $PM_{2.5}$ levels are expected to be substantially lower.

TEOM - Tapered element oscillating microbalance monitor, providing 1hour averages. Operates at 50 deg C, and may lose volatile particulates.

FDMS – Filter Dynamics Measurement System is a TEOM modification, providing 1hour averages, which can compensate for volatile particulate loss and provide direct gravimetric equivalence.

BAM - Beta attenuated mass monitor, providing 1hour averages

PARTICULATE $PM_{2.5}$ continuous monitors

Objective : Annual mean of 25 µg/m³ (gravimetric) maximum, with no exceedances

Target 15% reduction at urban background between 2010 and 2020

Relevant Exposure is where members of the public may be exposed to levels of particulate $PM_{2.5}$ above 25 µg/m³ (gravimetric) as an annual mean by December 31st 2020.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes, etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence; gardens of residential properties; kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is likely to be short term.

Sources

There are a variety of primary sources of particulate $PM_{2.5}$, which are very fine particles of less than 2.5 micron in size. Fine particles are composed of a wide range of materials from a variety of sources including:
Combustion sources (such as road traffic); *secondary particles*, mainly sulphate and nitrate formed by chemical reactions in the atmosphere, and often transported from far across Europe; c*oarse particles*, suspended soils and dusts (eg, from the Sahara), sea salt, biological particles, and particles from construction work.

Results (see opposite)

The measurement of particulate $PM_{2.5}$ has been the subject of considerable research over recent years. The standard TEOM continuous monitor, which is most common in the UK, has been shown to tend to read low due to its operating temperature of 50 deg C driving off volatile fractions, and this effect was more noticeable at the smaller particle size. An FDMS modification to the TEOM for both PM_{10} and $PM_{2.5}$ has been shown to provide equivalence to the European standard filter measurement system, and the BAM unit also shows equivalence, although an adjustment factor is required for PM_{10}.

The results, shown opposite, indicate that the Government target for 2020 is easily met at both sites, which are locations of relevant public exposure. The results also give an indication of what fraction particulate $PM_{2.5}$ may have of the total particulate PM_{10} measured. The FDMS TEOM and the BAM monitors indicate a $PM_{2.5}$ fraction of around 65%.

It is generally accepted in UK Government and other European reports, that the $PM_{2.5}$ fraction is approximately two thirds (66%) of the PM_{10} total. For the purpose of this report, a worst case factor of 70% will be used, which suggests that Tees Valley levels of $PM_{2.5}$ should not exceed 18 µg/m³ (based on 2015 annual PM_{10} measurements), ie within the Government target for 2020.

Health effects : Exposure to particulate $PM_{2.5}$ is associated with a range of effects on health, including effects on the respiratory and cardiovascular systems, asthma and mortality. Those members of the public with pre-existing lung and heart disease are particularly at risk.
Particulate $PM_{2.5}$ is thought to have a stronger association with these health effects than PM_{10}.

SULPHUR DIOXIDE

24 hour mean objective (2004) **maximum 125 µg/m³** **maximum 3 exceedances / year**

Continuous monitoring stations - all results µg/m³ as the maximum of 24 hour means

(any exceedances are shown in brackets)

Figures shown below the 24 hour maximums are the 99th percentile of the 24 hour means, which provides a direct comparison with the objective level.

AURN Station		2015	2014	2013	2012
Middlesbrough (1993) (Breckon Hill)	99th %ile	17 13	24 15	38 16	30 19

Local Stations		2015	2014	2013	2012
Redcar (2012) (Dormanstown)	99th %ile	14 11	31 16	24 18	14 13
Stockton, Billingham (1998) (Cowpen Depot)	99th %ile	19 11	18 14	26 23	13 9

SULPHUR DIOXIDE **continuous monitors**

Objective 1 of 3 : **24 hour mean of 125 µg/m³ (47 ppb) maximum, with up to 3 exceedances per year**

Relevant Exposure is where members of the public may be exposed to levels of sulphur dioxide above 125 µg/m³ as a 24 hour mean by December 31st 2004.

This includes all locations where members of the public might be regularly exposed, gardens of residential properties, and the building façades of residential properties, schools, hospitals, care homes, hotels etc.

Generally excluded are kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.

Sources

Sulphur dioxide (SO_2) is produced when a material, or fuel, containing sulphur is burned. Globally, much of the SO_2 in the atmosphere comes from natural sources, but in the UK the predominant sources are power stations burning fossil fuels, principally coal and heavy oils. Widespread domestic use of coal can also lead to high local concentrations of SO_2.
Within the Tees valley, the main source of SO_2 is industry along the Tees estuary, although emissions are normally from high stacks giving better dispersion away from ground level. In 2003, a EU directive limiting the sulphur content of certain fuel oils took effect.

Results (see opposite)

The 24 hour mean results from all monitors show that levels are consistently well within the objective, with no exceedance at any of the sites. The 99th percentile of 24 hour means is the level at which there have been 3 higher values over the year, and is a direct comparison with the objective level. All stations show 99th percentiles less than one quarter of the objective level, with 2015 results from Middlesbrough and Stockton confirming that trend.

The Redcar (Corporation Road) monitor, which was closed in March 2010, was replaced with a new monitor starting March 2011, moved to Dormanstown early in 2012, and continues to show low levels of sulphur dioxide from industry.

An earlier Hartlepool monitor (finally closed in 2009) has not been replaced, having consistently demonstrated low concentrations over the years.

The highest recorded levels have historically been at the Redcar station, which is more on the prevailing wind from industrial emitters than the others. However, levels have fallen significantly over recent years as a result of lower emissions from the main industrial complexes. It is noted that while the SSI steel blast furnace at Redcar was finally recommissioned in April 2012, it closed in October 2015.

This objective will continue to be met across the whole of the Tees Valley as long as industrial emissions do not significantly increase. If they do, this will be picked up at the Middlesbrough, Redcar and Stockton monitors.

Health effects : Exposure to sulphur dioxide is associated with restriction of the airways by stimulating nerves in the lining of the nose, throat and airways of the lung. The latter effect is particularly to occur in those suffering from asthma and chronic lung disease.

SULPHUR DIOXIDE

1 hour mean objective (2004) **maximum 350 µg/m³** **maximum 24 exceedances / year**

Continuous monitoring stations - all results µg/m³ as the maximum of 1 hour means

(any exceedances are shown in brackets)

Figures shown below the 1 hour maximums are the 99.7th percentile of the 1 hour means, which provides a direct comparison with the objective level.

AURN Stations		2015	2014	2013	2012
Middlesbrough (1993) (Breckon Hill)	99.7%ile	95 36	85 47	109 54	106 58

Local Stations		2015	2014	2013	2012
Redcar (2012) (Dormanstown)	99.7%ile	61 27	77 45	88 53	54 35
Stockton, Billingham (1998) (Cowpen Depot)	99.7%ile	113 35	107 43	102 61	54 29

SULPHUR DIOXIDE **continuous monitors**

Objective 2 of 3 : **1 hour mean of 350 µg/m³ (132 ppb) maximum, with up to 24 exceedances per year**

Relevant Exposure is where members of the public may be exposed to levels of sulphur dioxide above 350 µg/m³ as a 1 hour mean by December 31st 2004.

This includes all locations where members of the public might be regularly exposed, the gardens of residential properties, any outdoor locations to which the public might reasonably be expected to spend one hour or longer, kerbside sites (eg pavements of busy shopping streets), those parts of car parks, bus stations, and railway stations etc which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more, and the building façades of residential properties, schools, hospitals, care homes, hotels, etc.

Generally excluded are kerbside sites where the public would not be expected to have regular access.

Sources

Sulphur dioxide (SO_2) is produced when a material, or fuel, containing sulphur is burned. Globally, much of the SO_2 in the atmosphere comes from natural sources, but in the UK the predominant sources are power stations burning fossil fuels, principally coal and heavy oils. Widespread domestic use of coal can also lead to high local concentrations of SO_2.
Within the Tees valley, the main source of SO_2 is industry along the Tees estuary, although emissions are normally from high stacks giving better dispersion away from ground level. In 2003, a EU directive limiting the sulphur content of certain fuel oils took effect.

Results (see opposite)

The 1 hour mean results from all monitors show that levels are consistently well within the objective, with no exceedance at any of the sites. The 99.7th percentile of 1 hour means is the level at which there have been 24 higher values over the year, and is a direct comparison with the objective level. All stations show 99.7th percentiles less than one quarter of the objective level.

The Redcar (Corporation Road) monitor, which was closed in March 2010, was replaced with a new monitor starting March 2011, moved to Dormanstown early in 2012, and continues to show low levels of sulphur dioxide from industry.

An earlier Hartlepool monitor (finally closed in 2009) has not been replaced, having consistently demonstrated low concentrations over the years.

The highest recorded 1 hour mean has historically been at the Redcar station, which is more on the prevailing wind from industrial emitters than the others. Levels have fallen significantly over recent years as a result of lower emissions from the main industrial complexes. It is noted that while the SSI steel blast furnace at Redcar was finally recommissioned in April 2012, it closed in October 2015.

This objective will continue to be met across the whole of the Tees Valley as long as industrial emissions do not significantly increase. If they do, this will be picked up at the Middlesbrough, Redcar and Stockton monitors.

Health effects : Exposure to sulphur dioxide is associated with restriction of the airways by stimulating nerves in the lining of the nose, throat and airways of the lung. The latter effect is particularly to occur in those suffering from asthma and chronic lung disease.

SULPHUR DIOXIDE

15 minute mean objective (2005) **maximum 266 µg/m³** **maximum 35 exceedances / year**

Continuous monitoring stations - all results µg/m³ as the maximum of 15 minute means

(any exceedances are shown in brackets)

Figures shown below the 15 minute maximums are the 99.9th percentile of the 15 minute means, providing a direct comparison with the objective level.

AURN Stations		2015	2014	2013	2012
Middlesbrough (1993) (Breckon Hill)	99.9%ile	108 49	111 62	142 80	146 82

Local Stations		2015	2014	2013	2012
Redcar (2012) (Dormanstown)	99.9%ile	72 43	96 67	146 75	77 48
Stockton, Billingham (1998) (Cowpen Depot)	99.9%ile	180 55	182 72	138 91	120 49

SULPHUR DIOXIDE **continuous monitors**

Objective 3 of 3 : 15 minute mean of 266 µg/m³ (100 ppb) maximum, with up to 35 exceedances per year

Relevant Exposure is where members of the public may be exposed to levels of sulphur dioxide above 266 µg/m³ as a 15 minute mean by December 31st 2005.

This includes all locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.

There are no exclusions.

Sources

Sulphur dioxide (SO_2) is produced when a material, or fuel, containing sulphur is burned. Globally, much of the SO_2 in the atmosphere comes from natural sources, but in the UK the predominant sources are power stations burning fossil fuels, principally coal and heavy oils. Widespread domestic use of coal can also lead to high local concentrations of SO_2.
Within the Tees valley, the main source of SO_2 is industry along the Tees estuary, although emissions are normally from high stacks giving better dispersion away from ground level. In 2003, a EU directive limiting the sulphur content of certain fuel oils took effect.

Results (see opposite)

Of the three sulphur dioxide objectives, the 15 minute objective is the more difficult one to achieve, but the results show that significant progress has been achieved in reducing industrial emissions over recent years. The 15 minute mean results now show no exceedance of this objective.

The Redcar (Corporation Road) monitor, which was closed in March 2010, was replaced with a new monitor starting March 2011, moved to Dormanstown starting 2012, and continues to show low levels of sulphur dioxide from industry.
It is noted that while the SSI steel blast furnace at Redcar was finally recommissioned in April 2012, it closed in October 2015.

An earlier Hartlepool monitor (finally closed in 2009) has not been replaced, having consistently demonstrated low concentrations over the years.

The 99.9th percentile of 15 minute means is the level at which there have been 35 higher values over the year, and is a direct comparison with the objective level. All stations have shown 99.9th percentiles less than half of the objective level.

It is expected that this difficult objective will continue to be met across the whole of the Tees Valley as long as industrial emissions do not significantly increase. If they do, this will be picked up at the Middlesbrough, Redcar and Stockton monitors.

Health effects : Exposure to sulphur dioxide is associated with restriction of the airways by stimulating nerves in the lining of the nose, throat and airways of the lung. The latter effect is particularly to occur in those suffering from asthma and chronic lung disease.
The effects of sulphur dioxide on sensitive subjects appear almost immediately at the start of exposure, leading to this 15 minute objective, which is specific to the UK.

CARBON MONOXIDE

8 hour running mean objective (2003) maximum 10 mg/m³ no exceedances

Continuous monitoring stations - all results mg/m³ as the maximum of 8 hour running means

AURN Station	2015	2014	2013	2012
Middlesbrough (1993 - 2012) (Breckon Hill) **Closed December 2012**	-	-	-	1.2

CARBON MONOXIDE **continuous monitors**

Objective: **8 hour running mean of 10 mg/m³ (8.6 ppm) maximum, with no exceedances**

Relevant Exposure is where members of the public may be exposed to levels of carbon monoxide above 10 mg/m³ as an 8 hour running mean by December 31st 2003.

This includes all locations where members of the public might be regularly exposed, gardens of residential properties, and the building façades of residential properties, schools, hospitals, care homes, hotels etc.

Generally excluded are kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.

Sources

Carbon monoxide (CO) is a colourless, odourless, poisonous gas produced by incomplete, or inefficient, combustion of fuel. It is predominantly produced by road transport, in particular petrol-engine vehicles.
Within the Tees Valley, road transport is the main source at ground level. Industrial emissions along the Tees estuary are significant, but are normally emitted through tall stacks, which give dispersion away from ground level.

Results (see opposite)

Monitoring of carbon monoxide is no longer undertaken within the Tees Valley, and this is in keeping with the nationwide reduction of carbon monoxide monitoring sites. The Middlesbrough Breckon Hill AURN station, an urban industrial location, continued to monitor carbon monoxide until the end of 2012, when the monitor was decommissioned by the AURN network.

The Middlesbrough monitor shows no change over recent years, with concentrations well below the objective level.

It is safe to say that this objective will be easily met across the whole of the Tees Valley. There will be no further requirement for carbon monoxide monitoring.

Health effects : This gas prevents the normal transport of oxygen by the blood. This can lead to a significant reduction in the supply of oxygen to the heart, particularly in people suffering from heart disease.

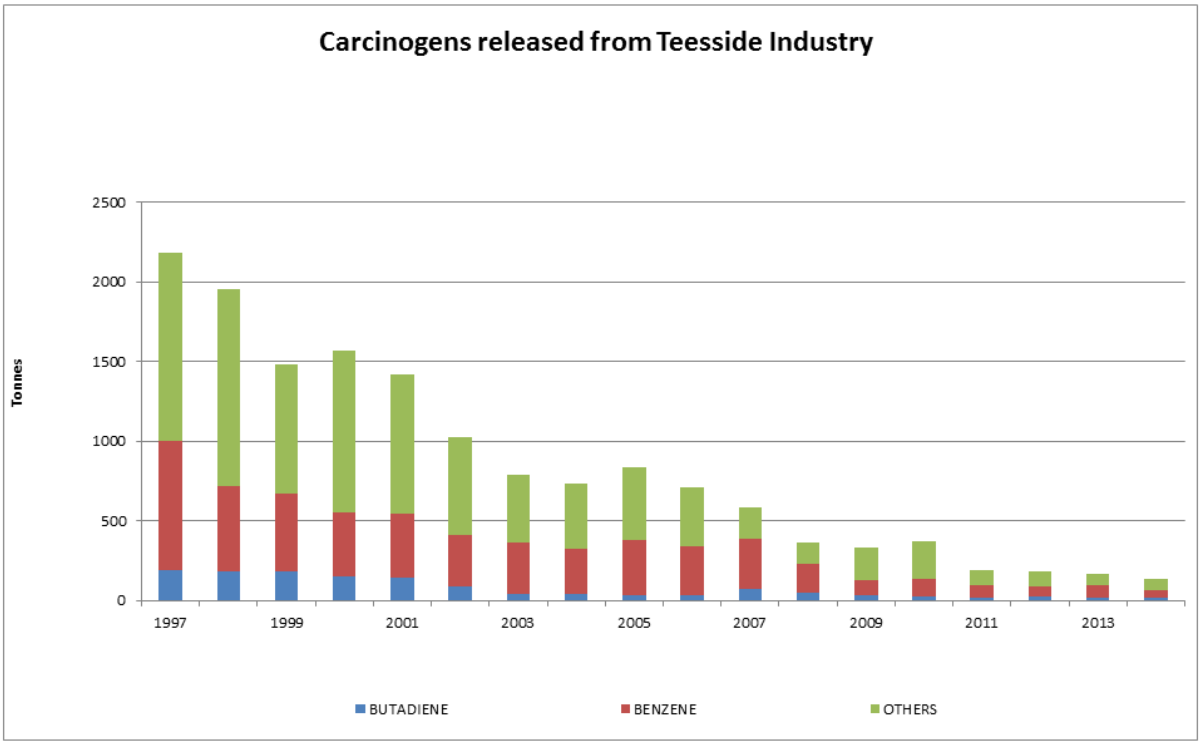
BENZENE

Running annual mean objective (2003)	**maximum 16.25 µg/m³**	**no exceedances**
Annual mean objective (2010)	**maximum 5.00 µg/m³**	**no exceedances**

Non-continuous monitoring stations - all results µg/m³ as the annual mean

National Network	2015	2014	2013	2012
Middlesbrough (Feb 2002) (Breckon Hill)	0.99	1.41	1.55	1.19
Stockton (2008) (Eaglescliffe)	0.67	0.94	0.86	0.79

Environment Agency - effects of action taken to reduce carcinogen releases from industry.



BENZENE **continuous and non-continuous monitors**

Objective 1 of 2 : **Running annual mean of 16.25 µg/m³ (5 ppb) maximum, with no exceedances**

Objective 2 of 2 : **Annual mean of 5.00 µg/m³ (1.54 ppb) maximum, with no exceedances**

Relevant Exposure is where members of the public may be exposed to levels of benzene above 16.25 µg/m³ as a running annual mean by December 31st 2003, and 5.00 µg/m³ as an annual mean by December 31st 2010.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes, etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence, gardens of residential properties; kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is likely to be short term.

Sources

Benzene is a volatile organic compound (VOC) which is a minor constituent of petrol. The main sources of benzene in the atmosphere in Europe are the distribution and combustion of petrol, with combustion being the single biggest source (70%).

Within the Tees Valley, another significant source is industry, on both sides of the Tees estuary. These are sometimes fugitive emissions that can lead to quite high concentrations, even if only for a short period.

Action taken by the Environment Agency has reduced emissions from industrial sources as shown in the graph opposite.

Results (see opposite)

Monitoring of Benzene is now restricted to national network pumped diffusion tube sites at Middlesbrough and Stockton. Results from both continue to be well below objective levels.

The Middlesbrough site is a public exposure location. Monitored levels are relatively stable, and the annual mean remains well within the objective level. The Stockton Eaglescliffe site is also a public exposure location, and shows a lower level than Middlesbrough. This probably reflects its isolation from industrial sources nearer the coast and estuary, and makes the site representative of a busy roadside location.

The historical data from the Stockton (Yarm) diffusion tube location, which was a kerbside location, clearly showed the impact that slow moving, heavy traffic can have on benzene concentrations. Although this was not a public exposure location, the first objective of 16.25 µg/m³ was easily met, and the second objective of 5.00 µg/m³ for 2010 was also comfortably met.

The Local continuous hydrocarbon monitoring station that used to be at Redcar (Corporation Road), was on a prevailing wind direction from the main industrial emitters industry for up to 70% of the year, and had historically shown relatively high concentrations. These fell significantly over the years as a result of reduced industrial emissions, with the first objective level of 16.25 µg/m³ easily met. The second objective level of 5.00 µg/m³ (for 2010) was not met prior to year 2000, but with the fall in industrial emission levels, this objective was consistently being met, and, based on Middlesbrough results, will continue to be the case as long as industrial emissions are kept under close control.

Health effects : Benzene is a recognised genotoxic human carcinogen, which means that no absolute safe level can be specified for ambient air concentrations of benzene. The first objective level of 16.25 µg/m³ as a running annual mean is considered to represent an exceedingly small risk to health.
The second objective level of 5.00 µg/m³ is set to keep exposure to benzene as low as practicable.

1,3-BUTADIENE

Running annual mean objective (2003) **maximum 2.25 µg/m³** **no exceedances**

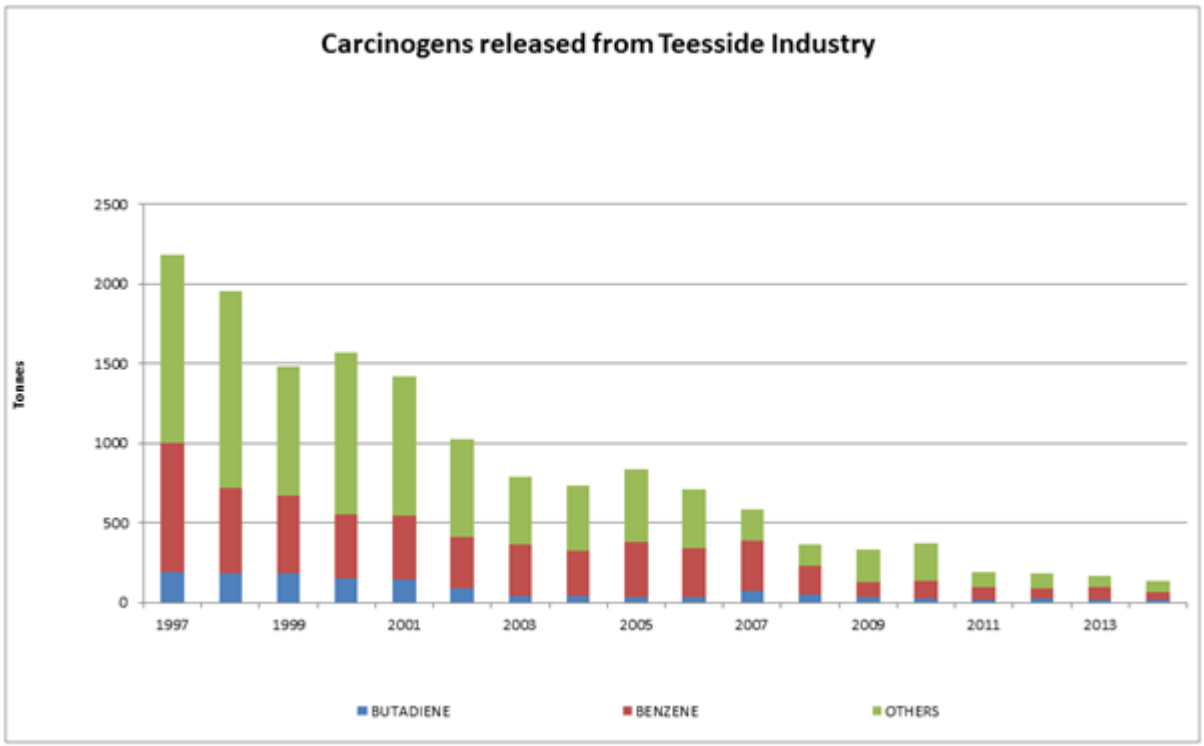
There is no 1,3-Butadiene monitoring now carried out in the Tees Valley.

The diffusion tube monitor at Middlesbrough Breckon Hill ceased operation in 2007.

The continuous hydrocarbon monitor at Redcar Corporation Road ceased operation in 2004.

Earlier results showed that 1,3-Butadiene levels were well below the annual mean objective.

Environment Agency - effects of action taken to reduce carcinogen releases from industry



1,3-BUTADIENE continuous monitors

Objective : Running annual mean of 2.25 µg/m³ (1 ppb) maximum, with no exceedances

Relevant Exposure is where members of the public may be exposed to levels of 1,3-butadiene above 2.25 µg/m³ as a running annual mean by December 31st 2003.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence, gardens of residential properties; kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is likely to be short term.

Sources

1,3-butadiene, like benzene, is a VOC emitted into the atmosphere principally from fuel combustion of petrol and diesel vehicles. 1,3-butadiene is also an important chemical in certain industrial processes, particularly the manufacture of synthetic rubber.

The main source of 1,3-butadiene emissions in the Tees Valley is from industry. These are sometimes fugitive emissions that can lead to quite high concentrations, even if only for a short period.

Action taken by the Environment Agency has reduced emissions from industrial sources as shown in the graph opposite.

Results (see opposite)

The Automatic Hydrocarbon Network continuous monitoring station at Middlesbrough (Breckon Hill), closed by the Government in December 2000, consistently picked up industrial emissions on a north-easterly wind direction, ie from the industrial sources. This wind direction is only around 15% of the year, and running annual means have been well within the objective level of 2.25 µg/m³, and showed some decline. Results from the diffusion system installed in 2003 (annual mean only) suggest that 1,3-butadiene concentrations have fallen close to the limit of detection.
Following a review by Defra of the 1,3-butadiene monitoring network, the diffusion tube monitor was closed in September 2007.

The Local continuous hydrocarbon monitoring station at Redcar (Corporation Road) was more on a prevailing wind direction from the industrial sources (for up to 70% of the year), and always showed a higher running annual mean than that at Middlesbrough. However, concentrations fell significantly over the last decade as a result of reduced industrial emissions, to well within the objective level. This unit was not in use over the period 2005 to 2008 due to operational difficulties, and is now closed.

1-3-butadiene monitoring in the Tees Valley is no longer being carried out, but concentrations are expected to continue to be well below the objective level as long as industrial emissions are kept firmly under control.

Health effects : Exposure to 1,3-butadiene is associated with the induction of cancers in the lymphoid system and blood-forming tissues, lymphomas and leukaemia. 1,3-butadiene is a genotoxic carcinogen in humans, for which no absolutely safe level can be defined. The objective level of 2.25 µg/m³ as a running annual mean is considered to represent an exceedingly small risk to health.

LEAD

Annual mean objective (2004)	**maximum 0.5 µg/m³**	**no exceedances**
Annual mean objective (2008)	**maximum 0.25 µg/m³**	**no exceedances**

All results are µg/m³ as the annual mean

Redcar & Cleveland Council Area	2015	2014	2013	2012	2011	2010	2009	2008
Redcar Dormanstown (downstream from steel works)	-	-	0.020	0.009	0.006	0.001	0.009	0.009
Redcar Normanby Flatts Lane Upstream from steel works)	-	-	0.004	0.005	0.004	0.001	0.007	0.005

Note : Corporation Road started June 2008, Flatts Lane started September 2008. Corporation road monitor moved to Dormanstown from January 2012.
Both stations shutdown by Defra end December 2013.

for comparison, national network results from other parts of the UK are as follows:

National Network	2015	2014	2013
London (Marylebone)	0.008	0.008	0.008
Manchester	-	-	0.01
Walsall Centre (lead industry site)	0.074	0.074	0.058
Port Talbot Margam	0.016	0.016	0.013

LEAD **non-continuous monitors**

Objective 1 : **Annual mean of 0.5 µg/m³ maximum, with no exceedances**

Objective 2 : **Annual mean of 0.25 µg/m³ maximum, with no exceedances**

Relevant Exposure is where members of the public may be exposed to levels of lead above 0.5 µg/m³ as an annual mean by December 31st 2004, and an annual mean of 0.25 µg/m³ as an annual mean by December 31st 2008.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, nursing homes, libraries, etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence; gardens of residential properties; kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is likely to be short term.

Sources

A major source of lead at ground level was from petrol-engine vehicle exhausts, but as a result of the introduction of lead-free petrol, this source is no longer significant.

In recent years, industry, in particular secondary non-ferrous metal smelters have become the most significant contributors to emissions of lead.

There are no lead-based industries located in the Tees Valley area.

Results (see opposite)

The national network for heavy metals includes lead monitoring upwind and downwind of the Redcar steel works. Results confirm that lead-in-air concentrations are very low in the Tees Valley, and indeed have fallen to very low levels across the UK, even close to lead industry sites. Following a Defra review of the heavy metals national network in 2013, the two monitors were removed at the end of December 2013 and will not be replaced.

Stockton Council also carried out lead monitoring at three locations as part of a heavy metal monitoring programme. Results going back to 1997, and earlier, clearly show that the objectives are easily met, and with all readings below the limit of detection, the monitoring programme was stopped during 2007.

There are no lead-based industries in any of the Tees Valley Council areas, and the Redcar results will reflect maximum lead levels across the region.

The two lead objectives will be easily met across the whole of the Tees Valley.

Health effects : Exposure to lead is associated with toxic biochemical effects in humans which can cause problems in the synthesis of haemoglobin, effects on the kidneys, gastrointestinal tract, joints and reproductive system, and acute or chronic damage to the nervous system.
The possible effects of lead on the brain development in children, and hence their intellectual development, is the greatest cause for concern.

OZONE

8 hour running mean *provisional* objective (2005)

maximum 100 µg/m³ maximum 10 day exceedances / year

Continuous monitoring stations - all results µg/m³ as the maximum of 8 hour running means

(any day exceedances are shown in brackets)

AURN Station	2015	2014	2013	2012
Middlesbrough (1993) (Breckon Hill)	136 (3)	123 (4)	110 (4)	116 (4)

Local Stations	2015	2014	2013	2012
Redcar (2012) (Dormanstown)	141 (5)	95 (0)	104 (3)	125 (11)
Stockton (2009) **closed** (Eaglescliffe)	-	127(11)	104 (2)	123 (4)

OZONE continuous monitors

Provisional objective : 8 hour running mean of 100 µg/m³ (50 ppb) maximum, with up to 10 day exceedances per year

Relevant Exposure is where members of the public may be exposed to levels of ozone above 100 µg/m³ as an 8 hour running mean by December 31st 2005.

This includes all locations where members of the public might be regularly exposed, gardens of residential properties, and the building façades of residential properties, schools, hospitals, care homes etc.

Generally excluded are kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.

Sources

Ozone is a secondary air pollutant. It is not emitted by any process, but is formed as a result of complex chemical reactions on other air pollutants, particularly in the presence of strong sunlight. The source pollutants, such as nitrogen dioxide and hydrocarbons, are emitted from traffic and industry, and as the chemical reaction process can take some time, the source pollutants can originate a considerable distance away, eg mainland Europe. It is recognised, therefore, that local or even national action may not be sufficient to reduce ozone levels. The government has therefore only set a target for ozone at this time, and ozone is not included in the national Air Quality Review and Assessment process.
Ozone levels tend to peak during sunny summer months, and are often highest in rural areas as a result from air pollution elsewhere.

Results (see opposite)

The results from the fixed AURN and Local monitors show a good degree of consistency on a year by year basis, and tend to be highest at all the locations when the summer weather is fine and sunny.. The summer weather since has tended to be poor over recent years, and this is reflected in the results.

The Redcar (Dormanstown / Corporation Road) site normally shows the highest number of days when the target level of 100 µg/m³ is exceeded, and can exceeds the target objective maximum number of exceedance days. This is a coastal influence, with ozone produced offshore as a result of local and / or continental air pollution, being carried on-shore by sea breezes. Nitrogen oxide levels are lower on the coast, which means that there is less scavenging of ozone to form nitrogen dioxide. The Redcar station had a new monitor has been installed from March 2011, since moved to Dormanstown early in 2012. Results for 2015 again demonstrate poor summer weather, particularly near the coast.

Middlesbrough and Eaglescliffe better reflect the main urban areas, where higher levels of nitrogen oxide often lead to lower ozone levels due to the ‘scavenging’ effect. Even so, in prolonged periods of hot summer weather, exceedances of this objective are likely in many parts of the Tees Valley.

Ozone is not yet a prescribed air pollutant under the UK air quality strategy, and is unlikely to be for some time. Ozone is not included in air quality review and assessment procedures.

Health effects : Exposure to high concentrations of ozone is associated with slight irritation to the eyes or nose. Very high levels of exposure (to over 1000 µg/m³, or 10 times the target level) over several hours can cause damage to the airway lining followed by inflammatory reaction.
At levels of ozone above 200 µg/m³ as an 8 hour concentration, effects in healthy individuals has been clearly demonstrated.

Polycyclic Aromatic Hydrocarbons (PAHs)

Annual mean *provisional* objective (2010) maximum 0.25 ng/m³ (BaP #) no exceedances

Non-continuous monitoring station - all results ng/m³ (B*a*P #) as the maximum of annual means

National Network	2015	2014	2013	2012	2011
Middlesbrough (Q4 2007) (Breckon Hill –digital sampler)	0.29	0.49	0.38	0.41	0.35

For comparison, the new national digital sampler network results from industrial towns, Port Talbot, Scunthorpe and Royston (Monkton, closed December 2014), are shown below, along with Newcastle Centre, and the rural Yorkshire area, High Muffles:

National Network	2015	2014	2013	2012	2011
Middlesbrough (Q4 2007) (Breckon Hill –digital sampler)	0.29	0.49	0.38	0.41	0.35
(upwind Redcar / South Bank Coke Ovens)					
Port Talbot Margam (Q4 2007)	0.68	0.65	0.42	0.39	0.42
(downwind Port Talbot Coke Ovens)					
Swansea (Q4 2007)	0.35	0.33	0.26	0.28	0.29
(upwind Port Talbot Coke Ovens)					
Scunthorpe Santon (Q4 2007)	3.50	3.72	3.41	2.86	2.99
(downwind Scunthorpe Coke Ovens)					
Scunthorpe Town (2007)	1.30	3.00	3.87	1.35	1.37
(upwind Scunthorpe Coke Ovens)					
South Hiendley (Q4 2007) #	0.25	0.44	0.35	0.54	0.72
(downwind Monckton Coke Ovens)					
Royston (Q4 2007) #	0.41	0.92	0.85	0.89	0.88
(upwind Monckton Coke Ovens)					
Newcastle Centre (July 2007)	0.12	0.10 *	0.13	0.15	0.19
High Muffles (1997)	0.07	0.07	0.08	0.07	0.07

* - 7 months data only for 2014
\# - Monkton Coke Ovens closed December 2014

notes:

A nanogram (ng) is one billionth of a gram (10^{-9})

\# A range of PAH species are measured. Annual means are expressed as concentrations of Benzo(a)Pyrene (B*a*P) as a marker for the total mixture of PAHs.

Polycyclic Aromatic Hydrocarbons (PAHs) **non-continuous monitors**

Provisional objective : Annual mean of 0.25 ng/m³ (BaP) maximum, with no exceedances

Relevant Exposure is where members of the public may be exposed to levels of PAH above 0.25 ng/m³ as an annual mean by December 31st 2010.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes etc.

Generally excluded are the building facades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence; gardens of residential properties; kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is likely to be short term.

Sources

Polycyclic aromatic hydrocarbons (PAHs) are a large group of organic compounds with two or more benzene rings within their molecular structure. Those compounds with two or three benzene rings are normally present in vapour phase, while heavier compounds with five or more benzene rings are mainly in particulate phase. The EU working group on PAHs has proposed benzo(a)pyrene (B*a*P) as a marker for PAHs, and it is this compound on which PAH measurement is focused.
The main sources of BaP in the UK are domestic coal and wood burning, fires (eg accidental fires, bonfires, forest fires etc) and industrial processes such as coke production, of particular relevance to the Tees Valley. Road transport is the largest source for total PAHs, but this source is dominated by species thought to be less hazardous than BaP.
The decline in domestic and industrial coal burning, new controls over agricultural burning, and upgrading of incinerators to high temperature technology, has led to a fall in emissions of B*a*P over the last decade. Emissions are expected to fall further as a result of reductions in domestic coal burning, improved industrial abatement and lower vehicle emissions.

Results (see opposite)

PAH used to be monitored at Middlesbrough Longlands College as part of the TOMPS national network. The monitor was in an elevated location, which was not a public exposure location. This site was closed in 2007.

The new PAH network monitor installed at Middlesbrough Breckon Hill AURN station in Q4 2007 is a public exposure location. The monitor is based on a more accurate technology than the TOMPS monitor above. Results now show that the UK objective level is being regularly exceeded.

The Environment Agency advises that the two coke ovens associated with the steel complex along the south side of the Tees estuary is the main source of PAHs. These two coke ovens closed in October 2015, and it is expected that PAH levels will fall significantly over time probably to below the UK objective level.

Other national results also show variable year-on-year results, but the main industrial towns with coke ovens nearby clearly show the highest concentrations, particularly downwind, again well above the objective level.

PAHs are not a prescribed air pollutant under the UK air quality strategy.

Health effects : Exposure to polycyclic aromatic hydrocarbons is associated with an increased incidence of tumours of the lung, skin, and other sites, with lung cancer most obviously linked to exposure through inhaled air. The objective level of 0.25 ng/m³ as an annual average is considered to represent a risk to health so small as to be undetectable.

Cadmium, Arsenic, Nickel, Mercury **non-continuous monitors**

No UK air quality objectives have yet been set for these metals, but EU targets are indicated

Redcar & Cleveland Council Area all measurements in nanogram/m³ as the annual mean

Flatts Lane site opened September 2008. Corporation Road site opened June 2008, moved to Dormanstown January 2012.

	cadmium	2015	2014	2013	EU target
	Redcar Dormanstown (downwind) *	-	-	0.41	5 ng/m^3
	Redcar Flatts Lane (upwind)	-	-	0.12	

	arsenic	2015	2014	2013	EU target
	Redcar Dormanstown (downwind) *	-	-	0.84	6 ng/m^3
	Redcar Flatts Lane (upwind)	-	-	0.38	

	nickel	2015	2014	2013	EU target
	Redcar Dormanstown (downwind) *	-	-	2.28	20 ng/m^3
	Redcar Flatts Lane (upwind)	-	-	0.54	

	Mercury (particulate)	2015	2014	2013	Draft EU target
	Redcar Dormanstown (downwind) *	-	-	0.01	No EU target set for Mercury (particulate). Draft EU target for Mercury (vapour) is 50 ng/m3 Mercury (vapour) not monitored at Redcar sites
	Redcar Flatts Lane (upwind)	-	-	0.01	

* - Corporation Road downwind site moved to Dormanstown downwind site from January 2012

Following a Defra review of the heavy metals national network in 2013, the two Redcar monitors were removed at the end of December 2013 and will not be replaced.

National Networks 2015

Annual average concentrations of twelve heavy metals were monitored at twenty-four multi-element sites, two of which were Redcar shown above. The network was reviewed by Defra for 2014, with some sites discontinued, including Redcar. A further selection of results around steel works is as follows; note that Mercury (vapour) is not monitored at these locations, and starting 2014, neither is Mercury (particulate):

Heavy Metal network	all measurements in nanogram/m³ as the annual mean			
	cadmium	**arsenic**	**nickel**	**Mercury (particulate)**
Scunthorpe Santon (downwind)	0.345	0.819	1.484	-
Scunthorpe Town (upwind)	0.256	0.698	1.191	-
Sheffield Tinsley (downwind)	0.445	0.955	17.551	-
Sheffield Devonshire Green (upwind)	0.143	0.698	1.968	-

Note : A nanogram (ng) is one billionth of a gram (10^{-9})

Cadmium, Arsenic, Nickel, Mercury

No UK air quality objectives have yet been set for these pollutants, but they are likely to be based on EU targets (see below) as an annual mean, with no exceedances. Public exposure will be as defined for PAHs.

Sources

Cadmium (Cd) is produced as an inevitable by-product of zinc, and sometimes lead, refining, but once collected is relatively easy to recycle. It is mainly used in high performance nickel/cadmium batteries, but is also a good corrosion resistance coating. Other uses are as pigments, stabilisers for PVC, in alloys, and electronic compounds. UK emissions are associated with lead-zinc smelting and battery recycling plants, iron and steel manufacturing, electricity and waste combustion. Cigarette smoking can be a significant source. However, for the non-smoking population, the major exposure pathway is through food. EU Cadmium target is 5 ng/m^3.

Arsenic (As) is a metalloid with a complex chemistry, which can form a number of inorganic and organic compounds. In its inorganic form, it is widely distributed in rocks, soils and sediments, but it is also widely found in oxidised forms. The principal use of arsenic (as arsenic trioxide) is in wood preserving products, but it is also to be found in agricultural chemicals such as insecticides, herbicides, algaecides and growth promoters. On a global scale, releases to air are from natural sources such as volcanic eruptions and forest fires. On a local scale, emissions are likely to arise from coal burning, industrial waste disposal, and the application of agricultural chemicals containing arsenic, and the burning of wood with arsenic-containing preservatives. Cigarette smoking can be a significant source. However, for the non-smoking population, the major exposure pathway is through food and water. EU Arsenic target is 6 ng/m^3.

Nickel (Ni) is a metal which has many similarities to the other ferromagnetic metals, iron and cobalt. It is mainly used in the production of stainless steels and other alloys because it imparts heat and corrosion resistance, as well as hardness and strength. Nickel alloys and plating are commonly found in vehicles, tools, electrical and household goods, jewellery and coinage. The main sources of nickel in air, besides nickel production and plating plants, are from the combustion of coal and oil for heat and power generation, and the incineration of wastes and sewage sludge. Cigarette smoking can be a significant source. However, for the non-smoking population, the major exposure pathway is through food. EU Nickel target is 20 ng/m^3.

Mercury Hg (v) is a global pollutant with complex chemical and physical properties. It occurs naturally in the atmosphere from degassing of the earth's crust, emissions from volcanoes, and evaporation from natural bodies of water. World-wide mining of the metal leads to indirect discharges to atmosphere. Mercury has widespread use in industrial processes and in products such as batteries, lamps and thermometers. It is widely used in dentistry as an amalgam for fillings, and by the pharmaceutical industry. Mercury is mainly present in the atmosphere in a relatively unreactive gaseous form, but with a long atmospheric lifetime (of the order of 1 year), but methylated forms can form naturally which are highly toxic. UK emissions are associated with chlorine manufacture using mercury cells, non-ferrous metal production, coal combustion, and crematoria. The main pathway for mercury to humans is through the food chain, and not inhalation. Draft EU Mercury (vapour) target is 50 ng/m^3, there is no target for mercury (particulate).

Results (see opposite)

Redcar has been part of the new national heavy metal network since 2008, monitoring heavy metal concentrations upwind and downwind of the steel works. Following a review, Defra decommissioned these monitors at the end of 2013. Stockton Council used to monitor heavy metal concentrations in air from 1991 at three locations, but with low results and the impending closure of the nearby Chrome industrial facility, monitoring was stopped during 2007.
Redcar & Cleveland steel works closed in October 2015.

Early results show that levels for the four elements compare favourably with results from other steel related industrial areas, and that concentrations are well below EU targets.

Cadmium, arsenic, nickel and mercury are not yet air pollutants that are included in the UK air quality strategy

Health effects :

Cadmium is bio-persistent and derives its toxicity from its chemical similarity to zinc, which is an essential micronutrient. Long-term exposure can cause renal misfunction. High levels are associated with lung disorders and bone defects.

Arsenic toxicity depends on its chemical form. It may be beneficial in small doses, but is generally considered to be carcinogenic to the lung and skin.

Nickel compounds generally exhibit a low acute toxicity. Nickel and its water-soluble salts are potent skin sensitisers, and are restricted for jewellery use where there may be direct contact with the skin.

Mercury is a toxic substance with no known function in human biochemistry or physiology. Inorganic poisoning can cause tremors, and spontaneous abortion. Mercury methyl compounds cause damage to the brain and central nervous system.

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TREND GRAPHS AND ANALYSIS

nitrogen dioxide annual mean
nitrogen dioxide 1 hour mean
particulate PM_{10} annual mean
particulate PM_{10} 24 hour mean
sulphur dioxide 1 hour mean
sulphur dioxide 15 minute mean
carbon monoxide 8 hour running mean
benzene running annual mean
1,3-butadiene running annual mean

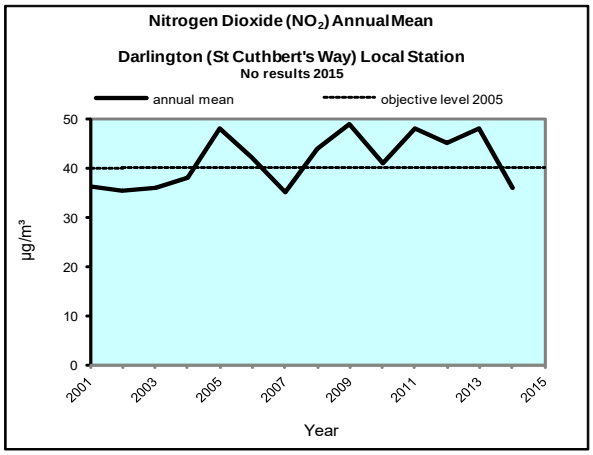
ozone 8 hour running mean and day exceedance
polycyclic aromatic hydrocarbons (PAHs) annual mean

NITROGEN DIOXIDE

annual mean trend – kerbside and roadside sites

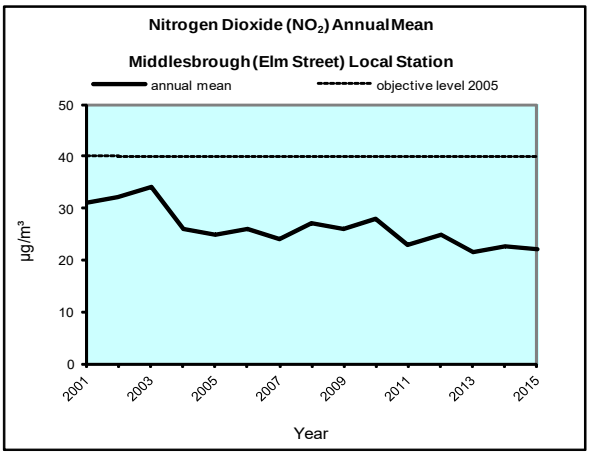
Darlington (St Cuthbert's Way), Middlesbrough (Elm Street), Darlington (Cockerton Bridge) Local Stations, Stockton (Eaglescliffe & Yarm) AURN Stations and Hartlepool (Stockton Road) Local Station

DARLINGTON (St Cuthbert's Way) Local Station
(urban kerbside site)

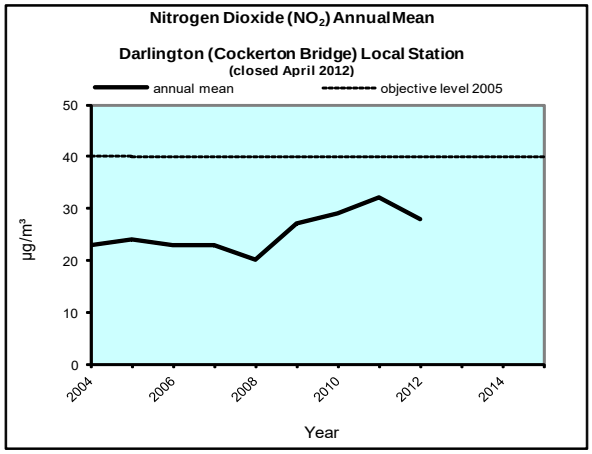


note: 2004 and 2005 data 3 months only, annualised using Yarm AURN data

MIDDLESBROUGH (Elm Street) Local Station
(urban roadside site)

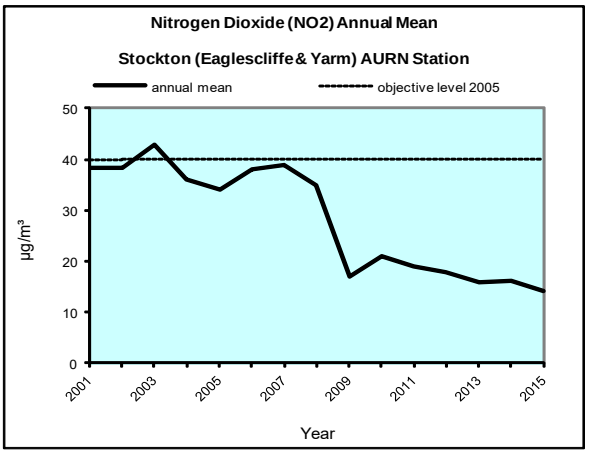


DARLINGTON (Cockerton Bridge) Local Station
(urban roadside site) **closed April 2012**



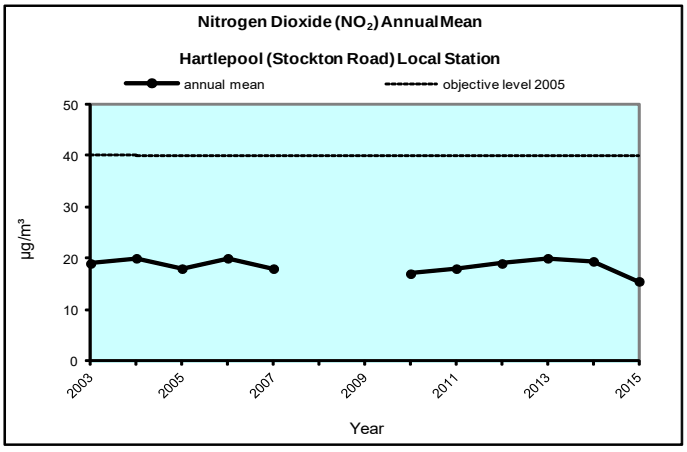
note: 2012 data 3 months only, annualised using Eaglescliffe AURN data

STOCKTON (Eaglescliffe and Yarm) AURN Stations
(roadside / kerbside site classification)



Eaglescliffe from 2009

HARTLEPOOL (Stockton Road) Local Station
(urban roadside site)



no data for 2008 - 2009

new monitor end October 2010. 2014 data 5 months only, annualised using three Tees Valley monitors

NITROGEN DIOXIDE ANNUAL MEAN POLLUTION TREND – kerbside and roadside sites

(continuous chemiluminescent analyser measurement)

1. The nitrogen dioxide objective for the annual mean (2005) is a maximum of 40 µg/m³, with no exceedances.

2. The two kerbside sites, Darlington (St Cuthbert's Way, closed December 2014), and the now closed Stockton (Yarm High Street), clearly demonstrate the impact of slow moving heavy traffic, with nitrogen dioxide levels hovering around the objective level. There are, however, no public exposure issues in the vicinity of either station. Note that the move from the Yarm kerbside site to the Eaglescliffe roadside side has seen a dramatic fall in annual means, confirming the rapid fall off in concentrations away from kerbside.

3. The roadside sites in Middlesbrough, Eaglescliffe (from 2009), Hartlepool and Darlington (closed 2012), are set back several metres from the kerbside, and this reflects in significantly lower annual means, comfortably below the objective level. Note that the Middlesbrough (Elm Street) site is in an area of slow moving traffic and tends to have higher annual means than say the Hartlepool (Stockton Road) site, which is in an area with significantly higher average traffic speeds.

4. Variations year on year tend to be weather related.

5. Of the roadside sites, Eaglescliffe is an area of relevant public exposure and along with the other roadside locations, is representative of the worst-case roadside location within the Tees Valley where public exposure issues may exist. This provides further evidence that Air Quality Management Areas are not required.

6. There is no obvious downward trend at most locations, with any reduction in vehicle emissions being offset by increases in traffic flow. This reflects the national trend.

Conclusion

Road traffic is the main source of nitrogen dioxide pollution at ground level, but this normally quickly disperses within a relatively short distance of the kerbside. There is no clear sign of nitrogen dioxide levels from traffic falling, with emission improvements generally being offset by traffic flow increases, and annual variations reflecting weather conditions.

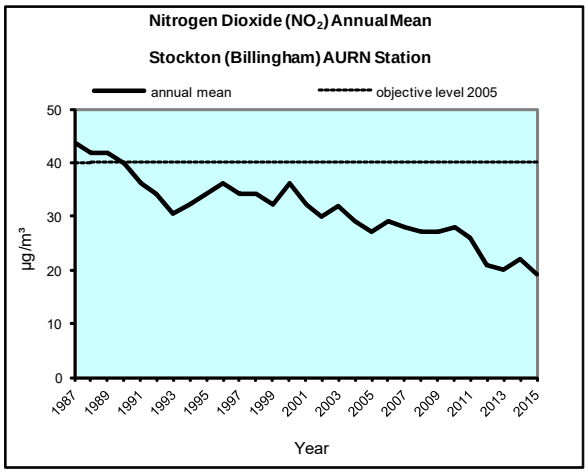
The annual mean objective of 40 µg/m³ maximum with no exceedances will continue to be met across the Tees Valley area in all areas where there is relevant public exposure.

NITROGEN DIOXIDE

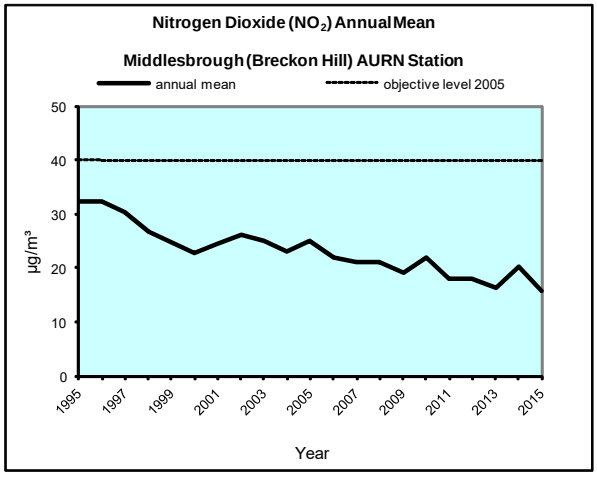
annual mean trend – industrial and urban background sites

Stockton (Billingham) and Middlesbrough (Breckon Hill) AURN Stations,
Redcar (Dormanstown / Corporation Road) and Middlesbrough (MacMillan College) Local Stations

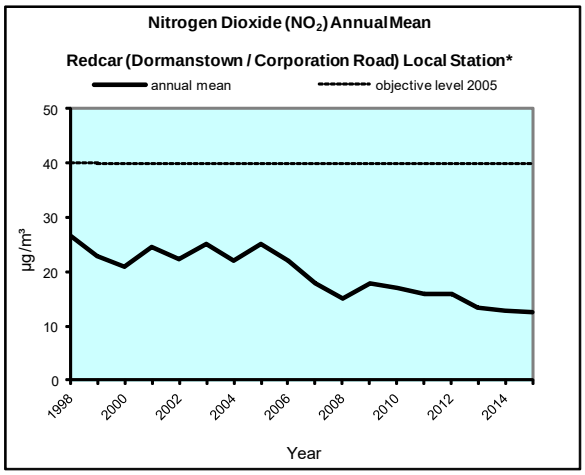
STOCKTON (Billingham) AURN Station
(urban-industrial site classification)



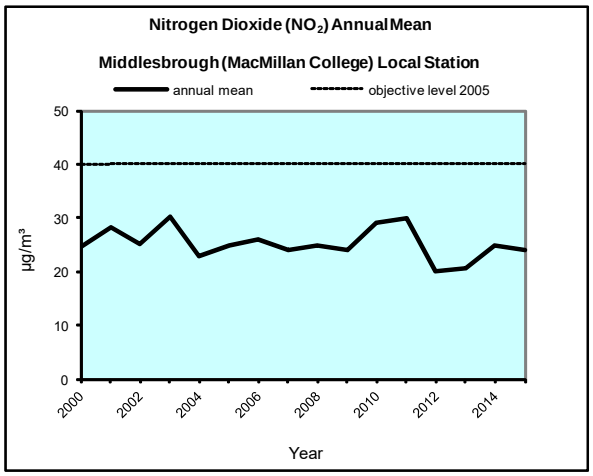
MIDDLESBROUGH (Breckon Hill) AURN Station
(urban-industrial site classification)



REDCAR (Dormanstown) Local Station
(suburban industrial site classification)



MIDDLESBROUGH (MacMillan College) Local Station
(urban background site)



* - Corporation Road was AURN, then Local station from October 2007

Years 2009 - 2011had limited data, annualised using Breckon Hill AURN station

Station relocated to Dormanstown January 2012

NITROGEN DIOXIDE ANNUAL MEAN POLLUTION TREND – industrial and urban background sites

(continuous chemiluminescent analyser measurement)

1. The nitrogen dioxide objective for the annual mean (2005) is a maximum of 40 µg/m³, with no exceedances.

2. There has been a downward trend at most locations, but with any reduction in vehicle emissions being offset by increases in traffic flow, the recent poorer weather conditions are also an influence.

3. The Stockton (Billingham) site has been operating the longest in the Tees valley (since 1987) and is close to the Billingham chemical complex, which specialises in nitrogen-based chemistry such as ammonia, nitric acid and fertiliser production. Nitrogen compound emissions have significantly reduced over the years, and this is reflected in the downward trend. However, this monitoring site is also a storage depot for Council vehicles, and indications are that vehicle emissions are now keeping annual means higher than would otherwise be expected. While there are no public exposure issues in the immediate vicinity, the inlet monitor was moved a short distance at the start of 2012 to minimise the effect of this localised traffic.

4. The Middlesbrough (Breckon Hill) site is an urban industrial background site within school grounds, a public exposure location. There is no obvious impact from industry, but the site is in a residential area bounded by busy town centre roads. An overall downward trend can be seen, and this probably reflects traffic diverting onto the A66 by-pass road. Annual means remain comfortably within the objective level.

5. The Redcar (Dormanstown) site is within school grounds, and is a public exposure suburban location. Traffic in the vicinity is generally light, and there is no obvious impact from the large chemical and steel industrial complexes, which are 3 – 4 kilometres away on a prevailing wind direction. Monitored levels are typical background levels in a built-up area, and are well within the objective level.

6. The Middlesbrough (MacMillan College) site is a public exposure urban background location. It is within 300 metres of the main trunk road interchange (A19 north-south, and A66 east-west) with generally free flowing, but high traffic flows. Results show good pollution dispersion over this distance, with annual means comfortably within the objective level, but no downward trend.

Conclusion

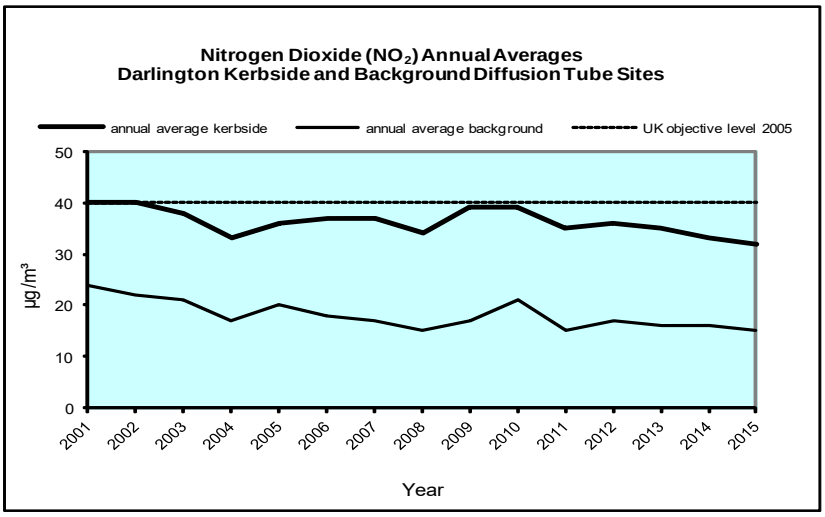
The annual mean objective of 40 µg/m³ maximum with no exceedances will continue to be met across the Tees Valley area in all areas where there is relevant public exposure.

NITROGEN DIOXIDE

annual mean trend

Darlington, Hartlepool and Stockton diffusion tube sites

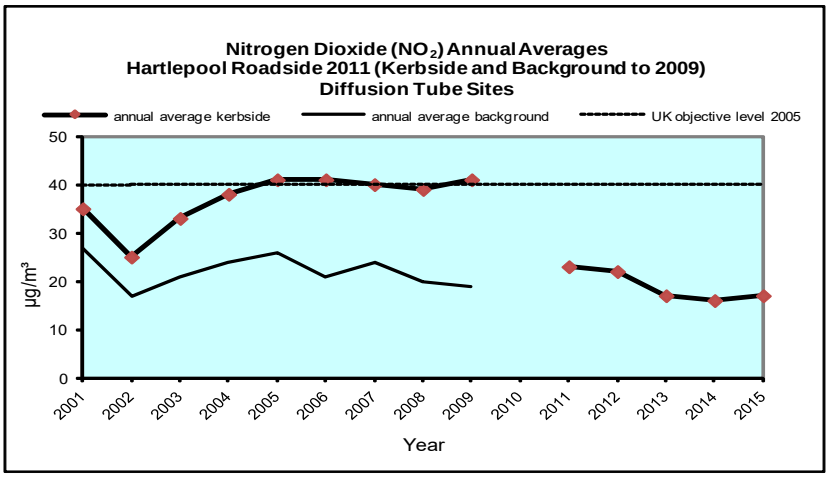
All results adjusted for overall bias



DARLINGTON

2014 data, 9 or 10 months only, annualised using three Tees Valley Continuous Monitor datasets.

HARTLEPOOL



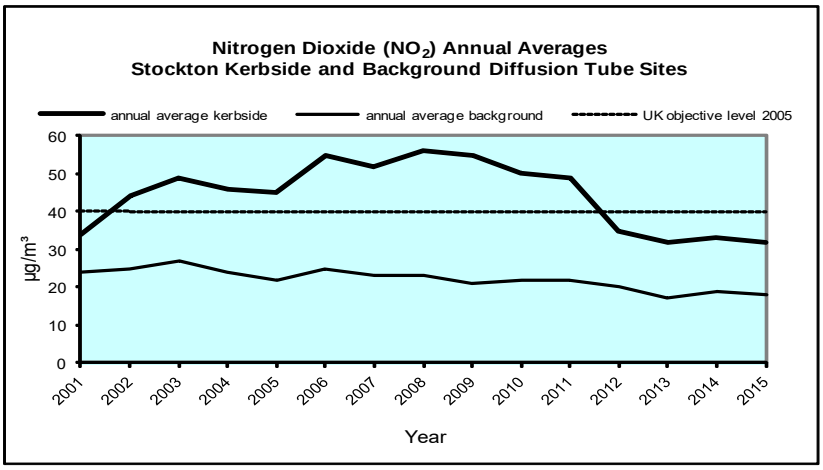
2009 data 2 months only, annualised using Stockton Thornaby Road tube data. No data 2010

2011 data all roadside, 2 months only, annualised using Stockton Thornaby Road tube data.

2012 data all roadside, 5 months only, annualised using Stockton Thornaby Road tube data.

2013 data all roadside, 4 to 9 months only, annualised using three Stockton roadsde diffusion tube datasets.

2014 data all roadside, 5 / 6 months only, annualised using three Tees Valley NO2 continuous monitor datasets.



STOCKTON

NITROGEN DIOXIDE ANNUAL MEAN POLLUTION TREND

(non-continuous diffusion tube measurement)

1. The nitrogen dioxide objective for the annual mean (2005) is a maximum of 40 µg/m³, with no exceedances.

2. Diffusion tubes are inherently less accurate than continuous monitors, but are a cost-effective way to measure annual averages of nitrogen dioxide over a wider area. There is evidence that diffusion tubes tend to read up to 20% higher than continuous monitors at the kerbside sites.

3. The graphs shown opposite are based on averages of similar locations of diffusion tubes covering kerbside and background sites in the three Council areas still using diffusion tubes. All results have been adjusted for diffusion tube bias. Within Hartlepool Council area, the four kerbside and two background sites were discontinued in 2009, and replaced with three roadside sites starting September 2011, with a further one in September 2012, although one had to be removed at the end of December 2014. This followed a review of air quality monitoring needs, and took account of latest guidance on diffusion tube placement. The results show that even a few metres away from kerbside, nitrogen dioxide levels fall significantly.

4. Diffusion tube bias factors are only available from 2001, so earlier diffusion tube results 1996 – 2000 are not shown.

5. There has been no significant downward trend, with any reduction in vehicle emissions being offset by increases in traffic flow. Variations year on year are heavily influenced by weather conditions.

6. Kerbside sites show levels of pollution at, or approaching, the objective level. In view of the inaccuracy of the tubes, it is unlikely that the sites exceed the objective level, but in any event there are no public exposure issues at this type of location. These diffusion tube sites were included in a road modelling study completed in July 2005, and submitted with the 2006 Updating and Screening Report. The study confirmed that kerbside diffusion tubes read significantly high, and that monitored levels at the nearest relevant public exposure points were well within the objective level.

7. The background sites show much lower levels, well within the objective level.

8. The results broadly confirm results and conclusions from the Tees Valley continuous monitors.

9. The new diffusion tube studies within Middlesbrough and Redcar & Cleveland have too few results to be shown here.

Conclusion

Road traffic is the main source of nitrogen dioxide pollution at ground level, but this normally quickly disperses within a relatively short distance of the roadside. There is no clear sign of nitrogen dioxide levels from traffic falling, with emission improvements being offset by traffic flow increases.

The annual mean objective of 40 µg/m³ maximum with no exceedances will continue to be met across the Tees Valley area in all areas where there is relevant public exposure.

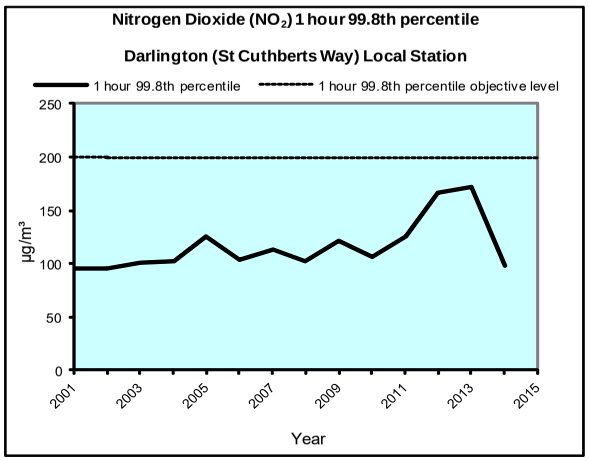
It is noted that Redcar & Cleveland Council stated a study of nitrogen dioxide roadside levels in July 2014. Middlesbrough Council has also initiated a similar study, starting January 2015.

NITROGEN DIOXIDE

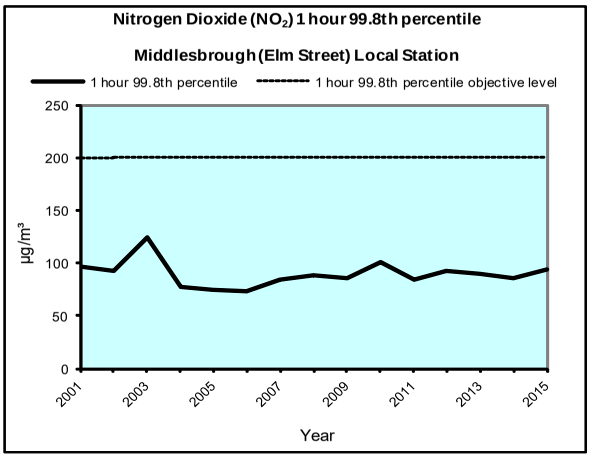
1 hour 99.8th percentile trend – kerbside and roadside sites

Darlington (St Cuthbert's Way), Middlesbrough (Elm Street), Darlington (Cockerton Bridge) Local Stations, Stockton (Eaglescliffe & Yarm) AURN Stations and Hartlepool (Stockton Road) Local Station

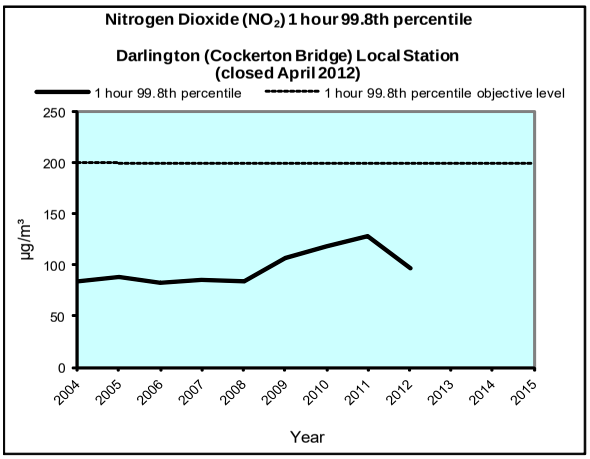
DARLINGTON (St Cuthbert's Way) Local Station
(urban kerbside site)



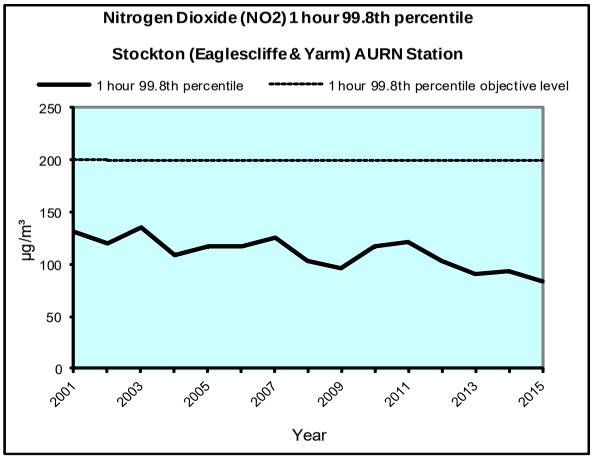
MIDDLESBROUGH (Elm Street) Local Station
(urban roadside site)



DARLINGTON (Cockerton Bridge) Local Station
(urban roadside site) **closed April 2012**

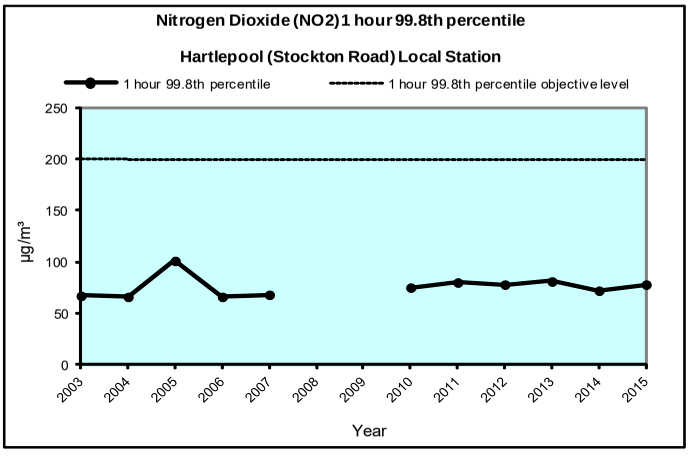


STOCKTON (Eaglescliffe and Yarm) AURN Stations
(roadside / kerbside site classification)



Eaglescliffe from 2009

Hartlepool (Stockton Road) Local Station
(urban roadside site)



no data for 2008 - 2009

new monitor end October 2010. 2014 data is 5 mths only

NITROGEN DIOXIDE 1 HOUR 99.8th PERCENTILE POLLUTION TREND – kerbside and roadside sites
(continuous chemiluminescent analyser measurement)

1. The nitrogen dioxide objective for 1 hour means (2005) is a maximum of 200µg/m³ with no more than 18 exceedances in any one year. This equates to the 99.8th percentile of 1 hour mean readings over the year, and is the measure of how well this objective is being met.

2. The two kerbside sites, Darlington (St Cuthbert's Way, closed December 2014) and the now closed Stockton (Yarm High Street) show that slow moving heavy traffic does not necessarily lead to a high incidence of peak 1 hour concentrations. This is only likely to happen if pollution dispersion is severely restricted, such as can happen along roads with 'canyon' type characteristics caused by tall buildings close to either side of the road. These are not found within the Tees Valley.

3. The difference between 1 hour kerbside concentrations and 1 hour roadside concentrations is much less than for the annual means shown earlier. Even at the kerbside sites, concentrations are well below the objective.

Conclusion

Road traffic is the main source of nitrogen dioxide pollution at ground level, but hourly means do not build up to the objective level under normal dispersion conditions.

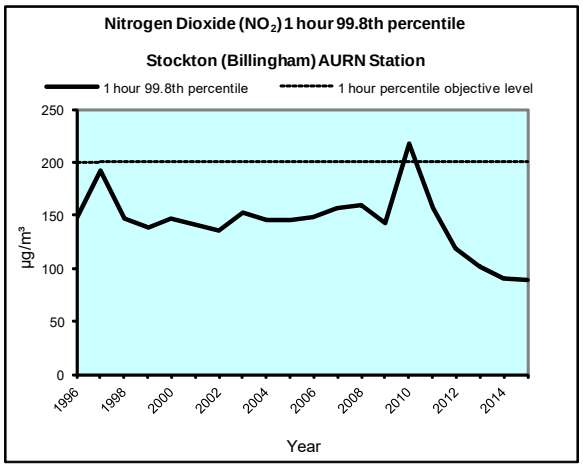
The 1 hour mean objective of 200 µg/m³ maximum with no more than 18 exceedances / year (99.8th percentile) will continue to be met in all parts of the Tees Valley area.

NITROGEN DIOXIDE

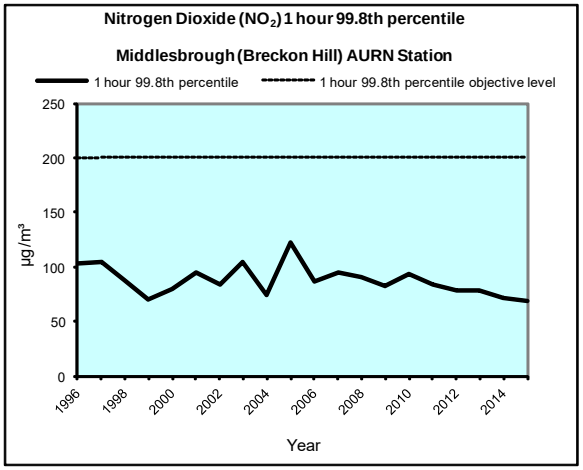
1 hour 99.8th percentile trend – industrial and urban background sites

Stockton (Billingham) and Middlesbrough (Breckon Hill) AURN Stations,
Redcar (Dormanstown / Corporation Road) and Middlesbrough (MacMillan College) Local Stations

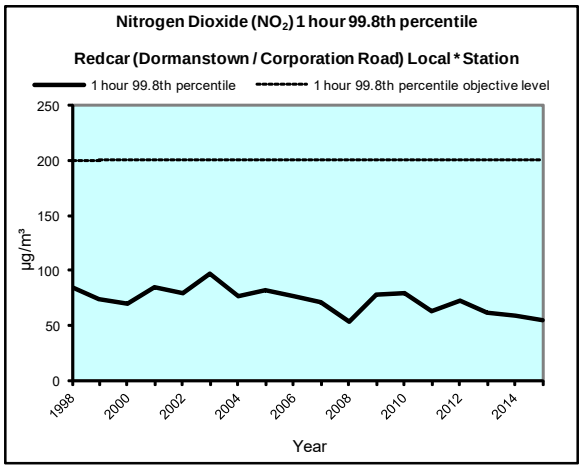
STOCKTON (Billingham) AURN Station
(urban-industrial site classification)



MIDDLESBROUGH (Breckon Hill) AURN Station
(urban-industrial site classification)

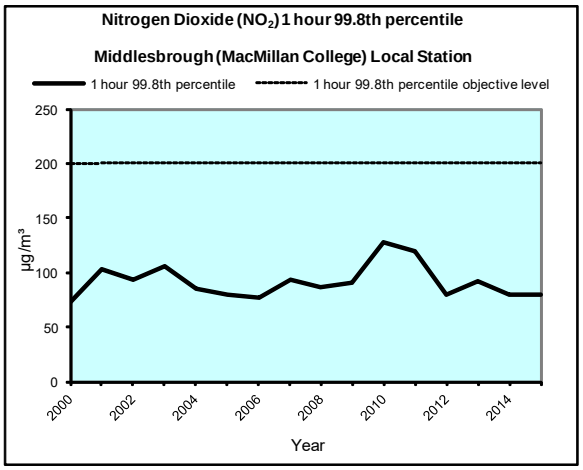


REDCAR (Dormanstown) Local Station
(suburban industrial site classification)



note * Corporation Road was AURN, then Local station from October 2007
Station relocated to Dormanstown January 2012

MIDDLESBROUGH (MacMillan College) Local Station
(urban background site)



NITROGEN DIOXIDE 1 HOUR 99.8th PERCENTILE POLLUTION TREND – industrial and urban background sites
(continuous chemiluminescent analyser measurement)

1. The nitrogen dioxide objective for 1 hour means (2005) is a maximum of 200µg/m³ with no more than 18 exceedances in any one year. This equates to the 99.8th percentile of 1 hour mean readings over the year, and is the measure of how well this objective is being met.

2. All of the sites show a degree of variation year on year probably due to weather variations, but are broadly constant with no clear downward trend.

3. Highest levels are recorded at the Stockton (Billingham), which is close to the Billingham chemical complex specialising in nitrogen-based chemistry such as ammonia, nitric acid and fertiliser production. Nitrogen compound emissions have significantly reduced over the years, but a reduction in the 1 hour 99.8th percentile is not as pronounced as with the annual mean trend. The monitoring site is also a storage depot for Council vehicles, and indications are that vehicle emissions during the key morning and afternoon logistic periods are contributing to more frequent and higher 1 hour levels than would otherwise be expected. This was particularly so in 2010, when prolonged cold weather at the beginning and end of the year significantly increased the percentile to above the objective level. There is however, no public exposure issues connected with this site. From 2012, the inlet to the monitor has been moved away from the vehicle movement area to minimise this influence, and the effect of this can be clearly seen.

4. The two urban background sites in Middlesbrough (Breckon Hill and MacMillan College) and the suburban background site in Redcar (Dormanstown) show similar levels of 1 hour 99.8th percentiles, well within the objective. There is no obvious impact on pollution levels from the large chemical and steel industrial complexes along the Tees estuary.

Conclusion

Road traffic is the main source of nitrogen dioxide pollution at ground level, but hourly means do not build up to the objective level under normal dispersion conditions.

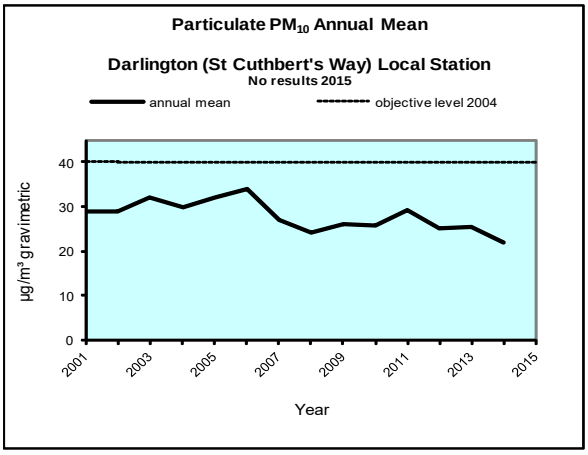
The 1 hour mean objective of 200 µg/m³ maximum with no more than 18 exceedances / year (99.8th percentile) will continue to be met in all parts of the Tees Valley area where there is relevant public exposure.

PARTICULATE PM_{10}

annual mean trend – kerbside and roadside sites

Darlington (St Cuthbert's Way), Middlesbrough (Elm Street), Darlington (Cockerton Bridge) Local Stations, Stockton (Eaglescliffe and Yarm) AURN Stations and Hartlepool (Stockton Road) Local Station

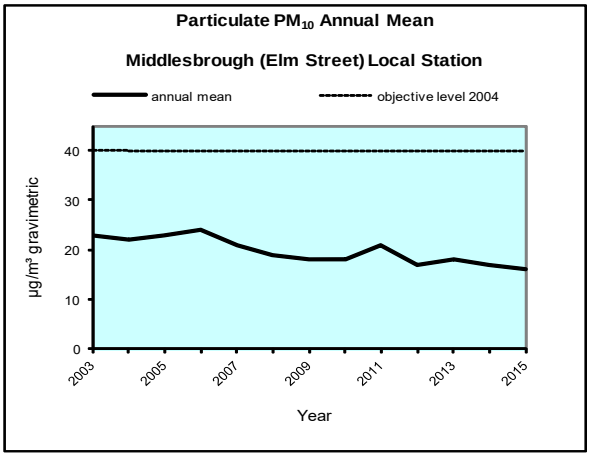
DARLINGTON (St Cuthbert's Way) Local Station
(urban kerbside site)



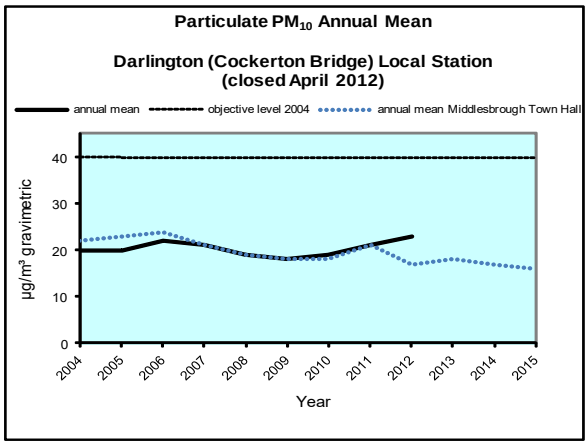
2004 / 5 data 3 months only, annualised using Stockton Yarm AURN data

2012 data 9 months only, annualised using Stockton Eaglescliffe AURN data

MIDDLESBROUGH (Elm Street) Local Station
(urban roadside site)



DARLINGTON (Cockerton Bridge) Local Station
(urban roadside site) **closed April 2012**

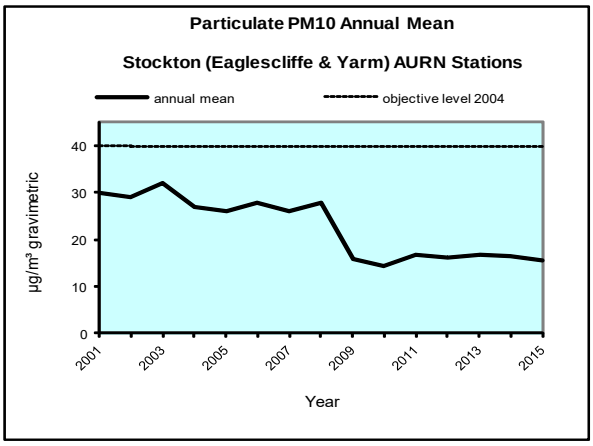


2004 data 4 months only, annualised using Stockton Yarm AURN data

2012 data 3 months only, annualised using Stockton Eaglescliffe AURN data

Middlesbrough Town Hall data added to indicate probable trend 2011- 2015

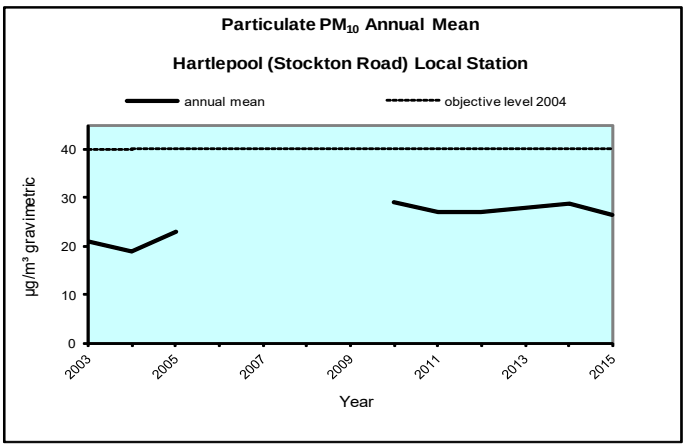
STOCKTON (Eaglescliffe and Yarm) AURN Stations
(urban roadside / kerbside site classification)



site closed, transferred to Eaglescliffe October 2008

2009 onwards data is for Eaglescliffe using a BAM monitor

HARTLEPOOL (Stockton Road) Local Station
(urban roadside site)



2005 data 5 months only, annualised using Stockton Yarm AURN data, no data 2006 - 2009

2010 data 2 months only, annualised using Stockton Eaglescliffe AURN data.

PARTICULATE PM_{10} ANNUAL MEAN POLLUTION TREND – kerbside and roadside sites

Beta Attenuated Monitors (BAM), continuous tapered element oscillating microbalance (TEOM) measurement using FDMS, or TEOM basic monitors with results adjusted to gravimetric values using current vcm method (1.3 factor prior to 2008).

1. The 2004 particulate PM_{10} objective for the annual mean is a maximum of 40 µg/m³ (gravimetric), with no exceedances.

2. The two kerbside sites, Darlington (St Cuthbert's Way, closed December 2014) and the now closed Stockton (Yarm High Street), show particulate PM_{10} annual means consistently higher than at the roadside monitoring sites, indicating that traffic particulates disperse with distance under normal conditions. This is clearly seen on the Yarm / Eaglescliffe trend graph (monitor moved at the end of 2008)

3. Annual variations of results are generally due to weather influences. There have been few recent high pressure episodes which allow particulate build-up, but these do not last for long periods.

4. Annual means are comfortably below the 2004 objective of 40 µg/m³ (gravimetric).

5. The Eaglescliffe roadside location is an area of relevant public exposure with the annual mean comfortably within the objective level. The Middlesbrough (Elm Street), Hartlepool (Stockton Road), and the now closed Darlington (Cockerton Bridge) roadside sites are set back from the road towards the building line, but they are indicative of worst case public exposure locations. Results show that there is normally good dispersion away from the kerbside, with annual means well within the objective level.

Conclusion

Road traffic is a major source of particulate PM_{10} pollution at ground level, but there is a wider range of particulate PM_{10} pollution sources that will have an impact away from roadside. Weather conditions also add to year variations.

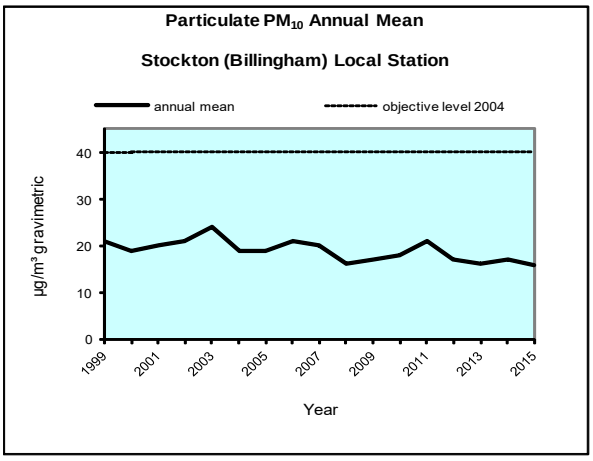
The 2004 annual mean objective of 40 µg/m³ (gravimetric) maximum with no exceedances will continue to be met across the Tees Valley.

PARTICULATE PM_{10}

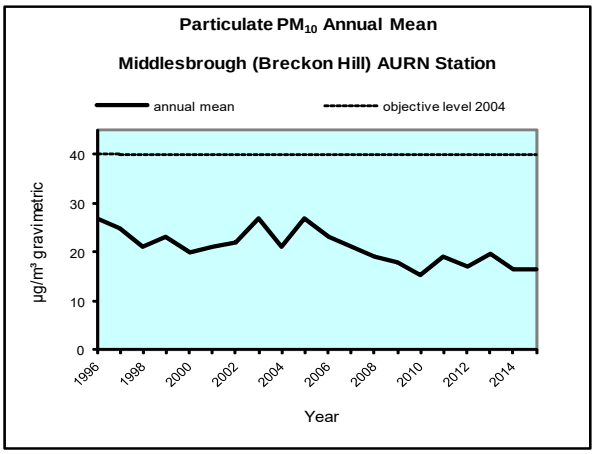
annual mean trend – industrial and urban background sites

Stockton (Billingham) and Middlesbrough (Breckon Hill) AURN Stations,
Redcar (Dormanstown / Corporation Road),
Middlesbrough (MacMillan College), and Hartlepool Town Wall Headland Local Stations

STOCKTON (Billingham) Local Station
(urban-industrial site)

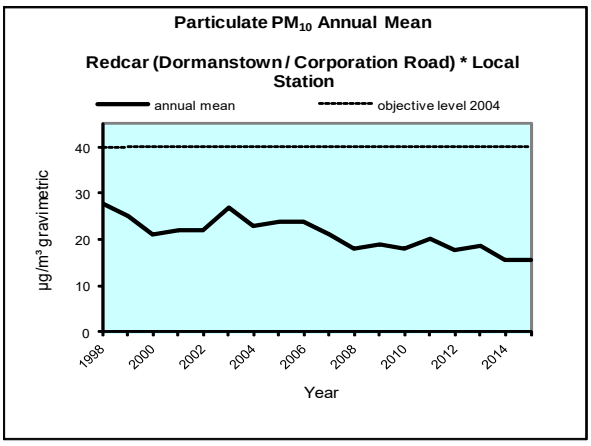


MIDDLESBROUGH (Breckon Hill) AURN Station
(urban background site classification)



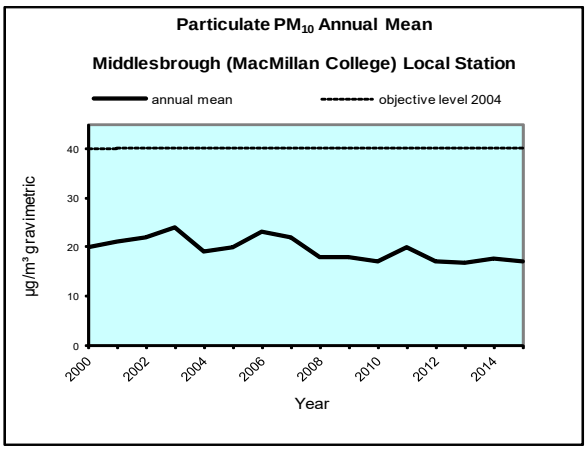
2009 onwards data is from a new TEOM FDMS monitor

REDCAR (Dormanstown / Corporation Road) * Local Station
(suburban industrial site classification)

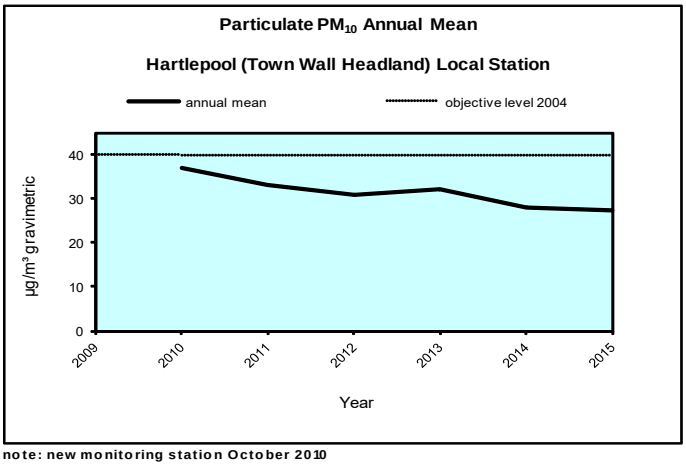


*** - Corporation Road was AURN, then Local station from October 2007**
2012 onwards - Dormanstown

MIDDLESBROUGH (MacMillan College) Local Station
(urban background site)



HARTLEPOOL (Town Wall Headland) Local Station
(urban - port site)



note: new monitoring station October 2010

PARTICULATE PM_{10} ANNUAL MEAN POLLUTION TREND – industrial and urban background sites

(Beta Attenuated Monitors (BAM), continuous tapered element oscillating microbalance (TEOM) measurement using FDMS, or TEOM basic monitors with results adjusted to gravimetric values using current vcm method / 1.3 factor prior to 2008.)

1. The 2004 particulate PM_{10} objective for the annual mean is a maximum of 40 µg/m³ (gravimetric), with no exceedances.

2. The Stockton (Billingham) site is more consistently at the low end of the range of annual means measured in the Tees Valley. It is sufficiently far inland to be unaffected by coastal sources, and does not seem to be significantly affected by the local industrial complex, or the short-term movements of vehicles on the site.

3. The Middlesbrough (Breckon Hill) site is an urban industrial background site within school grounds, a public exposure location. The trend line is more erratic, suggesting that the site is exposed to other sources of particulate pollution other than traffic, ie industry, local construction (as in 2005) etc.

4. The Redcar (Dormanstown) site is within school grounds, and is a public exposure suburban location. Traffic in the vicinity is generally light, and is unlikely to be the most significant source of particulate pollution. There is likely to be some impact from the large chemical and steel industrial complexes, which are 3 – 4 kilometres away on a prevailing wind direction, but another potential source of particulate PM_{10} at this location is from coastal sources such as sand and salt.

5. The Middlesbrough (MacMillan College) site is a public exposure urban background location. It is within 300 metres of the main trunk road interchange (A19 north-south, and A66 east-west) with high, but generally free flowing, traffic flows.

6. All four stations show that the 2004 annual mean objective is readily met.

7. The new Hartlepool Headland site has been installed to monitor port activities. Analysis of the results shows that while there is an issue with fugitive emissions from loading / unloading activities, natural coastal sources also have a significant impact. Results from this monitor reflect localised conditions only, and are within the objective level.

Conclusion

Road traffic is a major source of particulate PM_{10} pollution at ground level, but there is a wider range of particulate PM_{10} pollution sources that have an impact away from roadside. Weather conditions also add to year variations.

The 2004 annual mean objective of 40 µg/m³ (gravimetric) maximum with no exceedances will continue to be met across the Tees Valley.

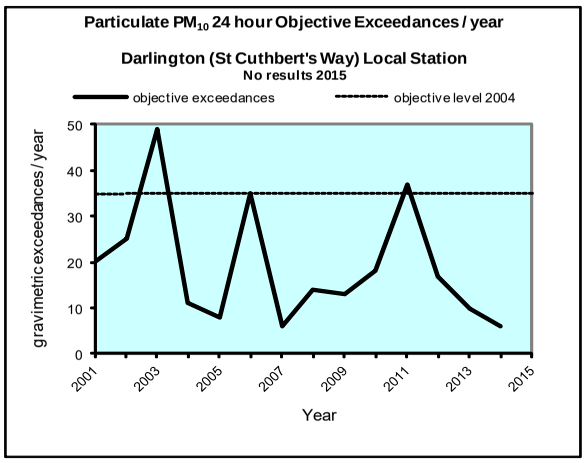
PARTICULATE PM_{10}

24 hour exceedance trend – kerbside and roadside sites

Darlington (St Cuthbert's Way), Middlesbrough (Elm Street), Darlington (Cockerton Bridge) Local Stations, Stockton (Eaglescliffe and Yarm) AURN Stations and Hartlepool (Stockton Road) Local Station

DARLINGTON (St Cuthbert's Way) Local Station

(urban roadside site)

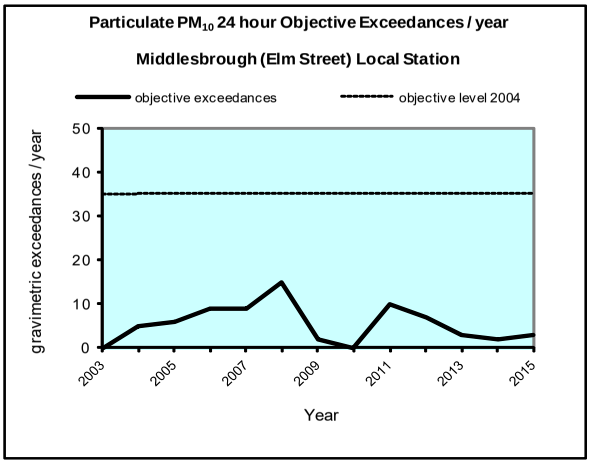


note: 2004 and 2005 data 3 months only

note: 2012 data 9 months only

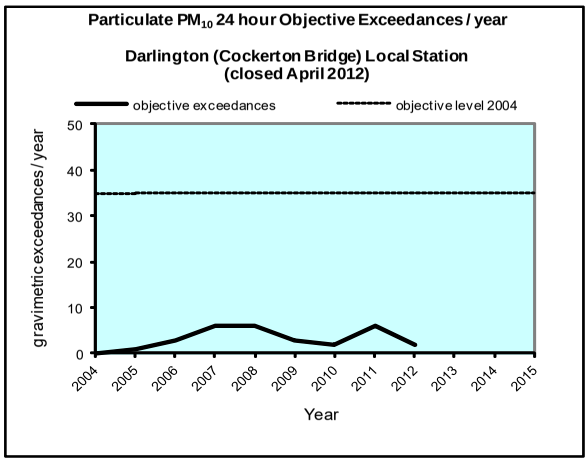
MIDDLESBROUGH (Elm Street) Local Station

(urban roadside site)



DARLINGTON (Cockerton Bridge) Local Station

(urban roadside site) **closed April 2012**

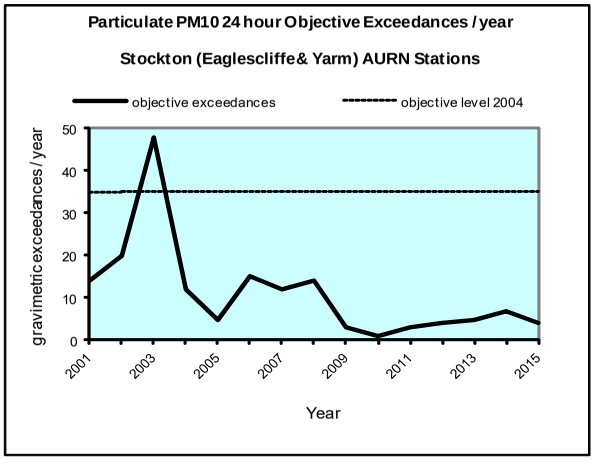


note: 2004 data 4 months only

note: 2012 data 3 months only

STOCKTON (Eaglescliffe and Yarm) AURN Stations

(urban roadside / kerbside site classification)

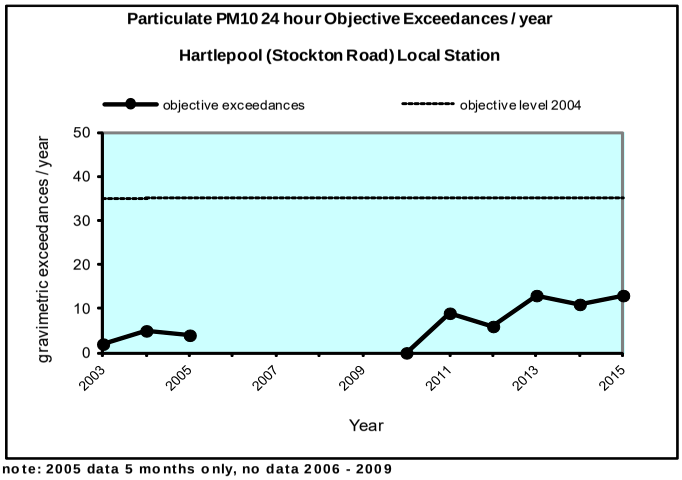


site closed, transferred to Eaglescliffe October 2008

2009 onwards data is for Eaglescliffe using a BAM monitor

HARTLEPOOL (Stockton Road) Local Station

(urban roadside site)



note: 2005 data 5 months only, no data 2006 - 2009

note: 2010 data 2 months only

PARTICULATE PM_{10} 24 HOUR MEAN POLLUTION EXCEEDANCE TREND – kerbside and roadside sites

(Beta Attenuated Monitors (BAM), continuous tapered element oscillating microbalance (TEOM) measurement using FDMS, or TEOM basic monitors with results adjusted to gravimetric values using current vcm method / 1.3 factor prior to 2008.)

1. The 2004 particulate PM_{10} objective for 24 hour means is a maximum of 50 µg/m³ (gravimetric), with no more than 35 exceedances in any one year.

2. The two kerbside sites, Darlington (St Cuthbert's Way, closed December 2014) and the now closed Stockton (Yarm High Street), show the number of particulate PM_{10} 24 hour mean exceedances consistently higher than at the roadside monitoring sites. The Yarm kerbside site was moved in 2009 a short distance to Eaglescliffe roadside site, which is representative of public exposure. Exceedances dropped dramatically demonstrating concentrations fall away with distance from kerbside where there is good dispersion.

3. The Middlesbrough (Elm Street) site is a town centre site, set back from the road on the building line. It is a possible public exposure location. Traffic is slow moving, but results show normal good dispersion away from the kerbside, with the number of exceedances well within the objective level.

4. The Hartlepool (Stockton Road), and the now closed Darlington (Cockerton Bridge) sites are set slightly further back from the road than Elm Street above. Both sites are well within the 35 exceedance objective.

5. Weather conditions, particularly high pressure episodes over a long period such as March / April 2011, can cause rapid particulate build-up around kerbside locations such as St Cuthbert's Way.

Conclusion

Road traffic is the main source of particulate PM_{10} pollution at ground level, but there is a wider range of particulate PM_{10} pollution sources that will have an impact away from roadside. Weather conditions also add to year variations.

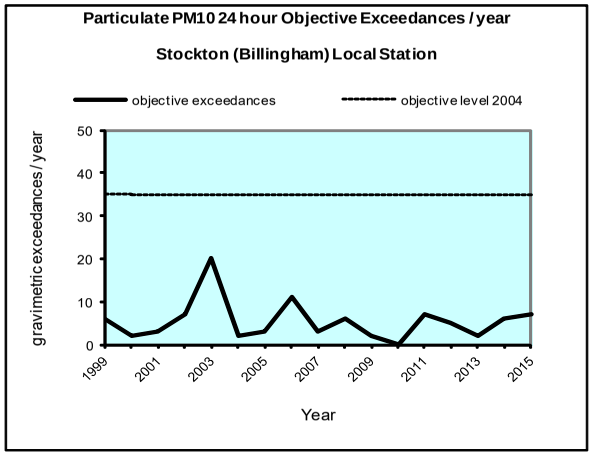
The 2004 objective of maximum 35 exceedances of the 24 hour mean will continue to be met across the Tees Valley where there is relevant public exposure.

PARTICULATE PM_{10}

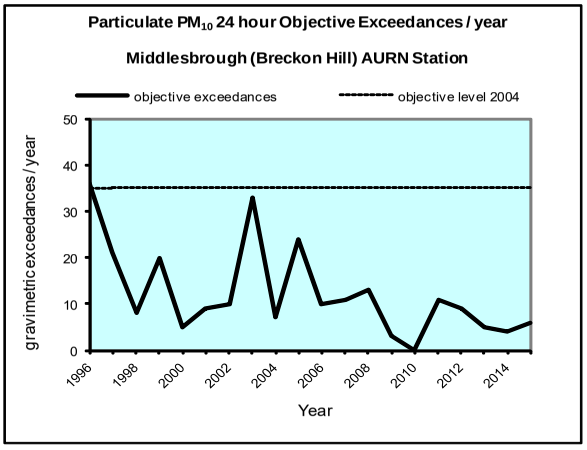
24 hour exceedance trend – industrial and urban background sites

Stockton (Billingham) and Middlesbrough (Breckon Hill) AURN Stations,
Redcar (Dormanstown / Corporation Road),
Middlesbrough (MacMillan College), and Hartlepool Town Wall Headland Local Stations

STOCKTON (Billingham) Local Station
(urban-industrial site)

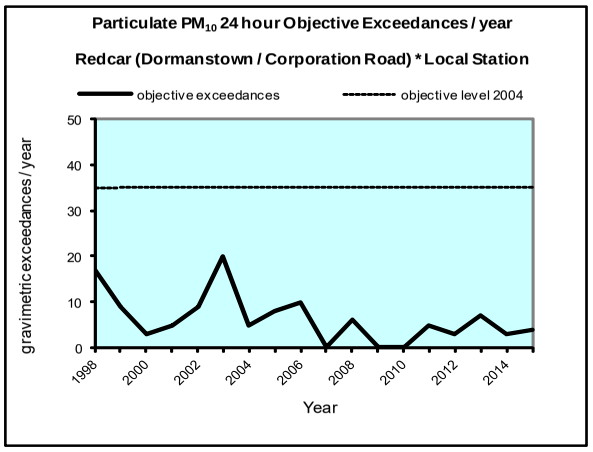


MIDDLESBROUGH (Breckon Hill) AURN Station
(urban background site classification)



2009 onwards data is from a new TEOM FDMS monitor

REDCAR (Dormanstown / Corporation Road) * Local Station
(suburban industrial site classification)

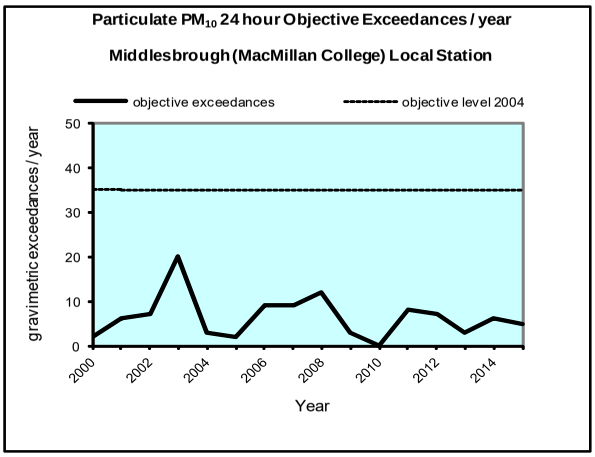


note * was AURN station, but Local station from October 2007

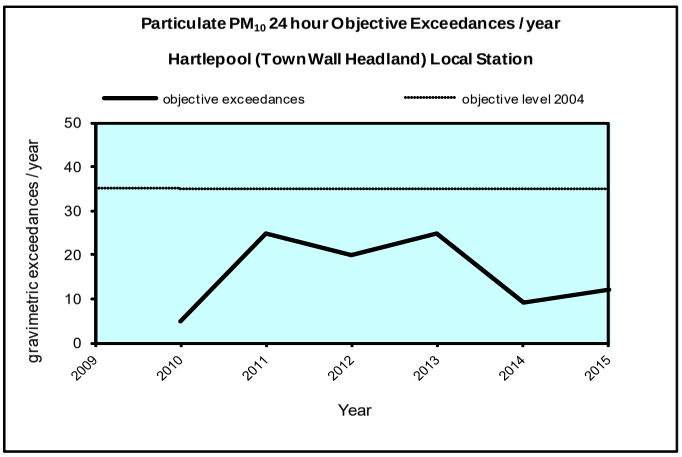
2009 - 10 results are less than six months data

2012 onwards - Dormanstown

MIDDLESBROUGH (MacMillan College) Local Station
(urban background site)



HARTLEPOOL (Town Wall Headland) Local Station
(urban - port site)



note: new monitoring station October 2010

note: 2010 data 2 months only

PARTICULATE PM_{10} 24 HOUR MEAN POLLUTION EXCEEDANCE TREND – industrial and urban background sites
(Beta Attenuated Monitors (BAM), continuous tapered element oscillating microbalance (TEOM) measurement using FDMS, or TEOM basic monitors with results adjusted to gravimetric values using current vcm method / 1.3 factor prior to 2008.)

1. The 2004 particulate PM_{10} objective for 24 hour means is a maximum of 50 µg/m³ (gravimetric), with no more than 35 exceedances in any one year.

2. The Stockton (Billingham) site is at the low end of the range of 24 hour mean exceedances measured in the Tees Valley. It is sufficiently far inland to be unaffected by coastal sources, and does not seem to be significantly affected by the local industrial complex, or the short term movements of vehicles on the site. The objective level of exceedance for 2004 is normally easily met.

3. The Middlesbrough (Breckon Hill) site is an urban industrial background site within school grounds, a target group location. The trend line is more erratic, suggesting that the site is exposed to other sources of particulate pollution other than traffic, ie industry, poor dispersion (as in 2003), construction (as in 2005) etc.
The number of objective exceedances is normally well below the 2004 objective level of 35.

4. The Redcar (Dormanstown) site is within school grounds, and is a public exposure suburban location. Traffic in the vicinity is generally light, and is unlikely to be the most significant source of particulate pollution. There may be some impact from the large chemical and steel industrial complexes which are 3 – 4 kilometres away on a prevailing wind direction, but another potential source of particulate PM_{10} at this location is from coastal sources such as sand and salt. The years of poor dispersion, 2003 and 2006, are prominent.
The number of objective exceedances is normally well below the 2004 objective level of 35.

5. The Middlesbrough (MacMillan College) site is a public exposure urban background location. It is within 300 metres of the main trunk road interchange (A19 north-south, and A66 east-west) with high, but generally free flowing, traffic flows. Traffic source pollution is well dispersed under normal conditions, but weather conditions that lead to poor dispersion can have a significant impact.
The objective level for 2004 of 35 exceedances maximum is comfortably met.

6. The new Hartlepool Town Wall Headland site started full year results from 2011. Analysis of the results shows that while there is an issue with the working port activities, natural coastal sources also have a significant impact. Results from this monitor reflect localised conditions only, and are within the objective level.

Conclusion

While road traffic is the main source of particulate PM_{10} pollution at ground level, there is a wider range of particulate PM10 pollution sources that will have an impact away from roadside, in particular long periods of poor dispersion due to weather conditions.

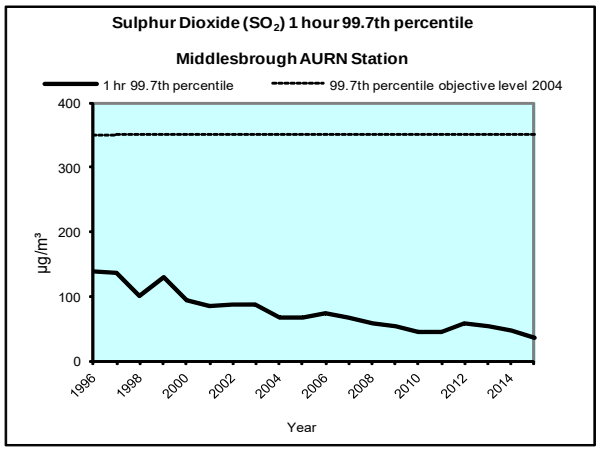
The 2004 objective of maximum 35 exceedances of the 24 hour mean will continue to be met across the Tees Valley where there is relevant public exposure.

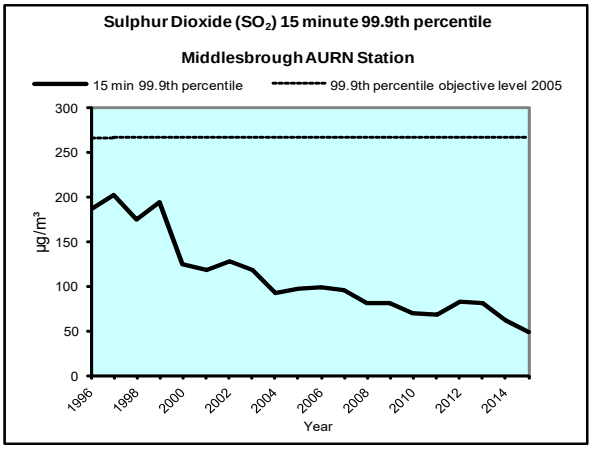
SULPHUR DIOXIDE

1 hour 99.7th percentile and 15 minute 99.9th percentile trends
Middlesbrough AURN Station,
Redcar (Dormanstown / Corporation Road) and Stockton (Billingham) Local Stations

MIDDLESBROUGH (Breckon Hill) AURN Station

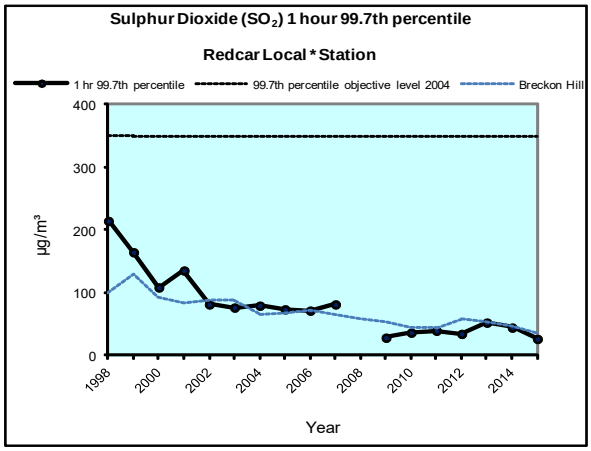
(urban background site classification)

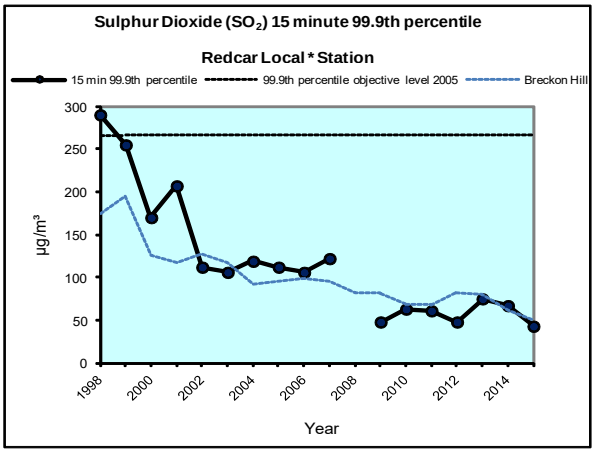




REDCAR (Dormanstown & Corporation Road) Local * Station

(suburban site classification)

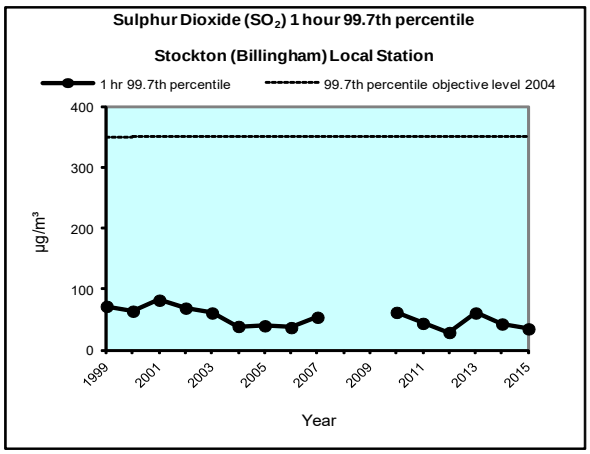


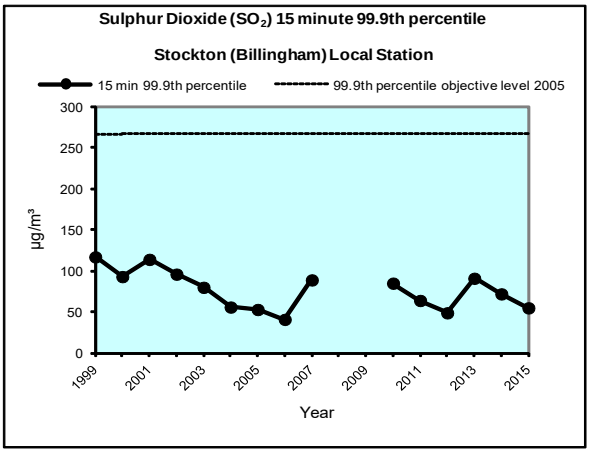


* was AURN station, but Local station from October 2007, no 2008 data, restart July 2009, limited data 2010, new monitor 2011. Dormanstown from 2012
Middlesbrough Breckon Hill AURN station trend line added for comparison

STOCKTON (Billingham) Local Station

(urban-industrial site)





SULPHUR DIOXIDE 24 HOUR MEAN 99th PERCENTILE, 1 HOUR MEAN 99.7th PERCENTILE, and 15 MINUTE 99.9th PERCENTILE POLLUTION TREND

(Continuous ultra-violet fluorescence (UVF) analyser)

1. The 2004 sulphur dioxide objective for 24 hour means is a maximum of 125 µg/m³ with no more than 3 exceedances in any one year. This equates to the 99th percentile of 24 hour readings over the year.
   This objective is easily met across the Tees Valley, with little variation year on year, and is not shown opposite.

2. The 2004 sulphur dioxide objective for 1 hour means is a maximum of 350 µg/m³ with no more than 24 exceedances in any one year. This equates to the 99.7th percentile of 1 hour readings over the year, and the trend at each monitoring location is shown opposite on the left.
   This objective is also easily met at the monitoring sites, with a clear downward trend at the Redcar site, and to a lesser extent at the Middlesbrough and Billingham sites. Levels have stabilised over the last few years. Sulphur dioxide pollution in the Tees Valley is almost entirely due to industrial emissions, but these have shown significant reductions over recent years, partly due to the increased availability of natural gas, and partly due to restrictions on the level of sulphur content of other fuels. This reduction in pollution levels has been more pronounced at the Redcar site, which is generally downwind of the major chemical and steel industrial complexes along the Tees estuary.

3. The 2005 sulphur dioxide objective for 15 minute means is a maximum of 266 µg/m³ with no more than 35 exceedances in any one year. This equates to the 99.9th percentile of 15 minute readings over the year, and the trend at each monitoring location is shown opposite on the right.
   This objective is the most demanding of the three sulphur dioxide objectives, but is now comfortably met at the monitoring sites. The downward trend at all three stations has now stabilised at less than half of the objective level.

Conclusion

Industrial emissions are the main source of sulphur dioxide pollution at ground level, normally from plume grounding as a result of adverse weather conditions and / or stack design factors.

Industrial emission levels have fallen by over 30 percent in the last five years, and this is reflected in the monitored levels.

All three sulphur dioxide objectives are expected to continue to be met in all parts of the Tees Valley, and will continue to be met as long as industrial emissions do not significantly increase. The 15 minute objective is the most susceptible to any future changes in the sulphur content of fuels used by industry.

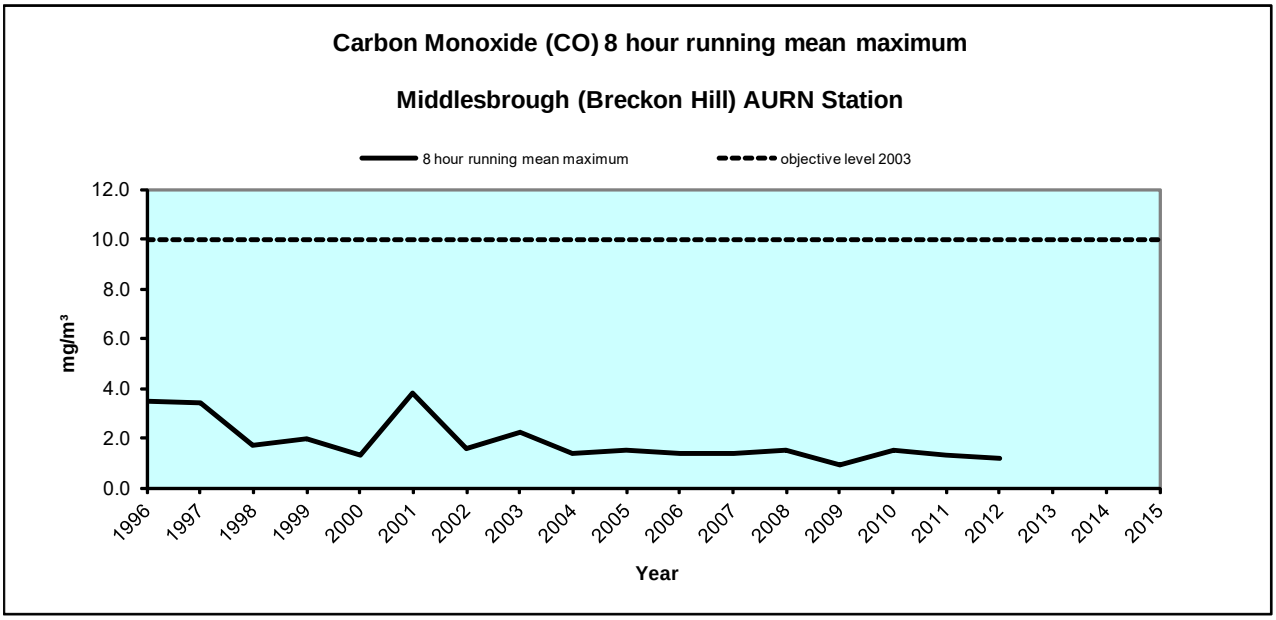
CARBON MONOXIDE

8 hour running mean trend

Middlesbrough (Breckon Hill) AURN Station, Redcar (Corporation Road) Local Station, and Stockton Yarm (High Street) AURN Station

MIDDLESBROUGH (Breckon Hill) AURN Station

(urban background site classification)

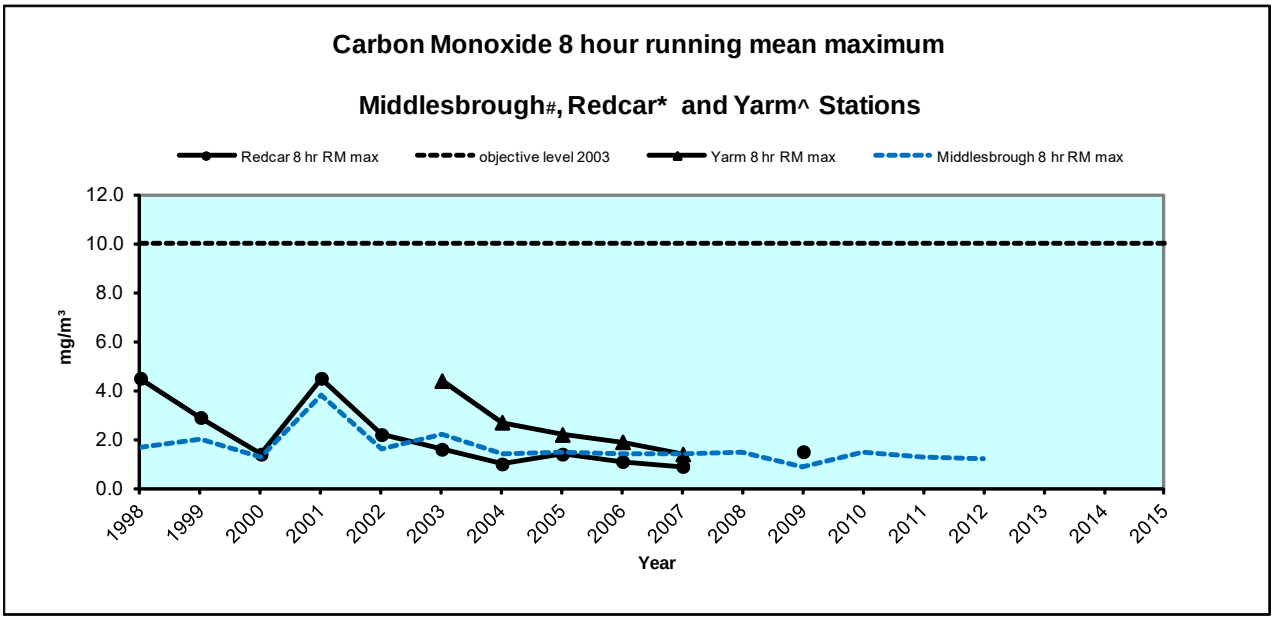


note Carbon Monoxide monitoring at Middlesbrough station discontinued December 2012

REDCAR (Corporation Road) Local Station and Yarm (High Street) AURN Station

(suburban and roadside site classifications)

with Middlesbrough Breckon Hill AURN Station trend line added for comparison



 # Carbon Monoxide monitoring at Middlesbrough AURN station discontinued December 2012
*** Carbon Monoxide monitoring at Redcar Local station discontinued December 2009, no 2008 data**
^ Carbon Monoxide monitoring at Stockton Yarm High Street AURN station discontinued October 2007

CARBON MONOXIDE 8 HOUR RUNNING MEAN POLLUTION TREND

(continuous gas correlation analyser)

1. The 2003 carbon monoxide objective for the 8 hour running mean is a maximum of 10 mg/m³ with no exceedances.

2. This objective is easily met at the monitoring sites. The Redcar (Corporation Road) site has shown slightly higher levels than at the Middlesbrough (Breckon Hill) site, and this is due to the Redcar site being generally downwind of industrial emissions from the major chemical and steel industrial complexes along the Tees estuary. However, both stabilised over recent years at low levels.

3. The more recent, but now closed, AURN monitoring station at Stockton (Yarm High Street) has provided a measure of emissions from congested slow moving traffic. Results show carbon monoxide levels consistently higher than those recorded at Middlesbrough and Redcar, but the 8 hour running means remain well below the objective level.

4. It is noted that carbon monoxide monitoring at the Stockton Yarm AURN site was discontinued in 2007 as part of the AURN network review. Although the Redcar Corporation Road AURN site lost AURN status in the same review, the site continued for a while as a Local station. Following a review of monitoring requirements by Redcar & Cleveland council, carbon monoxide monitoring was discontinued at the end of 2009. A further AURN network review in 2012 has resulted in carbon monoxide monitoring being discontinued at Middlesbrough Breckon Hill AURN station from the end of December 2012.

5. This reduction in carbon monoxide monitoring reflects reduced monitoring across the UK in view of the very low levels recorded at all stations. There is no further requirement for carbon monoxide monitoring within the Tees Valley.

Conclusion

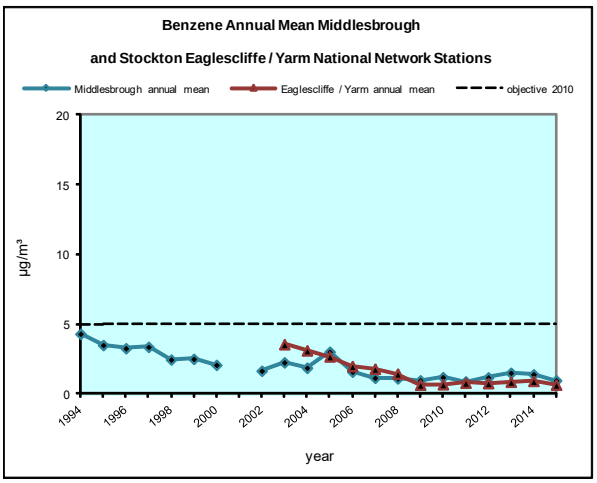
Traffic emissions are the main source of carbon monoxide pollution at ground level, but industrial emissions can impact from time to time, although it is not clear whether this results from plume grounding from tall stacks, or from lower level fugitive emissions.

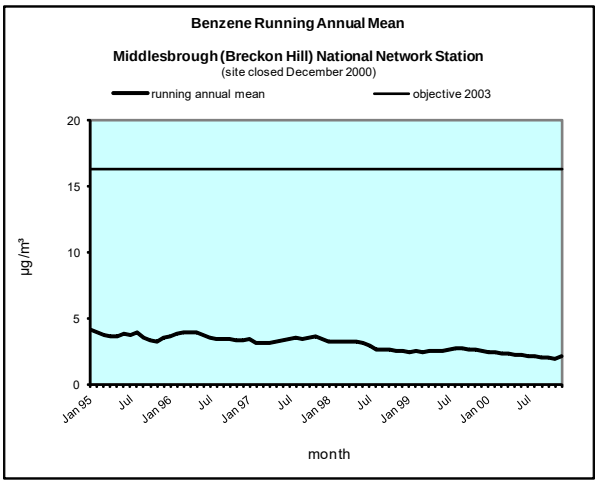
The 8 hour running mean objective of 10 mg/m³ with no exceedances will continue to be met across the Tees Valley.

BENZENE
annual mean trends

Middlesbrough Breckon Hill and Stockton Eaglescliffe / Yarm National Network Stations
Redcar (Corporation Road) Local Station

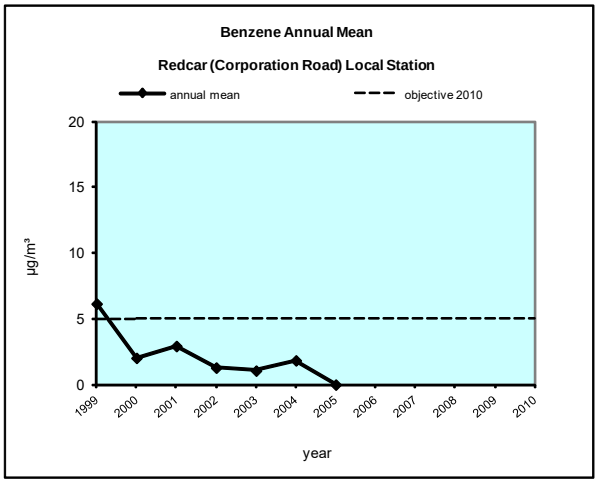
BENZENE - Middlesbrough (Breckon Hill) and Yarm National Network Stations
(urban background and roadside site classifications)

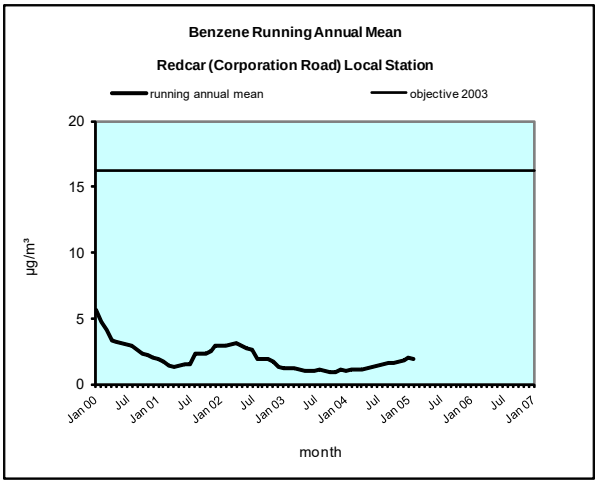




note 1 Middlesbrough AURN continuous monitor closed December 2000. Replaced with a national network Benzene pumped diffusion type system from February 2002.
note 2 No Middlesbrough annual mean data for 2001. No Middlesbrough running annual mean data for 2001 onwards.
note 3 Yarm national network Benzene pumped diffusion tube type system installed July 2002. Transferred to Eaglescliffe October 2008
note 4 Eaglescliffe value for 2009 is 0.67 µg/m^3, below that of Middlesbrough 2009 at 0.98 µg/m3

BENZENE - Redcar (Corporation Road) Local Station
(suburban site)





note 1 Redcar continuous monitor not operational March 2005 - December 2007
Hydrocarbon monitor closed January 2008

note 1 Redcar continuous monitor not operational March 2005 - December 2007
Hydrocarbon monitor closed January 2008

BENZENE ANNUAL MEAN AND RUNNING ANNUAL MEAN POLLUTION TREND

(Continuous gas chromatography analyser or non-continuous pumped diffusion tube measurement)

1. The 2003 benzene objective for the annual running mean is a maximum of 16.25 µg/m³ with no exceedances. The 2010 benzene objective for the annual mean is a maximum of 5 µg/m³ with no exceedances.

2. The Middlesbrough (Breckon Hill) monitoring station, a public exposure location, was a continuous national network hydrocarbon monitoring station to the end of 2000, and was replaced by a national network pumped diffusion tube system for benzene early in 2002. There was no measurement for 2001. The diffusion tube system only provides an annual mean, although in practice there is little difference between the annual mean and the running annual mean.
   The Redcar (Corporation Road) Local monitoring station was a continuous hydrocarbon monitoring station and provided both an annual mean and running annual mean. The station has been closed since early 2005.
   The Stockton Yarm site is also a national network pumped diffusion tube system, and started in 2003 as a kerbside site.
   In September 2008, the Yarm diffusion tube was transferred to Eaglescliffe, 1 kilometre away. This is a public exposure location.

3. All stations show that there has been a steady decline in monitored levels of benzene over the last decade, but levels have now stabilised at low levels. This fall is mainly due to significant reductions in industrial emissions from the chemical and steel industrial complexes along the Tees estuary. The Redcar site, being generally downwind of the industrial complexes, had shown historical levels higher than those at Middlesbrough, but by 2005 they were similar. This is almost certainly due to a greater impact from traffic emissions of benzene at Middlesbrough (see 4 below).

4. The pumped diffusion tube system at Stockton Yarm (transferred to Eaglescliffe end 2008) has provided a measure of emissions from congested slow moving traffic, and while historical results have shown a significantly higher annual mean than those measured at Middlesbrough or Redcar, they reached very similar levels, demonstrating how successful benzene abatement measures to vehicles have been. The 2014 Eaglescliffe roadside concentration was again less than that at Middlesbrough.

5. 2013 benzene levels in Middlesbrough increased over 2012 due to unidentified pollution incidents in the June / July. Even so, the annual mean continued to be well below the objective level.

6. The 2003 and 2010 benzene objectives are now readily met,

Conclusion

Industrial emissions of benzene within the Tees Valley have fallen significantly over recent years and this is reflected in a steady decline in monitored levels. There is now some evidence that traffic emissions may now be the major source of ground level benzene, although fugitive emissions from industry can still give very high short-term levels. The benzene abatement measures for vehicles, such as changes in the benzene content of petrol and the installation of catalytic converters, are contributing to lower traffic related emissions of benzene.

The running annual mean objective of 16.25 µg/m³ with no exceedances for 2003 will continue to be easily met across the Tees Valley. The annual mean objective of 5 µg/m³ with no exceedances for 2010 will continue to be met across the Tees Valley as long as industrial emissions are kept under tight control.

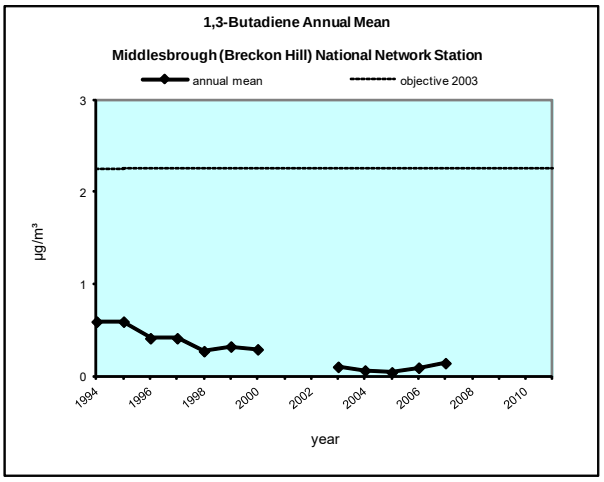
1,3-BUTADIENE

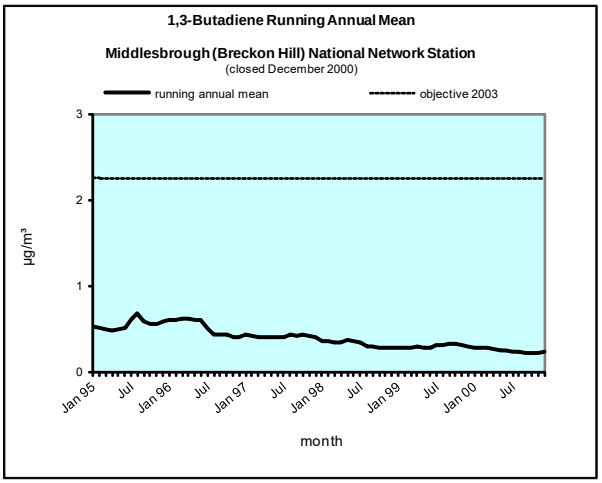
annual mean and running annual mean trends

Middlesbrough (Breckon Hill) National Network Station and Redcar (Corporation Road) Local Station

1,3-BUTADIENE - Middlesbrough (Breckon Hill) National Network Station

(urban background site)



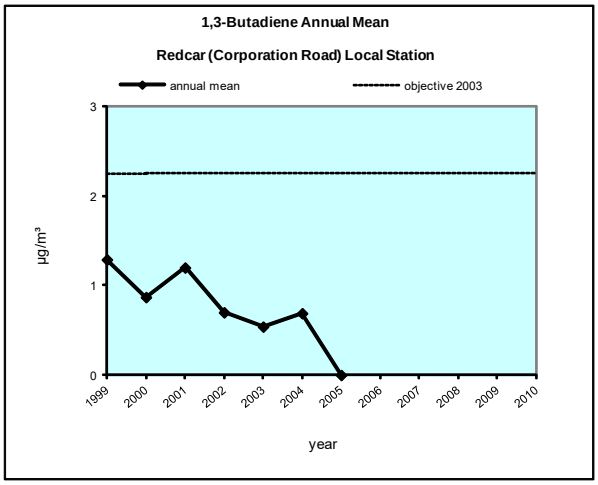


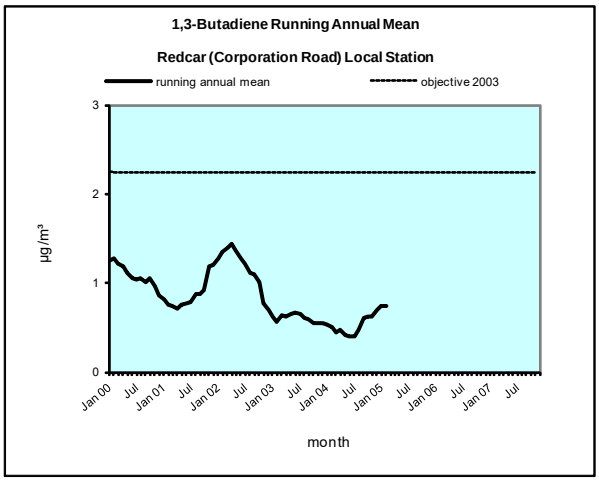
note 1 AURN continuous monitor closed December 2000. Replaced with a 1,3-Butadiene diffusion type system from March 2003 until September 2007.

note 2 No annual mean data for 2001 and 2002. No running annual mean data for 2001 onwards.

1,3-BUTADIENE - Redcar (Corporation Road) Local Station

(suburban site)





note 1 Redcar continuous monitor not operational March 2005 - December 2007
Hydrocarbon monitor closed January 2008

1,3-BUTADIENE ANNUAL MEAN AND RUNNING ANNUAL MEAN POLLUTION TREND

(Continuous gas chromatography analyser or non-continuous diffusion tube measurement)

1. The 2003 1,3-butadiene objective for the annual running mean is a maximum of 2.25 µg/m³ with no exceedances.

2. The Middlesbrough monitoring station was a continuous national network hydrocarbon monitoring station to the end of 2000, and was replaced by a diffusion tube system for 1,3-butadiene early in 2003. There was no measurement for 2001 or 2002. The diffusion tube system only provides an annual mean, although in practice there is little difference between the annual mean and the running annual mean.
   The Redcar Local monitoring station was a continuous hydrocarbon monitoring station and provided both an annual mean and running annual mean. The station has been closed since early 2005.

3. Both stations showed that there has been a decline in monitored levels of 1,3-butadiene over recent years. This is due to significant reductions in industrial emissions from the chemical industrial complexes along the Tees estuary. The Redcar site, being generally downwind of the industrial complexes, has shown historical levels higher than those at Middlesbrough, and this is likely to remain the case, since industrial emissions are the main potential source of 1,3-butadiene in the area.

4. The Middlesbrough Breckon Hill diffusion tube monitor was discontinued in September 2007 following a review of UK monitoring requirements for hydrocarbons, and there is now no monitoring of 1-3,butadiene in the Tees Valley.

Conclusion

Industrial emissions of 1,3-butadiene within the Tees Valley have fallen significantly over recent years and this is reflected in the overall decline in monitored levels.

The running annual mean objective of 2.25 µg/m³ with no exceedances for 2003 will continue to be met across the Tees Valley as long as industrial emissions are kept under tight control.

The Environment Agency, in conjunction with Redcar & Cleveland Council, have been considering a continuous hydrocarbon monitor at the Redcar Dormanstown site for early 2014, but this is now unlikely to go ahead due to installation difficulties.

OZONE

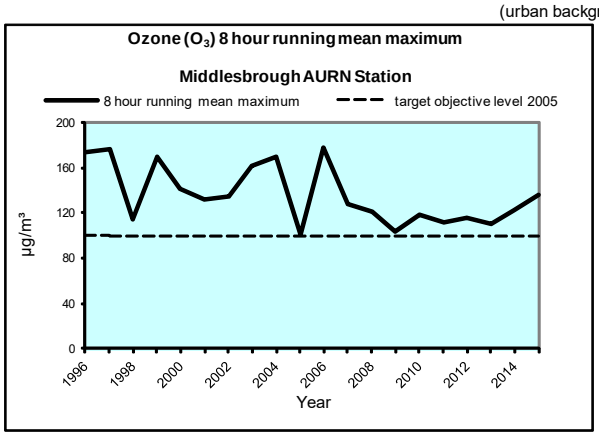
8 hour running mean and day exceedance trends

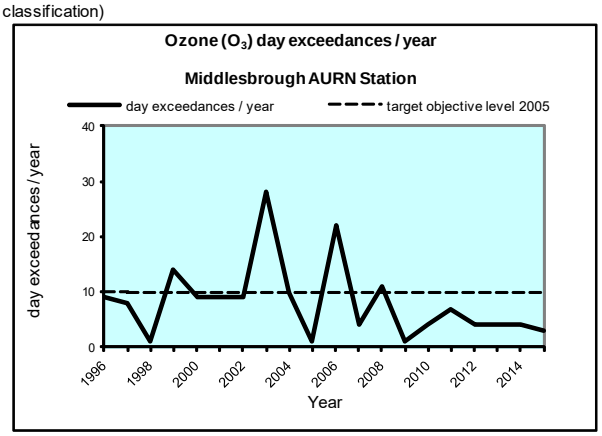
Middlesbrough (Breckon Hill) AURN Station

and Redcar (Dormanstown / Corporation Road), Stockton (Eaglescliffe / Yarm) Local Stations

MIDDLESBROUGH (Breckon Hill) AURN Station

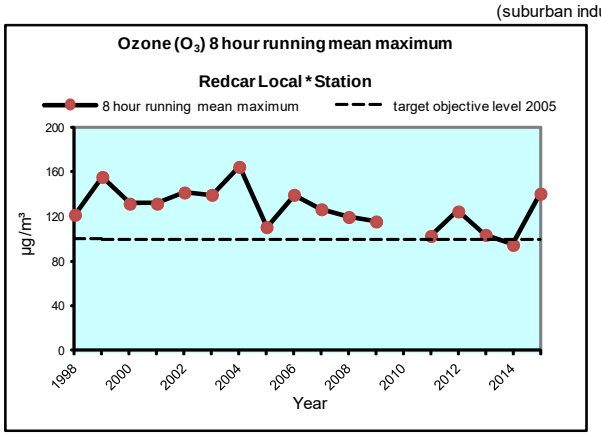
(urban background site classification)

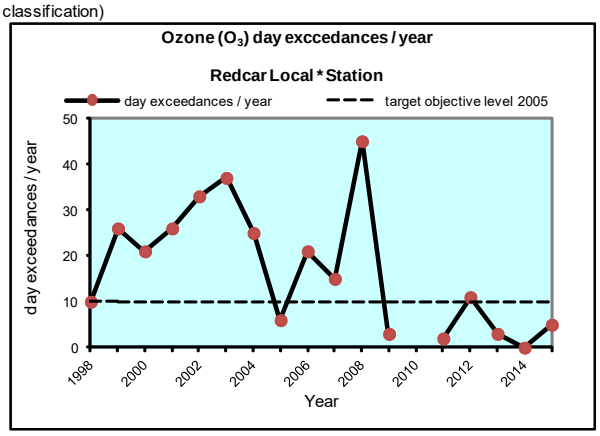




REDCAR (Dormanstown & Corporation Road) Local * Station

(suburban industrial site classification)

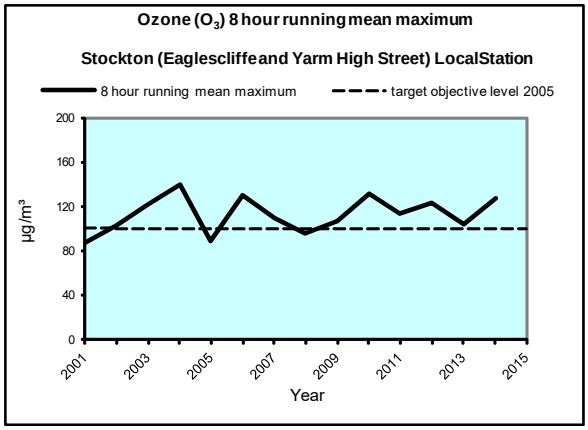


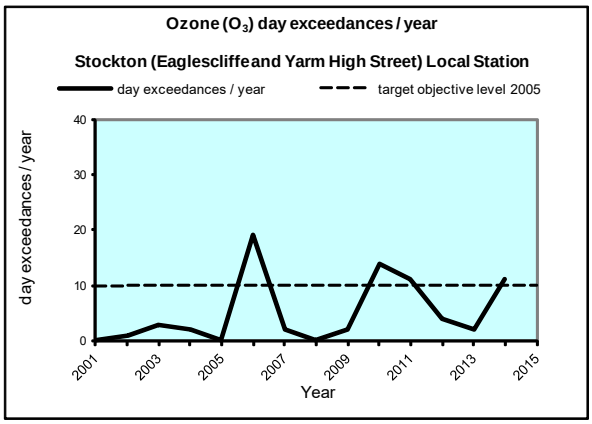


note * Corporation Road was AURN, then Local station from October 2007, no data 2010. Dormanstown from 2012

STOCKTON (Eaglescliffe and Yarm High Street) Local Station

(Yarm High Street - kerbside site, Eaglescliffe - roadside site)





Site transferred from Yarm High Street to Eaglescliffe December 2008. Closed December 2015

OZONE 8 HOUR RUNNING MEAN POLLUTION TREND

(continuous analyser)

1. Ozone is not currently a prescribed pollutant for air quality assessment, but has a target objective of 100 µg/m³ for the 8 hour running mean, with no more than 10 day exceedances in any one year.

2. Ozone is a secondary pollutant. It is not emitted by any process, but is formed as a result of complex chemical reactions on other air pollutants, particularly in the presence of strong sunlight. The source pollutants, such as nitrogen dioxide and hydrocarbons, are emitted from traffic and industry, and as the chemical reaction process can take some time, the source pollutants can originate a considerable distance away, eg mainland Europe. Ozone levels tend to peak during sunny summer months, and are often highest in rural areas as a result of air pollution from elsewhere. It is recognised by the Government that local or even national action may not be sufficient to reduce ozone levels.

3. All four stations show similar levels of maximum 8 hour running means each year (left graph), often above the objective level of 100 µg/m^3. The longer periods of sunnier weather in 2006 are reflected in higher monitored levels at all four stations, with a marked downturn since 2007 as a result of the poorer summer weather over the following years. The slightly better 2010 summer weather resulted in higher ozone levels, reversed since then as a result of poorer summer weather.

4. The number of days on which there is an exceedance (right graph) show a marked difference, with the coastal Redcar site normally showing day exceedances significantly above the objective maximum of 10 days. The Middlesbrough and Stockton (Billingham) sites normally show exceedance days around the objective maximum. The kerbside site at Stockton (Yarm) showed very few day exceedances due to the ozone scavenging effect from high levels of nitric oxide emitted from cars being oxidised to form nitrogen dioxide. The increase in day exceedances in 2008, most pronounced in Redcar, was due to a nationwide ozone episode in May of that year which has been shown to be due to import of pollution from the continent on easterly winds. There have been no significant ozone episodes since.

5. The reason for the high level of ozone exceedances at Redcar may also be associated with hydrocarbon emissions from the industrial complexes along the Tees estuary. During summer fine weather periods, it is thought that pollutants are taken out to sea on night time off-shore breezes, but are then returned to the coastal region as higher levels of ozone by day time on-shore breezes. There are also lower levels of ozone scavenging pollutants along the coastal region.

6. The proposed objective for ozone is unlikely to be met in many parts of the Tees Valley, particularly when there is a warm and sunny summer period. Ozone episodes across the UK are often associated with transboundary pollutants from the continent on south-easterly winds.

Conclusion

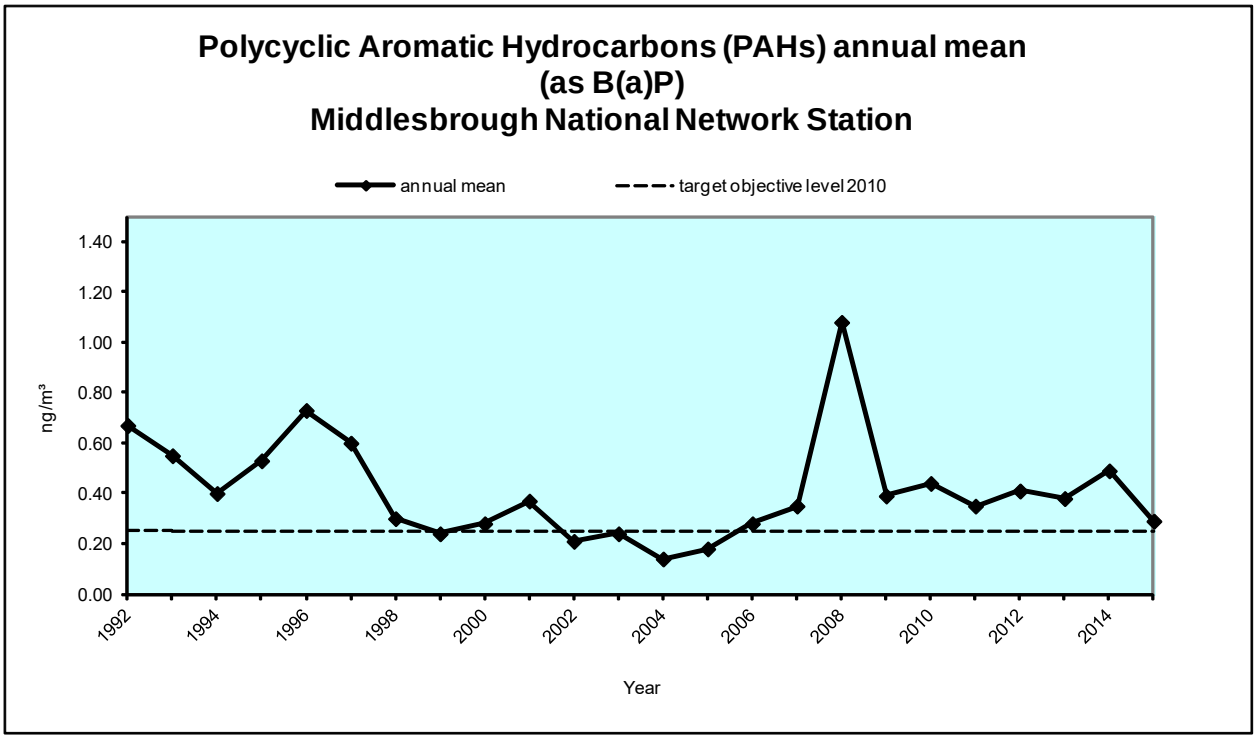
Industrial emissions of hydrocarbons within the Tees Valley and / or pollution from the continent are likely to result in high day exceedances of ozone along the coastal region, and to a lesser extent inland at times of warm and sunny weather.

The proposed 8 hour running mean objective of 100 µg/m³ with up to 10 day exceedances for 2005 will not be met across significant areas of the Tees Valley. However, the Government view is that this target objective is unlikely to enter regulation in the near future.

POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)
annual mean trend

MIDDLESBROUGH Breckon Hill (was Longlands College to 2007) Station
(non-continuous urban background site upwind of industrial sources)

note : New national network digital monitor at a Breckon Hill target group location from January 2008



POLYCYCLIC AROMATIC HYDROCARBONS (PAHs) ANNUAL MEAN POLLUTION TREND

(Non-continuous analyser)

1. PAHs are not yet a prescribed pollutant for air quality assessment under the new UK air quality strategy (2008). PAH has a 2010 objective of 0.25 ng/m³ as an annual mean (BaP) with no exceedances. A nanogram (ng) is one billionth of a gram (10^{-9}).

2. Polycyclic aromatic hydrocarbons are a large group of organic compounds with two or more benzene rings within their molecular structure. Those compounds with two or three benzene rings are normally in vapour phase, while heavier compounds with five or more benzene rings are mainly in particulate phase. The EU working group on PAHs has proposed benzo(a)pyrene (BaP) as a marker for PAH, and it is this compound on which PAH measurement is focused.

3. The main sources in the UK are domestic coal and wood burning, fires (eg accidental fies, bonfires, forest fires etc), and industrial processes such as coke production, which is of particular relevance to the Tees Valley. Road transport is the largest source of total PAHs, but the source is dominated by species of PAH thought to be less hazardous than BaP. The decline in domestic and industrial coal burning, new controls over agricultural burning, and upgrading of incinerators to high temperature technology, has led to a substantial decline in overall emissions of PAHs.

4. Monitoring of PAHs has been carried at Middlesbrough Longlands College since 1992, as part of a UK national network for micro pollutants. The station shows a significant overall decline in PAH over the period, but while concentrations fell below the objective level in 2004 /5, there was a steady increase to above the objective level in 2006 / 7.

5. The Middlesbrough Longlands College site was on the roof of the College building, and was part of the TOMPS monitoring network originally installed to monitor micropollutant concentrations in the atmosphere, rather than at public exposure locations required for air quality management. The monitor was removed at the end of 2007 as part of a national review of PAH monitoring.
   A new monitor for PAH was installed at the Middlesbrough Breckon Hill AURN station during 2007 as part of a new UK PAH monitoring network. This monitor provides ground level concentrations of PAH, and is a public exposure location. The new monitor is considered more accurate than the earlier TOMPS unit.

6. Results from the new monitor over the last four years show PAH concentrations above the UK objective level. As this is an upwind location from the main industrial areas, it is likely that other areas around the Tees estuary will exceed the objective level.

7. Comparison with other industrial and major conurbation sites on the national network (see page 46) show that Middlesbrough measurements are above city centre areas such as Newcastle, but below industrial areas such as Scunthorpe and Royston. This suggests that industrial emissions are the significant source factor within the Tees Valley. The Environment Agency has confirmed that the two coke ovens associated with the steel complex are the main source of PAHs. These closed in October 2015.

Conclusion

Industrial emissions of PAHs within the Tees Valley appeared to have fallen over recent years and this is reflected in a steady decline in monitored levels to below the objective level by 2004. The step change in concentrations in 2008 following the installation of ground level monitoring using the more accurate digital sampler is seen as a temporary aberration. Although results over the last four years are substantially lower, they remain above the UK objective level, and this is at an upwind site from the major industrial sources.

The proposed annual mean objective of 0.25 ng/m³ (BaP) with no exceedances for 2010 looks less likely to be met in the region of the main chemical and steel complexes along the Tees estuary, without further reductions in emission levels.

The closure of the two coke ovens in October 2015 is likely to lead to substantially lower PAH levels over time.

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APPENDICES

Appendix 1

MONITORING DATA RATIFICATION AND VALIDATION

Continuous Monitors

The monitoring results from the three AURN fixed continuous monitoring stations are ratified and validated centrally through agencies appointed by Defra.

The remaining Local fixed continuous monitoring stations are modern installations, operated under a comprehensive service contract with Enviro-Technology Services plc. Operators of the sites have received supplier training. Monitoring results are collected, ratified and validated by the appropriate Council.

Each Council is committed to achieving accuracy, precision, data capture, traceability and long term consistency to ensure that data is representative of ambient air quality. They each have a documented quality assurance and control programme, which includes an established schedule of regular site calibrations, validation of data, and documentation of all procedures. Details are summarised as follows:

Calibration	Daily 'automatic' calibration with frequent (usually fortnightly) manual checks. Calibration gas obtained from approved gas standard suppliers.
Equipment	Comprehensive service agreement with the supplier.
Data capture	Site operators are experienced and trained personnel, monitoring data capture on a daily basis where possible to ensure that faults are detected and corrected quickly.
Data Processing	Appropriate zero and span calibration factors are applied automatically on-site, with regular manual checks.
Ratification	Data is screened, where possible on a daily basis, to check for unusual measurements. Suspicious data is investigated fully, and if found to be faulty, is deleted from the records. Particular attention is paid to possible environmental changes in the vicinity of the analyser. Data is recorded monthly and compared with earlier results. Data is collated quarterly with that from other monitors within the Tees Valley, including AURN stations, as a further check on accuracy. All data is published annually by the Tees Valley Environmental Protection Group.

Nitrogen Dioxide Diffusion Tubes

The Tees Valley nitrogen dioxide diffusion tube programmes are operated through approved laboratories with formal accreditation to BS standards, and one that participates in the AIR-PT programme. The tube preparations are all based on 50% TEA in acetone, and the tubes are installed to a defined monthly exposure schedule. Particular attention is paid to proper installation of the tubes at the site, and reliable exposure duration.

Stockton-on-Tees Council carries out triple tube co-location studies with continuous monitors, and the data obtained has been used to correct results for diffusion tube bias for Stockton-on-Tees and Hartlepool Councils. The co-location data is also supplied to the national bias adjustment database. Tube precision is G, ie the coefficient of variation of all tube readings is less than 10%. Middlesbrough and Redcar & Cleveland Councils also have a triple tube co-location study with a continuous monitor.

For Darlington Council, overall bias adjustment factors from the relevant laboratory are used, as maintained by NPL on behalf of Defra.

Appendix 2

REVIEW AND ASSESSMENT SUBMISSIONS

These can be found on each local authority web-site. All submissions have been approved by Defra.

Review & Assessment 2000 Stage 1

A Tees Valley study

Review & Assessment 2000 Stage 3

Separate reports for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.

Review & Assessment Updating Report 2003

Separate reports for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.

Progress Report 2004

A single report for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.

Progress Report 2005

A single report for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.

Review & Assessment Updating Report 2006

Separate reports for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.

Progress Report 2007

A single report for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.

Progress Report 2008

A single report for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.

Review & Assessment Updating Report 2009

Separate reports for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.
New web-based reporting system

Progress Report 2010

Separate reports for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.
New web-based reporting system

Progress Report 2011

Separate reports for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.
New web-based reporting system

Review & Assessment Updating Report 2012

Separate reports for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.
New web-based reporting system

Progress Report 2013

Separate reports for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.
New web-based reporting system

Progress Report 2014

Separate reports for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.
New web-based reporting system

Review & Assessment Updating Report 2015

Separate reports for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.
New web-based reporting system

REFERENCES (to access links below, use Ctrl+click)

Reference 1 The Air Quality Strategy 2008

available to download on the DEFRA web-site, reference 2

Reference 2 Department for Environment, Food & Rural Affairs (DEFRA)

web-site for Air Pollution http://www.air-quality.org.uk/20.php

Reference 3 The UK National Air Quality Information Archive

web-site (for monitoring results) http://www.airquality.co.uk/index.php

Reference 4 Local Air Quality Management Technical Guidance LAQM TG09

Technical Guidance viewer http://laqm.defra.gov.uk/technical-guidance/

Reference 5 Defra UK Ambient Air Quality Interactive Maps

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

For further information, contact:

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